

IBM<sup>®</sup> DB2<sup>®</sup> Universal Database



# Replication Guide and Reference

*Version 7*



IBM<sup>®</sup> DB2<sup>®</sup> Universal Database



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*Version 7*

Before using this information and the product it supports, be sure to read the general information under "Appendix C. Notices" on page 403.

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# Contents

<b>About this book</b> . . . . .	<b>ix</b>	Data distribution . . . . .	19
Who should read this book . . . . .	x	Data consolidation . . . . .	20
How this book is structured . . . . .	x	Update anywhere . . . . .	21
Conventions . . . . .	x	Occasionally connected . . . . .	22
Terminology . . . . .	xi	Examples of replication configurations . . . . .	24
How to read syntax diagrams . . . . .	xi	Archiving audit information . . . . .	24
Road map . . . . .	xii	Consolidating data from distributed databases . . . . .	24
How to send your comments . . . . .	xiii	Distributing data to remote sites . . . . .	25
<b>What's new</b> . . . . .	<b>xv</b>	Distributing IMS data to remote sites . . . . .	27
Compatibility . . . . .	xv	Accessing data continuously . . . . .	28
What's new for Version 7 . . . . .	xv	Replicating operational data to decision support systems. . . . .	29
DATA LINK replication . . . . .	xv	Using target tables as sources of updates (update anywhere). . . . .	30
Replication for AS/400 . . . . .	xv	Updating data on occasionally connected systems . . . . .	31
Replication for UNIX, Windows, and OS/2 . . . . .	xvi	Retrieving data from a non-DB2 distributed data store . . . . .	32
What's new for Version 6 . . . . .	xvi	Replicating operational data to a non-DB2 reports and query database . . . . .	33
DB2 Satellite Edition . . . . .	xvi		
Database currency . . . . .	xvii		
Performance features . . . . .	xviii		
Integration with DB2 . . . . .	xviii		
<b>Part 1. Introduction.</b> . . . . .	<b>1</b>	<b>Chapter 3. Data replication scenario</b> . . . . .	<b>35</b>
<b>Chapter 1. Overview of data replication</b> . . . . .	<b>3</b>	Before you begin . . . . .	35
DB2 data replication components . . . . .	3	Planning this scenario. . . . .	36
Control tables . . . . .	4	Replication source . . . . .	36
Logical servers . . . . .	4	Replication target . . . . .	37
Administration interfaces . . . . .	5	Replication options. . . . .	37
Change-capture mechanisms . . . . .	6	Setting up the replication environment for this scenario . . . . .	38
Apply program . . . . .	7	Step 1: Customize control tables . . . . .	38
How the replication components communicate . . . . .	7	Step 2: Define a replication source . . . . .	39
DB2 data replication concepts . . . . .	10	Step 3: Define a subscription set and a subscription-set member . . . . .	40
Replication sources. . . . .	10	Step 4: Configure the source database . . . . .	43
Subscription sets and subscription-set members . . . . .	11	Step 5: Bind the Capture and Apply programs . . . . .	43
Apply qualifier . . . . .	13	Step 6: Create a password file . . . . .	44
Data manipulation . . . . .	13	Step 7: Replicate the scenario data . . . . .	45
Target tables . . . . .	14	Operating in a replication environment . . . . .	47
Schedule for applying updates . . . . .	17	Step 1: Update the source table . . . . .	47
		Step 2: Prune the control tables . . . . .	48
		Step 3: Stop the Capture and Apply programs . . . . .	49
<b>Chapter 2. Data replication configurations</b> . . . . .	<b>19</b>		
Overview of replication configurations . . . . .	19		

<b>Chapter 4. Data replication tasks</b>	<b>51</b>
Planning your replication requirements	51
Setting up your replication environment	53
Setting up the system	53
Setting up the replication criteria	53
Performing the initial replication	54
Adding to your replication environment	55
Copying your replication environment	55
Operating in your replication environment	55

## Part 2. Administration . . . . . 59

<b>Chapter 5. Planning for replication.</b>	<b>61</b>
Capacity planning	61
Storage planning	61
Database log and journal data	62
Active log file size for Capture for VSE and VM and current receiver size for Capture for AS/400	63
Target tables and control tables	63
Spill files	65
Network planning	65
Connectivity	65
Where to run the Apply program: push or pull configuration	66
Data blocking for large volumes of changes	68
Deciding what to replicate	69
Subsetting columns and rows	70
Replicating joins using views	71
Replicating before and after images	72
Renaming columns.	73
Creating computed columns	74
Using stored procedures for before and after run-time processing.	74
Replicating large objects	74
Replicating DATALINK values.	75
Key-update restrictions	76
General restrictions for replication	77
Capture triggers for non-IBM sources	80
How the Capture triggers capture the data changes	80
Capture Triggers and pre-existing triggers	81
Staging data	82
Attributes of CCD tables.	82
Using CCD tables as replication sources.	84
Pruning the CD and CCD tables	88
Auditing data usage	88
Planning for migration	89

<b>Chapter 6. Setting up your replication environment</b>	<b>93</b>
Using the DB2 Control Center to set up replication	93
Configuring the Control Center for host RDBMSs	94
Setting replication preferences in the DB2 Tools Settings notebook	95
Customizing CD table, index, and tablespace names	95
Using the DB2 DataJoiner Replication Administration tool to set up replication	96
Installing DJRA	98
Setting preferences.	99
Customizing DJRA.	99
Defining replication control tables	100
Creating replication control tables using DJRA	102
Customizing and running replication SQL files	103
Setting up security for replication	104
Authorization requirements for administration	104
Authorization requirements for running the Capture program.	104
Authorization requirements for running the Apply program	105
Defining replication sources	105
Defining replication sources for update-anywhere replication	106
Detecting conflicts	107
Defining views as replication sources	108
Enabling replication logical-partitioning-key support.	109
Defining CCD tables	111
Defining replication subscription sets	112
Defining subscription sets for update-anywhere replication	114
Choosing a target-table type	115
Defining the target-table structure: columns and rows	116
Defining a subscription set with a user-defined table.	119
Defining SQL statements or stored procedures for the subscription set	121
Data-sharing considerations	122
Specifying a data-blocking value.	122
Data currency requirements	123
Data consistency requirements	125
Maintaining external CCD tables.	126

Loading target tables offline using DJRA . . . . .	127
Copying your replication configuration to another system. . . . .	127
Setting up the Capture program . . . . .	128
Specifying tuning parameters for the Capture program . . . . .	128
Restrictions when running the Capture program . . . . .	130
Setting up the Apply program . . . . .	131
Refreshing target tables with the ASNLOAD exit routine . . . . .	131
Using the ASNDONE exit routine . . . . .	132
Using the ASNDLCOPY exit routine . . . . .	133
Using the ASNDLCOPYD file-copy daemon . . . . .	136
Setting up DB2 DataJoiner . . . . .	137

**Chapter 7. Operating DB2 DataPropagator 139**

Operating the Capture program . . . . .	139
Before you start the Capture program . . . . .	139
Starting or restarting the Capture program . . . . .	140
Operating the Apply program . . . . .	142
Improving Apply performance for Sybase or Microsoft SQL Server . . . . .	144
Performing regular database maintenance . . . . .	145
Monitoring the replication environment . . . . .	146
Resolving gaps between source and target tables . . . . .	147
Modifying your replication configuration . . . . .	147
Viewing or changing existing replication sources . . . . .	147
Removing replication sources . . . . .	148
Activating and deactivating subscription sets . . . . .	148
Cloning a subscription set to another server. . . . .	148
Viewing or changing an existing subscription set . . . . .	149
Removing subscription sets . . . . .	149

**Chapter 8. Problem determination . . . . . 151**

Problem determination scenario . . . . .	152
Problem determination for replication administration . . . . .	152
Problem determination for the Apply program . . . . .	153
Apply trail table . . . . .	153
Apply-program trace file . . . . .	155
Apply-program log file . . . . .	156

Problem determination for the Capture program . . . . .	156
Capture-program trace table . . . . .	157
Capture-program trace file . . . . .	157
Capture-program log file . . . . .	158
Other problem-determination facilities for the Capture program. . . . .	158
Problem determination for AS/400 . . . . .	159
Gathering information about active jobs . . . . .	159
Determining if the journal job is started . . . . .	160
Collecting data for problem determination . . . . .	160
Using the Replication Analyzer . . . . .	163
Troubleshooting . . . . .	166
Problem-source identification questions . . . . .	171

**Part 3. Operations . . . . . 173**

**Chapter 9. Capture and Apply for AS/400 175**

Coexistence considerations. . . . .	175
Setting up the Capture and Apply programs . . . . .	176
Installing DB2 DataPropagator for AS/400 . . . . .	176
Connecting to an AS/400 server . . . . .	176
Verifying and customizing your installation of DB2 DataPropagator for AS/400 . . . . .	177
Specifying tuning parameters for Capture for AS/400 . . . . .	178
Authorization requirements for running the Capture and Apply programs. . . . .	181
Granting authority . . . . .	181
Revoking authority . . . . .	189
Restrictions for running the Capture program . . . . .	190
The journal . . . . .	191
Remote journal function . . . . .	192
Creating journals for source tables . . . . .	192
Managing journals and journal receivers . . . . .	193
Defining replication sources and subscription sets . . . . .	196
Using a relative record number (RRN) as a primary key . . . . .	196
Operating Capture for AS/400 . . . . .	197
Starting Capture for AS/400 . . . . .	197
Determining the progress of the Capture program . . . . .	201
Scheduling Capture for AS/400 . . . . .	202
Stopping Capture for AS/400 . . . . .	202
Reinitializing Capture for AS/400 . . . . .	203

Pruning the change data and unit-of-work tables and minimizing source server DASD usage . . . . .	204	User ID requirements for running the Capture and Apply programs . . . . .	239
Warm and cold starts . . . . .	205	Setting up the Capture and Apply programs	239
How the Capture program processes journal entry types . . . . .	205	Configuring the Capture program for UNIX platforms . . . . .	239
Operating Apply for AS/400 . . . . .	207	Optional: Configuring the Apply program manually for UNIX platforms . . . . .	240
Creating packages to use with remote systems . . . . .	208	Other configuration considerations for UNIX-based components . . . . .	241
Before you start the Apply program . . . . .	210	Setting up end-user authentication at the source server . . . . .	241
Starting Apply for AS/400 . . . . .	210	Operating Capture for UNIX platforms . . . . .	243
Scheduling Apply for AS/400 . . . . .	217	Restrictions for running the Capture program . . . . .	243
Stopping Apply for AS/400 . . . . .	217	Scheduling Capture for UNIX platforms	244
Additional Apply program operations . . . . .	220	Setting environment variables for Capture for UNIX platforms . . . . .	244
Using the ASNDONE exit routine for AS/400 . . . . .	220	Starting Capture for UNIX platforms . . . . .	244
Refreshing target tables with the ASNLOAD exit routine for AS/400 . . . . .	221	Stopping Capture for UNIX platforms	247
<b>Chapter 10. Capture and Apply for OS/390</b>	<b>225</b>	Suspending Capture for UNIX platforms	247
Setting up the Capture and Apply programs	225	Resuming Capture for UNIX platforms	248
Applying DB2 maintenance . . . . .	225	Reinitializing Capture for UNIX platforms	248
Installing Capture and Apply for OS/390	225	Pruning the change data and unit-of-work tables . . . . .	249
Configuring Capture and Apply for OS/390 after installing a new release of DB2 . . . . .	226	Displaying captured log progress . . . . .	249
Operating Capture for OS/390 . . . . .	227	Operating Apply for UNIX platforms . . . . .	250
Restrictions for running the Capture program . . . . .	227	Before you start the Apply program . . . . .	250
Starting Capture for OS/390 . . . . .	227	Starting Apply for UNIX platforms . . . . .	251
Scheduling Capture for OS/390 . . . . .	229	Scheduling Apply for UNIX platforms	254
Stopping Capture for OS/390 . . . . .	230	Stopping Apply for UNIX platforms . . . . .	254
Suspending Capture for OS/390 . . . . .	230	<b>Chapter 12. Capture for VM and Capture for VSE . . . . .</b>	<b>255</b>
Resuming Capture for OS/390 . . . . .	230	Setting up the Capture program . . . . .	255
Reinitializing Capture for OS/390 . . . . .	230	Operating Capture for VM and Capture for VSE . . . . .	255
Pruning the change data and unit-of-work tables . . . . .	231	Restrictions for running the Capture program . . . . .	255
Displaying captured log progress . . . . .	231	Starting Capture for VM and VSE . . . . .	256
Operating Apply for OS/390 . . . . .	231	Stopping Capture for VM and VSE . . . . .	258
Starting Apply for OS/390 . . . . .	232	Suspending Capture for VM and VSE . . . . .	259
Scheduling Apply for OS/390 . . . . .	234	Resuming Capture for VM and VSE . . . . .	259
Stopping Apply for OS/390 . . . . .	234	Reinitializing Capture for VM and VSE	260
Rules for index types . . . . .	234	Pruning the change data and unit-of-work tables . . . . .	260
Using the DB2 ODBC Catalog . . . . .	235	Displaying captured log progress . . . . .	261
Setting up the DB2 ODBC Catalog . . . . .	235	<b>Chapter 13. Capture and Apply for Windows and OS/2 . . . . .</b>	<b>263</b>
DB2 ODBC Catalog tables . . . . .	237		
<b>Chapter 11. Capture and Apply for UNIX platforms . . . . .</b>	<b>239</b>		



User ID requirements for running the Capture and Apply programs . . . . .	263
Setting up the Capture and Apply programs	263
Configuring the Capture program for Windows and OS/2 . . . . .	263
Optional: Configuring the Apply program manually for Windows and OS/2 . . . . .	264
Setting up end-user authentication at the source server . . . . .	265
Setting up the NT Service Control Manager . . . . .	266
Operating Capture for Windows and Capture for OS/2 . . . . .	268
Restrictions for running the Capture program . . . . .	268
Setting environment variables for Capture for Windows and OS/2 . . . . .	268
Starting Capture for Windows and OS/2	269
Scheduling Capture for Windows and OS/2 . . . . .	271
Stopping Capture for Windows and OS/2	271
Suspending Capture for Windows and OS/2 . . . . .	272
Resuming Capture for Windows and OS/2 . . . . .	273
Reinitializing Capture for Windows and OS/2 . . . . .	273
Pruning the change data and unit-of-work tables . . . . .	274
Displaying captured log progress . . . . .	274
Operating Apply for Windows and OS/2	275
Before you start the Apply program . . . . .	275
Starting Apply for Windows and OS/2	275
Scheduling Apply for Windows and OS/2	278
Stopping Apply for Windows and OS/2	278
Replicating on demand (Windows 32-bit operating systems only). . . . .	279
Using DB2 DataPropagator for Microsoft Jet	280
The advantages of using DataPropagator for Microsoft Jet . . . . .	281
Data integrity considerations . . . . .	282
Terminology for DataPropagator for Microsoft Jet replication. . . . .	282
Setting up DataPropagator for Microsoft Jet replication . . . . .	283
Operating DataPropagator for Microsoft Jet . . . . .	285
Returning control to users with the ASNJDONE exit routine . . . . .	287

DataPropagator for Microsoft Jet control tables . . . . .	289
---	-----

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## Part 4. Reference information **291**

<b>Chapter 14. Table structures . . . . .</b>	<b>293</b>
Tables at a glance . . . . .	293
List of tables used at the source server . . . . .	296
List of tables used at the control server . . . . .	298
List of tables used at the target server . . . . .	299
Tables used at the source server . . . . .	300
Register table . . . . .	301
Register extension table for AS/400 . . . . .	308
Pruning control table. . . . .	309
Tuning parameters table . . . . .	312
Capture enqueue table (VM and VSE specific) . . . . .	313
Warm start table . . . . .	313
Critical section table . . . . .	315
Prune lock table . . . . .	316
Trace table . . . . .	316
Apply-qualifier-cross-reference table (AS/400 specific) . . . . .	317
Register synchronization table . . . . .	318
Unit-of-work table . . . . .	319
Change data table. . . . .	321
Tables used at the control server . . . . .	323
Subscription set table . . . . .	323
Subscription-targets-member table . . . . .	326
Subscription columns table. . . . .	329
Subscription statements table . . . . .	331
Row-replica-target-list table (Microsoft Jet specific) . . . . .	333
Subscription-schema-changes table (Microsoft Jet specific) . . . . .	334
Subscription events table . . . . .	335
Apply trail table . . . . .	336
Apply job table (AS/400 specific) . . . . .	340
Tables used at the target server . . . . .	341
User copy table . . . . .	341
Point-in-time table . . . . .	342
Consistent-change-data table . . . . .	343
Replica table . . . . .	345
Base aggregate table . . . . .	345
Change aggregate table . . . . .	346
Row-replica table (Microsoft Jet specific)	347
Conflict table (Microsoft Jet specific) . . . . .	348
Error information table (Microsoft Jet specific) . . . . .	348

Error messages table (Microsoft Jet specific) . . . . .	349	Starting the Capture program using a routine . . . . .	397
Error-side-information table (Microsoft Jet specific) . . . . .	349	Starting the Apply program using a routine	398
Key string table (Microsoft Jet specific)	349	Sample routine that starts the Capture and Apply programs . . . . .	398
Synchronization generations table (Microsoft Jet specific) . . . . .	350		
<b>Chapter 15. Capture and Apply messages</b>	<b>353</b>	<b>Appendix B. Education and services for DB2 data replication</b> . . . . .	<b>401</b>
Capture program messages . . . . .	353	Services . . . . .	401
Apply program messages . . . . .	368	Education . . . . .	401
<b>Chapter 16. Replication messages for AS/400</b> . . . . .	<b>381</b>	<b>Appendix C. Notices</b> . . . . .	<b>403</b>
Apply for AS/400 messages . . . . .	381	Programming interface information . . . . .	404
Capture for AS/400 messages. . . . .	386	Trademarks . . . . .	404
Other replication messages for AS/400. . . . .	390	Trademarks of other companies . . . . .	405
		<b>Glossary</b> . . . . .	<b>407</b>
<b>Part 5. Appendixes</b> . . . . .	<b>395</b>	<b>Index</b> . . . . .	<b>415</b>
		<b>Contacting IBM</b> . . . . .	<b>429</b>
<b>Appendix A. Starting the Capture and Apply programs from within an application</b> . . . . .	<b>397</b>	Product information . . . . .	429

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## About this book

This book introduces the concepts of DB2<sup>®</sup> data replication, and it describes how to plan, configure, and administer a replication environment.

The DB2 DataPropagator<sup>™</sup> product is the focus of the book. You can use it with other products in the IBM<sup>®</sup> replication solution to tailor a replication environment that suits your business needs.

You can replicate data from DB2 sources to DB2 targets. You can also replicate data between DB2 and non-IBM sources and targets. Specifically, you can use the following database management systems as sources, targets, or both:

<b>DB2 servers</b>	<b>Non-IBM servers</b>
DB2 Universal Database <sup>™</sup> for AIX <sup>®</sup>	Informix <sup>®2</sup>
DB2 Universal Database for AS/400 <sup>®</sup>	Microsoft <sup>®</sup> Access <sup>3</sup>
DB2 Universal Database for HP-UX <sup>®</sup>	Microsoft Jet <sup>3</sup>
DB2 Universal Database for OS/2 <sup>®</sup>	Microsoft SQL Server <sup>2</sup>
DB2 Universal Database Server for OS/390 <sup>®</sup>	Oracle <sup>®2</sup>
DB2 Universal Database for Solaris <sup>™</sup>	Sybase <sup>®2</sup>
DB2 Universal Database for Linux <sup>®</sup>	Sybase SQL Anywhere <sup>™2</sup>
DB2 Universal Database for NUMA-Q <sup>®</sup>	Teradata <sup>®4</sup>
DB2 Universal Database for VM <sup>1</sup>	
DB2 Universal Database for VSE <sup>1</sup>	
DB2 Universal Database for Windows <sup>®</sup> 32-bit operating systems (such as Windows 95, 98 and NT <sup>®</sup> )	

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## Who should read this book

This book is written for database administrators, LAN administrators, and others who must set up and maintain a data replication environment. It assumes that you are familiar with standard database terminology, that you have experience with database design and database administration, and that you understand your applications and the data that you want to replicate.

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## How this book is structured

This book consists of the following parts:

### Part 1: Introduction

Introduces the DB2 replication concepts and components, describes the typical replication configurations, guides you through a simple replication scenario using the DB2 Control Center, and outlines the major replication tasks that are described in the book.

### Part 2: Administration

Describes how to plan, set up, run, and maintain your replication environment.

### Part 3: Operations

Describes how to use DB2 data replication in particular operating systems.

### Part 4: Reference information

Provides reference information for control table structures (which are relational database tables that DB2 DataPropagator uses during its replication process), and messages.

---

## Conventions

This book uses these highlighting conventions:

- **Boldface type** indicates commands or user interface controls such as names of fields, folders, icons, or menu choices.
- `Monospace type` indicates examples of text that you enter exactly as shown.
- *Italic type* indicates variables that you should replace with a value. It is also used to indicate book titles and for emphasis of words.

- 
1. There is no Apply program for these products.
  2. These products require DB2 DataJoiner<sup>®</sup> V2 or later and the DB2 DataJoiner Replication Administration (DJRA) tool.
  3. These products require DJRA.
  4. There is no Capture program for this product.

---

## Terminology

This book uses standard terminology for database, copying, and LAN concepts. “Chapter 1. Overview of data replication” on page 3 explains many concepts used in this book. For definitions of replication terms, see “Glossary” on page 407.

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## How to read syntax diagrams

The following rules apply to the syntax diagrams used in this book:

- Read the syntax diagrams from left to right, from top to bottom, following the path of the line.

The  $\blacktriangleright$ — symbol indicates the beginning of a statement.

The — $\blacktriangleright$  symbol indicates that the statement syntax is continued on the next line.

The  $\blacktriangleright$ — symbol indicates that a statement is continued from the previous line.

The — $\blacktriangleleft$  symbol indicates the end of a statement.

Diagrams of syntactical units other than complete statements start with the  $\blacktriangleright$ — symbol and end with the — $\blacktriangleright$  symbol.

- Keywords, their allowable synonyms, and reserved parameters, are either shown in uppercase or lowercase, depending on the operating system. These items must be entered exactly as shown. Variables appear in lowercase italics (for example, *column-name*). They represent user-defined parameters or suboptions.

When entering commands, separate the parameters and keywords by at least one space if there is no intervening punctuation.

- Enter punctuation marks (slashes, commas, periods, parentheses, quotation marks, equal signs, and so on) and numbers exactly as given.
- Footnotes are shown by a number in parentheses, for example, (1).
- Required items appear on the horizontal line (the main path).

$\blacktriangleright$ —*required\_item*— $\blacktriangleleft$

- Optional items appear below the main path.

$\blacktriangleright$ —*required\_item*— $\blacktriangleleft$   
                  └─*optional\_item*—┘

- If you can choose from two or more items, they appear vertically, in a stack. If you *must* choose one of the items, one item of the stack appears on the main path.



If choosing one of the items is optional, the entire stack appears below the main path.




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## Road map

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If you want to ...	Refer to ...
Learn about the IBM data replication solution	DB2 DataPropagator at <a href="http://www.ibm.com/software/data/dpropr/">http://www.ibm.com/software/data/dpropr/</a>  Data replication solution at <a href="http://www.ibm.com/software/data/dbtools/datarepl.html">http://www.ibm.com/software/data/dbtools/datarepl.html</a>  Database and data management at <a href="http://www.ibm.com/software/data/">http://www.ibm.com/software/data/</a>
Learn about last-minute changes to the product	The Installation Notes on the CD-ROM or the Release Notes that are installed with the products.
Learn what's new this release in DB2 data replication	"What's new" on page xv.
Learn about the components of DB2 data replication	"Chapter 1. Overview of data replication" on page 3.
Learn about DB2 data replication concepts	"Chapter 1. Overview of data replication" on page 3.
Learn about typical replication configurations	"Chapter 2. Data replication configurations" on page 19.
Work through a simple replication scenario using the DB2 Control Center on Windows NT	"Chapter 3. Data replication scenario" on page 35.
Get an overview of the types of replication tasks that you can perform	"Chapter 4. Data replication tasks" on page 51.
Design and plan your replication environment	"Chapter 5. Planning for replication" on page 61.
Migrate from earlier versions of DPROPR to DB2 DataPropagator	The online Migration Guide, which is on the DataPropagator Web site: <a href="http://www.ibm.com/software/data/dpropr/">http://www.ibm.com/software/data/dpropr/</a>

If you want to ...	Refer to ...
Read customer case studies	The Case studies page of the DataPropagator Web site: <a href="http://www.ibm.com/software/data/dpropr/">http://www.ibm.com/software/data/dpropr/</a>
Set up your replication environment	"Chapter 6. Setting up your replication environment" on page 93.
Set up replication preferences in DJRA	See the DJRA online help.
Set replication preferences in the DB2 Control Center	DB2 Control Center online help.
Define and manage replication sources and targets	"Part 2. Administration" on page 59.
Configure and operate the Capture and Apply programs	"Part 3. Operations" on page 173; see the chapter for a particular operating system.
Learn about and run DB2 DataPropagator for Microsoft Jet	"Using DB2 DataPropagator for Microsoft Jet" on page 280.
Learn about data replication support for satellites	<i>DB2 Universal Database Administering Satellites Guide and Reference.</i>
Learn about the relational database tables that control the DB2 replication process	"Chapter 14. Table structures" on page 293.
Debug error messages for the Capture and Apply programs	"Troubleshooting" on page 166, and "Chapter 15. Capture and Apply messages" on page 353.
Find out about other DB2 information	<p>The Information Center, which is available on all platforms on which the DB2 administration tools are available. Depending on your system, you can access the Information Center from one of the following places:</p> <ul style="list-style-type: none"> <li>• Main product folder</li> <li>• Toolbar in the Control Center</li> <li>• Windows <b>Start</b> menu</li> <li>• <b>Help</b> menu of the Control Center</li> </ul>

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## How to send your comments

Your feedback helps IBM to provide quality information. Please send any comments that you have about this book or other DB2 DataPropagator documentation. You can use any of the following methods to provide comments:

- Send your comments from the Web. Visit the Web site at:  
<http://www.ibm.com/software/data/dpropr/>  
The Web site has a feedback page that you can use to enter and send comments.

- Send your comments by e-mail to [comments@vnet.ibm.com](mailto:comments@vnet.ibm.com). Be sure to include the name of the product, the version number of the product, and the name and part number of the book (if applicable). If you are commenting on specific text, please include the location of the text (for example, a chapter and section title, a table number, a page number, or a help topic title).



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## What's new

This section introduces the major features of DB2 DataPropagator for the two most recent versions, 6 and 7. For Version 7 (V7), see “What's new for Version 7”; for Version 6 (V6), see “What's new for Version 6” on page xvi.

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### Compatibility

All releases of DB2 DataPropagator Relational Version 1 (DPropR V1) are not compatible with this product. If you currently use DPropR V1, see “Planning for migration” on page 89 for instructions on upgrading.

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### What's new for Version 7

This section introduces the major features of DB2 DataPropagator Version 7 (V7), which are described in more detail in this book.

- “DATALINK replication”
- “Replication for AS/400”
- “Replication for UNIX, Windows, and OS/2” on page xvi

#### DATALINK replication

DB2 Universal Database provides a DATALINK data type that allows the database to control access, integrity, and recovery for external files. DB2 DataPropagator V7 replicates DATALINK columns, but does not replicate the external files to which the DATALINK columns point. To replicate the files, the Apply program uses a user exit routine. See “Replicating DATALINK values” on page 75 for more information about DATALINK support.

#### Replication for AS/400

DB2 Universal Database for AS/400 now supports:

- Replication of large objects (LOBs). See “Replicating large objects” on page 74 for more information about LOB support.
- Replication of BIGINT data types.
- Replication of DATALINK data types.

The following features were added to improve the performance of your AS/400 replication environment:

- The DPRVSN parameter lets you specify which version of the control tables to create: Version 5 or Version 7.
- The **STRDPRAPY** command has a new parameter, GENCDROW. The GENCDROW parameter is equivalent to the CHGONLY parameter that is

used on the other platforms. For more information about the GENCDROW parameter, see “Starting Capture for AS/400” on page 197.

- The **STRDPRCAP** command has two new parameters, DELAY and RTYWAIT. The DELAY parameter specifies the time delay (in seconds) at the end of each Apply program cycle when continuous replication is used. RTYWAIT specifies in seconds how long the Apply program should wait after it encounters an error before it retries the operation that failed.

## Replication for UNIX, Windows, and OS/2

DB2 DataPropagator Version 7 is available for Linux and NUMA-Q operating systems.

On Windows 32-bit operating systems, you can start the Capture and Apply programs on demand using the **ASNSAT** command. For information about this command, see “Replicating on demand (Windows 32-bit operating systems only)” on page 279.

You can start both the Capture and Apply programs from within an application by using the new asnCapture and asnApply application programming interfaces. For information about these interfaces, see “Appendix A. Starting the Capture and Apply programs from within an application” on page 397.

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## What’s new for Version 6

This section introduces the major features of DB2 DataPropagator Version 6 (V6), most of which are described in more detail in this book.

- “DB2 Satellite Edition”
- “Database currency” on page xvii
- “Performance features” on page xviii
- “Integration with DB2” on page xviii

### DB2 Satellite Edition

DB2 Universal Database Satellite Edition (DB2 Satellite Edition) brings the power of DB2 Universal Database to environments containing occasionally connected clients. It is supported on Windows 32-bit operating systems.

With DB2 Satellite Edition, you can replicate data between DB2 servers and some non-IBM source servers (Oracle, Sybase, Informix, Microsoft), and you gain the following benefits:

- Centralized group administration and problem determination
- Ability to easily support thousands of occasionally connected clients
- Capture and Apply programs that start and stop automatically, as required

Two new options let you run the Capture and Apply programs in batch mode:

**Capture program AUTOSTOP option**

You can run the Capture program in batch mode by using the new AUTOSTOP invocation parameter. The Capture program will run until it captures all of the changes from the log and then it terminates.<sup>5</sup>

**Apply program COPYONCE option**

You can run the Apply program in batch mode by using the new COPYONCE invocation parameter. The Apply program will try to run all eligible subscription sets one time and then it will terminate.<sup>6</sup>

**Database currency**

DB2 replication now provides:

**LOB support**

You can use DB2 DataPropagator to replicate columns with large-object (LOB) data. The Capture program flags information about changed LOB data, but does not copy the LOB data to staging tables. The Apply program copies changed LOB data directly from the source table to the target table. You can replicate LOB data between DB2 for OS/390 servers or between DB2 Universal Database servers for UNIX, Windows, and OS/2 operating systems. If you have DB2 Connect™ Version 6, you can also copy LOB data between DB2 for OS/390 and DB2 Universal Database servers for UNIX, Windows, and OS/2 operating systems.

**ROWID support**

DB2 for OS/390 V6 allows you to generate a unique identifier for each row in a table and store that identifier in a ROWID column. Using the ROWID, you can access a particular row without needing to access an index or scan the table space. Usually a ROWID identifies a row in the table that has the ROWID defined. However, by copying ROWID values from the source table to set the target rows with the same ROWID values, you can use the same ROWID value to identify both the source and target row.

**Version-independent capture**

The Capture program can read the log for DB2 for MVS/ESA V4, DB2 for OS/390 V5, or DB2 for OS/390 V6. Therefore you can run different versions of DB2 in a data-sharing environment, for example during version-to-version migration, and have one Capture program continue to capture transaction-consistent data.

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5. The Capture program AUTOSTOP option is not available on the Capture program for AS/400.

6. The Apply program COPYONCE option is not available on the Apply program for AS/400.

### **ODBC support**

This feature was added in DB2 for OS/390 V5 and updated in V6 to support a new catalog table (SQLProcedureColumns).

### **Unicode support**

DB2 DataPropagator for UNIX, Windows, and OS/2 operating systems supports unicode.

### **Port to Linux**

DB2 DataPropagator V6 runs on the Linux operating system.

## **Performance features**

The following features were added to improve the performance of your replication environment:

### **Option to capture only columns that are available for replication**

You can start the Capture program using the CHGONLY parameter if you want to capture changes only for those columns that you marked available for replication. By default, the Capture program captures changes that are made to the source table data for all columns.

### **Capture program sleeptime option**

You can use the SLEEP=N invocation parameter to indicate how long you want the Capture program to sleep before it reads the log again, after it reaches the end of the log. To save on CPU, the Capture program will sleep if no data is returned on the log. This parameter is supported for DB2 for MVS™ 4.1 and later with data sharing. If you use the SLEEP=N parameter with data sharing, and only a small amount of data is returned, then the Capture will sleep for N seconds.

### **Continuous block fetch by the Apply program**

The Apply program uses DB2 continuous block fetch to improve data-transfer rates and overall performance for replicating data from DB2 for OS/390 to other operating systems.

### **Automated use of RUNSTATS utility**

For DB2 DataPropagator on UNIX, Windows, and OS/2 operating systems, the RUNSTATS utility is run automatically after the Apply program completes a full-refresh copy to the target tables. This utility collects new statistics on the target tables and their indexes.

## **Integration with DB2**

The replication components are integrated with DB2 Universal Database more closely than before.

### **DB2 DataPropagator for OS/390 feature**

When you order DB2 for OS/390 V6, you also receive a free trial version of DB2 DataPropagator for OS/390. This trial version has all the features and functions of the standard product. You can use the trial version for 90 days without paying a licensing charge. After the

trial period ends, you must order a license for the DB2 DataPropagator priced feature to continue using the product.

### **Integrated installation for OS/390**

You can install DB2 DataPropagator for OS/390 V6 using the DB2 Installer interface. The DB2 Installer is a workstation-based tool that provides an easy-to-read map for the entire installation process. The status of a task is denoted by the changed icons on the windows. Help text is provided for each field, and "Guide Me" help text is provided for each window.

### **Control Center**

A Java<sup>®</sup> version of the DB2 Control Center is available that you can use to perform administration tasks from a Web browser. It includes improved support for administering replication environments for DB2 for OS/390. For more information about this new interface, see the DB2 Universal Database documentation.

### **DataJoiner Replication Administration tool**

The DataJoiner Replication Administration (DJRA) tool comes with DB2 Universal Database and it runs on Windows 95, Windows 98, and Windows NT operating systems. With DJRA, you can perform administration tasks for replication configurations involving DB2 databases, non-IBM databases, or both. Using DJRA, you can easily promote (copy) your replication criteria from one environment to another. You can also start a replication monitor to help you monitor replication activity and produce periodic reports about that activity. If your files are stored on the AS/400 platform, you can use DJRA to automatically generate relative record numbers (RRN) for replication sources so that you can replicate data without user-defined unique keys. The details about these and other benefits of DJRA are documented in this book.



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## Part 1. Introduction

This part of the book contains the following chapters:

“Chapter 1. Overview of data replication” on page 3 describes the DB2 data replication components and concepts.

“Chapter 2. Data replication configurations” on page 19 describes the basic replication configurations and how to build on them with DB2 replication.

“Chapter 3. Data replication scenario” on page 35 lists steps that you can follow to use the DB2 Control Center and the Capture and Apply programs to perform a simple replication scenario on sample data in DB2 for Windows NT.

“Chapter 4. Data replication tasks” on page 51 introduces the tasks that you perform at various stages of the replication process.





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## Chapter 1. Overview of data replication

*Replication* is a process of maintaining a defined set of data in more than one location. It involves copying designated changes from one location (a source) to another (a target), and synchronizing the data in both locations. The source and target can be in logical servers (such as a DB2 database or a DB2 for OS/390 subsystem or data-sharing group) that are on the same machine or on different machines in a distributed network.

A number of IBM products enable you to replicate data. The product that is the focus of this book—DB2 DataPropagator—is a replication product for relational data. You can use it to replicate changes between any DB2 relational databases. You can also use it with other IBM products (such as DB2 DataJoiner and IMS DataPropagator) or non-IBM products (such as Microsoft SQL Server and Sybase SQL Server) to replicate data between a growing number of database products—both relational and nonrelational.

The replication environment that you need depends on when you want data updated and how you want transactions handled. You have the flexibility to choose the locations of the replication components to maximize the efficiency of your replication environment.

Before you go to Chapter 2 and begin designing your replication environment, read this chapter to familiarize yourself with the DB2 replication components and their associated concepts.

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### DB2 data replication components

DB2 DataPropagator consists of three main components: administration interfaces, change-capture mechanisms, and the Apply program.

- You use the administration interfaces to create control tables, which store your replication criteria.
- After you set up your replication environment, the change-capture mechanism captures changes as they occur in the source database and stores them temporarily in tables.
- The Apply program reads the tables and applies these changes to target databases, or copies data directly from the source database to the target databases.

This section describes the control tables that manage replication requests, the logical servers that contain the replication components, as well as the main

components (administration interfaces, change-capture mechanisms, and the Apply program) and how they communicate with each other.

## Control tables

The replication components use control tables to communicate with each other and to manage replication tasks (such as managing replication sources and targets, capturing changes, replicating changes, and tracking how many changes are replicated and how many remain to be done).

The change-capture mechanisms use the following control tables: register table, unit-of-work table, pruning control table, prune lock table, critical section table, warm start table, tuning parameters table, and change data tables. For additional control tables that are platform-specific, see “Chapter 14. Table structures” on page 293.

The Apply program uses the following control tables: Apply trail table, critical section table, pruning control table, prune lock table, register table, subscription set table, subscription statements table, subscription events table, subscription-targets-member table, subscription columns table, unit-of-work table, and change data tables.

## Logical servers

All the replication components reside on a logical server. In this book, logical servers refer to *databases*, not to servers in the client/server sense. For the OS/390 operating system, logical servers are equivalent to *subsystems* or *data-sharing groups* (that is, the domain of a single database catalog). There are three types of logical servers:

### Source server

The source server contains the change-capture mechanism, the source tables that you want to replicate, and the control tables for the Capture program that are also used by the Apply program.<sup>7</sup>

### Target server

The target server contains the target tables.

### Control server

The control server contains control tables for the Apply program.

The Apply program can reside on any of the logical servers in the network. It uses distributed DB2 technology to connect to the control, source, and target servers.

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7. If you use the remote journal set up on DPROPR/400, the source server will not contain the source tables that you want to replicate. For more information about the remote journal set up, see “The journal” on page 191.

Each Apply program is associated with one control server, which you specify when you start the Apply program. Multiple Apply programs can share a control server.

## Administration interfaces

You use the administration interfaces to create control tables, which store your replication criteria. Two user interfaces are available: DB2 Control Center and DataJoiner Replication Administration (DJRA).

### DB2 Control Center

The DB2 Control Center is a database administration tool that you can use to administer the replication of data between DB2 servers. It automates many initialization functions, such as creating target tables and control tables when you specify target information.

You can use the Control Center to perform the following administration tasks for replication:

- Define DB2 tables and DB2 views as replication sources.
- Define or remove subscription sets.
- Add subscription-set members to existing subscription sets.
- Remove subscription-set members from existing subscription sets.
- Remove replication sources.
- Clone subscription sets to other servers.
- Activate and deactivate subscription sets.
- Add or delete a call to a procedure or a SQL statement that runs before or after data is replicated.

### DataJoiner Replication Administration (DJRA)

The DataJoiner Replication Administration (DJRA) tool is a database administration tool that you can use to perform various replication administration tasks. You can use this tool for DB2-to-DB2 replication; however, you must use it if your replication environment includes non-IBM databases.

You can use DJRA to perform the following administration tasks:

- Create the control tables and put them on your source, target, and control servers.
- Define DB2 tables, non-DB2 tables, non-IBM tables, and DB2 views as replication sources.
- Alter the definitions for existing DB2 source and target tables to add new columns.
- Remove replication sources.
- Define or remove subscription sets.

- Add subscription-set members to existing subscription sets.
- Remove subscription-set members from existing subscription sets.
- Add or delete SQL statements or called procedures that run before or after data is replicated.
- Monitor the replication process.
- Copy your replication environment to another system using the promote functions.
- Load target tables off-line.
- Activate or deactivate subscription sets.

## Change-capture mechanisms

The DB2 data replication solution offers these mechanisms for capturing data:

- The *Capture program* for DB2 source tables.
- *Capture triggers* for source tables in non-IBM databases, except Teradata, Microsoft Access, and Microsoft Jet.

The following sections describe the Capture program and triggers. For more information about how changes are replicated in Microsoft Access and Microsoft Jet databases, see “Using DB2 DataPropagator for Microsoft Jet” on page 280.

### Capture program

When the source is a DB2 table, the Capture program captures changes that are made to the source. The Capture program uses the database log<sup>8</sup> to capture changes made to the source database and stores them temporarily in tables.

The Capture program runs at the source server. Typically it runs continuously, but you can stop it while running utilities or modifying replication sources.

For instructions on using the Capture program, see “Part 3. Operations” on page 173.

### Capture triggers

When the source table is in a non-IBM database (other than Teradata, Microsoft Access, and Microsoft Jet), Capture triggers capture changes that are made to the source. Capture triggers are fired when a particular database event (UPDATE, INSERT, DELETE) occurs.

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8. The Capture program retrieves changed and committed information from the active and archive logs on DB2 for MVS 4.1 or higher and DB2 Universal Database. Capture for VSE and VM 5.1 can read only the active log on DB2 for VSE & VM.

DJRA automatically creates the Capture triggers. These triggers capture the changes made to tables defined as replication sources and store the changes temporarily in tables.

## Apply program

The Apply program reads data directly from source tables or views to initially populate the target table. If the source tables are in a non-IBM database, the Apply program reads the data from a nickname. If you want changes copied, the Apply program reads the changed data that is stored temporarily in tables, and applies the changes to target tables.

The Apply program generally runs at the target server, but it can run at any server in your network that can connect to the source, control, and target servers. Several Apply program instances can run on the same or different servers. Each Apply program can run using the same authorization, different authorization, or as part of a group of Apply programs where each Apply program in the group runs using the same authorization (user ID).

Each Apply program is associated with one control server, which contains the control tables that contain the definitions for the subscription sets. The control tables can be used by more than one instance of the Apply program. For example, if you have one source server and two target servers, you can have separate Apply programs running at each target server. The two apply instances can share the control tables, which will have the specific information related to each Apply instance.

For instructions on using the Apply program, see “Part 2. Administration” on page 59 .

## How the replication components communicate

The replication components are independent of each other, so they rely on information that is stored in control tables to communicate with each other. The Capture and Apply programs and the Capture triggers update control tables to indicate the progress of replication and to coordinate the processing of changes.

The replication components communicate differently depending on whether the source server is a DB2 server or a non-IBM server. For replication between DB2 servers, the Capture program captures changes that are made to data in source tables by reading the server *log* or *journal*. Then the Capture program places the changes into tables called change data (CD) tables. For non-IBM sources, Capture triggers capture changes and store them in consistent-change-data (CCD) tables.

Each time that the Apply program copies data to the target database, the contents of the target database reflect the changes that were made to the

source database. The Apply program works by applying transactions accumulated since the Apply program last ran. The Apply program keeps track of the latest update that it makes to each target.

### **Log-based communication**

The Capture program uses some of the control tables to indicate what changes have been made to the source database, and the Apply program uses these control table-values to detect what needs to be copied to the target database.

**Important:** The Capture program will not capture any information until the Apply program signals it to do so, and the Apply program will not signal the Capture program to start capturing changes until you define a replication source and associated subscription sets. See “Performing the initial replication” on page 54 for more information about the steps that you must perform so that the components communicate with each other and replicate changes.

The following process describes how the Apply and Capture programs communicate in a *typical* replication scenario to ensure data integrity:

#### *Capturing data from a source database*

1. The Capture program reads the register table to determine the replication sources for which it needs to start capturing changes. If new replication sources are defined while the Capture program is running, they won't be recognized by the Capture program until you either reinitialize, or stop and restart the Capture program.
2. The Capture program monitors the DB2 log or journal to detect change records from source tables that are defined as replication sources.
3. The Capture program adds one row (or two rows if updates are saved as DELETE and INSERT operations) to the *change data (CD) table* for each change that it finds in the DB2 log or journal. Each replication source has a CD table.
4. The Capture program stores information about committed transactions in the *unit-of-work (UOW) table*. The rows in this control table identify the transactions that have been committed in the source server. With log-based change capture, one UOW table exists for every DB2 source server.
5. The Capture program updates the register table to record how much committed data was captured for each replication source.

#### *Applying data to a target database*

6. For all new subscription sets, the Apply program first synchronizes the target with the replication source by copying all the data from the source table to the target table. This action is called a *full-refresh copy*. After the full-refresh copy, the Capture program begins capturing changes at the source.

7. If any subscription set is due for replication, the Apply program checks the register table to determine whether there are changes that need to be replicated.
8. The Apply program updates the pruning control table to synchronize the capture of the related source table changes in the CD table.
9. The Apply program copies the changes from the join of the CD table and the UOW table to the target table. By joining the two control tables, the Apply program ensures that it copies only the changes that were committed at the source.

#### *Pruning the tables*

10. The Apply program updates the pruning control table with a value that indicates the point to which it copied changes to the target database.
11. When the Capture program prunes the CD and UOW control tables, it determines which changes were applied and deletes them from the CD table and the UOW table.

#### **Trigger-based communication**

DJRA, working through DB2 DataJoiner, creates Capture triggers on non-IBM source tables when you define them as replication sources. Three types of triggers are created on the source table: DELETE, UPDATE, and INSERT. Also, UPDATE triggers are created on the pruning control table and the register synchronization table. The Apply program uses these control tables to detect what needs to be copied to the target database.

The following process describes how the Capture triggers and the Apply program communicate in a *typical* replication scenario to ensure data integrity:

#### *Capturing data from a source*

1. Whenever a DELETE, UPDATE, or INSERT operation occurs at the source table that is defined as a replication source, a Capture trigger records the change in the *consistent-change-data (CCD) table*.

#### *Applying data to a target*

2. When the Apply program is started, the UPDATE trigger on the register synchronization table updates the register table to record how much committed data has been captured.
3. The Apply program gets the source table information from the register table.
4. Before the Apply program can copy the changes to the target, it synchronizes the target with the replication source by copying all the data from the source table to the target table.<sup>9</sup> This action is called a *full-refresh copy*.

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9. This is not true for noncomplete CCD tables.

5. The Apply program updates the pruning control table to synchronize the capture of the related changes in the CCD table.
6. The Apply program reads the CCD table using DB2 DataJoiner nicknames, copies the changes to the target server, and applies the changes to the target table.

#### *Pruning the tables*

7. The Apply program updates the pruning control table with a value that indicates the point to which it copied changes to the target database.
8. The UPDATE trigger on the pruning control table checks all of the CCD tables that are at the source server and deletes those entries that were replicated.

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## DB2 data replication concepts

This section introduces some of the important concepts of DB2 data replication. You should read the whole section to get a complete overview.

### Replication sources

A *replication source* is a *user table* or view from which you want data copied. Before you can replicate data, you must define a replication source to describe the information that the change-capture mechanisms will use. When you define a replication source you must specify which columns you want to replicate, and decide whether you want updates treated as UPDATE operations or DELETE and INSERT operations. See “Enabling replication logical-partitioning-key support” on page 109 for more information on how to treat updates. In addition, you must decide:

- Whether you want before-image values for a column
- Whether you want to replicate with change capture (differential-refresh copying) or without change capture (full-refresh-only copying)
- What level of conflict detection to use for update-anywhere replication (where a replication source has read/write target tables)

### After-image columns and before-image columns

An *after-image* column contains the value of a data column in a source table after the value in that data column is updated. A *before-image* column contains the value of a data column in a source table before that data column is updated. When you define a replication source, you can choose to capture only the after-image or both the after-image and the before-image. Your decision will depend both on the way in which you plan to use the data and on the types of tables that you are using.

Before-image columns are useful if your applications require auditing or rollback capability. Some restrictions apply to how you use these columns, and they are discussed later in this book (“Replicating before and after images” on page 72).



### **Full-refresh and differential-refresh copying**

The Apply program copies data from the source to the target either by full-refresh only or differential-refresh copying.

During *full-refresh only* copying, the Apply program performs these tasks:

1. Deletes all of the rows from the target table
2. Reads all of the rows from the source table
3. Copies the rows to the target table

During *differential-refresh copying*, the Apply program copies only the changed data to the target table.

### **Levels of conflict detection**

*Conflict detection* pertains only to update-anywhere replication configurations. It is the process of detecting if the same row was updated in the source and target tables during the same replication cycle. With *standard conflict detection*, the Apply program searches for conflicts in rows that are already captured in the CD tables. With *enhanced conflict detection*, the Apply program locks all of the target tables, thus ensuring that all changes are considered when checking for conflicts. *Row-replica conflict detection* applies only to tables that are maintained by DataPropagator for Microsoft Jet; where conflicts are detected on a row-by-row basis instead of a transaction-by-transaction basis.

## **Subscription sets and subscription-set members**

Before you can replicate data from the replication source, you must associate the replication source with the target to which you want the changes replicated. You define this information using subscription sets and subscription-set members. The information that you provide is stored in various replication control tables.

A *subscription set* contains the attributes of a replication subscription. When you create a subscription set, you define the following attributes:

- A name for the subscription set
- The source server and the target server
- The Apply qualifier
- When to start replication, how often to replicate, and whether to use interval timing, event timing, or both
- Data blocking, if you expect large volumes of changes

A subscription set must have one *subscription-set member* for each target table or view. When you create a subscription-set member, you define the following attributes:

- The source table or view and a target table or view
- The structure of the target table or view

- The columns that you want replicated (subselect columns)
- The rows that you want replicated (SQL predicates)

Subscription sets ensure that all subscription-set members are treated alike during replication: either changes are applied to all targets or to none of them. The changed data for all the subscription-set members in a subscription set is replicated to the specified target tables in a single transaction. Subscription sets optimize performance because the target tables in a set are processed in one transaction against the target server. Subscription sets also preserve referential integrity.

Each subscription set is processed by one Apply program; however, each Apply program can process many subscription sets. The relationship between a subscription set and subscription-set members is shown in Figure 1.

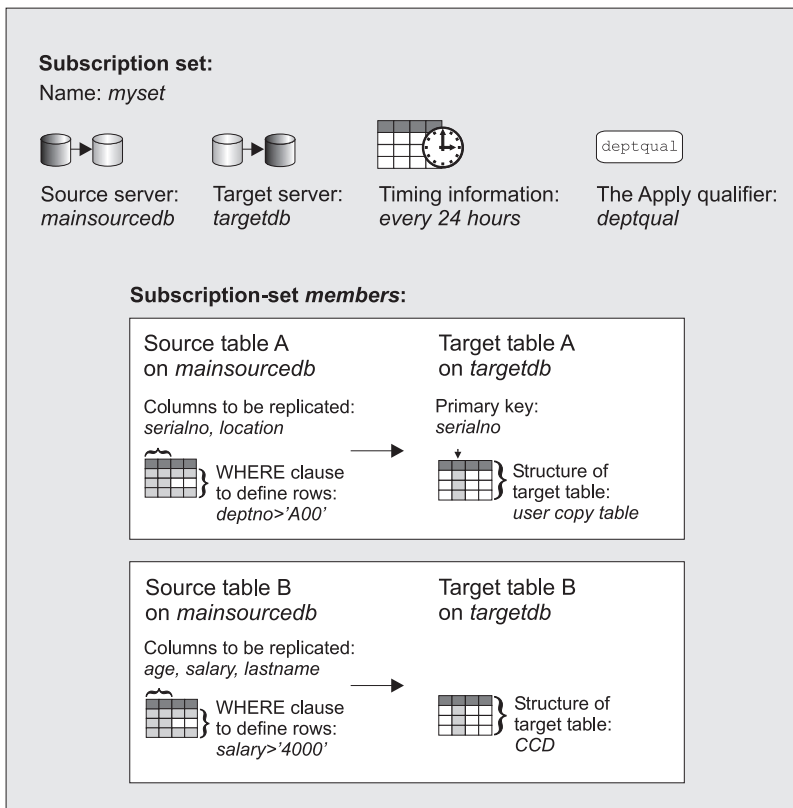


Figure 1. Subscription sets and subscription-set members. Example of the relationship between a subscription set and subscription-set members.

## Apply qualifier

The *Apply qualifier* associates an Apply program with one or more subscription sets. You specify a case-sensitive string as the value for the Apply qualifier when you define a subscription set.<sup>10</sup>

By using more than one Apply qualifier, you can run more than one instance of the Apply program from a single user ID. The Apply qualifier is used to identify records at the control server that define the work load of an instance of the Apply program; whereas the user ID is for authorization purposes only. For example, assume that you want to replicate data from two source databases to the target tables on your computer. The data in source table A is replicated using full-refresh copying to target table A, and the data in source table B is replicated using differential-refresh copying to target table B. You define two subscription sets (one for table A and one for table B), and you use separate Apply qualifiers to allow two instances of the Apply program to copy the data at different times. You can also define both subscription sets using one Apply qualifier.

## Data manipulation

You might want to replicate only a subset of your source table, use a simple view to restructure the data from the source table to the target table, or use more complex joins and unions.

### Subsets of source tables

You can replicate certain columns or rows from the source table instead of replicating the whole source table. This process, which is sometimes known as *table partitioning*, is called *column subsetting* and *row subsetting* in this book.

Use column subsetting if you want to replicate only a subset of all of the columns from the source. This type of subsetting is appropriate, for example, if some of the columns in the source are very large, such as large objects (LOBs), or if the column data types are not supported by the intended target table.

Use row subsetting if you want to replicate only some of the rows from the source database. For example, when you are replicating data to more than one regional office, you might want to replicate only records that are relevant to that particular regional office. To subset rows, use the WHERE clause when defining the subscription-set member.

### Views as sources

Simple views are useful in data warehouse scenarios if you want to restructure copies so that data in target tables is easily queried.

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10. The Apply qualifier appears in many control tables; therefore, do not attempt to change its value after you set it.

For example, assume that a database contains both a resume table and a photograph table. The human resources department needs one table that contains every employee's resume and photograph. You can create a view that contains both the resume and photograph tables, define that view as a replication source, and create a subscription set to replicate the data from the view to a target table in the human resources database.

Views are also useful for introducing related columns in other tables. You can reference the columns in other tables in the subscription-set member predicates, which facilitates the routing of updates to the appropriate target sites.

### **Joins and unions for targets**

You can create and maintain target tables with contents that are joins or unions of existing source tables.

You can use the following types of joins:

- Simple inner-joins over one or more defined replication sources, possibly in combination with other tables or views that are not themselves replication sources.
- Simple inner-joins over CCD tables that are defined as replication sources. These CCD tables can be maintained by the Apply program or they can be maintained by another application for external data sources (such as IMS DataPropagator).

You can use joins and unions to manipulate data in the following ways:

- Joins of tables from a single DB2 source server (by defining a DB2 view as the join of certain tables)
- Unions of tables from one source server (by using multiple subscription-set members in a set where each member has the same target table)
- Unions of tables from multiple source servers, sometimes referred to as *multisite unions* (by creating multiple subscription-set members in multiple subscription sets because there are multiple source servers)

## **Target tables**

When you define a subscription-set member, you must specify the type of target table that you want to use. The following types of tables are available:

- User copy tables
- Point-in-time tables
- Aggregate tables
- Consistent-change-data (CCD) tables
- Replica or row-replica tables
- User tables

The following sections describe the unique characteristics of each type of target table.

### **User copy tables**

These tables are read-only copies of the replication source with no replication control columns added. They look like regular source tables and are a good starting point for replication. They are the most common type of target table.

### **Point-in-time tables**

These tables are read-only copies of the replication source with a timestamp column added. The timestamp column is originally null. When changes are replicated, values are added to indicate the time when updates are made. Use these types of tables if you want to keep track of the time of changes.

### **Aggregate tables**

These are read-only tables that use SQL column functions (such as SUM and AVG) to compute summaries of the entire contents of the source tables or of the recent changes made to the source table data. Rows are appended to aggregate tables over time. There are two kinds of aggregate tables: base aggregate tables and change aggregate tables.

*Base aggregate tables* summarize the contents of a source table. Use a base aggregate table to track the state of a source table on a regular basis. For example, assume that you want to know the average number of customers that you have each month. If your source table has a row for each customer, you would average the number of rows in your source table on a monthly basis and store the results in a base aggregate table.

A base aggregate table does not track change information. For example, assume you had an average of 500 customers in January and 500 in February; however, in February you lost two existing customers and gained two new ones. The base aggregate table shows you that you had the same average number of customers in both months, but it does not show the changes that were made during February. If you want to track change information, use a change aggregate table.

*Change aggregate tables* work with the change data in the control tables, not with the contents of the source table. Use a change aggregate table to track the changes (UPDATE, INSERT, and DELETE operations) made over time. For example, assume that you want to know how many new customers you gained each month (INSERTS) and how many existing customers you lost (DELETES). You would count the changes that are made to the rows in your source table on a monthly basis and store that number in a change aggregate table.

### **Consistent-change-data (CCD) tables**

These tables contain data from committed transactions. They also contain an indicator of whether the target table was changed using an INSERT, DELETE, or UPDATE operation. They can contain both the old and new value of the data. Each type of CCD table (local and remote, complete and noncomplete, condensed and noncondensed, internal and external), has a different use. “Attributes of CCD tables” on page 82 describes these types, when to use them, and how to define them. You can use the different types of CCD tables to collect and manipulate data in the following ways:

- Staging changes to remote locations. If you have many remote targets, instead of replicating from the source to all of the targets, you can replicate from the source to a CCD table, and then replicate from the CCD table to the remote targets. By using the CCD table, the join of the CD table and UOW table is done only once. If the CCD is remote but near the targets then it might save network transfer time as well.
- Replicating only the net change for a row to the target. CCD tables can reduce the load on your network and prevent updates from being made repeatedly to the same rows over a short period of time.
- Collecting audit information.
- Acting as the source of change data from change-capture mechanisms other than the Capture program, such as:
  - IMS DataPropagator for change data from IMS
  - Data Difference utility for change data from VSAM
  - Capture triggers for change data from non-IBM data sources

### **Replica or row-replica tables**

These are the only target tables that your applications can update directly. Changes made to replicas and row-replicas are replicated to the associated source table; the source table in turn replicates the changes to other replicas. Replicas are supported only in DB2 databases. A *row-replica table* is a special type of replica table for DB2 DataPropagator for Microsoft Jet. Use the replica table types for update-anywhere replication.

### **User tables**

You don't actually specify a *user table* as a target; however, in update-anywhere replication, a user table is automatically a target for the replicas or row-replicas that are associated with it. The user table is the *parent of the replica*, and its copies are *dependent replicas*. The parent of the replica receives updates from a dependent replica and, if there are no conflicts detected, it replicates the changes to the other dependent replicas. The parent of the replica is the primary source of data. If there are any update conflicts detected, the contents of the parent of the replica prevail. Typically your applications access the dependent replica tables; however, they connect to the server containing the user table when the replicas are not available.

## Schedule for applying updates

*Synchronous replication* delivers updates continually. When a change is made to the source data, it is temporarily stored and forwarded to the target at a later time. A change is committed to the source database only after the change is replicated to the target database. If for some reason the change cannot be replicated to the target database, the change is not made to the source database. This type of replication is also called *real-time replication*. If your application requires synchronous updates, code your applications to update tables in a single, distributed transaction instead of using the products described in this book.

*Asynchronous replication* delivers updates in stages. When a change is made to the source data, it is stored temporarily for a preset interval and forwarded to the target at a later time. The interval can be a measure of time (seconds, minutes, hours) or can represent a prescribed event (midnight, or some other time of day). If changes cannot be made to a target database (for example, if the target database is down or the network is down), they are stored and applied later, in the order in which they were made to the source. This type of replication provides many benefits over synchronous replication: better use of network resources, less database contention, and the opportunity to enhance data before it reaches the target database.

DB2 DataPropagator performs asynchronous replication; therefore, changes made to the source are not made immediately to the targets. You can control how frequently the changes are applied to the target by specifying time intervals, events, or both. For environments that have occasionally connected clients, you can replicate data on demand.

### Interval timing

This is the simplest method of controlling the timing of replication. To use *interval timing*, you choose a date and time for the Apply program to start replicating data to the target, and set a time interval that describes how frequently you want the data replicated. When the Apply program stops, it will not start again until the time interval passes. The time interval can be a period of time (from one minute to one year), or it can be continuous. A *continuous time interval* means that the Apply program starts replication cycles one after the other, with only a few seconds delay in-between (you can control the delay with the start parameter). The intervals that you provide are approximate. The interval actually used by the Apply program depends on the number of updates that the Apply program has to replicate and on the availability of resources (that is, database table, table space).

### Event timing

This is the most precise method of controlling the timing of replication. To use *event timing*, you specify the name for an event when you define the subscription set. You then set the time when you want that event processed.

Optionally, you can set an end-of-period time; the Apply program will not replicate any transactions committed after this time, but will defer their replication until a future date.

You or your application must provide information for event timing. This information is stored in the subscription events table. The Apply program searches the subscription events table for the event name and the associated time and end-of-period information.

### **On-demand timing**

You can replicate data on demand by using the **ASNSAT** command. This command starts the Apply program and, if necessary, it also starts the Capture program. Each program self-terminates after it completes its part of one replication cycle. This command is supported on Windows 32-bit operating systems, and its invocation parameters are described in “Replicating on demand (Windows 32-bit operating systems only)” on page 279.

**ASNSAT** is also used in replication configurations that include occasionally connected systems. For details, see *DB2 Universal Database Administering Satellites Guide and Reference*.



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## Chapter 2. Data replication configurations

This chapter describes the typical data replication configurations and provides examples of replication solutions for common business needs. Some of these configurations show how other products can be used with DB2 DataPropagator to create a unique replication solution. The replication configurations covered here are not exhaustive because users are continually developing new and creative implementations.

**Important:** DB2 replication is designed for asynchronous replication and is *not* suitable for the following situations:

- Performing real-time replication: In real-time replication, sometimes called synchronous replication, changes to the source system are made immediately to the target tables. If synchronous data delivery is essential to your application, code your application to update the application table and all of its copies with a single transaction to ensure that both the source and target are changed at the same time.
- Maintaining a backup server (hot-site backup): Do *not* use asynchronous replication to maintain a backup server that can be accessed when your primary server is down. If the source (primary) server becomes unavailable, there is no way to guarantee that all updates were made to the target (backup) server. If you must maintain a backup server, consider using other tools or features. For example, for System/390<sup>®</sup> consider Peer-to-peer remote copy (PPRC) hardware feature or the extended recovery component (XRC).

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### Overview of replication configurations

You can combine configurations to suit your business needs. The following sections describe these typical configurations, including some variations of each:

- Data distribution
- Data consolidation
- Update anywhere
- Occasionally connected

Data distribution and data consolidation are easier to set up and maintain than the other configurations.

#### Data distribution

In *data distribution* configurations, a primary data source resides on a source server (see Figure 2 on page 20). Changes made to the data source are

replicated to one or more target tables that reside anywhere in a distributed network. The target tables are read-only; therefore, you don't need to set up conflict detection because no update conflicts occur during replication. Applications can use the target tables, which are local copies, so that they don't overload the network or central server. This configuration is useful if you need to share data among several sites but you don't want to reduce the performance of your applications.

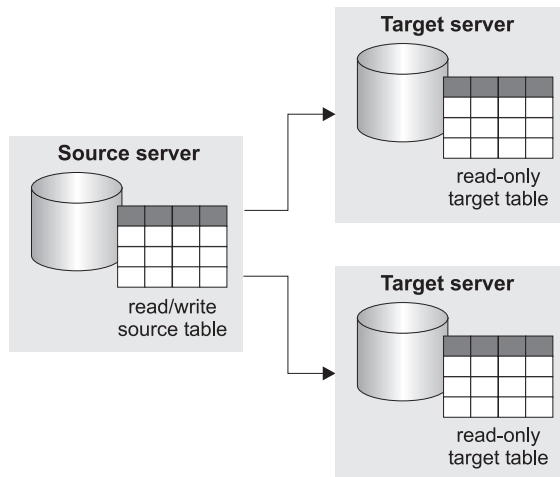


Figure 2. Data distribution. Changes made to a source table are replicated to read-only target tables.

## Data consolidation

In *data consolidation* configurations, a central data server is used as a repository for data from many data sources (see Figure 3 on page 21). Therefore, this configuration consists of many source tables or views and one target table with multiple subset views. Changes made to each data source are replicated to the central data server, which is read-only.

**Restriction:** If you consolidate data from more than one server into a CCD target table, you must *not* use that CCD target table as a replication source for other target tables. The original servers use separate log sequences that cannot be distinguished in further replication.

Data consolidation configurations are useful for maintaining a local decision support system (DSS) so that you can analyze data without competing for production database resources. To ensure that there are no update conflicts, you must design the replication environment so that there is only one source for each data item. If each source updates a unique set of rows, you will never encounter update conflicts.

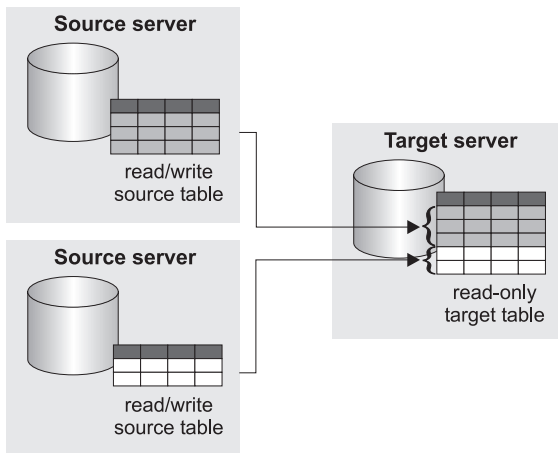


Figure 3. Data consolidation. Each source table can update a unique set of rows in a read-only target table.

## Update anywhere

In *update-anywhere* configurations, a replication source has target tables that are read/write copies. Changes made to a target table are applied to the source table, which maintains the most up-to-date data. If a conflict occurs between a source and target, the source wins. The source table then applies the changes to all of its target tables. Unless you design your application correctly, update conflicts can occur when the data is replicated (see Figure 4 on page 22). It is best to design your application so that a conflict can never occur when data is replicated from the source to all the target tables (see Figure 5 on page 22). You have the option of ignoring conflicts and rejecting any conflicting updates. By rejecting conflicting updates, you risk losing some information.

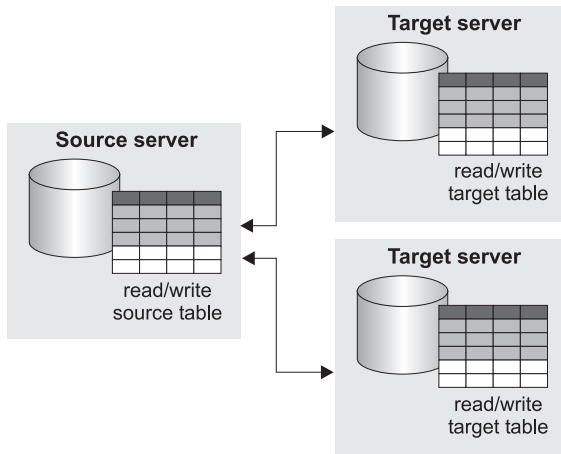


Figure 4. Update-anywhere replication with risk of conflicts between target tables. This configuration requires conflict detection because all rows can be updated at the source table or at any target table.

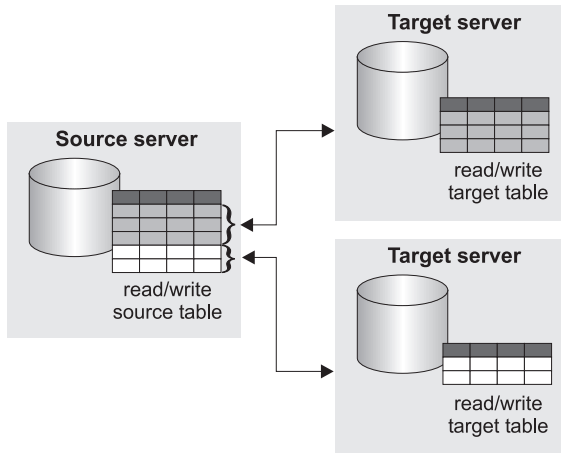
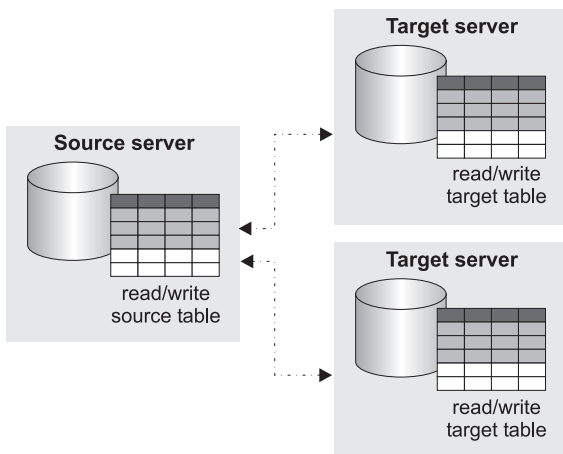


Figure 5. Update-anywhere replication with no risk of conflicts between target tables. Each read/write target table has a unique set of rows that can be updated locally; the source table at the source server maintains the most up-to-date data.

## Occasionally connected

In *occasionally connected* configurations, you have the flexibility to connect to and transfer data to and from a primary source on demand. These types of configurations allow users to connect to the primary data source only long enough to synchronize their local database. The data source doesn't require a continuous connection for replication administration (see Figure 6 on page 23).

Occasionally connected configurations are well-suited for synchronizing data on laptop computers or at computers in home offices. These configurations minimize the frequency and duration of communication-line connections and reduce telecommunication costs, yet the data is available for update. This type of configuration also works well for replicating data to onsite computers that are not constantly connected to the network (for example, if employees are in the office only three days a week).



*Figure 6. Occasionally connected configuration.* The target servers are not continuously connected to the source server; changes that are made to the tables are replicated when the target server is connected to the source server.

You can use DB2 Universal Database Satellite Edition (or any other DB2 server that participates in a satellite environment) to administer *satellites*, which are occasionally connected DB2 servers. DB2 data replication enables you to synchronize data between a central control site and many satellites. At the home office you set up the replication environment, test it, and when it is ready to be rolled out to the occasionally connected systems, you store it in the Satellite Administration Center database. You don't access any of the occasionally connected systems and only need to set up the environment once.

For information about setting up data replication for satellites, enabling the satellite environment for replication, and testing replication on a satellite, see the *DB2 Universal Database Administering Satellites Guide and Reference*.

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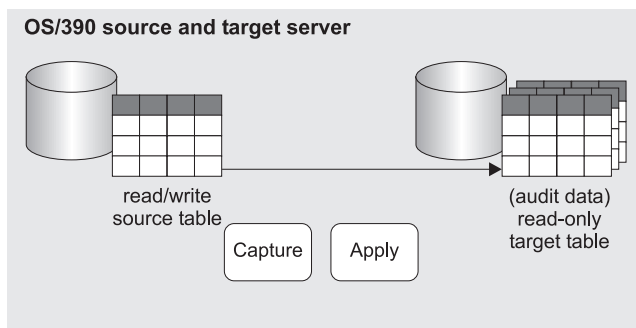
## Examples of replication configurations

You can build on the typical replication configurations to come up with replication models that meet your specific needs. This section discusses examples of some common business needs and the DB2 replication solutions that address those needs. Design issues that are unique to each replication solution are also described.

### Archiving audit information

**Requirements:** A customer in a DB2-IMS Transaction Manager (TM) environment generates audit data by writing audit information to the IMS log. New applications access DB2 through DRDA<sup>®</sup>, bypassing IMS TM completely. The customer needs to track all changes to relational tables for auditing purposes to determine which users made particular changes to the data.

**Replication solution:** The Capture and Apply programs for DB2 DataPropagator are used to capture and store the DB2 for OS/390 changes in target tables (see Figure 7).



*Figure 7. Audit information.* Audit data is replicated to a target table that can be read by the customer's application.

**Design highlights:** Both the before-image and the after-image values of each row are captured and stored. The authorization ID of the user who changed the data is also stored in the audit tables. All of this information is captured from the DB2 for OS/390 log.

### Consolidating data from distributed databases

**Requirements:** A large retail chain has almost 500 stores around the country, each of which gathers purchase details through an electronic point of sale (EPOS) system. Each store keeps its data in local databases on DB2 for AIX. The data is transferred nightly to a central DB2 for OS/390 site using a pre-existing file-transfer process from the EPOS terminals. The company wants to enhance the data at the central site.

**Replication solution:** Data changes from each retail store are captured and saved by the Capture program on DB2 for AIX (see Figure 8). The Apply program on DB2 for OS/390 consolidates the data from all stores and summarizes it.

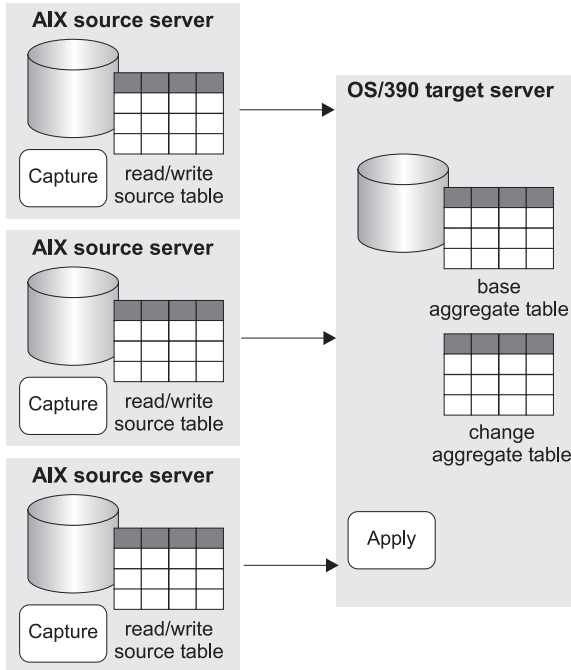


Figure 8. Consolidating data from distributed databases. Data from three source servers is replicated to two target tables on a target server.

**Design highlights:** The Apply program uses base aggregate and change aggregate tables to summarize the consolidated store data. The base aggregate tables summarize the contents of the source files. The change aggregate tables summarize the results of the changes made between each refresh of the target that is performed by the Apply program.

### Distributing data to remote sites

**Requirements:** A small bank installed several new Windows NT client/server applications in its 85 branches. A major source of data for the new applications is the customer and financial reference data, which is derived and held at a host site in two operational systems, one on DB2 for OS/390 and the other on DB2 for AIX. If branches accessed the data directly from the host site, network traffic would be congested and the availability of the production data could be affected.

**Replication solution:** To minimize the network traffic, a local copy of the database is maintained at each branch (see Figure 9). Therefore, each branch is a target server. Changes are captured from DB2 for OS/390 and DB2 for AIX, condensed in control tables on DB2 for AIX, and replicated to the branches overnight.

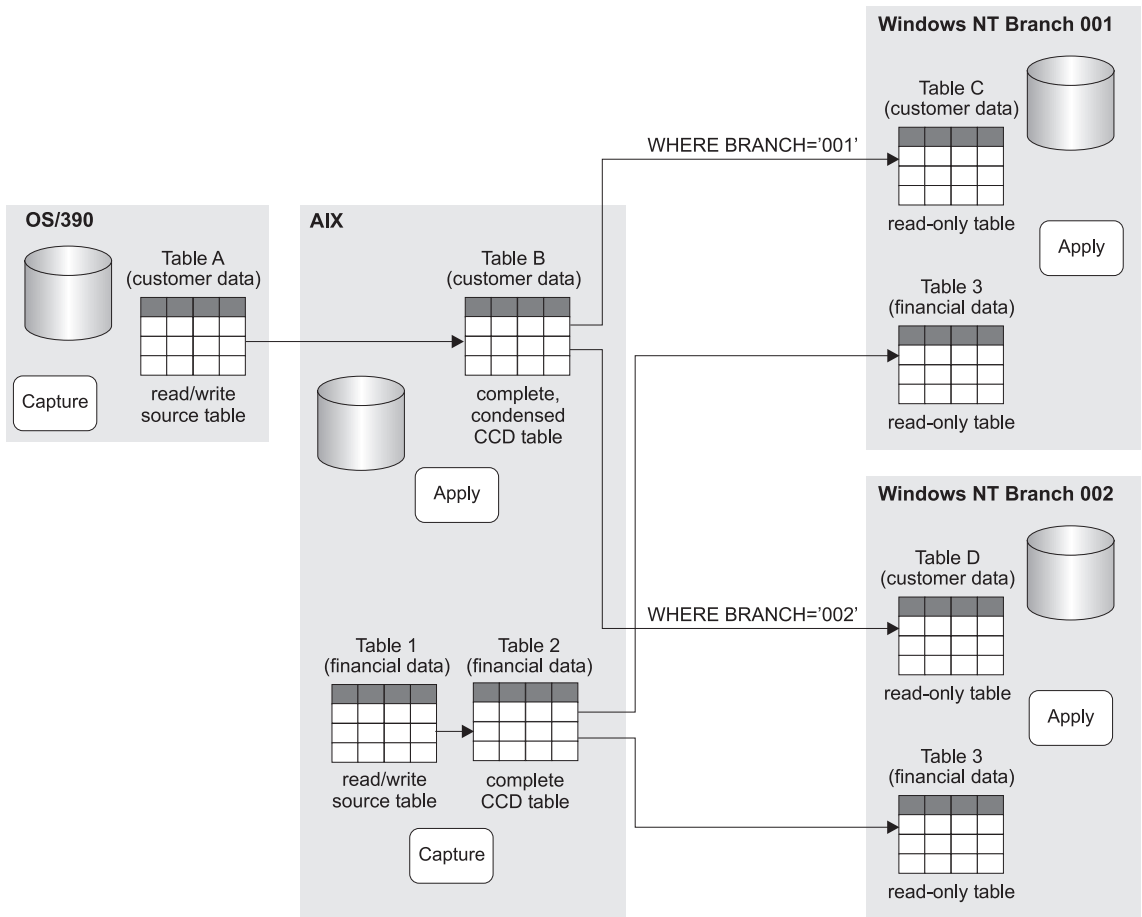


Figure 9. Distributing data to remote sites. Source data is consolidated on an AIX server and replicated to the branches. Each branch gets all of the financial data and some of the customer data. WHERE clauses are used to ensure that each branch gets the records that pertain to their own customers only.

**Design highlights:** One Apply program resides on AIX and replicates from DB2 for OS/390 and DB2 for AIX. There is one subscription set for replicating from DB2 for OS/390 to DB2 for AIX and one for replicating from DB2 for AIX to DB2 for AIX.

An Apply program also resides on the target servers at each branch. The Apply program on the source server runs separately from the Apply



programs at the target servers. The Apply program at each of the branches replicates from the control tables on DB2 for AIX at the host site. Each of the Apply programs on the target servers has a subscription set for replicating from the host site to its local database. Each branch gets all of the financial data but only some of the customer data. WHERE clauses are used to ensure that each branch gets the records that pertain to their own customers only.

The Capture and Apply programs maintain complete, condensed CCD tables in DB2 for AIX. The administrator chose a condensed CCD table because that type of staging table contains only the most recent change made to a row, so network traffic is reduced during replication.

When the subscription sets were created for each branch, the administrator put the control server on the Windows NT server. If the administrator had put the control server on DB2 for AIX, the Apply program from each Windows NT server would need to connect to the host site over the network to read and update the control information about the subscription set, and to detect changes to its control information.

### **Distributing IMS data to remote sites**

**Requirements:** A large financial institution wants to improve the flow of information from two legacy operational systems to its OS/2-based branches. It wants to provide more accurate and timely data to help loan-application research and to detect credit-card fraud. The data for loan applications is in DB2 for OS/390, and the credit card details are in an IMS system. Previous attempts to copy the legacy data consisted of an unworkable mixture of ad-hoc reports and file transfer techniques.

**Replication solution:** IMS DataPropagator is used to capture and save the changes to IMS data into CCD tables in DB2 for OS/390 (see Figure 10 on page 28). The Capture program is used to capture and save the changes to DB2 for OS/390 data. The data that is saved is historical—it records every change made. The Apply program runs at the branches and uses the historical data from IMS and DB2 for OS/390 to maintain DB2 for OS/2 tables.

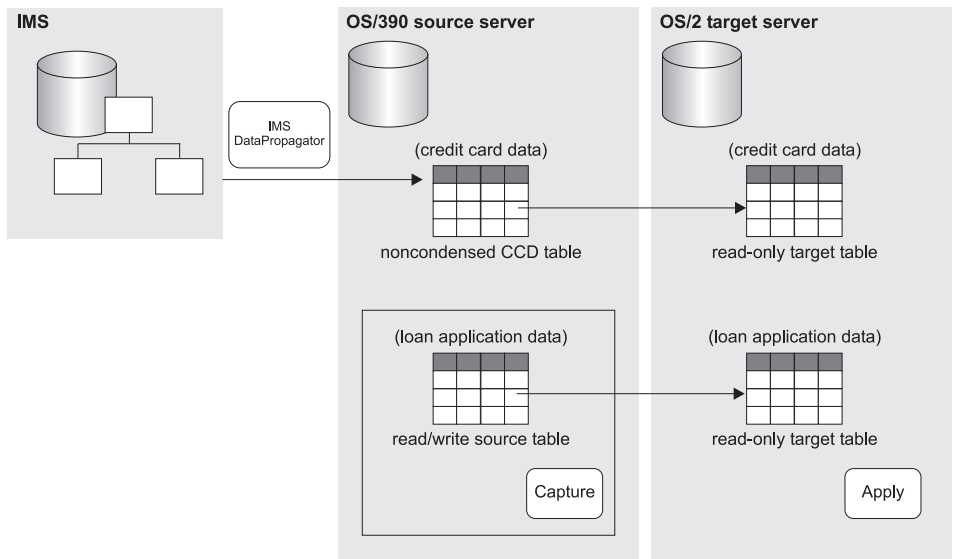


Figure 10. Distributing IMS data to relational databases. IMS DataPropagator replicates IMS data to target tables on an OS/390 source server. DB2 DataPropagator captures data from the OS/390 source server and replicates it to OS/2 servers.

**Design highlights:** IMS DataPropagator captures changes from the IMS log and creates a noncondensed CCD table in DB2 DataPropagator format on the OS/390 source server. DB2 DataPropagator uses this CCD table as a replication source. The Capture program on the OS/390 server captures information from the local tables that contain the credit-card and loan-application data. The Apply program on the OS/2 target server pulls the change data to the target tables.

## Accessing data continuously

**Requirements:** An international bank wants to keep its system online 24 hours a day. Currently the system is online 23 hours 45 minutes a day. Every day the bank stops the system to quiesce it for a batch application, which requires exactly one day's worth of data. During the 15 minutes when the system is down, the required tables are extracted. After the extraction, the system is made available for the next financial day.

**Replication solution:** Data changes made during the day are captured and replicated to CCD tables (see Figure 11 on page 29). The batch application was modified to process the changes in the CCD tables instead of the table extracts. The online system does not need to be stopped to provide consistent data for the batch application.

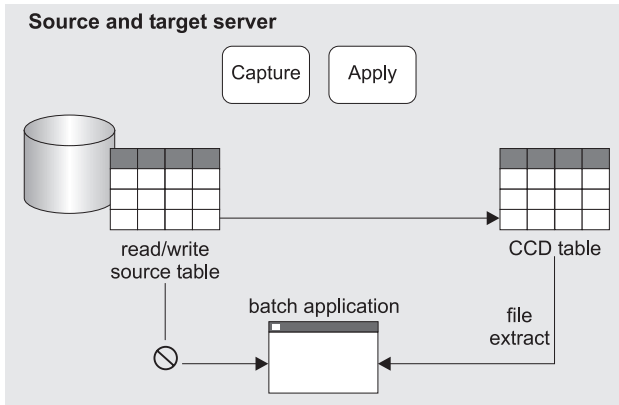


Figure 11. *Batch application using replicated data.* The source data is replicated to a CCD table. The batch application extracts data from the CCD table when the source table is unavailable.

**Design highlights:** The CCD table includes a timestamp that is used to identify the changes made during a time period (in this case, one day).

## Replicating operational data to decision support systems

**Requirements:** A financial institution needs to replicate updates from its customer information database on DB2 for AS/400 to a decision support system that is also on DB2 for AS/400. Historical data about updates must be saved and stored with no code changes to production applications and no impact to the performance of those applications.

**Replication solution:** Updates are captured from the key operational tables and, on an hourly basis, replicated to CCD tables in the decision support system (see Figure 12).

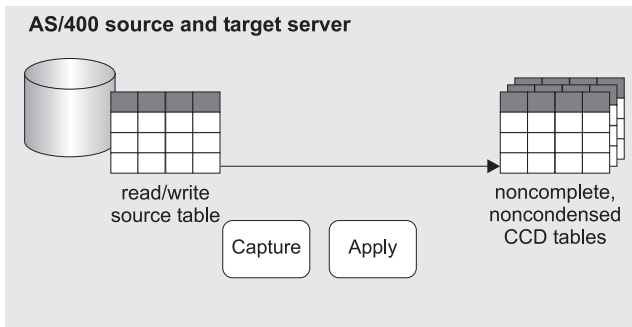


Figure 12. *Replicating operational data to decision support systems.* The noncondensed CCD target table is used to record all changes made to the source database.

**Design highlights:** The Capture and Apply programs maintain noncomplete, noncondensed CCD tables. Noncondensed CCD tables are used because they

record all changes that are made to the customer information database. Furthermore, noncomplete CCD tables are used because the financial institution does not want to record the original contents of the source, it wants only the changes.

The Capture and Apply programs are given job priorities such that replication does not impact production CPU resources. The decision support system could be implemented just as easily on any of the supported target platforms and could still be ported to other platforms if required.

### **Using target tables as sources of updates (update anywhere)**

**Requirements:** A financial institution has hundreds of agents at several branches who must fill in online forms to set up and modify client accounts. The agents base the quotation rates on information that was generated at the head office and sent to the branch. The agents send reports back to the head office, and the accounts are finalized only after the information is verified at the head office. The agents would be more productive if they had access to up-to-date data without the network problems of accessing the central database directly.

**Replication solution:** A special type of target table, called a *replica*, is used to set up circular subscriptions (see Figure 13 on page 31). Changes to the replica are replicated back to the primary replication source, which is a *user table*. An update that is made at one location is reflected in the databases at other locations. Agents have the current information that they need to finalize accounts while meeting with the client, and the head office has the new business data generated that day.

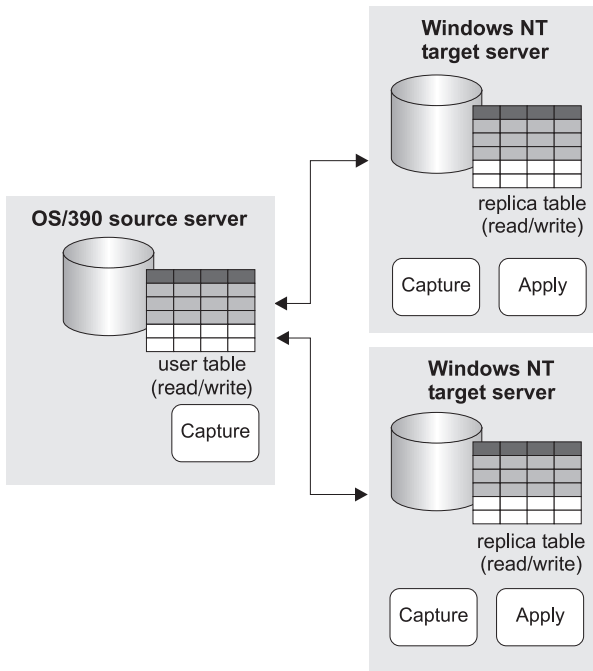


Figure 13. Update-anywhere replication. The primary data source, or parent replica, is on an OS/390 server; and the dependent replicas are on Windows NT client systems.

**Design highlights:** The primary replication source is a user table. It contains the most up-to-date information.

This type of replication works best when transaction conflicts between the central database and the updatable copies can be avoided, such as when copies can update only key ranges at specific sites, or when sites can make updates only during certain time periods.

DB2 DataPropagator detects conflicts that occur when the same row is updated on the host system and on an agent's system and neither change has been replicated. If an agent made updates that are in conflict, these updates are discarded during replication to ensure data integrity. The transaction containing the conflict and all captured transactions that are found that are dependent on the conflicting transaction are backed out.

### Updating data on occasionally connected systems

**Requirements:** An insurance company wants to equip its sales agents, who rarely visit the company's home office, with a set of offers to attract both new and existing customers—special introductory offers and personalized packages. Much of the time, the agents' computers will not be connected to

the home office. When they connect to the home office, they need to get any updated information from the central database. Managing the potential backlog of changes can be an issue.

**Replication solution:** The sales force is supplied with laptop computers running DB2 Universal Database Satellite Edition. As a sales campaign is launched, each agent downloads the customer profiles and history, as well as the latest product offers. DB2 replication also solves the problem of keeping the information up to date. Only new and changed data rows are copied across the network.

**Design highlights:** DB2 Universal Database Satellite Edition is used because it meets the replication requirements and can be administered by a central administrator. An administrator at the home office sets up the replication environment, tests it, and copies it to the occasionally connected systems. The administrator also provides user IDs and passwords to the agents in the field so that they can connect to the server at the home office from their laptop computers. While they are logged on, the agents can synchronize the information on their laptop computer with the information at the source server by pressing a button.

### **Retrieving data from a non-DB2 distributed data store**

**Requirements:** A manufacturing company uses an Oracle application to process customer orders, and DB2 on OS/390 for its central operational data store. The new order information is uploaded into DB2 in overnight batch extracts. The company wants the data to be replicated sooner because customers want their orders to be processed faster.

**Replication solution:** Triggers on the Oracle tables simulate the Capture program by placing the changed records into CCD tables at the Oracle server. Nicknames in DataJoiner make the Oracle source tables and CCD tables appear to be tables in a DB2 database so that the Apply program on OS/390 can replicate them to the DB2 for OS/390 tables. The Apply program is set to replicate every hour during the business day.

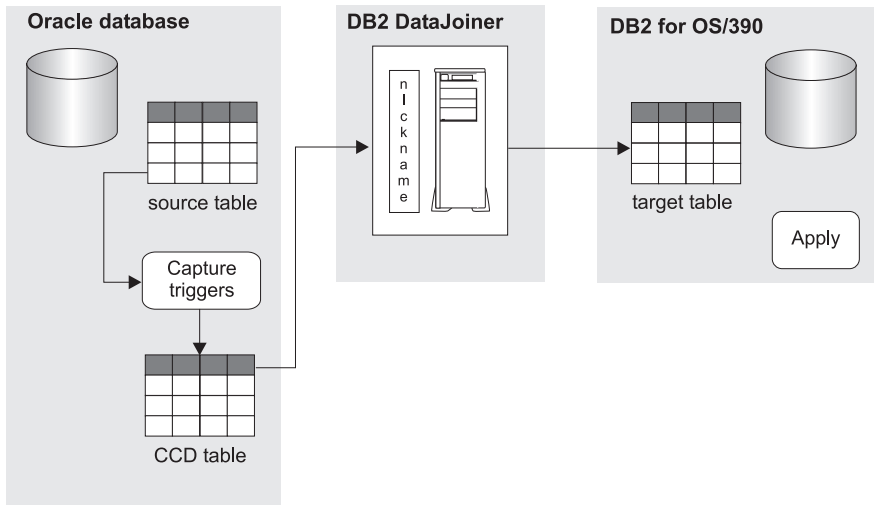


Figure 14. Retrieving data from a non-DB2 distributed data store. Triggers are used to capture changes made to source tables in Oracle, and DataJoiner is used to replicate to target tables on DB2 for OS/390.

**Design highlights:** DataJoiner Replication Administration (DJRA) is used to define the Capture triggers and the CCD tables in the Oracle database. DJRA also generates SQL statements to create all database objects and data type mappings. DataJoiner lets the Apply program access non-IBM data as if it were in DB2. The Apply program can also be run on DB2 for OS/390 to pull data.

## Replicating operational data to a non-DB2 reports and query database

**Requirements:** A large retail chain has their business operations applications on a mainframe that uses a DB2 for OS/390 subsystem. Staff and headquarters personnel need to query the operational data to create reports. The retail chain wants to replicate the data needed for the queries and reports to an Informix database management system on a UNIX server. The retail chain needs the reports and query results to be based on data that is less than four hours old.

**Replication solution:** The Capture program places the updates that are made to the operational data in DB2 for OS/390 tables. The subscription timing interval is set to four hours to make sure that the query results and reports are based on current operational data. Using DataJoiner nicknames, the Apply program replicates updates from the DB2 tables to the query and reports tables in the Informix database.

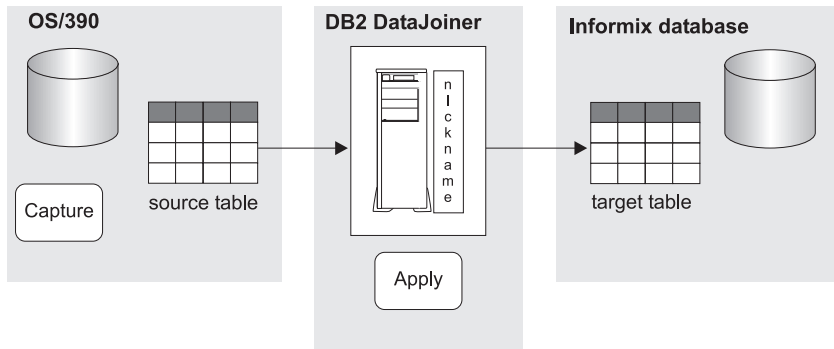


Figure 15. Replicating operational data to a non-DB2 reports and query database example. Changes made to source tables on DB2 for OS/390 are captured and replicated to target tables on Informix using nicknames defined in DataJoiner.

**Design highlights:** DataJoiner Replication Administration (DJRA) is used to create the target tables in Informix with the correct Informix data types. The Apply program replicates data to Informix using DataJoiner nicknames and any data type transformations that are needed.



---

## Chapter 3. Data replication scenario

Use the scenario in this chapter to get some experience using the DB2 Control Center and the Capture and Apply programs. Follow the steps in this simple scenario to copy changes from a DB2 replication source to a target table in a database on DB2 for Windows NT Enterprise Edition (EE) or Workgroup Edition (WE).

The scenario consists of the following parts:

1. "Before you begin"
2. "Planning this scenario" on page 36
3. "Setting up the replication environment for this scenario" on page 38
4. "Operating in a replication environment" on page 47

---

### Before you begin

If you want to work through this scenario on your computer, set up your system using these steps:

1. Make sure that you have DB2 for Windows NT installed on your computer.
2. Make sure that your DB2 Control Center uses the default settings. If you explicitly changed the default settings, some of the steps described in this scenario will not match what you see on your display.
3. Create the C:\scripts directory in which you will store the SQL files for replication.
4. Use the DB2 Control Center to create a new database called COPYDB, which you will use as the target and control server. To create the database, right-click the **Database** folder and follow the instructions for creating a new database using the wizard with default options.
5. Use the **First Steps** icon in DB2 Universal Database (or select **Start -> Programs -> DB2 for Windows NT -> First Steps**) to create the SAMPLE database. After the database is created, close the First Steps window. If you did not install First Steps when you installed DB2 for Windows NT, go to a DB2 command window and issue the **db2sampl** command to create the SAMPLE database.

The steps in this chapter use the data in the DEPARTMENT table from the SAMPLE database. The fully qualified name is *userID.Department*; where *userID* is the user ID that created the table. Table 1 on page 36 shows the DEPARTMENT table.

Table 1. DEPARTMENT table

DEPTNO	DEPTNAME	MGRNO	ADMRDEPT	LOCATION
A00	SPIFFY COMPUTER SERVICE	000010	A00	-
B01	PLANNING	000020	A00	-
C01	INFORMATION CENTER	000030	A00	-
D01	DEVELOPMENT CENTER	-	A00	-
D11	MANUFACTURING SYSTEMS	000060	D01	-
D21	ADMINISTRATION SYSTEMS	000070	D01	-
E01	SUPPORT SERVICES	000050	A00	-
E11	OPERATIONS	000090	E01	-
E21	SOFTWARE SUPPORT	000100	E01	-

For the remainder of this exercise, use the user ID with which you created the SAMPLE and COPYDB databases. Because you created the databases, you have the authority (DBADM or SYSADM) to perform replication tasks.

---

## Planning this scenario

Assume that an application that generates reports needs information that exists in the DEPARTMENT table of the SAMPLE database. Instead of using the data directly from the source table, you want to copy the changes to a target table that can be read only by the report-generating application. For ease of administration, you want to keep the target table on the same machine as the source server.

You require a simple data distribution configuration, with changes from one replication source being replicated to a single read-only copy. This section describes the design and planning issues that you need to consider before you perform any replication tasks.

### Replication source

You already know that the replication source is the *userID*.DEPARTMENT table in the SAMPLE database. Before you set up your environment, you must decide what you want to replicate from that table. You decide to make all columns available for replication; and you want to save before-image values for each of them so that you can see what is changed.

**Tip:** You might want to always include before-image values when you define a replication source. If you later change an update-anywhere configuration, you won't have to redefine your replication source.

## Replication target

You decide that you want your replication target to be the COPYDB database, which you created using DB2 for Windows NT earlier in this chapter. Currently there is no target table in that database; you want the Control Center to create the target table according to your specifications.

**Using existing target tables:** When you use the Control Center, the target table is created if it doesn't exist. This method of automatically generating a target table is preferred because it ensures correct mapping to the replication source. You can use existing target tables if they were created by any DB2 product.

Assume that you want the target table in COPYDB to contain the following columns of information:

### DEPTNO

Information from the DEPTNO column in the replication source (this column will be the primary key of the target table)

### DEPTNAME

Information from the DEPTNAME column in the replication source

### MGRNO

Information from the MGRNO column in the replication source

### ADMRDEPT

Information from the ADMRDEPT column in the replication source

### LOCATION

Information from the LOCATION column in the replication source

Because the columns in the target table simply reflect the data from the source table, and there is to be only one record in the target table for each record in the source table, you can use a *user copy* type of target table.

## Replication options

For the purpose of this exercise, you decide to store the target table and the replication control tables in the default table space, USERSPACE1.

Logical server	Table space	Contents
Source server: SAMPLE	USERSPACE1	Source replication control tables, including the CD table

---

Control server and target server: COPYDB	USERSPACE1	Replication control tables and the target table
---	------------	--

---

Typically you will want to put the UOW table and the CD tables (and CCD tables if you are using them) in their own table spaces, with table or table space locking. You can put all other replication control tables together in one table space with row-level locking.

For scheduling replication, assume that you want DB2 replication to check for any changes from the source table every minute and replicate them to the target table. Although a report-generating application doesn't require that kind of turnaround, you want to test the replication environment that you set up to make sure that everything is working correctly.

Also, you decide that after each replication cycle, you want to delete any records from the Apply audit trail table that are older than one week (seven days). This pruning prevents the table from growing too large.

You won't need to set constraints because you have a read-only target. Constraints are needed only when applications are updating a target table. In this scenario, the updates are committed at the replication source, and they must satisfy the constraints defined on that system. There is no reason for you to reevaluate the same constraints at the target.

---

## Setting up the replication environment for this scenario

After planning the replication model, you are ready to set up the replication environment.

### Step 1: Customize control tables

The Control Center automatically creates control tables at the source server and at the target server. By default, it builds the control tables with default settings (locking, table space) that are suitable for testing purposes but not for production environments. To customize the control tables for your production environment, you must edit and run the `dpcntl.udb` file *before* you perform any other replication task.

#### *To customize control tables:*

1. On the drive where you installed the DB2 Universal Database, change to the `sqlib\samples\repl\` directory.
2. Open the `dpcntl.udb` file. If you were in your production environment, you would edit and run this file to customize the control tables for your needs. For the purpose of this exercise, do not edit this file.
3. Close the `dpcntl.udb` file.

## Step 2: Define a replication source

After you customize the control tables, go to the Control Center to define the DEPARTMENT table as a replication source.

*To define a replication source:*

1. In the object tree, click the **Tables** folder under the SAMPLE database. All of the tables that exist in SAMPLE appear in the contents pane.
2. Right-click the DEPARTMENT table and select **Define as Replication Source -> Custom**. A custom replication is one that lets you manipulate the data before it is applied to the source. The Define as Replication Source window opens.
3. For this exercise, don't change anything on the Define as Replication Source window because you want to use the default settings. Click **OK**.
4. The Run Now or Save SQL window opens. Use these steps from the Run Now or Save SQL window:
  - a. You can run SQL now or later. Accept the default, which is to save the SQL to a file and run it later, by clicking **OK**.

**Tip:** Most of the time you will want to use the default. By saving the SQL to a file, you can look at the SQL to understand what it will do, make any modifications that you require, save the file, and run it after you are confident that it will do what you expect it to do.

- b. The System name window opens. Click **OK**.
- c. Use the File browser window to create a file in which to save the SQL:
  - 1) In the **Drives** field, select **C:**.
  - 2) In the **Directories** list, select **scripts** by double-clicking it. (To move up one directory level, double-click the two dots (..) at the top of the list.)
  - 3) In the **Path** field, type replsrc.sql.
  - 4) Click **OK**.

**Tip:** By default, the SQL file is saved in the sqllib directory. When you work in your own replication environment, you will want to keep all the files in a separate directory instead of storing them in sqllib.

- d. View the file that you created. Go to the C:\scripts directory and open the replsrc.sql file using an editor. For the purpose of this exercise, don't change anything in the file. Close the file.

**Tip:** When you set up your own replication environment, be careful how you edit this file. If you change the name of the CD table or the table space in which the CD table will be put, you must also

modify the CREATE INDEX statement for the CD table and update the CD table entry in the ASN.IBMSNAP\_REGISTER row.

5. Run the file to define the replication source:
  - a. Right-click the **Replication Sources** folder and select **Run SQL Files**.
  - b. Use the File browser window to select the SQL file that you saved in step 4c on page 39:
    - 1) In the **Drives** field, select **C:**.
    - 2) In the **Directories** list, select **scripts** by double-clicking it.
    - 3) In the **Files** field, select **replsrc.sql**.
    - 4) Click **OK**.
6. Verify that DEPARTMENT is defined as a replication source by right-clicking **Replication Sources** -> **Refresh**. The table name, DEPARTMENT, appears in the contents pane of the Control Center.

The table DEPARTMENT is now defined as a replication source. When you ran the SQL file, the Control Center created the change data (CD) table for this replication source and it created the replication control tables in the default table space (USERSPACE1) for the SAMPLE database.

### Step 3: Define a subscription set and a subscription-set member

After you define the source, you need to define a subscription set. A subscription set defines a relationship between the replication source (DEPARTMENT in this scenario) and a target table (that you will call DEPTCOPY in this scenario). It also defines some replication parameters.

*To define a subscription set and a subscription-set member:*

1. Select the **Replication Sources** object in the object tree, then right-click the **DEPARTMENT** object that appears on the right pane of the Control Center and select **Define Subscription**. The Define replication subscription window opens.
2. Set up the target table and subscription set:
  - a. Name the subscription set that you are defining by typing DEPTSUB in the **Subscription name** field.
  - b. Identify the database where the target table will reside by selecting COPYDB in the **Target server** field.
  - c. Type DEPTQUAL in the **Apply qualifier** field. This string identifies the definitions unique to the instance of the Apply program that will run this subscription set.

**Tip:** The Apply qualifier is case-sensitive. If you want the Apply qualifier to be in lowercase characters, you must delimit it when

you type it; for example "deptqual". If you simply type deptqual, the Control Center converts the value to uppercase characters by default.

- d. Specify that you want the Control Center to create the target table by selecting the **Create table** check box.
  - e. Click **Change**. The Change window opens.
    - 1) Change the default target table from *userid.DEPARTMENT* to *userid.DEPTCOPY* by typing over it.
    - 2) Click OK to return to the Define replication subscription window.
  - f. Click **Advanced**. The Advanced Subscription Definition notebook opens. Do the following steps:
    - 1) Leave the default selections on the **Target Type** page because you want to create a user copy target table.
    - 2) On the **Target Columns** page, make DEPTNO the primary key of the target table by selecting the **Primary key** check box next to DEPTNO.  
  
**Tip:** You might want to expand the window to view all of the columns. Also, some rows have names beginning with the letter X (for example, XDEPTNO). These rows store the before-image column values that you requested.
    - 3) On the **Rows** page, indicate that you want to replicate rows that meet certain criteria by typing the following for the WHERE clause:  
DEPTNO >= 'A00'
    - 4) Click **OK** to save these settings and return to the Define replication subscription window.
3. Define the SQL statements that will be processed when the subscription set is run:
- a. Click **SQL** to open the SQL window.
  - b. Click **Add** to open the Add SQL window.
  - c. Indicate that you want to delete any records in the Apply audit trail table that are older than seven days by typing the following processing statement in the **SQL statement or Call procedure** field:  
DELETE FROM ASN.IBMSNAP\_APPLYTRAIL WHERE LASTRUN  
< (CURRENT\_TIMESTAMP - 7 DAYS)
  - d. Indicate that "row not found" is an acceptable SQL state by typing the value 02000 in the **SQLSTATE** field and clicking **Add**. This value is added to the **Acceptable SQLSTATE values** list box.

**Tip:** You can define up to ten SQL states that you want to ignore for this subscription.

- e. Specify that the SQL is to run before the subscription set is processed by selecting the **At the target server before subscription is processed** radio button. In this case, you must run the SQL at the target server because the control server and target server are collocated and the Apply trail table is at the control server.
  - f. Click **OK**. The SQL statement is added to the list box in the SQL window and the Add SQL window closes.
  - g. Click **OK** in the SQL window to return to the Define replication subscription window.
4. Click **Timing** and use the Source to Target page of the Subscription Timing notebook to specify when and how often to replicate the subscription set.
    - a. Keep the default values for **Start date**, **Start time**, **Time-based**, and **Using relative timing**.
    - b. Specify that you want the subscription set to run in 1-minute intervals:
      - 1) Use the spin button on the **Minutes** field to select 1-minute intervals (or type 1 in the field).
      - 2) Use the spin button on the **Hours** field to change the default number to 0 (or type 0 in the field).
    - c. Click the **Data Blocking** tab, and use the spin buttons to select 1 as the number of minutes at a time that Apply will copy committed data.
 

**Tip:** The value that you set for data blocking depends on how much free space you have on the workstation that runs the Apply program. Typically, you would use a number from 5 to 20. If you want to be very conservative, use 1 minute.
    - d. Click **OK** to save these values, close the Subscription Timing notebook, and return to the Define replication subscription window.
  5. Submit the subscription set.
    - a. Click **OK** in the Define replication subscription window. The Run Now or Save SQL window opens.
    - b. Specify the control server, which is the database that will contain the subscription set control information, by selecting C0PYDB. This server is the database in which you want to store the subscription control information.
    - c. On the Run Now or Save SQL window, accept the default option, which is to save the SQL file and run it later, by clicking **OK**.
    - d. The System name window opens. Click **OK**.
    - e. Use the File browser window to create a file in which to save the SQL:
      - 1) In the **Drives** field, select C:.
      - 2) In the **Directories** list, select scripts by double-clicking it.
      - 3) In the **Path** field, type replsub.sql.



- 4) Click **OK**. The File browser window closes.
6. Run the file to define the subscription set:
  - a. Right-click the **Replication Subscriptions** object under the SAMPLE database and select **Run SQL Files**.
  - b. Specify the SQL file, `replsub.sql`, which you named in step 5e on page 42, and click **OK**.
7. Right-click the **Replication Subscriptions** object under the SAMPLE database and select **Refresh**. The DEPTSUB subscription set appears as an object on the contents pane of the Control Center.

#### Step 4: Configure the source database

**Tip:** If your source server were on another machine, you would need to log on to the source server over the network. You would use a user ID that has DBADM or SYSADM authority for the source server. However, because the source server for this exercise is on your local machine, you don't need to log on again.

*To configure the Capture program:*

1. Right-click the **SAMPLE** database object and select **Configure**. The Configure Database notebook opens.
2. Go to the Logs page, select the **Retain log files for roll-forward recovery and/or Capture** parameter from the list. In the **Value** box, select the **CAPTURE** radio button. By retaining the log, you ensure that DB2 won't overwrite log entries before the Capture program reads them.
3. Click **OK** to save the values.
4. Right-click the **SAMPLE** database object and select **Disconnect**.
5. Right-click on the **SAMPLE** database object and select **Backup -> Database**. Follow the instructions in the window to back up now to a directory on your system using the default options.

**Tip:** You must perform the backup action to make the database accessible. The database was put in backup pending mode when you specified that you want to retain log files for roll-forward recovery.

#### Step 5: Bind the Capture and Apply programs

**Tip:** For the purpose of this exercise, you will manually create and bind the Capture and Apply program packages. However, DB2 DataPropagator for all supported UNIX, Windows, and OS/2 operating systems can automatically create and bind the packages for you.

*To manually bind the Capture program*

1. Select **Start -> Programs -> DB2 for Windows NT -> Command Window** to open a DB2 command window.
2. Connect to the source server:  
DB2 CONNECT TO SAMPLE
3. Go to the sqllib\bnd directory. All the bind files are located in that directory.
4. Create and bind the Capture program package to the source server database by typing the following command:  
DB2 BIND @CAPTURE.LST ISOLATION UR BLOCKING ALL

The capture.lst file contains a list of the packages created.

Continue with the steps listed below.

*To manually bind the Apply program:*

1. Create and bind the Apply program package to the source server by typing both of the following commands:  
DB2 BIND @APPLYUR.LST ISOLATION UR BLOCKING ALL  
DB2 BIND @APPLYCS.LST ISOLATION CS BLOCKING ALL

The applyur.lst and applycs.lst files contain a list of the packages that were created.

2. Connect to the target server:  
DB2 CONNECT TO COPYDB
3. Create and bind the Apply package to the target server database by typing both of the following commands:  
DB2 BIND @APPLYUR.LST ISOLATION UR BLOCKING ALL  
DB2 BIND @APPLYCS.LST ISOLATION CS BLOCKING ALL

The applyur.lst and applycs.lst files contain a list of the packages that were created.

## **Step 6: Create a password file**

For end-user authentication to occur at the source server, you must create a password file with an AUTH=SERVER scheme. The Apply program uses this file when connecting to the source server. Make sure that the user ID that will run the Apply program can read the password file.

*To create a password file:*

1. Go to the C:\scripts directory.
2. Open a file editing session for a new file.
3. Type the following records in the empty file:

```
SERVER=SAMPLE USER=userid PWD=password  
SERVER=COPYDB USER=userid PWD=password
```

Where:

*server*

The name of the source, target, or control server, exactly as it appears in the subscription set table. (In this example, SAMPLE and COPYDB.)

*userid*

The user ID that you plan to use to administer that particular server. This value is case-sensitive on Windows NT and UNIX operating systems.

*password*

The password that is associated with that user ID. This value is case-sensitive on Windows NT and UNIX operating systems.

**Password file format:** Do not put blank lines or comment lines in this file. Add only the server-name, user ID, and password information. This information enables you to use different passwords or the same password for each server.

4. Save and close the file as deptqual.pwd.

**Password file naming convention:**

The password file name is *applyqual.pwd*; where *applyqual* is a case-sensitive string that *must* match the case and value of the Apply qualifier (APPLY\_QUAL) in the subscription set table. The file naming convention from Version 5 of DB2 DataPropagator is also supported: *ApplyqualInstance\_nameControl\_server.pwd*; which includes the case-sensitive Apply qualifier, the instance name that the Apply program runs under (the default name is DB2, in uppercase), and the name of the control server in uppercase (for example, COPYDB).

For more information about authentication and security, refer to the *IBM DB2 Administration Guide*.

## Step 7: Replicate the scenario data

After defining the replication source and the subscription set, you can submit the copy request by starting the Capture and Apply programs.

**To start the Capture program:**

1. In a Windows NT command prompt window, go to the C:\scripts directory.
2. Type the following command to start the Capture program using the cold start option without automatic pruning:

```
ASNCCP SAMPLE COLD NOPRUNE
```

**Tip:** Usually you would not specify the cold start option; you would let the Capture program determine whether it should cold start or warm start. For this exercise, you are forcing the Capture program to cold start to clean up the records in the CD and UOW tables.

The Capture program starts running but no new command prompt appears. This action creates a \*.ccp file. The Capture program is initialized but it does not start capturing changes for the defined replication source until you start the Apply program and it completes its initial full-refresh copy.

**To start the Apply program:**

1. From another Windows NT command prompt window, go to the C:\scripts directory on the target server where you stored the password file.

**Tip:** You must start the Apply program in the same directory in which you stored the password file. If you try to start the Apply program in another directory, you will get an error message.

2. Type the following command to start the Apply program:

```
ASNAPPLY DEPTQUAL COPYDB
```

**Tip:** The Apply qualifier, DEPTQUAL, is case-sensitive and must be entered in uppercase for this exercise.

**Tip:** You can use the LOADX invocation parameter to call the ASNLOAD program. Type the LOADX parameter after the database name (COPYDB) in the command statement above. The default ASNLOAD program uses the EXPORT utility to export data from the source table and uses the LOAD utility to fully refresh the target table. You can modify ASNLOAD to call any IBM or vendor utility.

The Apply program starts running, but no new command prompt appears. You can check the Apply trail table (ASN.IBMSNAP\_APPLYTRAIL) in COPYDB for status information.

If you view the DEPTCOPY target table after one replication cycle, you should see results that match the data shown in Table 2.

*Table 2. DEPTCOPY table*

DEPTNO	DEPTNAME	MGRNO	ADMRDEPT	LOCATION
A00	SPIFFY COMPUTER SERVICE	000010	A00	-
B01	PLANNING	000020	A00	-
C01	INFORMATION CENTER	000030	A00	-

Table 2. DEPTCOPY table (continued)

DEPTNO	DEPTNAME	MGRNO	ADMRDEPT	LOCATION
D01	DEVELOPMENT CENTER	-	A00	-
D11	MANUFACTURING SYSTEMS	000060	D01	-
D21	ADMINISTRATION SYSTEMS	000070	D01	-
E01	SUPPORT SERVICES	000050	A00	-
E11	OPERATIONS	000090	E01	-
E21	SOFTWARE SUPPORT	000100	E01	-

## Operating in a replication environment

After the replication environment is up and running, changes that are made to the replication source will be replicated to the target table. You must prune the control tables periodically to prevent them from growing too large. Although the Capture and Apply programs can run continuously, there are times when you will want to stop them (for example, to run utilities that use the table spaces that contain the control tables).

### Step 1: Update the source table

Assume that two new departments were created at the Spiffy Computer Service: a technical writing department and a public relations department.

*To update the source table:*

1. Select **Start -> Programs -> DB2 for Windows NT -> Command Window** to open a DB2 command window.
2. Connect to the source server:  
DB2 CONNECT TO SAMPLE
3. Add two new rows, one for each department, by typing both of the following commands:  
DB2 INSERT INTO DEPARTMENT VALUES ('F01','TECHNICAL WRITING','000110','F01',NULL)  
DB2 INSERT INTO DEPARTMENT VALUES ('G01','PUBLIC RELATIONS','000120','G01',NULL)
4. Connect to the target server:  
DB2 CONNECT TO COPYDB
5. Verify that the new rows are replicated to the target database by typing the following command:  
DB2 SELECT \* FROM DEPTCOPY

**Tip:** The replication process does not occur immediately. You should wait approximately five minutes before checking the table.

Table 3 shows the results of the replication, with two new rows appended to the table.

*Table 3. DEPTCOPY table after changes are replicated*

DEPTNO	DEPTNAME	MGRNO	ADMRDEPT	LOCATION
F01	TECHNICAL WRITING	000110	F01	-
G01	PUBLIC RELATIONS	000120	G01	-
A00	SPIFFY COMPUTER SERVICE	000010	A00	-
B01	PLANNING	000020	A00	-
C01	INFORMATION CENTER	000030	A00	-
D01	DEVELOPMENT CENTER	-	A00	-
D11	MANUFACTURING SYSTEMS	000060	D01	-
D21	ADMINISTRATION SYSTEMS	000070	D01	-
E01	SUPPORT SERVICES	000050	A00	-
E11	OPERATIONS	000090	E01	-
E21	SOFTWARE SUPPORT	000100	E01	-

## Step 2: Prune the control tables

The following steps assume that the Capture program is running. If the Capture program is not running, the **prune** command will not work.

**Tip:** On Windows NT, you can use the Task Manager to determine if the Capture program (ASNCCP) is running.

*To verify that there is something to prune:*

1. Open a DB2 command window. Use this window for the remainder of the steps in this exercise.
2. Type the following command to connect to the source server:  
DB2 CONNECT TO SAMPLE
3. Check that there are some rows in the unit-of-work table by typing the following command:  
DB2 SELECT COUNT(\*) FROM ASN.IBMSNAP\_UOW

There should be two rows in the unit-of-work table from the previous replication.

*To run the prune command:*

1. Type the prune command; and include the name of the source server:  
ASNCMD SAMPLE PRUNE

**Tip:** Usually you should prune during off-peak hours.

2. Verify that the prune command worked and the unit-of-work table is empty by typing the following command:  
DB2 SELECT COUNT(\*) FROM ASN.IBMSNAP\_UOW

There should be no rows in the table.

### **Step 3: Stop the Capture and Apply programs**

An important part of maintaining your replication environment is regular database maintenance. Sometimes that maintenance will require you to stop the Capture and Apply programs. For example, you must stop the Capture and Apply programs before you run utilities that directly use the table spaces that are used by these programs.

Perform the following steps in the DB2 command window that you opened in the previous step.

*To stop the Capture program:*

Type the following command: ASNCMD SAMPLE STOP

*To stop the Apply program:*

Type the following command: ASNASTOP DEPTQUAL (where DEPTQUAL is the case-sensitive Apply qualifier).

You can run DB2 utilities on your database now that you stopped the Capture and Apply programs. (Running the utilities is beyond the scope of this exercise.)





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## Chapter 4. Data replication tasks

This chapter introduces the key replication tasks that you perform at various stages in the replication process. The tasks are grouped into these major stages:

1. Planning your replication requirements
2. Setting up your replication environment
3. Operating in your replication environment

After you read this chapter, go to “Part 2. Administration” on page 59 for detailed information about these tasks. Also, see “Part 3. Operations” on page 173 for specific information about using the Capture and Apply programs on particular operating systems.

---

### Planning your replication requirements

An important step in coming up with the appropriate replication environment is determining the characteristics of your application data, who needs to access the data, and how frequently they need to access it.

You can use DB2 data replication to maintain data in more than one location and keep the various copies of it synchronized. You must determine where your source data will be coming from. You must decide whether you want all or some of the source information copied, or whether you want only changes copied, and how many copies (or targets) you need. You also need to determine where the copies will be located.

Although you cannot update the source tables and target tables synchronously, you can schedule the updates to meet the needs of your applications and your replication environment. The frequency of replication depends on how much lag time is acceptable between the time that the source is updated and the time that the targets are updated. Therefore, you must decide how synchronized the copies must be with the source and with each other before you can come up with a replication model.

After you understand your application data requirements, you can design the replication model that will help you meet those requirements. There are many facts that you need to consider when you design your model. These are some of the more important decisions that you need to make:

#### The replication configuration

Based on your data needs, you must decide whether you need a consolidation, distribution, update-anywhere, or occasionally

connected configuration. You have the flexibility to design your environment so that it uses one of these configurations or some combination of them.

#### **Where to locate the control server**

You will get slightly better performance if you place the control tables on the same server as the Apply program instead of placing them centrally, because the Apply program frequently reads the control tables at the control server. You can have your Apply programs share a single control server so that your control information is stored centrally. The control server can be located at the source server, the target server, or any database server that the Apply program can connect to. A central control server is popular because it simplifies the administration of large networks, but it has two drawbacks: the Apply program must access the control information over the network and, if the control server goes down, all of the Apply processes are affected. However, if the source server is in a secure environment, locating the control server at the source server can improve security and let you manage and monitor replication subscriptions centrally.

#### **The type of target tables to use**

The type of target table that you use depends on your replication requirements. Each type is best suited for specific situations. For example, a replica is the only type of target table that you can use for update-anywhere replication; and a row-replica is the only type of target table you can use with DataPropagator for Microsoft Jet.

#### **Whether to use existing target tables**

You can let the administration interface create the target table for you or you can use an existing table as a target. If the existing tables are DB2 tables, the data types are supported by the DB2 data replication components. If your replication environment includes non-IBM databases, some of the data types might not map directly to the source tables that you are using.

#### **Which columns to make available for replication**

You can choose to capture only the after-image column values or both the before-image column values and the after-image column values. If you will be using the targets for auditing purposes, or if you have replica target tables, you must copy both the after-image and before-image column values.

#### **How to capture SQL operations**

You might want to capture all updates as two rows in the CD table or in the CCD table of a non-IBM source: a DELETE of the before-image column values followed by an INSERT of the after-image column values. This includes updates of columns that will be the primary key of the target, columns that will be the partitioning key of the target, or

columns that are part of the WHERE clause or predicate of the subscription set. You might need to adjust the size of the CD table to accommodate this increased overhead.

### **The level of constraints**

You must use referential constraints to enforce referential integrity *only* if you have target tables that are replica tables. If you have a read-only table, you do not need to set constraints at the target. The referential integrity of other types of target tables is ensured if you define your subscription sets appropriately.

### **Which joins to use**

Joins are described in views, which in turn are defined in replication sources. For example, you might use a view to change the name of copied columns, to reference columns from related tables in the WHERE clause in your subscription member predicate, to incrementally maintain copies that are inner joins of two or more tables, or to replicate information from one table when an update is made to another table.

When you are ready to plan your replication environment, see “Chapter 5. Planning for replication” on page 61 for detailed planning information.

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## **Setting up your replication environment**

After you design the replication model, you must set up your replication environment. These steps are involved in setting up your replication environment:

1. Setting up the system
2. Defining the replication criteria
3. Performing the initial replication

The rest of this section introduces the steps involved in setting up your environment. “Chapter 6. Setting up your replication environment” on page 93 contains detailed instructions on setting up your replication environment.

### **Setting up the system**

To set up the system, you perform the following steps:

1. Migrate from previous releases of DataPropagator products.
2. Grant access to the proper user IDs.

### **Setting up the replication criteria**

To set up the replication criteria, you perform the following steps:

1. Configure the administration tool. For example, if you are using DJRA, you need to associate passwords with databases.
2. Customize and create replication control tables.

3. Customize change data (CD) tables. This step is optional. You can change the default name and table space of your CD tables. If you are using the DB2 Control Center, you must customize your CD tables *before* you define a replication source. If you are using the DJRA tool, you customize the CD tables when you define the replication source.
4. Define replication sources. This step includes identifying the table or view from which you want data copied and the types of changes that you want captured.
5. Define subscription sets and subscription-set members. This step includes associating the replication source with the target to which you want the changes replicated. You can define subscription sets and subscription-set members at any time prior to starting the Apply program.
6. Configure the Capture program. This step includes enabling the source server for logging; it also includes creating and binding the Capture program package to the source server.
7. Configure the Apply program. This step includes creating and binding the Apply program package to the source server; the target server, and the control server, it also includes creating and binding the Apply program to the target server.<sup>11</sup>

## Performing the initial replication

**Important:** When you set up your replication environment, you must start the Capture program and let it initialize fully before you start any Apply programs.

To perform the initial replication, you must perform the following steps in the exact order:

1. Make sure that at least one replication source is defined.
2. Start the Capture program. This step includes specifying invocation parameters (such as `NOPRUNE`, which prevents automatic pruning of the CD and UOW tables). After the Capture program is fully initialized, it will not capture any changes until the Apply program signals it to do so.
3. If you haven't already done so, define at least one subscription set and one subscription set member.
4. Start one or more Apply programs. This step includes specifying invocation parameters (such as `LOADX`, which calls `ASNLOAD`—an exit routine to initialize target tables). Each Apply program will perform a

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11. If the Capture program and the Apply program are not on OS/390, they will automatically bind.

full-refresh copy for all subscription-set members and the Capture program will begin capturing changes for the associated replication sources.<sup>12</sup>

**Tip:** Use the WARMNS option in the Capture program if you want to be able to repair any problems (such as unavailable databases or table spaces) that might prevent a warm start from occurring.

## Adding to your replication environment

You probably need to add replication sources and subscription sets to your replication environment from time to time.

To add to your replication environment, you must perform the following steps in the exact order:

1. Define the new replication source.
2. Run the Capture **reinit** command, or stop the Capture program and warm start it.
3. Define the new subscription sets and subscription set members.
4. The Apply program will automatically recognize the new subscription set if the Apply program is already running and it uses the Apply qualifier that is associated with the new subscription set. Otherwise, you must start a new Apply program using the appropriate Apply qualifier before the Apply program can recognize the new subscription set.

## Copying your replication environment

After you define your replication environment on one system (for example, a test system), you can copy the replication environment to another system (for example, a production system). You use the promote functions to reverse-engineer your tables, replication sources, and subscription sets and to create a script file with the appropriate data definition language (DDL) and data manipulation language (DML). For more information about the promote functions, see “Copying your replication configuration to another system” on page 127 and the on-line help for the administration interface.

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## Operating in your replication environment

After your replication environment is up and running and updates are replicated, you need to perform periodic maintenance tasks. These include the following tasks:

### Configuring the pruning of control tables

The UOW and CD tables will grow too large if the contents are not

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12. If you use non-IBM load utilities, it is recommended that you use the offline load feature in DJRA. For more information on setting up the offline load feature with DJRA, see “Loading target tables offline using DJRA” on page 127.

pruned regularly. You can configure your system to prune automatically, or you can prune manually. You control how frequently obsolete information will be removed from these tables. If the tables aren't pruned often enough, the table space that they're in will run out of space, which will force the Capture program to stop. If they are pruned too often or during peak times, the pruning interferes with the change capture process. You can use the optimal pruning frequency for your replication environment.

### **Monitoring important criteria**

Many factors determine how well your replication environment performs. You can use the Replication Monitor, which is part of DJRA, to generate a report that will help you monitor the activities of the Capture and Apply components, as well as the status of the subscription sets. For example, the report contains historical information to help you determine trends about subscription latencies.

### **Dealing with data modification conflicts**

If you are using update-anywhere replication, and you did not design your configuration to prevent update conflicts, you must handle update conflicts and rejected transactions.

### **Performing regular database maintenance**

If you want your replication environment to run smoothly, you must regularly perform database maintenance tasks. For example, use the RUNSTATS utility against the DB2 catalog tables to collect new statistics for tables and indexes. Also use the RUNSTATS utility once after the CD and UOW tables have sufficient data in them so that the DB2 Optimizer will use indexes on them. Periodically use the REORG utility (or the RGZPFM command in AS/400) for the change data tables, the unit-of-work table, and the target tables. You must also delete rows from the Apply trail table, which contains subscription set statistics and error information.

### **Coordinating with DB2 utility operations**

If you want to run DB2 utilities (such as REORG, RUNSTATS, BIND PACKAGE, and REVOKE) that will use the table spaces that contain the replication control tables, you must stop the Capture and Apply programs before running the utilities.

### **Changing your replication configuration as your business needs change**

You are likely to need to modify your replication environment from time to time. Whether you add a new column to an existing source table, or drop a source table, you will need to modify your replication criteria. Also, you will need to maintain password files. For more information about modifying your replication configuration, see "Modifying your replication configuration" on page 147.

## Troubleshooting

If you find that your replication environment is not performing as you expected, or if you can't replicate data, you can run the Replication Analyzer. The Replication Analyzer is a tool that is packaged with DB2 Universal Database and the DataJoiner Replication Administration tool. You can use the Replication Analyzer to analyze the behavior of the Capture program or the Apply program. It can answer such questions as: "why is the Capture program not capturing?" and "why is the Apply program not applying?" The Replication Analyzer can help diagnose problems, verify replication setup, and offer suggestions for performance tuning. You can also look in the Apply trail table for status information about the Apply program, or in the Capture trace table for status information about the Capture program. For details see "Chapter 8. Problem determination" on page 151.

For general information about operating in a replication environment, see "Chapter 7. Operating DB2 DataPropagator" on page 139. For information about operating in a particular operating system, see the appropriate chapter in "Part 3. Operations" on page 173.





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## Part 2. Administration

This part of the book contains the following chapters:

“Chapter 5. Planning for replication” on page 61 explains the information you need to help you design your replication environment.

“Chapter 6. Setting up your replication environment” on page 93 describes the steps for setting up and starting replication.

“Chapter 7. Operating DB2 DataPropagator” on page 139 describes how to operate the Capture and Apply programs generally. Platform-specific information is in “Part 3. Operations” on page 173.

“Chapter 8. Problem determination” on page 151 describes the available problem-determination facilities.



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## Chapter 5. Planning for replication

This chapter explains the information that you need to help you design your replication environment: capacity planning, storage requirements, network requirements, deciding what to replicate, auditing requirements, staging data, and planning for migration.

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### Capacity planning

The Capture program does not generally impact other applications and requires a minimum of central processing unit (CPU) or central processing complex (CPC) capacity. For example, you can schedule Capture for OS/390 at a lower priority than the application programs that update the source tables. In this case, the Capture program lags behind when CPU resource is constrained.

The Capture program does use CPU resources when it prunes the CD tables and UOW table, but you can defer this activity to reduce system impact.

The Apply program affects CPU usage depending on the frequency of replication, that is, on the currency requirement of the target database. Because the Apply program reads data from the source server and copies that data to the target server, it uses CPU resources on both systems.

In general, the DB2 Control Center and DJRA do not require many local CPU resources. However, when you generate the SQL for replication sources and subscription-set definitions, DB2 DataPropagator extensively searches the catalogs of the source server. And for large sites, these searches can have a noticeable CPU or database system impact.

**Recommendations:** Plan replication administration for times when impact to the source and target database systems is minimal. Use filtering to minimize the amount of data returned from the source server.

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### Storage planning

In addition to the storage required for DB2, replication requires storage for:

#### Database log and journal data

The additional data logged to support the replication of data.

### **Active log file size for Capture for VSE and VM and current receiver size for Capture for AS/400**

You need to ensure that the data needed for replication remains on the active log, rather than on archived logs.

### **Target tables and control tables**

The replicated user data and control tables (including change data tables).

### **Spill files**

The Apply program requires temporary space to store data. Apply for OS/390 can use memory rather than disk space for the spill files; the Apply program for all other operating-system environments uses disk space for the spill files.

If there is insufficient disk space for the spill files, the Apply program terminates. If you specify that Apply for OS/390 should use memory, but there is not enough memory for the spill files, the Apply program abends; in this case, specify that the Apply program should use disk space and restart it. For more information about spill files, see “Spill files” on page 65.

All of the sizes given in the following sections are estimates only. To prepare and design a production-ready system, you must also account for such things as failure prevention. For example, the holding period of data (discussed in “Target tables and control tables” on page 63) might need to be increased to account for potential line outage.

If storage estimates seem unreasonably high, reexamine the frequency interval of the Apply program (how often your subscriptions run) and pruning. Trade-offs frequently must be considered between storage usage, capacity for failure tolerance, and CPU overhead.

### **Database log and journal data**

Before you can replicate a table, you must create it (or alter it) with the DATA CAPTURE CHANGES keywords. One of the effects of these keywords is that DB2 logs full-row images for each UPDATE statement. For a replica table (in an update-anywhere scenario), DB2 also logs the before-images for each update to the table. Another increase to the log or journal volume comes from DB2’s logging insertions to and deletions from the unit-of-work (UOW) and change data (CD) tables.

Although estimating the increase in the log or journal volume is not easy, in general you will need an additional three times the current log volume for all tables involved in replication.

To make a more accurate estimate, you must have detailed knowledge of the updating application and the replication requirements. For example, if an

updating application typically updates 60% of the columns in a table, the replication requirements could cause the log records to grow by more than half compared to a similar table that is not replicated. One of the replication requirements that adds the most to the log is the capturing of before- and after-images (as in the case of update-anywhere replication scenarios). One way to reduce the log volume is to reduce the number of columns defined for the replication source.

In addition to logging for the source database, there is also logging for the target database, where the rows are applied. Because the Apply program does not issue interim checkpoints, you should estimate the maximum amount of data that the Apply program will process in one time interval and adjust the log space (or the space for the current receiver for AS/400) to accommodate that amount of data.

### **Active log file size for Capture for VSE and VM and current receiver size for Capture for AS/400**

For VM and VSE, when the active log is full, DB2 archives its contents. For AS/400, when the current receiver is full, the system switches to a new one; you can optionally save and delete old ones no longer needed for replication. When a system handles a large number of transactions, the Capture program can occasionally lag behind. If the log is too small, some of the log records could be archived before they are captured. Capture for VSE and VM running with DB2 for VSE & VM cannot recover archived log records.<sup>13</sup>

For DB2 for VSE & VM, ensure that your log is large enough to handle at least 24 hours of transaction data. For DB2 for AS/400, ensure that the current receiver is large enough to handle at least 24 hours of data.

### **Target tables and control tables**

The space required for a target table is usually no greater than that of the source table (or tables), but can be much larger if the target table is denormalized or includes before images (in addition to after-images) or history data. The following also affect the space required for a target table: the number of columns replicated, the data type of columns replicated, any row subsets defined for the subscription-set member, and data transformations performed during replication.

The CD tables and the UOW table also affect the disk space required for a source database. The space required for the replication control tables is generally small because each requires only a few rows.

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13. Capture for OS/390 running with DB2 for MVS/ESA V4 or higher and DB2 Universal Database V5 or later can recover archived log records.

The CD tables grow in size according to the amount of data replicated until the Capture program prunes them. To estimate the space required for the CD tables, first determine how long you want to keep the data before pruning it, then specify how often the Capture program should prune these tables or how often you issue the **prune** command. To determine the minimum size for the CD table, use the following formula:

$$\text{minimum\_CD\_size} = (21 \text{ bytes} + \text{sum}(\text{length of all registered columns})) * (\text{number of inserts, updates, and deletes to source table}) * (\text{exception factor})$$

When calculating the number of bytes of data replicated, you need to include 21 bytes for overhead data added to the CD tables by the Capture program. In the formula, determine the number of inserts, updates, and deletes to the source table within the interval between capturing and pruning of data. The exception factor allows for such things as network failures or other failures that prevent the Apply program from replicating data. Use a value of 2 initially, then refine the value based on the performance of your replication environment.

**Example:** If the Capture program prunes applied rows from the CD table once daily, your interval is 24 hours. If the rows in the CD table are 100 bytes long (plus the 21 bytes for overhead), and 100,000 updates are applied during a 24-hour period, the storage required for the CD table is about 12 MB.

The maximum size of a CD table is dependent on the maximum number of columns and maximum size of a row allowed by DB2 for a particular platform. Table 4 shows how to calculate the maximum size for a CD table. For replica tables, you must divide the maximum number of columns and maximum row length by two, because the CD table for a replica table includes columns for before images.

*Table 4. Calculating maximum size for a CD table.* The value *maxCols* represents the maximum number of columns allowed by DB2 for a table; the value *maxLength* represents the maximum row length allowed by DB2.

	For read-only target tables	For read-write (replica) target tables
Number of columns	<i>maxCols</i> – 3 columns	( <i>maxCols</i> – 3 columns) / 2
Row length	<i>maxLength</i> – 21 bytes	( <i>maxLength</i> – 21 bytes) / 2

The UOW table grows and shrinks based on the number of rows inserted in a particular time interval (the number of commits issued within that interval by transactions that update source tables or by Capture for AS/400). You should initially overestimate the size required and monitor the space actually used to determine if any space can be recovered. The size of each row in the UOW

table is fixed at 79 bytes (except for DB2 for AS/400, where it is 109 bytes). For a first approximation of the space needed for the UOW table, multiply 79 bytes (or 109 bytes) by the number of updates applied during a 2-hour period. Use a formula similar to the one given above for CD tables to obtain a better estimate for the space needed for the UOW table. For more information, see “Unit-of-work table” on page 319.

## Spill files

The Apply program stores updates to target tables in temporary files called spill files.<sup>14</sup> These files hold the updates until the Apply program applies them to the target tables. The Apply program uses multiple spill files for subscription sets with multiple subscription-set members: one spill file for each target table. The Apply program stores the spill file on disk for every operating-system environment, but Apply for OS/390 can use virtual memory instead. Unless you have virtual memory constraints, store the spill files in virtual memory rather than disk.

The size of the spill file is equal to the size of the data selected for replication during each replication interval. You can estimate the size of the spill file by comparing the frequency interval (or data-blocking interval; see “Data blocking for large volumes of changes” on page 68) planned for the Apply program with the volume of changes in that same time period (or in a peak period of change). The spill file’s row size is the *target row* size, including any DB2 DataPropagator overhead columns. This row size is not in DB2 packed internal format, but is in expanded, interpreted character format (as fetched from the SELECT). The row also includes a row length and null terminators on individual column strings.

**Example:** If change volume peaks at 12,000 updates per hour and the Apply program frequency is planned for one-hour intervals, the spill file must hold one-hour’s worth of updates, or 12,000 updates. If each update represents 100 bytes of data, the spill file will be about 1.2 MB.

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## Network planning

This section describes connectivity requirements, discusses where to run the Apply program (using the push or pull configuration), and describes how data blocking can improve performance.

### Connectivity

Because data replication usually involves physically separate databases, connectivity is important to consider during the planning stages. The workstation that runs the DB2 Control Center or DJRA must be able to

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14. If you are using the ASNLOAD utility, you have a load input file instead of a load spill file.

connect to the control, source, and target server databases to perform their tasks. And the Apply program must be able to connect to the control, source, and target server databases.

When the databases are connected to a network, connectivity varies according to the platforms being connected:

- For connections between DB2 Universal Database databases, your choices are TCP/IP, SNA, NetBIOS, or IPX/SPX.
- For connections between DB2 Universal Database databases and DB2 for OS/390, DB2 for VSE, or DB2 for VM databases, you need DB2 Connect Personal Edition (or DB2 Connect Enterprise Edition) on the same workstation as the database to which you are connecting, or you need DB2 Connect Enterprise Edition (or DB2 Universal Database Enterprise Edition) available through your network. You can use TCP/IP or SNA for any of the following: DB2 for OS/390 V5 or later, AS/400 V4R2 or later, or DB2 for VM V5 or later. For all other connections, you can only use SNA.

If you use password verification for DB2 for OS/390, use Data Communication Service by adding DCS to the CATALOG DB statement. If you connect using SNA, add SECURITY PGM to the CATALOG APPC NODE statement. However, if you connect using TCP/IP, there is no equivalent security keyword for the CATALOG TCPIP NODE statement.

If your replication design involves staging data at a server that is different from the source database, you must carefully consider the communications between the various servers. For example, in an occasionally-connected replication scenario between DB2 Universal Database running on Windows 95 on a laptop PC and DB2 for OS/390, a good connectivity scenario might be for the Windows 95 PC to dial a local server (for example, an AIX server with DB2 Universal Database Enterprise Edition) using TCP/IP over a modem. The AIX workstation then connects to DB2 for OS/390 to fulfill the request from the Windows 95 machine.

Be sure to limit the layers of emulation, LAN bridges, and router links required, because these can all affect replication performance.

### **Where to run the Apply program: push or pull configuration**

You can run the Apply program at the source server or at the target server. When the Apply program runs at the source server, you have a *push configuration*: the Apply program pushes updates from the source server to the target server. When the Apply program runs at the target server, you have a *pull configuration*: the Apply program pulls updates from the source server to the target server.

The Apply program can run in either or both configurations at the same time: it can push updates for some subscription sets and pull updates for others.



If the target table is in a non-IBM database, the Apply program connects to a DB2 DataJoiner database (with DB2 DataJoiner connected to the non-IBM database) and applies the changes to the target table using DB2 DataJoiner nicknames. In this case, the Apply program pushes updates from the DB2 DataJoiner source server to the target server or pulls updates from the DB2 DataJoiner source server to the target server. The Apply program cannot push or pull directly from the non-IBM server.

Figure 16 shows the differences between the push and pull configurations.

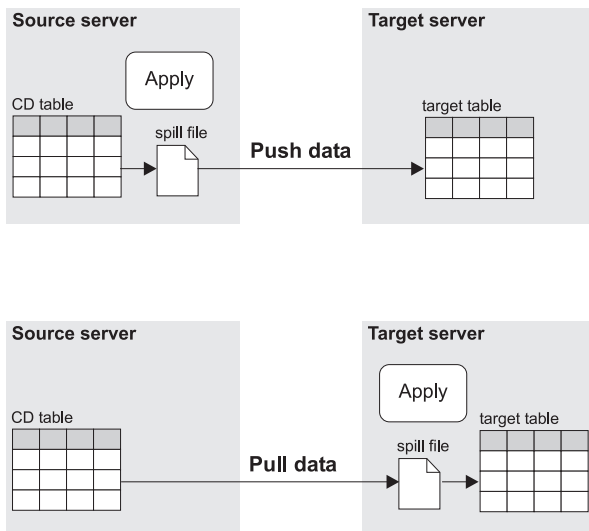


Figure 16. Push versus pull configuration

In the push configuration, the Apply program connects to the local source server (or to a DB2 DataJoiner source server for non-IBM sources) and retrieves the data. Then, it connects to the remote target server and pushes the updates to the target table. The Apply program pushes the updates row by row, and cannot use DB2's block-fetch capability to improve network efficiency.

In the pull configuration, the Apply program connects to the remote source server (or to a DB2 DataJoiner source server for non-IBM sources) to retrieve the data. DB2 can use block fetch to retrieve the data across the network efficiently. After all data is retrieved, the Apply program connects to the local target server and applies the changes to the target table.

Generally, a pull configuration performs better than a push configuration because it allows more efficient use of the network. However, under the following circumstances a push configuration is a better choice:

- When there is no Apply program for the target server platform, for example, as with VSE or VM.
- When you use remote journaling or relative record numbers (RRN) on your AS/400 source servers and the target server is a non-AS/400 system.
- The source table changes very infrequently, but when it does change it should be replicated as soon as possible.

To set up a push or pull configuration you need only to decide where to run the Apply program. DB2 DataPropagator, the DB2 Control Center, and DJRA recognize both configurations.

### Data blocking for large volumes of changes

Replication subscriptions that replicate large blocks of changes in one Apply cycle can cause the spill files or log (for the target database) to overflow. For example, batch-Apply scenarios can produce a large backlog of enqueued transactions that need to be replicated. Or, an extended outage of the network can cause a large block of data to accumulate in the CD tables, which can cause spill-file overflows.

Use the Data Blocking page of the Subscription Timing notebook in the DB2 Control Center or the **Blocking factor** field of the Create Empty Subscription Sets window in DJRA to specify how many minutes worth of change data the Apply program can replicate during a subscription cycle. The number of minutes that you specify determines the size of the data block.<sup>15</sup> This value is stored in the MAX\_SYNC\_MINUTES column of the Subscription set table. If the accumulation of change data is greater than the size of the data block, the Apply program converts a single subscription cycle into many mini-cycles, reducing the backlog to manageable pieces. It also retries any unsuccessful mini-cycles and will reduce the size of the data block to match available system resources. If replication fails during a mini-cycle, the Apply program retries the subscription set from the last successful mini-cycle. Figure 17 on page 69 shows how the changed data is broken down into subsets of changes.

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15. If your subscription set includes tables with DATALINK columns, this value also specifies the number of files passed to the ASNDLCOPY exit routine.

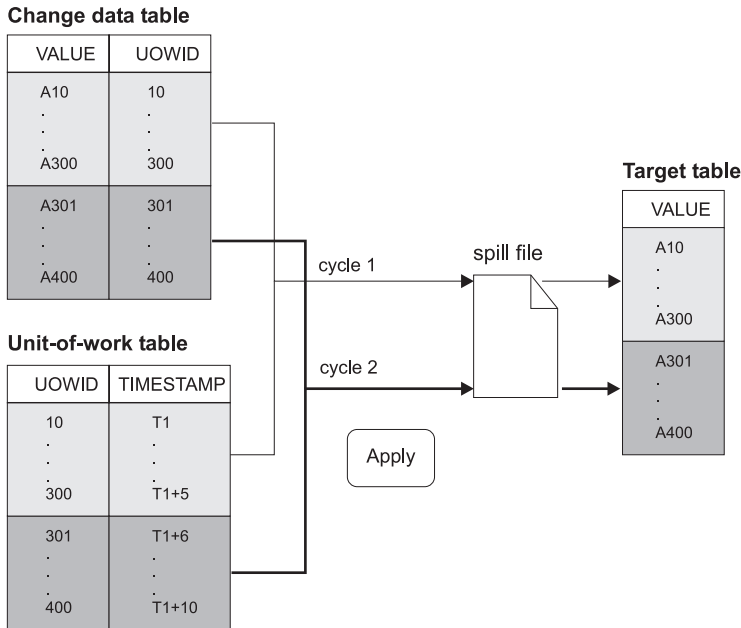


Figure 17. Data blocking. You can reduce the amount of network traffic by specifying a data-blocking value.

By default, the Apply program uses no data blocking, that is, it copies all available committed data that has been captured. If you set a data-blocking value, the number of minutes that you set should be small enough so that all transactions for the subscription set that occur during the interval can be copied without causing the spill files or log to overflow. For AS/400, ensure that the total amount of data to be replicated during the interval does not exceed 4 MB.

**Restrictions:**

- You cannot split a unit of work.
- You cannot roll back previous mini-subscription cycles.
- You cannot use data blocking for full refreshes.

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**Deciding what to replicate**

As part of planning for replication, you need to consider how the data will be used at the target site. Often, the source data will need to be subsetted, transformed, or enhanced for decision-support or data-warehousing applications. This section sorts these requirements into those that are easily fulfilled by using the DB2 Control Center or DJRA, and those that require direct manipulation of the control tables.

The Control Center and DJRA support the following data manipulations:

- Subsetting columns and rows
- Replicating joins using views
- Replicating before and after images
- Renaming columns
- Creating computed columns
- Using stored procedures for before and after run-time processing

The following sections describe the data manipulations that you can perform using the Control Center or DJRA. This chapter also describes replicating large-object (LOB) data, limits for column names for before-image data, and data-type restrictions.

## Subsetting columns and rows

IBM Replication supports both column (vertical) and row (horizontal) subsetting of the source table. This means that you can specify that only a subset of the source table columns and rows be replicated to the target table, rather than all of the columns and rows:

### Column subsetting

In some replication scenarios, you might not want to replicate all columns to the target table, or the target table might not support all data types defined for the source table. You can define a column subset that has fewer columns than your source table. Column subsetting is available for all tables except replica tables.

You can define column subsetting at one of two times:

- When you define a replication source table for differential refresh. Select *only* those columns that you want to make *available* for replication to a target table. Because CD tables must contain sufficient key data for point-in-time copies, you must include primary-key columns in your subset. The columns that you do not select will not be available for replication to any target table.

- When you define a subscription set.

For the Control Center, use the advanced subscription options to select *only* those columns that you want to replicate to the target table. For DJRA, you can select the columns when you add members to the subscription set. The columns that you do not select are still available for other subscription sets, but are not included for the current subscription set.

**Recommendation:** When you define a replication source, select *all* columns (that is, do not subset any of them). Create your column subsets when you define subscription sets. By defining your column

subsets in the subscription sets rather than in the replication sources, you will not have to redefine your replication sources if your subscription requirements change.

### **Row subsetting**

In some replication scenarios, you might want to replicate different data from a source table to several target tables. You can define a row subset that contains rows matching a certain condition (a WHERE clause), for example, all rows for department “J35”.

Use the advanced subscription options to define a WHERE clause when you define the subscription. All target table types support row subsetting.

If the primary key values of the target table will be updated, or the table (or view) contains a logical partitioning column that will be updated, you must specify replication logical-partitioning-key support when you define the replication source. Replication logical-partitioning-key support performs an UPDATE as a DELETE followed by an INSERT. See “Enabling replication logical-partitioning-key support” on page 109 for more information.

### **Replicating joins using views**

Join views fill many requirements, both for denormalizing (restructuring) copies in data-warehouse scenarios, which enables simpler queries of copied data, and also for addressing the routing problem, sometimes called the database partitioning problem in distributed computing scenarios.<sup>16</sup> Views are also useful when you need to specify predicates for a row subset that exceed 512 bytes (the capacity of the PREDICATES column of the subscription-targets-member control table). Thus, you can choose to manage your subset predicates using views rather than as part of the subscription-set definition.

To define a join view as a replication source using the Control Center, first define all tables that participate in the join as replication sources (you do not need to define subscriptions for them). To define a join view as a replication source using DJRA, you can use existing views or you can define a join view that includes tables that are not defined as replication sources. You can use the Control Center or DJRA to define the view as a replication source; see “Defining views as replication sources” on page 108. If the replication sources defined in the join have CD or CCD tables, the Control Center or DJRA creates a CD view from the replication sources’ CD tables.

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16. For example, knowing where to send a bank account update may require a join of the account table with the customer table to determine which branch of the bank the customer deals with. Typically, production databases are normalized so that the geographic details, such as branch-number, are not stored redundantly throughout the database.

IBM Replication supports the following types of view definitions:

- Simple views over a single table

Only views of tables that reside within DB2 databases are supported. Views of tables that are stored on Oracle, Microsoft SQL Server, Sybase, Sybase SQL Anywhere, Informix, or Teradata are not supported.

When defining DB2 views as a replication source, create them using a correlation ID.

- Simple inner-joins over one or more defined replication sources
- Simple inner-joins over one or more CCD staging tables<sup>17</sup> that are defined as replication sources and maintained by an Apply program or an application other than an IBM Replication component and an external data source, such as IMS DataPropagator with IMS<sup>CTM</sup> source data

**Tip:** If you define a view that includes two or more source tables as a replication source, also define a CCD table for one of the source tables in the join. This CCD table should be condensed and non-complete (or it can be complete) and should be located on the target server. A view that includes more than two source tables can be subject to the problem of “double deletes” which DB2 DataPropagator cannot replicate.

For example, if you define a view that contains the CUSTOMERS table and the CONTRACTS table, and if you delete a row from the CUSTOMERS table and also delete the corresponding row (from the join point of view) from the CONTRACTS table during the same replication cycle, you have a double delete. The problem is that, because the row was deleted from the two source tables of the join, the row does not appear in the views (neither base views or CD-table views), and thus the double-delete cannot be replicated.

Defining a condensed and non-complete CCD table for one of the source tables in the join solves this problem because you can use the IBMSNAP\_OPERATION column of this CCD table to detect the deletes. You can add an SQL statement to the definition of the subscription set that should run after the subscription cycle. This SQL statement removes all the rows from the target table for which the IBMSNAP\_OPERATION is equal to “D” in the CCD table.

## Replicating before and after images

You can define both before and after images in your replication sources and subscriptions. A before-image column is a copy of a column before it is updated, and an after-image column is a copy of a column after it is updated. DB2 logs both the before-image and after-image columns of a table for each change to that table. Replicating before images is required for

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17. The CCD tables for simple inner-joins must be complete and condensed. See “Staging data” on page 82.

update-anywhere scenarios when you define the replica with standard or enhanced conflict detection; in this case, the before images provide the required information for automatic compensation of rejected transactions. Replicating before images can also be useful for auditing purposes.

The before and after images have different values for different actions performed against the target tables, as shown below:

Action	Column Value
<b>Full refresh</b>	All before-image columns have a NULL value.
<b>Insert</b>	The before-image column has a NULL value.
<b>Update</b>	Column values before the change are captured in the before-image columns; values after the change are in the after-image columns.  When you enable logical-partitioning key support, the before-image column appears in the deleted column and the after-image column appears in the inserted column. See “Enabling replication logical-partitioning-key support” on page 109 for more information.
<b>Delete</b>	Both the before-image and after-image columns contain the before-image value.

Before images do not make sense for base aggregate target-table types (there is no before image for computed columns). All other target-table types can make use of before-image columns.

**Restriction:** For columns that have a before-image defined, DB2 DataPropagator limits column names to 17 characters. Because DB2 DataPropagator adds a before-image column identifier (usually *X*) to target tables and because you must ensure that each column name is unique, you cannot use longer column names for those tables you replicate. For tables you do not plan to replicate, you can use longer column names, but consider using 17-character names in case you might want to replicate these tables in the future. For tables in DB2 for OS/390, you can use 18-character column names, but DB2 DataPropagator will replace the 18th character with the before-image column identifier in target tables, so you must ensure that the first 17 characters of the name are unique.

## Renaming columns

You can rename columns for point-in-time and user-copy target-table types. For other table types, you must define views in order to rename columns.

## Creating computed columns

Using SQL, you can derive new columns from existing source columns. For aggregate target-table types, you can define new columns by using aggregate functions such as COUNT or SUM. For other table types, you can define new columns using SQL expressions.

You can also create computed columns by referring to user-defined functions when you create a view that will be used a replication source.

## Using stored procedures for before and after run-time processing

You can define run-time processing statements using SQL statements or stored procedures that can run before or after the Apply program processes a subscription set. Such statements can be useful for pruning CCD tables and controlling the sequence in which subscription sets are processed. You can run the run-time processing statements at the source server before a subscription set is processed, or at both the source and target servers before or after a subscription set is processed. For example, you can execute SQL statements before retrieving the data, after replicating it to the target tables, or both.

Stored procedures use the SQL CALL statement without parameters. The procedure name must be 18 characters or less in length (for AS/400, the maximum is 128). If the source table is in a non-IBM database, DB2 DataJoiner processes the SQL statements. The run-time procedures of each type are executed together as a single transaction. You can also define acceptable SQLSTATes for each statement.

Depending on the DB2 platform, the SQL before and after processing statements can perform other processing, such as calling stored procedures.

## Replicating large objects

DB2 Universal Database supports large object (LOB) data types, which include: binary LOB (BLOB), character LOB (CLOB), and double-byte character LOB (DBCLOB). This section refers to all of these types as LOB data.

The Capture program reads the LOB descriptor to determine if any data in the LOB column has changed and thus should be replicated, but does not copy the LOB data to the CD tables. When a LOB column changes, the Capture program sets an indicator in the CD tables. When the Apply program reads this indicator, it then copies the entire LOB column (not just the changed portions of LOB columns) directly from the source table to the target table.

To allow the Capture program to detect changes to LOB data, you must include the DATA CAPTURE CHANGES keywords when you create (or alter) the source table.



Because a LOB column can contain up to two gigabytes of data, you must ensure that you have sufficient network bandwidth for the Apply program. Likewise, your target tables must have sufficient disk space to accommodate LOB data.

**Restrictions:**

- The Apply program always copies the most current version of a LOB column directly from the source table (not the CD table), even if that column is more current than other columns in the target table. Thus, there is a small period of time during which the target row that includes a LOB column could be inconsistent with the rest of the row. To reduce this small period of time, ensure that the interval between Apply cycles is as small as practical for your application.
- To copy LOB data between DB2 for OS/390 V6 (or later) and DB2 Universal Database (for any other operating system), you need DB2 Connect 5.2 or later.
- You can copy LOB data only to read-only tables. Thus, you cannot replicate LOB data to replica or row-replica tables.
- The primary key for the source table and the subscription-set definition must match. Code-page differences that affect key values can inhibit the Apply program's ability to locate the source-table row that contains LOB data.
- You cannot refer to LOB data using nicknames.
- Before-image values for LOB columns are not supported.
- For DB2 for OS/390, any table that contains LOB columns must also contain a ROWID column.
- Replication is not supported for DB2 Extenders™ for Text, Audio, Video, Image, or other extenders where additional control files associated with the extender's LOB column data are maintained outside of the database.
- DB2 can replicate only a full LOB; it cannot replicate parts of a LOB.

**Replicating DATALINK values**

Accessing large files (such as multimedia data) over a remote network can be inefficient and costly. If these files do not change, or change infrequently, you gain faster access to the files and reduced network traffic by replicating these files to remote sites. DB2 Universal Database provides a DATALINK data type that allows the database to control access, integrity, and recovery for these kinds of files. DB2 Universal Database supports DATALINK values on all platforms except OS/390.

DB2 replicates DATALINK columns and uses the ASNDLCOPY user exit routine to replicate the external files to which the DATALINK columns point. This routine transforms each source link reference to a target link reference and copies the external files from the source system to the target system. In

the `sqlib/samples/repl` directory, you can find a sample routine (`ASNDLCOPY.SMP`) that can use FTP or the file-copy daemon (`ASNDLCOPYD.SMP`) for the file transfer. For AS/400, you can find the sample programs in the files `QCSRC`, `QCBLLSRC`, and `QRPGLESRC` in library `QDPR`. See “Using the `ASNDLCOPY` exit routine” on page 133 and “Using the `ASNDLCOPYD` file-copy daemon” on page 136.

Because external files can be very large, you must ensure that you have sufficient network bandwidth for both the Apply program and whatever file-transfer mechanism you use to copy these files. Likewise, your target system must have sufficient disk space to accommodate these files.

### **Recommendation:**

- Use a separate subscription set for DATALINK columns because the Apply program waits for the `ASNDLCOPY` routine to complete its replication before the Apply program completes replication of the subscription set. Any failures in copying the external files will cause replication of the entire subscription set to fail.

### **Restrictions:**

- Because of the way DB2 supports DATALINK values, you can replicate DATALINK values between DB2 databases on the following operating systems:
  - AIX
  - AS/400
  - Windows NT

You cannot replicate DATALINK values to platforms that do not support them.

- If you use update-anywhere replication with DATALINK columns, you must specify **None** for the conflict-detection level. DB2 does not check update conflicts for external files pointed to by DATALINK columns.
- Before-image values for DATALINK columns are not supported.
- DB2 always replicates the most current version of an external file pointed to by a DATALINK column.
- Target tables that are base-aggregate or change-aggregate tables do not support DATALINK columns.

### **Key-update restrictions**

If you are replicating to condensed target tables (user copy, point-in-time, condensed CCD, or replica tables), do not use the syntax `SET KEYCOL=KEYCOL + n` for updates. Data cannot be replicated correctly with this form of key update. Use a different column in the source table as the key

in the subscription set. If no alternate key exists in the source table, you can still replicate your data correctly using the following method:

1. Create a new column in the source table.
2. Assign unique values in the new column for the existing rows.
3. Define the table as a replication source.
4. Include the new key column in the subscription set for any condensed target tables.
5. Whenever rows are inserted into the source table, assign unique key values to the new column.

## General restrictions for replication

Currently, DB2 DataPropagator has specific restrictions for certain operating-system environments and for certain data types. The major restrictions are:

- **Table name length:** DB2 supports table names and user IDs up to 30 characters in length, but replication only supports a length of 18 characters.
- **Archive-log access restrictions with DB2 for VSE & VM**  
Allocate sufficient disk space for the active log because Capture for VSE and Capture for VM cannot read archived logs.
- **Data compression restrictions with DB2 for MVS/ESA**  
DB2 DataPropagator can replicate data that is compressed through DB2 software or hardware compression on DB2 for MVS/ESA V4 (or later) if the dictionary used to compress the data is available. Before issuing REORG for compressed replication sources, you must either:
  - Ensure that the Capture program completed capturing all existing changes.
  - Use the KEEPDICTIONARY option on the REORG command to preserve the existing compression dictionary.

DB2 DataPropagator cannot replicate data that is compressed using EDITPROC or FIELDPROC.

- **Restrictions using DB2 Enterprise - Extended Edition**  
DB2 Enterprise - Extended Edition can be a target server for the Apply program. Also, DB2 Enterprise - Extended Edition can be the middle tier in a 3-tier configuration. For example, you can capture changes at one database (tier 1) and replicate them to a CCD table in a DB2 Enterprise - Extended Edition database (tier 2), and then replicate the changes from the CCD table to another database (tier 3).

You can capture changes on DB2 Enterprise - Extended Edition *only* if the source table is nonpartitioned and it resides on the catalog node. Any replication control tables must also be nonpartitioned and reside on the catalog node.

The Control Center does not allow you to select DB2 Enterprise - Extended Edition objects as replication sources or make them part of a subscription set. However, DJRA does allow them.

- **Restriction using AS/400 remote journaling**

Because of how communications are handled, you can use DB2 DataPropagator with remote journaling and any SNA connection or you can use DB2 DataPropagator with DRDA and any TCP/IP connection. Other combinations are not supported.

- **Restriction for partitioning keys**

For DB2 for MVS V4 or earlier, if you have a target-tablespace partitioning key, it must match the primary key.

- **Restriction for stored procedures**

DB2 DataPropagator does not capture stored-procedure calls, but does capture row updates caused by stored procedures.

- **Restrictions for referential constraints**

DB2 DataPropagator only supports referential constraints for user tables and replica tables.

DB2 DataPropagator does not support the following keywords of the SQL CREATE TABLE statement for replica tables that are subject to compensation: DELETE CASCADE, DELETE RESTRICT, and UPDATE RESTRICT.

- **Utility program restrictions**

DB2 DataPropagator cannot capture updates made by any of the database utilities. DB2 DataPropagator also cannot capture updates to data loaded with the LOAD RESUME LOG YES options.

- **Data encryption restrictions**

DB2 DataPropagator cannot replicate data that is encrypted.

- **Data type restrictions**

DB2 DataPropagator *cannot* replicate the following data types under any circumstances:

- Any column on which a VALIDPROC is defined
- Binary data types with precision

DB2 DataPropagator *can* replicate the following data types under certain circumstances:

- Long variable graphic (LONG VARGRAPHIC) data requires that the source and target tables be in DB2 for MVS/ESA, DB2 for VSE, or DB2 for VM.
- Long variable character (LONG VARCHAR) data requires either that the source tables be in DB2 for OS/390 or both the source and target tables be in DB2 Universal Database (for Windows, OS/2, and UNIX) Version

5.2 or later. See the Alter Table section of the DB2 Universal Database SQL Reference to learn how to enable LONG VARCHAR data.

- Binary large objects (BLOBs), character large objects (CLOBs), and double-byte character large objects (DBCLOBs) require DB2 for OS/390 V6 (or later) or DB2 for AS/400 V7 (or later). See “Replicating large objects” on page 74.
- DB2 DataPropagator cannot capture changes to ASCII or Unicode tables on DB2 for OS/390. DB2 DataPropagator can perform full refresh using ASCII or Unicode tables.

User-defined data types (distinct data types in DB2 Universal Database) are converted to the base data type before replication.

- **DB2 DataJoiner restrictions**

You must have one DB2 DataJoiner database for *each* non-IBM source server. Although you can use one DB2 DataJoiner database for replicating data to multiple non-IBM target servers, you need a unique DB2 DataJoiner database for *each* non-IBM source server.

For DataJoiner for AIX, replication from Microsoft SQL Server 6.0 and 6.5 must use a DBLIB connection; for DataJoiner for NT, replication from Microsoft SQL Server 6.5 must use the ODBC protocol.

When the data source is Sybase or Microsoft SQL Server and the source table has a column of type timestamp, do not select before and after images when you define the table as a replication source. SQL Server allows only one column of type timestamp. If you require the before and after images, do not select the column of type timestamp when defining the replication source.

When the data source is Oracle, do not select before and after images if the source table has column of type LONG. An Oracle table can contain only one column of type LONG.

DJRA does not support replication of LOB columns in a heterogeneous environment.

DJRA does not support update anywhere replication in a heterogeneous environment.

You do not need to define nicknames for Microsoft Jet or Microsoft Access tables in DB2 DataJoiner. See “Using DB2 DataPropagator for Microsoft Jet” on page 280.

If you run DJRA in a Windows 9x environment, and you experience TCP/IP-related connection problems (for example, a connection failure can make client applications appear to be frozen), you can set network options to control the interval before failure is detected. These are system-wide parameters and can impact all TCP/IP applications. To set these options, edit TCP/IP parameters in the Windows Registry. Be sure to back up your Registry before making changes.

### Recommendations for Informix:

- Enable transaction logging for Informix databases involved in replication.
- To set the synchpoint granularity to show fractions, set USEOSTIME in the onconfig file (usually in the \$INFORMIXDIR/etc directory) to 1. If it is not set to 1, Informix displays only zeroes for the fraction.

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## Capture triggers for non-IBM sources

Capture triggers are used for replication from non-IBM databases. They capture changed data from a source table and make the changed data available for replication. Capture triggers perform the same task as the Capture program does for DB2, but in a different manner. DJRA generates the Capture triggers.

DJRA, working through DB2 DataJoiner, creates Capture triggers at the non-IBM source database when you define the source tables as replication sources. Capture triggers capture committed changes made to source data and place the captured changes into a staging table, called the *consistent change data* (CCD) table. DB2 DataJoiner has a nickname for the CCD table, and programs that want to replicate the changes (for example, the Apply program) can access this nickname. See “Staging data” on page 82 for more information about CCD tables.

There are three triggers for each source table: DELETE, UPDATE, and INSERT.

### How the Capture triggers capture the data changes

The Capture triggers work with the following objects: the CCD table, the register control table, the pruning control table, and the register synchronization control table.

DJRA generates SQL (when you define a table as a replication source) that, when run:

- Creates Capture triggers on the source table.
- Creates the CCD table on the source server. There is one CCD table for each source table.
- Inserts a row into the register control table (to represent the new source table).
- Creates a nickname for the CCD table in the DB2 DataJoiner database.

Whenever a delete, update, or insert operation occurs at the defined source, a Capture trigger records the change into the CCD table. When the Capture triggers retrieve changed information, they can also obtain before and after column data to put into the CCD table.

If the primary key values of the target table will be updated, or the table (or view) contains a logical partitioning column that will be updated, you must specify replication logical-partitioning-key support when you define the replication source. Replication logical-partitioning-key support performs an UPDATE as a DELETE followed by an INSERT. See “Enabling replication logical-partitioning-key support” on page 109 for more information.

The Apply program then reads the CCD table (through DB2 DataJoiner nicknames), copies the changes to the target server, and applies the changes to the target table. Figure 18 shows the relationship between the Capture triggers, the source table, the register control table, and the CCD table.

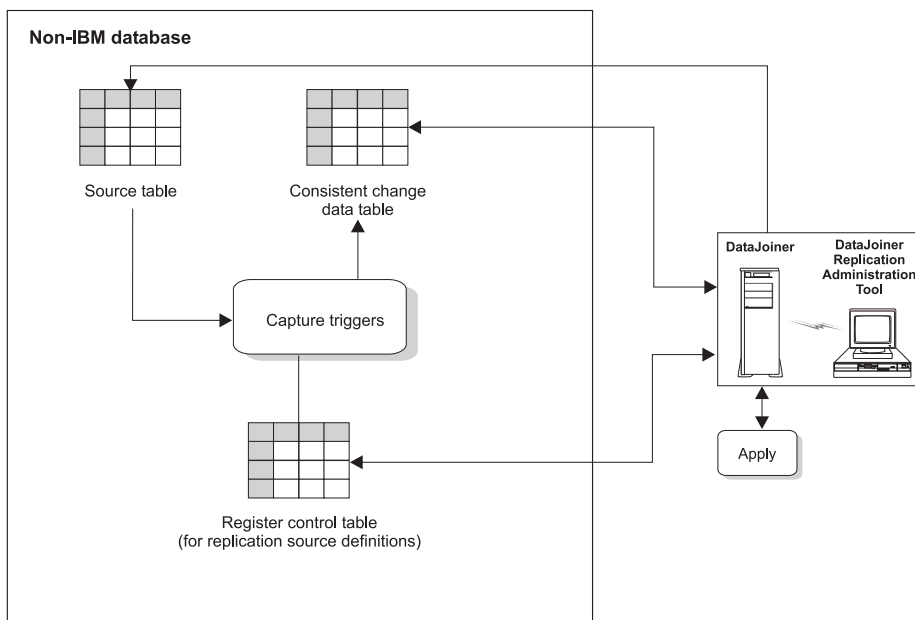


Figure 18. Capture triggers at the source server. The Capture triggers monitor source changes, capture the changed data, and write the changed data to the CCD table.

## Capture Triggers and pre-existing triggers

When DJRA creates and places Capture triggers on a non-IBM database, you might encounter the following situations:

- **On Oracle:** If an attempt is made to create a Capture trigger on a table where there is a pre-existing trigger with the same name, or where the pre-existing trigger performs an identical event (insert-before, insert-after, delete-before, delete-after, update-before, update-after), Oracle issues the following message: ORA-04081 (trigger name already exists). If this error is generated, the Capture trigger is not created.

- **On Informix:** If an attempt is made to create a Capture trigger on a table where there is a pre-existing trigger with the same name, or where the pre-existing trigger performs an identical event (insert, delete, update), Informix issues an -741 error and will not create the Capture trigger.
- **On Microsoft SQL Server or Sybase:** If an attempt is made to create a Capture trigger on a table where there is a pre-existing trigger with the same name, or where the pre-existing trigger performs an identical event (insert, delete, update), Microsoft SQL Server and Sybase do not generate error or warning messages indicating a conflict. Microsoft SQL Server and Sybase replace the pre-existing trigger with the new Capture trigger. However, DJRA does check to see if a trigger already exists. If a trigger with the same events exists, DJRA creates the new triggers but all lines within the trigger body are commented out. You must determine how you want to merge pre-existing triggers with the new triggers. Then you can uncomment the lines in the new triggers.

**Recommendation:** If you anticipate conflict between DJRA's Capture triggers and pre-existing triggers, put the content of both triggers into one trigger. For each table event, append the pre-existing business trigger to the end of the Capture trigger script that is generated by DJRA.

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## Staging data

Typically during replication, changes to a source table are captured, the changed rows are inserted into the CD table, and the related transaction information is inserted into the UOW table. The CD table is joined with the UOW table to determine which changes are committed and can therefore be replicated to target tables. This joined output can be saved in a CCD table from which changed data information can also be read. A CCD table contains committed changes only. By using a CCD table, several subscription sets (and their members) can refer to that information without each incurring overhead for a join of the CD and UOW tables for each subscription cycle.<sup>18</sup>

There are other uses for CCD tables apart from eliminating the need to join the CD and UOW tables. When you set up your replication environment, you can choose the type of CCD table that is appropriate for your replication environment. To help you determine whether or not you need to use CCD tables, this section describes the attributes of CCD tables and the typical uses of CCD tables.

### Attributes of CCD tables

If you want to use a CCD table, you must decide where you want it located and what change data it must contain.

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18. CCD tables are not used in update-anywhere replication.



### **Local versus remote CCD tables**

A *local* CCD table resides in the source database. A *remote* CCD table resides away from the source database; that is, in any other database in the network that the Apply program can access. If you have many remote targets, you can use a remote CCD table as the source table to reduce network traffic from the source.

### **Complete versus noncomplete CCD tables**

A *complete* CCD table contains *all* rows that satisfy the source view and predicates from the source table or view. The Apply program uses a complete CCD table as the source for full refreshes or to replicate changes to other target tables.

A *noncomplete* CCD table contains only changes that were made to the source table. Thus, a noncomplete CCD table is initially empty and is populated as changes are made to the source table. When a noncomplete CCD table is initially created, or when the Capture program is cold started, the Apply program does not refresh a noncomplete CCD table with all the rows of the source table.<sup>19</sup> The Apply program records changes that are made to the source table but does not replicate the original rows. The Apply program cannot use a noncomplete CCD table to refresh other target tables.

### **Condensed versus noncondensed CCD tables**

A *condensed* CCD table contains only the most recent values for columns. For example, if one row is changed 5 times in the source table, the condensed CCD table would contain one row showing the results of all 5 changes to the source table. Condensed CCD tables consolidate changes and reduce network traffic for staged replication. A *noncondensed* CCD table contains one row for each change that is made to a row in the replication source. In this case, if a single row is changed 5 times in the source table; the noncondensed CCD table would contain 5 rows (one for each change). That is, it represents the history of changes to each row. Noncondensed CCD tables are useful for auditing purposes.

**Defining unique indexes:** A condensed CCD table requires unique key values for each row, but a noncondensed CCD table can have multiple rows with the same key values. Because of the differences in key uniqueness, you *must* define a unique index for a condensed CCD table, and you *must not* define one for a noncondensed CCD table.

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19. If changes are made to a source table while the Capture program is cold started, those changes might not get into a noncomplete CCD table. To ensure that such changes get replicated to the noncomplete CCD table, you must stop all activity against the source table when you cold start the Capture program.

## Basic types of CCD tables

Table 5 summarizes the types of CCD tables based on the possible combinations of attributes.

*Table 5. Basic types of CCD tables.* A CCD table can be local or remote, complete or noncomplete, condensed or noncondensed, or any combination of these.

Location	Complete	Condensed	Description
Local	Yes	Yes	A CCD table that resides in the source database and contains the same data as the replication source.
		No	A CCD table that resides in the source database and contains a complete history of changes including the original data from the replication source.
	No	Yes	A CCD table that resides in the source database and contains the latest change data only.
		No	A CCD table that resides in the source database and contains all change data only.
Remote	Yes	Yes	A CCD table that resides in a database that the Apply program can access, other than the source database, and contains the same data as the user table.
		No	A CCD table that resides in a database that the Apply program can access, other than the source database, and contains a complete history of changes including the original replication source data.
	No	Yes	A CCD table that resides in a database that the Apply program can access, other than the source database, and contains the latest change data only.
		No	A CCD table that resides in a database that the Apply program can access, other than the source database, and contains all the change data only.

## Using CCD tables as replication sources

You can use CCD tables as sources for replication to other target tables.<sup>20</sup>

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20. You can define CCD tables as targets for non-IBM databases, but not as sources. Also, if the CCD target is in a non-IBM database, it can be neither an internal nor external CCD table.

### Internal and external CCD tables

Depending on your replication environment, you can choose to register your complete CCD table as a replication source (an *external CCD table*), or you can set up your CCD table so that it is used implicitly as a source for replication (an *internal CCD table*).

**External CCD tables:** If you perform a full refresh on an external CCD table, the Apply program performs a full refresh on all target tables that use this external CCD table as a replication source. This process is referred to as a *cascade full refresh*. You can define more than one external CCD table for a replication source. An external CCD table can have any attributes you like (local or remote, complete or noncomplete, condensed or noncondensed); however, if you use it to stage data, you *must* use a complete CCD table because the Apply program will use it to perform both full refresh and change replication.

**Internal CCD tables:** Internal CCD tables are useful for staging changes. The Apply program uses the original source table for full refreshes, and it uses the internal CCD for change replication (instead of joining the CD and UOW table each time changes are replicated).<sup>21</sup>

Use an internal CCD table as a local cache for committed changes to a source table. The Apply program replicates changes from an internal CCD table, if one exists, rather than from CD tables.

You can use an internal CCD table as an implicit source for replication without explicitly defining it as a replication source. When you add a subscription-set member, you can specify that you want an internal CCD table if the table has the following attributes:

- It is a local CCD table. That is, the source server and the target server are the same database.
- The CCD table is noncomplete.
- No other internal CCD table exists for this replication source.

### Using CCD tables as replication sources in multi-tier staging

The following list shows all types of CCD tables and describes whether they are suitable for staging data.

#### Complete, condensed CCD tables

You can define this type of CCD table as a replication source and use it in the following ways:

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21. If you define an internal CCD table, it is ignored by the Apply program when processing a subscription set with a replica as a target.

- The staging table in a three-tier or four-tier distribution configuration. In this case, targets are maintained entirely from rows in the complete CCD table, with no additional overhead on the original source database.
- A CCD table that is maintained by an external program (such as IMS DataPropagator) and serves as a replication source for a CCD table in DB2 replication. In this case, the change data comes from an IMS database. (For more information, see “Using CCD tables with nonrelational or non-IBM data” on page 87.)

Typically you would create this table nearer the targets rather than local to the source to save network traffic during both change replication and full refreshes. Also, multiple updates to a single source table row will result in replication of a single row to all target tables.

### **Complete, noncondensed CCD tables**

Do not define this type of CCD table as a replication source nor as an internal CCD table.

Do not use this type of CCD table as a replication staging table because of the space consumed by saving each and every change.

This table contains a complete set of rows initially, and it is appended with each and every row change. No information is overwritten, and no information is lost. Use this type of CCD table with applications that need to process temporal queries (for example, as of last Tuesday, a month ago, or yesterday) anytime following the initialization of the CCD table. Also use this type of CCD table for auditing applications that require a complete set of rows. (Other ways of auditing are described in “Auditing data usage” on page 88.)

### **Noncomplete, condensed CCD tables**

You can define this type of CCD table as an internal CCD table for the replication source. By defining it as an internal CCD table, you access the original source during full refreshes only, and use the CCD table for updates. It is efficient because the join of the CD and UOW tables happens only once, to populate the CCD table, and then changes are replicated from the CCD table to all targets without the join overhead. Because the CCD table is noncomplete, full refreshes must come from the original source table. This type of table is also useful for condensing change data from a CD table. Condensing reduces the number of rows replicated to remote sites, and the number of SQL operations against the target tables, by eliminating all but the last change for each row.

### **Noncomplete, noncondensed CCD tables**

In most cases, do not define this type of CCD table as a replication source. Use this type of table for auditing applications that do not require a complete set of rows, only the recently changed rows.

You might define the CCD table as an internal CCD for a replication source when the remote targets themselves are noncondensed. In this case, if there are many remote targets, you can benefit by avoiding repeated joins of the CD tables with the UOW table, as long as this benefit outweighs the cost of storing and maintaining the CCD table.

### **Using internal CCD tables with multiple targets**

If you define an internal CCD table as a target, all other target tables associated with the source table will have changes replicated from that internal CCD table and not from the original source table. For this reason it is important to plan all the potential target tables to make sure that you define the internal CCD table correctly. If you do not include all the columns of the source table in the internal CCD table, but a target table includes all of those columns, then replication will fail. Similarly if the CD table used to maintain the internal CCD table does not include all the columns of the source table, but a target table includes all the columns, then replication will fail also.

Internal CCD tables do not support additional UOW table columns. If you define target CCD tables (with UOW columns) as a replication source, you cannot then define an internal CCD table. Do not use an internal CCD table if you already defined a target CCD table that includes UOW columns.

If you want to use column subsetting in an internal CCD table, review all previously-defined target tables to make sure that the internal CCD table definition includes all appropriate columns from the source tables. If you define the subscription set for the internal CCD table before you define any of the other subscription sets from this source, the other subscription sets are restricted to the columns that are in the internal CCD table.

### **Using CCD tables with nonrelational or non-IBM data**

You can use CCD tables to replicate changes that are captured by application programs or tools on other database management systems, such as Oracle. Triggers on the Oracle tables simulate the Capture program by placing the changes into Oracle CCD tables. Capture triggers for non-IBM sources also use the internal CCD setup to replicate changes. For an example of this usage, see “Retrieving data from a non-DB2 distributed data store” on page 32.

Similarly, changes captured by application programs or other tools, such as IMS DataPropagator, can be defined as sources for subscription sets. The application program must create and maintain a complete CCD table, and that CCD table is considered to be an external CCD table. This CCD table must be external, but can be condensed or noncondensed. For example, IMS DataPropagator captures changes to IMS DB segments and updates its CCD

table. You define the CCD table as a replication source, and then you define subscription sets using this CCD table, regardless of where the original updates occur. For an example of this usage, see “Distributing IMS data to remote sites” on page 27.

### Pruning the CD and CCD tables

The Capture program can prune CD tables based on information inserted into the pruning control table by the Apply program. You control whether the Capture program prunes CD tables by using the PRUNE or NOPRUNE parameter. You can also control when the pruning takes place and how the prune interval is set by modifying the tuning parameters control table.

Some CCD tables can continue to grow in size, especially noncondensed CCD tables. These tables are not pruned automatically; you must prune them manually or use an application program. For some types of CCD tables, you might want to archive them and define new ones, rather than prune them.

When the source table is a non-IBM table, the Capture triggers prune the CCD table based on a synchpoint that the Apply program writes to the pruning control table.

---

## Auditing data usage

Auditing is the need to track histories of data use, in terms of before and after comparisons of the data or identifying changes by time and by updating user ID.

IBM Replication supports auditing in the following ways:

### Before and after images

When you define replication sources, you can include before-image columns of the updated rows in the target tables. A set of before-image and after-image copies is useful in some industries that require auditing or application rollback capability.

### Maintenance of history

A noncondensed CCD table holds one row per UPDATE, INSERT, or DELETE operation, thus maintaining a history of the operations performed on the source table. If you capture UPDATE operations as INSERT and DELETE operations (for partitioning key columns), the CCD table will have one row per DELETE and INSERT and two rows per UPDATE.

**Important:** Do not cold start the Capture program if you want to maintain accurate histories of change data. A gap might occur if the

Apply program could not replicate changes before the Capture program was shut down. See “Resolving gaps between source and target tables” on page 147.

Use noncomplete, noncondensed CCD tables to keep a partial history of updates to a source table or to maintain an audit trail of database usage. For improved auditing capability, include the extra columns from the UOW table.<sup>22</sup>

Use complete, noncondensed CCD tables to keep a complete history of changes to a source table.

For more information see “Attributes of CCD tables” on page 82.

### Transaction identification

Several columns in the CD tables and UOW table are available for audit use. You can find the approximate commit time of the changed row at the source server in the UOW table, and you can find the operation type (INSERT, UPDATE, and DELETE) in the CD table. If you need to keep this information, you can define noncomplete CCD tables that include UOW columns using DJRA, and you can replicate to these CCD tables. Normally, the Capture program prunes the CD and UOW tables, but does not prune CCD tables.

If you need more user-oriented identification, columns for the DB2 for OS/390 correlation ID and primary authorization ID or the AS/400 job name and user profile are available in the UOW table.

---

## Planning for migration

### Migration for AS/400:

You *cannot* run Version 1 of DPropR/400 concurrently with Version 7. If you currently use Version 1, or if you use Version 1 replication components in a Version 5 DPropR/400 environment, you must either:

- Migrate your Version 1 replication environment to Version 5. Instructions are in the *Migration Guide* available from the Library page of the DB2 DataPropagator Web site ([www.ibm.com/software/data/dpropr/](http://www.ibm.com/software/data/dpropr/)).
- If your Version 1 replication environment is small (for example, if it contains fewer than 50 source registrations and subscriptions), do not migrate to Version 5. Instead, use DJRA to recreate your replication environment in Version 7.

Migrating from DPropR/400 V5 to V7 does not require any special migration.

---

22. If you have target CCD tables defined for a replication source and you want to then define an internal CCD table, note that internal CCD tables do not support additional UOW table columns. Do not use an internal CCD table if you already defined a target CCD table that includes UOW columns.

You should use DJRA for all replication administration tasks. However, both DJRA and the DB2 Control Center provide basic replication administration functions for defining replication sources and subscription sets.

### **Migration for OS/2, UNIX, and Windows:**

Beginning with Version 5 of DB2 Universal Database (for Windows, OS/2, and UNIX), the replication component is automatically installed with DB2 (that is, it is not optional). After you install DB2 UDB Version 7, you cannot:

- Continue to use Version 5 or Version 6 of the Capture and Apply programs on the V7 database instance.
- Install Version 7 of the Capture and Apply programs on a DB2 UDB Version 6 (or earlier) system.

Migrating from DB2 UDB V6 to V7 does not require any special migration for replication.

**Important:** Interoperability between Version 1 and Version 6 or Version 7 replication components is not supported. Therefore, you must complete all Version 1 to Version 5 migrations before you introduce DB2 UDB Version 6 or Version 7. Instructions are in the *Migration Guide* available from the Library page of the DB2 DataPropagator Web site ([www.ibm.com/software/data/dpropr/](http://www.ibm.com/software/data/dpropr/)).

The Version 5 Capture and Apply components can run alongside the Version 6 or Version 7 Capture and Apply programs; you do not need to migrate all servers at the same time.

In addition:

- The Version 7 Capture and Apply programs are backward-compatible with Version 5 or Version 6 sources and subscription sets. The Version 7 components will continue to use the critical section table in the same way that the Version 5 or Version 6 Capture and Apply programs did if the new prune lock control table is not present.
- The Version 7 Capture and Apply programs can use the invocation options introduced for DB2 Universal Database Satellite Edition, even if the administration component remains at the Version 5 or Version 6 level.

DB2 UDB supports the DB2 Universal Database Satellite Edition enabler command **ASNSAT**. However, you cannot use the DB2 Universal Database Satellite Edition **SYNCH** command in an existing replication environment because the **SYNCH** command relies on centralized administration controlled by a central control server. The central control server is not aware of any existing replication environment administered without use of the **SYNCH** command.



For more information about DB2 Universal Database Satellite Edition, see *DB2 Universal Database Administering Satellites Guide and Reference*.

**Migration for OS/390:**

Interoperability between Version 1 and Version 6 or Version 7 replication components is not supported. Therefore, you must complete all Version 1 to Version 5 migrations before you introduce DB2 for OS/390 Version 6 or Version 7. Instructions are in the *Migration Guide* available from the Library page of the DB2 DataPropagator Web site ([www.ibm.com/software/data/dpropr/](http://www.ibm.com/software/data/dpropr/)).

Migrating from DB2 for OS/390 V6 to V7 does not require any special migration for replication.

The Version 5 Capture and Apply components can run alongside the Version 6 or Version 7 Capture and Apply programs; you do not need to migrate all servers at the same time.



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## Chapter 6. Setting up your replication environment

This chapter describes the steps for setting up and starting replication. It does not include specifics about operating the Capture and Apply programs for each operating system. See “Part 3. Operations” on page 173 for such specifics.

To set up the replication environment, you will complete the following general steps:

1. Create control tables in the logical source, target, and control servers
2. Define replication sources
3. Create subscription sets and add members to the sets

You can use either the DB2 Control Center or the DB2 DataJoiner Replication Administration (DJRA) tool to define sources and targets for replication, to set the schedule for updating the targets, to specify the enhancements to the target data, and to define any triggers that initiate replication. You can use the DB2 Control Center to administer replication only when your source and target tables are in DB2 Universal Database databases (for any operating-system environment), but you can use DJRA to administer replication when your source and target tables are in DB2 Universal Database databases (for any operating-system environment) or in supported non-IBM databases.

The administration tasks described in this chapter set up the control information that both the Capture and Apply programs use to capture changed data and replicate it to the target tables, in the proper format, and at the appropriate interval.

---

### Using the DB2 Control Center to set up replication

When setting up the replication environment, you can use the DB2 Control Center to manage the source and target table definitions and the control tables. Use the following high-level steps to administer your replication objects:

1. Check, and optionally update, the default settings in the Tools Settings notebook. See “Setting replication preferences in the DB2 Tools Settings notebook” on page 95 for more information.
2. Review the DPCNTL file for your platform to determine whether you need to customize the control tables for your site.

3. Optionally customize the DPCNTL file for your platform and site requirements. See “Defining replication control tables” on page 100 for more information.
4. Define and manage replication sources. See “Defining replication sources” on page 105 for more information.
5. Define and manage replication subscriptions. See “Defining replication subscription sets” on page 112 for more information.

After you create the control tables and define the replication sources and targets, you need to configure and run the Capture and Apply programs to begin replicating data.

You can access your replication sources and targets through the Control Center. There are three containers in the Control Center for organizing the objects that you use to set up and maintain your replication environment:

**Tables folder**

The folder containing DB2 tables.

**Replication Sources folder**

The folder containing tables that have been defined as replication sources: DB2 tables, views, or target tables redefined as sources for replication.

**Replication Subscription folder**

The folder containing subscription-set definitions for copying source data or source-data changes to target tables.

Each object also has a menu for the actions that can be performed with the object.

## Configuring the Control Center for host RDBMSs

If you are connecting to a DB2 for MVS/ESA, DB2 for VSE, DB2 for VM, or DB2 for AS/400 server from the Control Center, you must configure connectivity to the remote database, catalog the remote databases, and bind packages to the remote databases.

*To bind the database:*

1. Change to the directory where the Capture program bind files are located, which is usually the \SQLLIB\BND directory on the drive where you installed DB2 Universal Database or the client application enabler (CAE).
2. Create and bind the DB2 for MVS/ESA, VSE, VM, or AS/400 package to the DB2 database by issuing the following commands:

```
DB2 CONNECT TO dbname USER userid USING password  
DB2 BIND @DDCSxxx.LST ISOLATION CS BLOCKING ALL SQLERROR CONTINUE
```

Where CS specifies the cursor stability isolation level, and xxx specifies the platform name: MVS, VSE, VM, or AS/400.

If the user ID and password are different than the local logon ID and password for the Control Center workstation, you must explicitly connect to the database server using the **Connect** menu choice from the pop-up menu for your remote database object.

## Setting replication preferences in the DB2 Tools Settings notebook

The Tools Settings notebook contains default preferences for the DB2 Universal Database administration tools. You can set replication default values on the Replication page of the notebook, as shown in Figure 19. These default values are used for all replication activities administered by the Control Center.

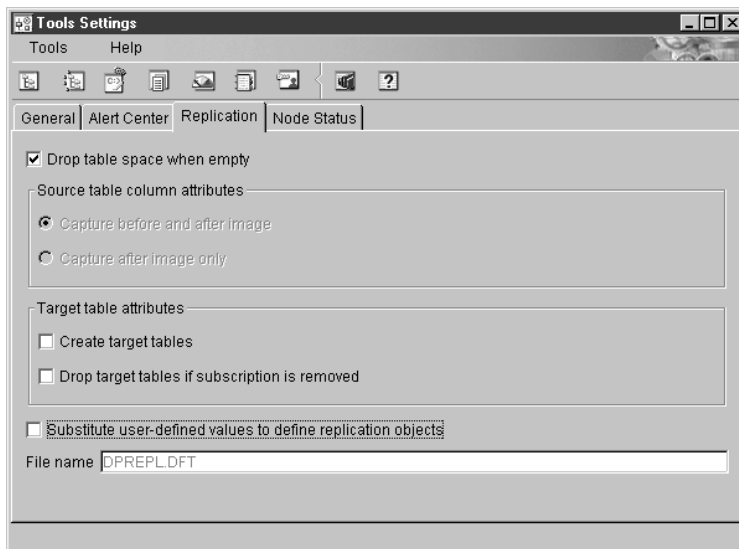


Figure 19. The Replication Page of the Tools Settings Notebook. Use this page to specify default preferences for replication.

## Customizing CD table, index, and tablespace names

You can customize CD table names, index names, and tablespace names while defining replication sources or subscription sets. You can edit the template file DPREPL.DFT, found in the working directory for the Control Center (\sqllib\bin or \sqllib\java), to change these names. See the instructions in the file for syntax and examples.

You specify that you want to use this file from the Replication page of the Tools Settings notebook. See Figure 19.

---

## Using the DB2 DataJoiner Replication Administration tool to set up replication

When you use the DB2 DataJoiner Replication Administration (DJRA) tool to perform replication administration tasks, DJRA connects to the source, target, or control server to create and update the control information and target tables on the server (depending on the operation performed). The client workstation where DJRA is located must be authorized and able to connect to all source, target, and control servers that are managed by DJRA.

DJRA provides objects and actions that define and manage source and target table definitions. Working through DB2 DataJoiner, DJRA creates:

- Capture triggers on the non-IBM source servers
- Nicknames in the DB2 DataJoiner database for the remote tables where the changed data is to be captured
- Target tables (and their associated nicknames) in the non-IBM database for the remote target tables

The Apply program reads from and writes to DB2 DataJoiner nicknames, which eliminates the need to connect explicitly to non-IBM databases.

If the source database is a DB2 database, the Capture program for that database captures the changes, therefore, the Capture triggers and DB2 DataJoiner are not involved. If the target database is a DB2 database, the Apply program writes the changed data to the DB2 target database directly and DB2 DataJoiner is not involved.

DJRA, working with DB2 DataJoiner, the Capture program, Capture triggers, and the Apply program, replicates relational data from a variety of sources to a variety of targets. The databases that DJRA supports as sources or targets are:

- DB2 UDB (for UNIX, Windows, and OS/2) V5 or later
- DB2 UDB for AS/400 V5 or later
- DB2 UDB for OS/390 V5 or later
- DB2 DataJoiner V2 or later
- Oracle V7.3.4 or later
- Informix V7.2x or later
- Sybase V11.5 or later
- Sybase SQL Anywhere Version 6.0 or later
- Microsoft SQL Server V6.0 or later<sup>23</sup>
- NCR Teradata V2R4 or later (as target only)

---

23. For DataJoiner for AIX, replication from Microsoft SQL Server 6.x must use a DBLIB connection. For DataJoiner for Windows NT, replication from Microsoft SQL Server 6.x is restricted to using the ODBC protocol.

- Microsoft Jet V3.5 or later (as target only)

For DB2 source, target, or control servers, DB2 DataJoiner's distributed database connection services (DDCS) or the DB2 Connect product provides connectivity. For non-IBM sources and targets, DJRA uses DB2 DataJoiner to connect to the non-IBM servers.

DJRA provides a user interface that is divided into areas that deal with control tables, replication sources, subscription sets, and the running or editing of SQL (see Figure 20 on page 98).

Using this interface, you can perform the following administration tasks:

- Create replication control tables and put them on your source, target, or control servers
- Define DB2 tables, non-IBM tables, and DB2 views as sources
- Remove replication sources
- Change the definitions for existing DB2 source tables to add new columns
- Promote table, registration, and subscription definitions
- Define subscription sets and subscription members
- Activate and deactivate subscription sets
- Change existing subscription-set members for DB2 target tables to add new columns
- Remove subscription sets or subscription-set members that are no longer needed
- Add SQL statements or delete SQL statements or stored procedures that should run before or after the target tables are replicated
- Run or edit SQL that is generated by DJRA
- Monitor replication
- Perform an offline load of a table

You can also customize the logic for most of the administration tasks listed above.

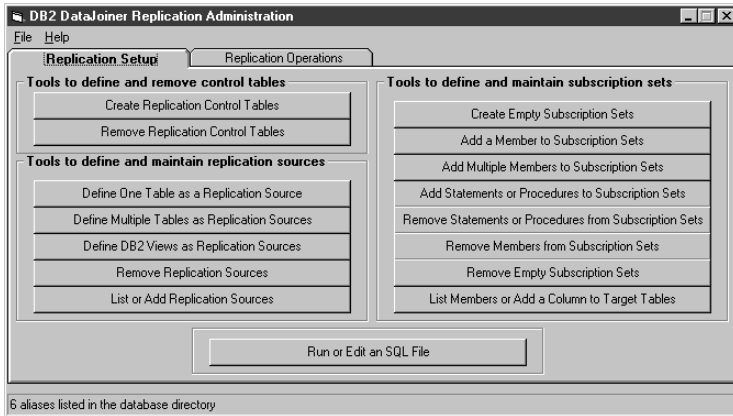


Figure 20. The DJRA primary window

## Installing DJRA

When you install DB2 UDB on a Windows system, the DB2 setup program copies the DJRA setup program (djra.exe) to the \sqllib\djra directory. DJRA also comes with DB2 DataJoiner V2; when you install DataJoiner on Windows NT, you can also optionally install DJRA. In addition, you can download DJRA from the Web.<sup>24</sup> When you install DJRA, if you do not already have Object Rexx installed, DJRA will install it, otherwise DJRA will use your existing copy.

DJRA runs in the following environments:

- Windows NT 4.0 with service pack 3 or later
- Windows 95 with service pack 2
- Windows 98

### To install DJRA:

1. From the Windows Explorer, go to the \sqllib\djra directory, then double-click the djra.exe file. This starts the DJRA setup program.
2. Follow the online instructions. Online help is available to help you with the remaining steps. When you complete setup, DJRA appears in the Windows Start menu.
3. To start DJRA:
  - a. Click the **Start** icon.
  - b. Select the **Programs** menu.

24. <http://www.ibm.com/software/data/dpropr>



- c. Select either the **DB2 for Windows NT** or **DataJoiner for Windows NT** menu (depending on whether you installed DJRA with DB2 or DataJoiner).
- d. Select the **Replication** menu.
- e. Select **Replication Administration Tools**. The DJRA primary window opens, as shown in Figure 20 on page 98.

## Setting preferences

You can specify your preferences for:

- DJRA working directory
- Location of console or file output
- User IDs and passwords
- Tracing SQL execution activity and Replication Monitor activity
- Converting table and column names to uppercase or lowercase for Sybase or Microsoft SQL Server targets

To set preferences, select **File** → **Preferences** from the menu on the DJRA primary window. You can change the preferences at any time.

On the Connection page of the Preferences notebook, you see a list of databases that are currently cataloged on your system.

**Restriction:** If you are using Microsoft SQL Server in your replication environment, do not use an alias user ID. Microsoft SQL Server will reject the alias user ID.

## Customizing DJRA

You can customize DJRA staging tables, indexes, predicates, and so on by selecting the appropriate Edit Logic button from the following windows:

### Create Replication Control Tables

Select the **Edit Tablespace Logic** button to specify the table spaces for the control tables and the UOW table. Check this file to make sure that the table spaces are being defined in the location where you want them.

### Define One Table as a Replication Source

Select the **Edit Logic** button to specify the owner and name of the CD or CCD table and the table space in which the CD or CCD table is placed. You can also customize index names for CCD tables.

**Recommendation:** If the source table is a non-IBM table, do not change the owner for the CCD table.

You can also select the **Edit Logic** button from the Define Multiple Tables as Replication Sources window. In this case, add a three-digit

number to the end of the CD\_TABLE (or CCD\_TABLE) parameter value; DJRA automatically increments this number to ensure that each table has a unique name.

You can specify where table spaces are created by changing the default directory (C:\). Be sure to add a backslash (\) after the directory name.

### **Add a Member to Subscription Sets**

Select the **Edit Predicate Logic** button to specify which rows from the source table can be replicated to the target table.

Select the **Edit Create Table Logic** button to specify the table space or segment in which to create target tables.

You can specify where table spaces are created by changing the default directory (C:\). Be sure to add a backslash (\) after the directory name.

You can also select the **Edit Predicate Logic** or **Edit Create Table Logic** button from the Add Multiple Members to Subscription Sets window.

---

## **Defining replication control tables**

Normally, the replication control tables are created in one of the following ways:

- By selecting **Create Replication Control Tables** in DJRA.
- By customizing the DPCNTL file for your operating system and running the file *before* initiating any actions from the DB2 Control Center.

See comments within the file for tailoring the SQL for a specific database platform. You need to customize the DPCNTL file for the following definitions:

- To define the location and size of DB2 for MVS/ESA table spaces and databases for the control tables. The Control Center creates the control tables in the default table space and database, unless you specify a different table space or database.
  - To define and size DB2 for VSE or VM dbspaces for the control tables. The Control Center creates the control tables in the default dspace, unless you specify a different dspace.
  - To tailor the control tables for specific operating system environments because not all definitions are supported for all operating systems.
  - To place control tables in specific DB2 Universal Database table spaces or in a DB2 EEE single node group.
- By using the Control Center to define replication sources and subscriptions; these actions create default versions of the control tables.

If you use this option, you cannot customize the replication control tables without dropping the existing control tables and customizing them. If you are running OS/390, VSE/ESA, or VM/ESA, you *must* customize the replication control tables.

When you create customized control tables, you must customize the CREATE TABLE statements in the DPCNTL files. There is one DPCNTL file for each operating system environment; these files are located in the `sqlib\samples\repl\` directory. The file names are:

**DPCNTL.UDB**

Creates control tables for DB2 Universal Database (for UNIX, Windows, or OS/2).

**DPCNTL.MVS**

Creates control tables for DB2 for MVS/ESA and DB2 for OS/390.

**DPCNTL.VM**

Creates control tables for DB2 for VSE & VM.

**DPCNTL.400**

Creates control tables for DB2 for AS/400.

**DPCNTL.SAT**

Creates and drops control tables for DB2 Universal Database Satellite Edition.

If, after creating customized control tables, you need to drop them, you must customize the DROP TABLE statements in the DPNCNTL files. There is a DPNCNTL file for each operating system environment located in the `sqlib\samples\repl\` directory. The files names are:

**DPNCNTL.UDB**

Drops control tables for DB2 Universal Database (for UNIX, Windows, or OS/2).

**DPNCNTL.MVS**

Drops control tables for DB2 for MVS/ESA and DB2 for OS/390.

**DPNCNTL.VM**

Drops control tables for DB2 for VSE & VM.

**DPNCNTL.400**

Drops control tables for DB2 for AS/400.

***To customize the SQL for creating or dropping control tables:***

1. Open the appropriate file (`sqlib\samples\repl\dpctl.platform_name` or `sqlib\samples\repl\dpncntl.platform_name`, where *platform\_name* is UDB, MVS, VM, 400, or SAT.) in a text editor.
2. Read the commented areas for each operating system and table.

3. Edit the file for your site or application.
4. Close the file.
5. Connect to the database in which the control tables will be created (use the **DB2 CONNECT TO** *database-name* command).
6. Run the file (DPCNTL or DPNCNTL) using one of the following commands from a command window:

```
db2 -tf dpcntl.platform_name
```

```
db2 -tf dpncntl.platform_name
```

---

## Creating replication control tables using DJRA

You must create control tables at each DB2 (and DataJoiner) system involved in replication.<sup>25</sup> When you complete this step, DJRA places a register table, a pruning control table, and a register synchronization control table at the database source (and for non-IBM sources, creates nicknames for these tables in DB2 DataJoiner).

From the DJRA primary window, click the **Create Replication Control Tables**. The fields you complete to create a control table are:

### Source, control, or target server

When you click the down arrow, DJRA checks to see what type of server it is and then lists all databases and aliases that are cataloged on the workstation from which you are running DJRA. If you select a DataJoiner server from the list, the DataJoiner non-IBM source server pull-down list becomes active. If you do not choose a DataJoiner server, you will link directly to a DB2 database.

### DataJoiner non-IBM source server

If you selected a DataJoiner alias from the **Source, control, or target server** pull-down list and you have performed server mappings in DataJoiner, then this list displays available remote server names.

Specify **(None)** if you want the control tables to be created in the DataJoiner database rather than in the remote server database.

### Edit Tablespace Logic

Click this push button to customize table space names for control tables or for CREATE TABLESPACE options. The default table space names for DB2 for OS/390 are:

- TS\_UOW for the UOW table
- TS\_CNTL for all other control tables

---

25. For DB2 Universal Database systems, you can use the DB2 Control Center or DJRA to perform this task; for other systems, including DB2 for OS/390, DB2 for AS/400, and all non-IBM databases, you must use DJRA.

For other platforms, the default table space name is *TSnnnnnnn*, where *nnnnnnn* is a unique identifier.

### Generate SQL

Click this push button to generate SQL after you supply all the information on this panel. While the SQL is being generated, a window is displayed showing processing messages and error messages, if any.

When the procedure completes successfully, save the file by selecting **File→Save**. You can now edit the generated SQL, if necessary, according to the guidelines listed in “Customizing and running replication SQL files”. When you are ready, run the SQL by selecting **File→Run**. You must save the generated SQL before you can run the SQL. You must run the SQL for generating control tables before you generate and run SQL to create replication sources or subscription sets.

---

## Customizing and running replication SQL files

From the DB2 Control Center, you have the option to run a replication task immediately or save the generated SQL file to run at a later time. From DJRA, you can run or edit SQL files from the main window. The SQL files can be customized for large scale replication actions such as defining subscription sets, or customized for an application beyond implementations supported by either the Control Center or DJRA.

You might want to save and customize the SQL files to:

- Create multiple copies of the same replication action, customized for multiple servers.
- Customize CD table names.
- Define the location for CD tables (DB2 for OS/390 database, DB2 Universal Database table spaces, DB2 for VSE & VM dbspaces).
- Set the size of the table spaces, databases, or dbspaces of the CD tables.
- Define site-specific standards.
- Combine definitions together and run as a batch job.
- Defer the replication action until a specified time.
- Create libraries of SQL files for backup, site-specific customization, or to run stand-alone at distributed sites, such as for an occasionally-connected environment.
- Edit create table and index statements to represent clusters and other database objects.
- For Oracle and other remote servers, ensure that tables are created in the existing table spaces that you want.
- For Microsoft SQL Server, create control tables on an existing segment.

- Review and edit subscription member predicates as a way of defining multiple subscription sets at one time. You can use substitute variables in your predicates and resolve the variables with programming logic.

If you save the definitions of a large replication subscription set in an SQL file, you can rerun the definitions as necessary.

When editing generated SQL, be careful not to change special markers that DJRA places within the SQL. For example, `:ENDOFTRIGGER:` or `:ENDOFPROCEDURE:` is part of a comment that is necessary for DJRA to run successfully. Altering create trigger blocks can result in incorrect SQL that ends in error when run. If you add lines to the end of the file, be sure to add an extra newline (CRLF) to the end of the file.

The DJRA **Run SQL** push button is intended to be used for SQL generated by DJRA. SQL that you generate outside DJRA might not run successfully if you use DJRA to start it. Likewise, you might not be able to run SQL generated by DJRA at a DB2 command line.

**Recommendation:** Run DJRA-generated SQL from DJRA.

---

## Setting up security for replication

Because DB2 DataPropagator is table driven, security for all replication objects depends on the database security. The database administrator who defines replication sources and subscription sets also defines security for them. Additionally, the Capture program must be authorized to access the source database and the Apply program must be authorized to access the control, source, and target databases.

### Authorization requirements for administration

When you define replication sources and subscription sets, the DB2 Control Center and DJRA create many tables. Depending on the operating system, they might also create table spaces or dbspaces. Because all of these actions require a high level of database privilege, you should plan to have at least one user ID that acts as the replication administrator and has the authority to create objects, bind plans, and run generated SQL for each of the source databases.

### Authorization requirements for running the Capture program

The user ID that runs the Capture program must be able to access the DB2 system catalog, be able to access and update all replication control tables, and have execute privileges on the Capture program packages. The user ID that runs the Capture program can be the same as the administrator user ID, but this is not a requirement.

For OS/390, the user ID that runs the Capture program should have either SYSADM authority or have the following authorizations:

- SELECT, UPDATE, INSERT, and DELETE privileges for all Capture-related tables created explicitly, and any Capture-related tables that the Control Center or DJRA implicitly creates. See “Chapter 14. Table structures” on page 293 for a list of these tables.
- SELECT privilege for the DB2 catalog (SYSIBM.SYSTABLES and SYSIBM.SYSCOLUMNS).
- TRACE privilege.
- MONITOR1 and MONITOR2 privilege.
- EXECUTE privilege for the Capture plan.

For VM and VSE, the user ID that runs the Capture program must have DBA authority. For all other operating systems, the user ID that runs the Capture program must have either DBADM or SYSADM authority.

### **Authorization requirements for running the Apply program**

The user ID that runs the Apply program must be a valid logon ID for the source, control, and target servers, and for the workstation where the Control Center or DJRA is installed. The user ID that runs the Apply program must be able to access the source tables, access and update all replication control tables, and update the target tables. This user ID must also have execute privileges on the Apply program packages. The user ID that runs the Apply program can be the same as the administrator user ID, but this is not a requirement. With the proper authorization, any user ID can run any Apply program instance.

An Apply program might require a password file to connect to the source or target server. For more information about authorization requirements for the Apply program, see the Capture and Apply chapter for your operating system in “Part 3. Operations” on page 173.

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## **Defining replication sources**

**To define a replication source using the DB2 Control Center:**

Click the **Tables** folder for the source database to show all tables. Right-click on a table object to show the pop-up menu and select **Define as replication source**.

You can define replication sources using the **Quick** or **Custom** choices. **Quick** allows you to define a replication source using default values. **Custom** allows you to customize the defaults, such as specifying that certain columns should not be captured.

After you define the replication source, an object is created in the **Replication Sources** folder. The source table can now be defined in a subscription set.

### To define a replication source using DJRA:

Click **Define One Table as a Replication Source** or **Define Multiple Tables as Replication Sources**, then fill in the required information, such as source server, source table names, and source columns.

For information about Capture triggers, see “Capture triggers for non-IBM sources” on page 80. For data restrictions when defining replication sources and subscription sets, see “General restrictions for replication” on page 77.

The Capture program does not recognize new DB2 replication sources until you issue either the **reinit** command or stop and restart the Capture program. The Capture program does not begin capturing changes for a replication source until a subscription set is created for that replication source and the subscription-set members have been fully refreshed.

## Defining replication sources for update-anywhere replication

### To define a replication source for update-anywhere replication using the DB2 Control Center:

Define a custom replication source and use the following selections:

1. Select the **Table will be used for update anywhere** check box.
2. Select a conflict detection level:

**None** No conflict detection.

**Attention:** Conflicting updates between the source table and the replica will *not* be detected. This option is *not* recommended for update-anywhere replication.

#### **Standard**

Moderate conflict detection, in which the Apply program searches rows already captured in the replica’s change data tables for conflicts. Standard detection is the default value.

When you select this option, the DB2 Control Center also selects the **Define as Source** and **Capture before image** check boxes for every column.

#### **Enhanced**

Conflict detection that provides the best data integrity among all replicas and the source table. The Apply program locks all replicas in the subscription set against further transactions, and begins detection after all changes prior to the locking are captured.



Even if you specify enhanced conflict detection, when the Apply program runs in an occasionally-connected environment (started with the **asnsat** command, or with the **COPYONCE** keyword), the Apply program uses standard conflict detection.

### **To define a replication source for update-anywhere replication using DJRA:**

Select the conflict detection level (described above) when you define a table as a replication source, and select the replica target structure when you add the member to the subscription set.

### **When to use update anywhere:**

To reduce the risks of conflicts and costs of rejected conflicting transactions, use update-anywhere replication under the following conditions:

#### **Fragmentation by key**

Design your application so that the replication source is updated by replicas for key ranges at specific sites. For example, your New York site can update sales records only for the Eastern United States (using ZIP codes<sup>26</sup> less than or equal to 49999 as the key range), but can read all sales records.

#### **Fragmentation by time**

Design your application so that the table can be updated only during specific time periods at specific sites. The time periods must be sufficiently separated to allow for the replication of any pending changes to be made to the site that is now becoming the master version. Remember to allow for time changes, such as Daylight Savings Time or Summer Time, and for time-zone differences.

## **Detecting conflicts**

For update-anywhere replication, update conflicts can occur when:

- An update is made to a row in the source table and a different update is made to the same row in one or more replica tables.
- Constraints are violated.

The Apply program detects update conflicts, after they occur, during the subscription cycle. The source table is considered the primary table. That is, it can receive updates from replica tables, but if there is a conflict, the source table wins and the replica tables' conflicting transactions are rejected. The Apply program detects direct row conflicts by comparing the key values in

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26. United States postal codes.

the CD tables with the source and target tables. If it finds any that match, it marks the replica transaction as rejected in the UOW table and rolls back the replica transaction.

The Apply program cannot detect read dependencies. If, for example, an application reads information that is subsequently removed (by a DELETE statement or by a rolled back transaction), the Apply program cannot detect the dependency.

DB2 DataPropagator provides three levels of conflict detection: no detection, standard detection, and enhanced detection. Each level has a numerical value which is stored in the CONFLICT\_LEVEL column of the register control table. You must decide, based on your tolerance for lost or rejected transactions and performance requirements, which type of detection to use. See “Defining replication sources for update-anywhere replication” on page 106 for more information about the levels of conflict detection and how to specify them.

**Restriction:** Although you set the conflict-detection level for individual replication sources, the Apply program uses the highest conflict-detection level of any subscription-set member as the level for all members of the set.

Use the rejection codes provided in the UOW table to identify the before and after row values in the CD table for each rejected transaction. Because the ASNDONE exit routine runs at the end of each subscription cycle, you can add code to the routine to handle any rejected transactions. See “Using the ASNDONE exit routine” on page 132 for more information on the ASNDONE exit routine. Alternatively, because the change data rows and UOW control table rows for rejected transactions are exempt from normal pruning (they are, however, subject to RETENTION\_LIMIT pruning), you could handle the rejected transactions as a batch by using a program that scans the UOW table.

## Defining views as replication sources

You can define replication sources that are views of other tables. After defining each replication source table included in the view, you can create a view replication source. The view replication source is then available for replication to a target table.

You cannot use the DB2 Control Center to define an existing view as a replication source; use DJRA instead. You can use the DB2 Control Center to define a new view as a replication source.

*To define a view using the DB2 Control Center:*

1. Define the source tables to be used in the view (or join) as replication sources.

2. Click on the **Replication Sources** folder. Select the replication sources to be used in the view from the contents pane. Right-click the mouse button, then select **Define join** from the pop-up menu. The Define Join window opens.

3. In the **CREATE VIEW** field, type the SQL statement for the view. For example:

```
USERID.VIEW_NAME AS SELECT A.COL1, A.COL2, B.COL6, B.COL5
```

Do not type the words **CREATE VIEW**. This part of the statement is automatically supplied during processing.

4. In the **FROM** field, type table names that define the join. For example:

```
TABLEA A, TABLEB B
```

Do not type the word **FROM**. This part of the statement is automatically supplied during processing.

5. If you want to use a row predicate, type the **WHERE** clause SQL statement in the **WHERE** field. For example:

```
A.COL1=B.COL1
```

Do not type word **WHERE**. This part of the statement is automatically supplied during processing.

6. Select **OK** to save the values and close the window. After you run the SQL that defines the join view, it is available for replication.

*To define a view as a replication source using DJRA:*

Click **Define DB2 Views as Replication Sources** and fill in the required information, such as source server, source view qualifier, and source view name. You cannot define a join as a replication source using DJRA, but you can define a view for the join and use DJRA to define the view as a replication source.

## **Enabling replication logical-partitioning-key support**

Generally, the Capture program captures an update to a source table as an **UPDATE** statement. However, for the following conditions, you must instruct the Capture program to capture updates as **DELETE** and **INSERT** statements (that is, you must enable logical-partitioning-key support):

- Your source applications update one or more columns that are part of a target table's primary key.

Because the values for the target-table primary key come from the changes captured on the source server, which reflect the new key values, these values cannot be used to find the existing target table row (it doesn't exist yet). Converting the **UPDATE** to a **DELETE** and **INSERT** pair ensures that the target table reflects the changes made at the source server.

- Your source applications update one or more columns referenced by a subscription-set predicate.

In this case, the column included in the predicate need not be a primary-key column. If a subscription set is defined with a predicate based on a specific column value (for example, `WHERE DEPT = 'J35'`), and you change that column (for example, to `DEPT='FFK'`), the captured change will not be selected for replication because it does not meet the predicate criteria. That is, your new FFK department will not be replicated because your subscription is based on department J35. Converting the UPDATE to a DELETE and INSERT pair ensures that the target-table row is deleted.

- Your source applications update one or more columns of a target-table partitioning key (either the target table is a partitioned database managed either by DB2 Enterprise - Extended Edition (EEE) or DB2 for AS/400, or is a table in a DB2 for MVS/ESA<sup>27</sup> partitioned table space).

Enabling logical-partitioning-key support ensures that target rows are moved from one node to another when the source column for the logical-partitioning key is changed and replicated. The move is accomplished by a DELETE at the old node and an INSERT at the new node.

You can capture updates as updates or as delete/insert pairs for both DB2 and non-DB2 sources.

By default, when you update the primary keys of either the source or target tables, the Capture program captures the changed row for the update. The Apply program then attempts to update the row in the target table with the new key value. This new key value is not found in the target table, so the Apply program converts this update to an insert. In this case, the old row with the old key value remains in the table (and is unnecessary). When you enable replication logical-partitioning-key support, the Capture program captures the change as separate DELETE and INSERT statements: delete the old row and insert the new row.

For DATALINK columns defined as ON UNLINK DELETE, the unlink is ignored because a DELETE and INSERT pair is handled within the same transaction. The external file is not deleted, but is updated.

Each captured UPDATE is converted to two rows in the CD table for all columns, non-key columns as well as key columns. You might need to adjust the space allocation for the CD table to accommodate this increase in captured data.

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27. Version 4 or earlier only. This restriction does not apply to DB2 for OS/390 V5 or later.

When you use the DB2 Control Center to define the source table, select the **Changed data for partitioned key columns captured as delete and insert** check box on the Define as Replication Source window to specify that the Capture program should capture updates as DELETE and INSERT statements.

When you use DJRA to define the source table, select the **Updates as delete/insert pairs** radio button from either the Define One Table as a Replication Source window or the Define Multiple Tables as Replication Sources window.

---

## Defining CCD tables

**Recommendation:** Use DJRA to define CCD tables. The DB2 Control Center does create CCD tables, but does not allow you to define them directly.

To define a CCD table using DJRA, select CCD as the **Target structure** from the Add Member to a Subscription Set window, then click the **Setup** pushbutton. Select the type of CCD table you want from the Staging (CCD) table property selection for target server window. This window prompts you for all valid combinations of CCD tables.

For noncomplete CCD tables, you can include one or more of the UOW table columns; these columns are useful for auditing and include Apply qualifiers, authorization IDs, UOW ID, and so on.

If you are using a CCD table to stage replication (for example, in a three-tier replication environment), complete the following steps:

1. Add the (complete and condensed) CCD table to a subscription set.  
The Apply program that owns the subscription set populates the CCD table based on the subscription-set definition.
2. If the CCD is defined as external, define it as a replication source.  
From the DJRA Staging (CCD) table property selection for target server window, select the **Register as external replication source** checkbox after selecting a complete CCD table. See “Defining replication sources” on page 105 for more information.
3. Create a new subscription set.  
This new set is the Apply program that applies changes from the CCD table to the target tables. Usually, you use a different Apply qualifier than the one used to populate the CCD, but you can use the same one.  
See “Defining replication subscription sets” on page 112.
4. Define the target tables within the subscription set.  
Select the source table depending on the type of CCD table you are using:

- Because an internal CCD table is an implicit source, specify the original source table as the source. The Apply program automatically performs a full refresh from the source table to the target tables, and uses the CCD table as the source for change capture.

**Restrictions:** To register an internal CCD table, the source server must be colocated with the target server. You can only register *one* internal CCD for each source table.

- For an external CCD table, specify the CCD table as the source table. The Apply program uses the CCD table for both full refresh and changes.

For more information about CCD tables, see “Staging data” on page 82.

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## Defining replication subscription sets

*To define a replication subscription set using the DB2 Control Center:*

1. Click the **Replication Sources** folder for the source database to show all tables and views defined as replication sources. The replication sources appear in the contents pane.
2. Select one or more tables or views that you want to define as sources for the subscription set, and right-click on one to show the pop-up menu and select **Define subscription**. The Define Subscription window opens.
3. Give the subscription a name, specify the target server, and specify the Apply qualifier for the subscription. You can also change the name of the target table and specify whether the Apply program should create the target table. Target-table names cannot exceed 18 characters in length.  
If you specify that the Apply program should create the target table, and that table will contain DATALINK columns, these columns will have the default level of link control (none). If you want these columns to have a different level of link control, edit the generated SQL to modify the CREATE TABLE statement and specify a new level of link control, then run the modified SQL.
4. Click the **Advanced** push button to specify the target type and to specify specific columns and rows. See “Choosing a target-table type” on page 115 and “Defining the target-table structure: columns and rows” on page 116 for more information about these tasks.
5. Click the **Timing** push button to specify the frequency of replication and a data blocking value. See “Specifying a data-blocking value” on page 122 for more information.
6. Click the **SQL** push button to add SQL statements or stored procedures that you want to run before or after a subscription cycle. For example, you can add a DELETE statement to prune the Apply trail control table.

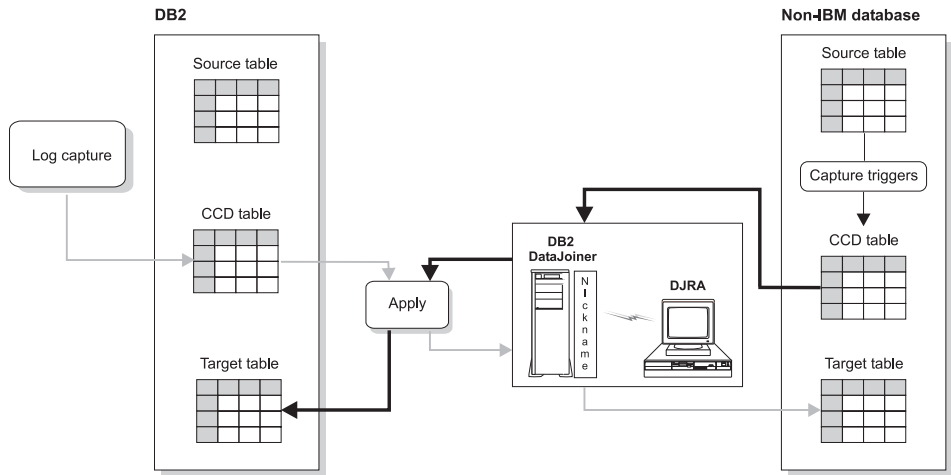
7. Click the **OK** push button to complete the subscription definition. The Subscription Information window opens. In that window, specify the control server name.

*To define a replication subscription set using DJRA:*

1. From the main window, click **Create Empty Subscription Sets** to open the Create Empty Subscription Sets window.
2. In this window, specify the source server, control server, target servers, the Apply qualifier, the subscription set name, the subscription timing, and blocking factor.
3. Add subscription-set members to the subscription set.
  - a. From the main window, click **Add a Member to Subscription Sets** or **Add Multiple Members to Subscription Sets** to display either the Add a Member to Subscription Sets window or the Add Multiple Members to Subscription Sets window.
  - b. In either window, specify the subscription sets to which you want to add a member, the tables and views to add to the subscription set, whether the target table should be a column or row subset of the source table (see “Defining the target-table structure: columns and rows” on page 116), the target table type (see “Choosing a target-table type” on page 115), and how the index for the target table should be created.

When you add members to a subscription set, you can specify which primary key to use for the target table. You can specify that DJRA should generate the target primary key from the source primary key and source table indexes, or you can specify the particular columns for the key, or you can specify the source primary key.

After you create subscription sets for a non-IBM source server, the Apply program connects to the DB2 DataJoiner database that is associated with the non-IBM server and accesses (through nicknames) the information in the register control table and the staging table on the non-IBM source server (see Figure 21 on page 114).



*Figure 21. DB2 DataJoiner in action.* In a scenario where the source table is a non-IBM table (the dark arrows), DB2 DataJoiner nicknames give the Apply program access to the non-IBM source server and to changes made to the non-IBM source table (through the staging table). In a scenario where the source table is a DB2 table (the light arrows), DB2 DataJoiner nicknames give the Apply program access to the non-IBM target tables.

If you defined an event to start the Apply program, you must populate the event table. See “Event timing” on page 124 for more information about this task. To begin replicating data to the target tables, start the Capture program at the source server, then start the Apply program using the name of the control server that you specified in the Control Center Subscription Information window or the DJRA Add a Member to Subscription Sets window (or Add Multiple Members to Subscription Sets window).

## Defining subscription sets for update-anywhere replication

To define a subscription set for update-anywhere replication using the DB2 Control Center, define a subscription set and use the following selections:

1. Select the replication sources that you want to be in the subscription set. Include all sources affected by the replica tables being updated.
2. From the Subscription Definition window, select a target table to be defined as a replica table.
3. Click **Advanced** to open the Advanced Subscription notebook. The following selections are required on the Advanced Subscription notebook:
  - a. From the Target Type page, click on **Target table is replica**.
  - b. From the Target Columns page, repeat the following steps for each target table:
    - 1) Ensure that the **Subscribe** check boxes are selected for every column. *Do not* create new columns for the replica table.
    - 2) Specify a primary key for the replica table by clicking on the **Primary Key** check boxes next to the key column names.



Make the primary key the same as the source-table primary key to prevent conflicts. Do not use before-image columns as primary-key columns for the target table.

**Important:** For existing target tables, you must select the primary-key columns.

- c. If you want the replica to be a subset of the source table, type a row predicate in the **WHERE** field on the Rows page.
  - d. Click **OK** to close the Advanced Subscription notebook.
4. Click **Timing** to open the Subscription Timing notebook:
    - a. On the Source to Target page, fill in the subscription set timing information for copying the source-table's changed data to the target tables.
    - b. On the Replica to Source page, fill in the subscription-set timing information for copying the replica-table's changed data to the source tables.
    - c. Click **OK** to close the notebook.
  5. If you want to define SQL or CALL procedures to run before or after the subscription set is processed, click **SQL** and define the processing statements.

To define a replication subscription for update-anywhere replication using DJRA, select the replica target structure when you add the member to the subscription set.

## Choosing a target-table type

You can specify a target-table type if you do not want to accept the default target type of user copy.

*To specify a target-table type using the DB2 Control Center:*

1. From the Define Subscription window, select a source and target table combination, and click **Advanced** to open the Advanced Subscription Definition notebook.
2. From the Target Type page, select one of the following table types:
  - For read-only target tables, you can select:

### **User copy**

A target table that matches the source table exactly at the time of the copy.

### **Point-in-time**

A target table that matches the source table, with a timestamp column added.

### **Staging table**

Also known as a CCD table. See "Attributes of CCD tables" on page 82

page 82 for more information about CCD tables. If you select this option without selecting either of the two options below, the DB2 Control Center creates a noncomplete, noncondensed CCD table.

#### **Used as source for future copies**

Select this option if you want a complete, condensed CCD table.

#### **Include Unit-of-Work (UOW) table columns**

Select this option if you want a noncomplete, condensed CCD table that includes extra columns from the UOW table.

#### **Base aggregate**

A target table that contains aggregated data for a user table appended at specified intervals.

#### **Change aggregate**

A target table that contains aggregated data based on changes recorded for a source table.

- For updateable target tables, select **Target table is replica** to create an updateable target table used for update-anywhere replication.
3. If you are finished using the Advanced Subscription Definition notebook, click **OK** to close the notebook. Otherwise, use the other pages of the notebook to define the target table columns and rows, as needed.

*To specify a target-table type using DJRA:*

Click **Add a Member to Subscription Sets** or **Add Multiple Members to Subscription Sets**. Fill in the required information for the subscription-set member. You can specify the target-table type from the **Table structure** drop-down list. The available types include the same as those described for the DB2 Control Center, plus choices for CCD table types.

### **Defining the target-table structure: columns and rows**

For some applications, the target table does not need all of the rows or columns that exist in the source table. You can define the target table to be a column or row subset of the source table using the Control Center or DJRA. For more information on subsetting, see “Subsetting columns and rows” on page 70.

**Restriction:** Replica target tables must contain the same columns as the source table: you cannot create subsets for them; you cannot add columns; and you cannot rename columns.

#### **Defining the target-table columns**

*To define the target-table columns using the DB2 Control Center:*

1. From the Define Subscription window, select a source and target table combination and click **Advanced** to open the Advanced Subscription Definition notebook.
2. From the Target Columns page, specify which columns should be the primary-key columns for the target table; you can rename columns and you can change column definitions.

If you want to specify a column as a primary-key column for the target table, select the **Primary Key** check boxes next to the column names.

**Attention:** For the following target-table types you must select one or more columns as part of a primary key: user copy, point-in-time, replica, and condensed staging tables. If you do not select columns for the primary key, DB2 uses the primary-key definition of the source table. However, if the source table does not have a primary-key definition, the Apply program issues an error message.

If you want to rename a column, select the column name and type over the existing column name. A column name can have up to 17 characters and can be an ordinary or delimited identifier.

If you want to change a column definition for the target table, click **Change** to open the Change Column window. From this window, you can:

- Change the name of the column.
- Change the definition of the column by entering an SQL expression. For example: `COUNT(*)` or `EMP_SALARY - EMP_COMM`.

The expression can contain up to 254 characters and can be any valid SQL expression. This expression can contain ordinary or delimited identifiers. Columns used in the expression must be valid after-image columns from the source table. These column names are listed in the **Available columns** box.

See the *DB2 SQL Reference* for information on valid SQL expressions. Invalid SQL expressions cause an SQL error when the Apply program processes the subscription.

- See examples of valid SQL expressions; click **Examples**.

If you want to remove a column from the target table, clear the **Subscribe** check box next to the column name.

If you want to create a new computed column or use aggregation for the target table:

- a. Click **Create Column** to open the Create Column window.
- b. Type the name of the column in the **Column name** field. The name can have up to 17 characters and can be an ordinary or delimited identifier.
- c. Type the SQL expression defining the new column.
- d. Click **OK** to close the window.

3. If you are finished using the Advanced Subscription Definition notebook, select **OK** to close the notebook. Otherwise, use the Rows page to define the target table rows, as needed.

*To define the target-table columns using DJRA:*

Click the **Selected columns** radio button from the Add a Member to Subscription Sets window. Then select the columns you want replicated to the target table.

**Defining the target-table rows**

*To define the target-table rows using the DB2 Control Center:*

1. From the Define Subscription window, select a source and target table combination and click **Advanced** to open the Advanced Subscription Definition notebook.
2. From the Rows page, specify a WHERE clause that defines the row subset. To specify which rows are copied to the target table, type an SQL predicate in the **WHERE** field. The predicate can contain ordinary or delimited identifiers. See the *DB2 SQL Reference* for more information about WHERE clauses.

*Row Predicate Restrictions:*

- Do not type WHERE in the clause; it is implied. Type WHERE in the clause only for subselect statements.
- Do not end the clause with a semicolon (;).
- You can use only those column names shown in the **Target columns** list on the Target Columns page; these names are also listed in the **Available columns** list.
- Do not use before-image columns, computed columns, or IBMSNAP columns in the WHERE clause. Before-image columns are supported for CD tables but not for user tables, point-in-time tables, or replica tables.<sup>28</sup>
- If you added computed columns (on the Target Columns page), you must provide a GROUP BY clause. Both base aggregate and change aggregate tables must have a GROUP BY clause.
- If your WHERE clause contains the Boolean expression OR, enclose the predicate in parentheses; for example, (COL1=X OR COL2=Y).
- If the target table is a change aggregate table and contains before-image columns, you must include the before-image columns in a GROUP BY clause, even though these columns are not displayed in the **Available columns** box on the Target Columns page.

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28. If you use before-image columns or computed columns, for example, full refresh is no longer possible. You must also modify the register control table.

- When both of the following conditions are true, you must provide a dummy *WHERE* clause:
  - You are creating an aggregate column that requires a *GROUP BY* clause.
  - You do not use any other predicate in the **WHERE** field.

The Apply program issues error messages if you do not provide the dummy *WHERE* clause in this situation.

3. To see examples of SQL predicates, click the **Examples** button.

***WHERE clause examples:***

The following examples show *WHERE* clauses that you can use to filter rows of the target table. These examples are very general and designed for you to use as a model.

- *WHERE* clause specifying rows with specific values

To copy only the rows that contain a specific value, such as *MGR* for employees that are managers, use a *WHERE* clause like:

```
EMPLOYEE = 'MGR'
```

- *WHERE* clause specifying rows with a range of values

To copy only the rows within a range, such as employee numbers between 5000 and 7000 to the target table, use a *WHERE* clause like:

```
EMPID BETWEEN 5000 AND 7000
```

- Dummy *WHERE* clause

To support aggregation, use a *WHERE* clause like:

```
1=1
```

4. If you are finished using the Advanced Subscription Definition notebook, click **OK** to close the notebook.

***To define the target-table rows using DJRA:***

Add a *WHERE* clause in the **Where clause** field of the Add a Member to Subscription Sets window.

**Defining a subscription set with a user-defined table**

DB2 DataPropagator allows you to use a previously-defined DB2 table as the target table in a subscription set. That is, you can define a subscription-set member to be a target table that is defined outside of the DB2 Control Center or DJRA. This type of target table is known as a user-defined target table.

**Restrictions:**

- The subscription-set definition must contain the same number of columns as exist in the user-defined target table.
- New columns in the subscription-set definition must allow nulls and must not have defined default values.

- The target table and unique index must exist when you run the Apply program.

*To define a subscription with a user-defined target table:*

1. Refer to “Chapter 14. Table structures” on page 293 to determine the structure for the target-table type. For example, if you are defining a subscription for a base aggregate table, refer to the table structure definition for base aggregate tables.
2. Alter the target table to add any required columns, such as timestamp columns.
3. For point-in-time, user copy, replica, and condensed CCD tables, create a unique index.
4. Define the subscription-set member to match the user-defined target table structure, including new columns, subset columns, changed column names, and renamed before-image columns.

From the DB2 Control Center, in the Define Subscription window:

- a. Clear the **Create table** check boxes next to the table names for which you are providing the target tables.
- b. Type the user-defined target-table name in the **Target table** field.
- c. If you want to subset columns or rows, enhance data, or specify a target-table type other than user copy, click **Advanced** to open the Advanced Subscription Definition notebook.

If you want to select an alternate table type, see “Choosing a target-table type” on page 115. If you want to modify the target-table columns to match the user-defined target table, or subselect the rows or use an aggregate expression, see “Defining the target-table structure: columns and rows” on page 116.

DJRA tolerates existing target tables, and checks that the columns in the target table match those defined for the subscription-set member.

DB2 DataPropagator does not check for inconsistencies between the subscription definition and a user-defined target table. You must:

- Ensure that there is a target table that matches the subscription definition.
- Debug any inconsistencies that exist between the target table and the subscription definition.
- If you want to use a CCD table between the source table and the user-defined target table, define a subscription to match the attributes specified for the target table. Then define a subscription for the target table in which the CCD table is the source table.
- Ensure that there is a unique index for point-in-time, user copy, replica, and condensed CCD tables.

## Defining SQL statements or stored procedures for the subscription set

You can define SQL statements or stored procedures to be run before or after the Apply program copies the data from the source to the target table. For example, you can prune the Apply trail control table each day to remove older entries.

*To specify SQL statements or stored procedures for the subscription set using the DB2 Control Center:*

1. From the Define Subscription window, click **SQL** to open the SQL window.  
Use the SQL window to add or remove SQL statements or stored procedures that run at the target or source server either before or after the replication subscription is processed. The statements are processed in the order that they appear in the list.
2. Click **Add** to open the Add SQL window.
3. Type the SQL statement or stored procedure name in the **SQL statement or Call procedure** field. The stored procedure name must begin with CALL. This field can contain ordinary or delimited identifiers.
4. If you know that the SQL statement or stored procedure will generate SQLSTATEs that would otherwise terminate execution, specify these SQLSTATEs so that the Apply program can bypass them and treat them as successful execution. For example, a DELETE statement will generate a SQLSTATE 02000 when attempting to delete nonexistent rows, but for new tables you might not care about this error.  
Enter valid 5-byte SQLSTATE values in the **SQLSTATE** field and click **Add**. The value is added to the **Acceptable SQLSTATE values** box. You can add up to 10 values.
5. Specify whether you want to run the SQL statement or stored procedure at the source or target server before the subscription set is processed, or at the target server after the subscription set is processed by clicking the appropriate radio button in the **Submit SQL statement** field.
6. Click **OK** to add the statement to the box in the SQL window and close the Add SQL window.

*To specify SQL statements or stored procedures for the subscription using DJRA:*

1. From the main DJRA window, click **Add Statements or Procedures to Subscription Sets**.
2. Specify the source server and subscription sets to which you are adding SQL statements or stored procedures.

3. Type the SQL statement in the **SQL statement** field or type the stored procedure name in the **Stored procedure** field. The stored procedure name must begin with CALL. This field can contain ordinary or delimited identifiers.
4. If you know that the SQL statement or stored procedure will generate SQLSTATES that would otherwise terminate execution, specify these SQLSTATES so that the Apply program can bypass them and treat them as successful execution. For example, a DELETE statement will generate a SQLSTATE 02000 when attempting to delete nonexistent rows, but for new tables you might not care about this error.  
Select a statement number from the **Statement number** spin box, and enter valid 5-byte SQLSTATE values in the **Acceptable SQLSTATE values** field.
5. Specify whether you want to run the SQL statement or stored procedure at the source server before the subscription set is processed, or at the target server before or after the subscription set is processed by selecting the appropriate radio button.

### Data-sharing considerations

You can implement replication in an System/390 data-sharing environment. In a data-sharing environment, you run one Capture program for each source data-sharing group and one or more Apply programs for each target data-sharing group.

The Capture program can read the data-sharing logs for all supported versions of DB2 for OS/390. That is, you can run different versions of DB2 in a data-sharing environment, for example during version-to-version migration, and have one Capture program continue to capture transaction-consistent data. However, this mixed-version environment is not recommended for long-term use, either for replication or for DB2. See the *DB2 for OS/390 Administration Guide* for information about data sharing with mixed versions of DB2.

### Specifying a data-blocking value

To specify how many minutes worth of change data DB2 DataPropagator can replicate during a subscription cycle, use the Data Blocking page of the Subscription Timing notebook in the DB2 Control Center, or set the **Blocking factor** in the Create Empty Subscription Sets window in DJRA. The number of minutes that you specify determines the size of the data block. See “Data blocking for large volumes of changes” on page 68 for more information about how to determine this value.

DB2 DataPropagator saves this value in the MAX\_SYNCH\_MINUTES column of the subscription set control table. To change this value, execute the following SQL statement:



```
UPDATE ASN.IBMSNAP_SUBS_SET
SET MAX_SYNCH_MINUTES=new_val
WHERE APPLY_QUAL=ApplyQual AND SET_NAME=name AND WHOS_ON_FIRST=val
```

where *new\_val* is the new blocking factor value, *ApplyQual* is the current Apply qualifier, *name* is the current subscription-set name, and *val* is either F or S.

## Data currency requirements

How up to date do you want target tables to be? How out of date can they be without disrupting the application programs that use them? The answers to these questions reveal your data currency requirements. You can control how often the Apply program processes subscriptions and thereby control the currency of the data. You can set an interval (or relative timing) schedule for the Apply program, or define an event trigger that the Apply program uses to start processing a subscription set.

You define subscription timing with the Subscription Timing notebook in the DB2 Control Center or from the **Subscription set timing** field on the Create Empty Subscription Sets window in DJRA. You can control the timing using time-based or event-based scheduling, or you can use these timing options together. For example, you can set an interval of one day, and also specify an event that triggers the subscription cycle. For update-anywhere replication, you can also specify different timing for source-to-replica and replica-to-source replication.

**Recommendation:** When moving from a test environment to a production environment, set a mid-range timing value (such as 2 hours) and tune your system from there (to a more frequent or less frequent interval, as appropriate).

### Interval timing (relative timing)

The simplest method of controlling subscription timing is to use interval timing. You determine a specific start time, date, and interval. The interval can be specific (from one minute to one year) or continuous, but time intervals are approximate. The Apply program begins processing a subscription set as soon as it can, based on its workload and the availability of resources. If you specify continuous timing, the Apply program replicates data as frequently as it can.

Choosing a timing interval does not guarantee that the frequency of replication will be exactly at that interval. Before specifying an interval, you should determine whether it is possible to refresh all tables in the subscription set within that interval: determine the amount of data that the Apply program is likely to select for each interval and estimate the time that it will take to copy the data.

You can set and change the interval using the DB2 Control Center, DJRA, or by executing SQL statements against the subscription-set control table.

### Event timing

To replicate data using event timing, specify an event name when you define the subscription set in the DB2 Control Center or DJRA. You must also populate (using an application program or the DB2 Command Center) the subscription events table with a timestamp for the event name. When the Apply program detects the event, it begins replication (either change-data capture or full refresh).

The subscription events table has three columns, as shown in Table 6.

*Table 6. The subscription events table*

EVENT_NAME	EVENT_TIME	END_OF_PERIOD
END_OF_DAY	2000-05-01-17.00.00.000000	2000-05-01-15.00.00.000000

EVENT\_NAME is the name of the event that you specify while defining the subscription set. EVENT\_TIME is the timestamp for when the Apply program begins processing the subscription set. END\_OF\_PERIOD is an optional value that indicates that updates that occur after the specified time should be deferred until a future time. Set EVENT\_TIME using the clock at the control server, and set END\_OF\_PERIOD using the clock at the source server. This distinction is important if the two servers are in different time zones.

In Table 6, for the event named END\_OF\_DAY, the timestamp value (2000-05-01-17.00.00.000000) is the time when the Apply program is to begin processing the replication subscription. The END\_OF\_PERIOD timestamp value (2000-05-01-15.00.00.000000) is the time after which updates are not replicated and will be replicated on the next day's cycle. That is, the event replicates all outstanding updates made before three o'clock, and defers all subsequent updates.

Your application programs must post events to the subscription events table to tie your application programs to subscription activity. When you post an entry using CURRENT\_TIMESTAMP plus one minute for EVENT\_TIME, you trigger the event named by EVENT\_NAME. Any subscription set tied to this event becomes eligible to run in one minute. You can post events in advance, such as next week, next year, or every Saturday. If the Apply program is running, it starts at approximately the time that you specify. If the Apply program is stopped at the time that you specify, when it restarts, it checks the subscription events table and begins processing the subscription set for the posted event.

Any event that occurs prior to the most recent time the Apply program processed the subscription set (as specified by the value in the LASTRUN column of the subscription-set control table), is considered to be an expired event and is ignored. Therefore, if the Apply program is running, you should post events that are slightly in the future to avoid posting an expired event.

### Changing subscription-set timing

You can change subscription-set timing while both the Capture program and Apply program are running by modifying values in the subscription set table. For example, to change the interval value, execute the following SQL statement:

```
UPDATE ASN.IBMSNAP_SUBS_SET
SET INTERVAL_MINUTES=new_val
WHERE APPLY_QUAL=ApplyQual AND SET_NAME=name AND WHOS_ON_FIRST=val
```

where *new\_val* is the new interval value, *ApplyQual* is the current Apply qualifier, *name* is the current subscription-set name, and *val* is either F or S.

To change a subscription set to use event timing rather than interval timing, execute the following SQL statements:

```
UPDATE ASN.IBMSNAP_SUBS_SET
SET REFRESH_TIMING='E', EVENT_NAME='END_OF_DAY'
WHERE APPLY_QUAL=ApplyQual AND SET_NAME=name
```

```
INSERT INTO ASN.IBMSNAP_SUBS_EVENT
(EVENT_NAME, EVENT_TIME)
VALUES ('END_OF_DAY', 'timestamp')
```

where *new\_val* is the new interval value, *ApplyQual* is the current Apply qualifier, *name* is the current subscription-set name, *val* is either F or S, and *timestamp* is the timestamp for when the Apply program should begin processing the subscription set. If you already have an event named END\_OF\_DAY, you do not need the INSERT statement shown above, but you might need to modify the EVENT\_TIME.

See “Subscription set table” on page 323 and “Subscription events table” on page 335 for more information about these control tables.

## Data consistency requirements

When planning and defining a subscription set, you need to be aware of the following rules and constraints:

- If any member of the subscription set requires full-refresh copying for any reason, the entire set is refreshed. For update-anywhere replication, full-refresh copying occurs only from the replication source to the replica, not from replica to source.
- A single synchpoint is maintained for the subscription set to indicate the copy progress for the entire subscription set.

- You must refresh target tables that have referential-integrity constraints using the ASNLOAD exit routine to bypass referential-integrity checking.
- Do not define referential constraints for read-only target tables.
- The first occurrence of any referential-integrity violation terminates the current replication cycle. The subscription cycle is automatically retried, after the transaction is rejected and compensated.
- For update-anywhere replication, you must specify a collision-detection level when you define a replication source.
- For update-anywhere replication, each replica table must be of the same generation as all other replicas in the subscription set, and they must all have the same source table.
- For update-anywhere replication, because no single application program updates both source and target tables, referential-integrity violations cannot be detected in application logic, so you must use declarative referential-integrity constraints.
- The administration tools do not copy referential-constraint definitions from a source table to target tables. For update-anywhere replication, you must include all referential constraints that exist among the source tables in the replica tables to prevent referential-integrity violations. If you omit some referential constraints, an update made to a replica table could cause an referential-integrity violation when it is replicated to the source table.
- For a subscription that includes external CCD tables, all the external CCD tables must have a common original source database.

## Maintaining external CCD tables

If you maintain your own CCD table, you must update three columns in the register control table: `CCD_OLD_SYNCHPOINT`, `SYNCHPOINT`, and `SYNCHTIME`:

### `CCD_OLD_SYNCHPOINT`

The synch point associated with when the CCD table was last initialized or pruned.

Before a full refresh of the CCD table, set `CCD_OLD_SYNCHPOINT` to `NULL`.

After a full refresh of the CCD table, set the `CCD_OLD_SYNCHPOINT` to a value greater than the previous value of `SYNCHPOINT`. If `SYNCHPOINT` has no previous value (in the case of the initial load), set the `CCD_OLD_SYNCHPOINT` to `X'00000000000000000000'`.

### `SYNCHPOINT`

A sequence value useful for maintaining the state of CCD copies, subscription states, and for controlling pruning.

Set the SYNCHPOINT for the CCD table to MAX(IBMSNAP\_COMMITSEQ) whenever you commit new changes to the CCD table. Be sure also to set SYNCHTIME accordingly.

### SYNCHTIME

The timestamp-equivalent of SYNCHPOINT.

---

## Loading target tables offline using DJRA

DJRA guides you through the process of creating an offline load of a table or database. The following procedure does not maintain the additional control information required for loading external CCD tables, so for these tables you must use the manual procedure.

*To perform an offline load using DJRA:*

1. Ensure that the Capture program is running.
2. Click **Off-line load** on the DJRA main window.
3. In the Off-line load — STEP 1 window, generate the SQL statements to disable current subscriptions for the selected subscription sets. After you load the target tables, you will re-enable these subscriptions.
4. Unload the source tables. Then click **Next Step** on the Off-line load — STEP 2 window.
5. Load the target tables. Then click **Next Step** on the Off-line load — STEP 3 window.
6. In the Off-line load — STEP 4 window, generate the SQL statements to re-enable current subscriptions for the selected subscription sets. Then click **Finished**.

---

## Copying your replication configuration to another system

When you define tables, replication sources, or subscription sets on one system (a test system, for example), and you need to copy the replication environment to another system (a production system, for example), you can use the DJRA promote functions. These functions reverse engineer your tables, replication sources, or subscription sets, to create script files with appropriate data definition language (DDL) and data manipulation language (DML). Table 7 on page 128 shows the three promote functions.

For example, use the promote functions to define subscription sets for remote DB2 Personal Edition target databases. After you define a model target system in your test environment, you can create subscription-set scripts (and modify which Apply qualifier is used and so on) for your DB2 Personal Edition systems, which are not otherwise supported from a central control point.

Table 7. Promote functions provided by DJRA

Promote function	Description
Promote registration	This function promotes source tables and views from a source server.
Promote table	<p>This function promotes tables, table spaces, and indexes. It does not promote constraints defined for a table.</p> <p>This function is fully supported for DB2 UDB V5 and later, but for the IBM Common Server you can promote only tables, not table spaces.</p>
Promote subscription	<p>This function promotes subscriptions: subscription sets, subscription-set members, subscription columns, subscription prune control, and subscription statements. It enables you to create a new subscription set from an existing one.</p> <p>From the Promote Subscriptions window in DJRA, you can change your subscriptions (before promoting them) by setting new values for any of the following fields: <b>Apply Qualifier</b>, <b>Set Name</b>, <b>Source server</b>, <b>Source alias</b>, <b>Target server</b>, <b>Target alias</b>, <b>Control server</b>, and <b>Control alias</b>.</p>

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## Setting up the Capture program

This section describes setting the Capture program generally. See the appropriate chapter for your operating system environment (in “Part 3. Operations” on page 173) for specific information about setting up the Capture program.

### Specifying tuning parameters for the Capture program

To control the performance of the Capture program, you can specify the following tuning parameters in the tuning parameters table:

#### Retention limit

The number of minutes to keep the CD table rows and the unit-of-work (UOW) table rows. The default value is 10 080, which is 7 days.

For AS/400, you can keep the size of tables smaller by reorganizing them using the RGZPFM command.

#### Lag limit

The number of minutes that the Capture program can be backlogged from the current local time before shutting itself down. The default value is 10 080, which is 7 days. If this value is exceeded, the Apply program will perform a full refresh of all target tables.

**Recommendation:** Set a high value for the lag limit to ensure the Capture program does not shut itself down unnecessarily.

If the database does not have or support an archive log, and the Capture program shuts itself down, you should perform a cold start of the Capture program.

### **Commit interval**

The number of seconds that the Capture program waits before issuing a COMMIT statement. The default value is 30 seconds.

If the Apply program is *not* running at the same time as the Capture program, you can set the commit interval no higher than the DB2 timeout interval.

For AS/400, this value has a different meaning: it is the number of seconds between the time that an application program updates a source table and the time that the corresponding update in the CD table is written to disk. The commit interval can range from 30 to 600 seconds, and the default is 180. If the value is too small, overall system performance can be degraded.

### **Prune interval**

The number of seconds that the Capture program waits before pruning the CD and UOW tables. The default value is ten times the commit value, or 300 seconds, whichever is larger. This parameter is ignored if you start the Capture program with the NOPRUNE option; however, you can override this option by using the **prune** command.

For AS/400, you can override this value by specifying a value for the wait-time subparameter of the CLNUPITV keyword of the **STRDPRCAP** command. If you specify **\*NO** on the start-clean-up subparameter of the CLNUPITV keyword, the prune interval value is ignored.

For AS/400, if you start up the Capture program daily, **\*NO** allows you to defer pruning (for example, to the weekend). During the week, you can use CLNUPITV (**\*DPRVSN \*NO**) on the **STDPRCAP** command. On weekends, you can use CLNUPITV (**\*DPRVSN \*IMMED**), which is the default.

**Important:** When you manually prune the CD table, do not delete the most recent row. Always keep at least one row in the table.

*To specify the tuning parameters, do one of the following tasks:*

- Customize the DPCNTL.\* file in the DB2 \sqlib\samples\repl directory before you define the first replication source for a database.<sup>29</sup>

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29. Customizing DPCNTL.400 is not necessary if you already installed DataPropagator for AS/400.

- If you want to change the default values, update the tuning parameters table with the following SQL statement after you create it:

```
UPDATE TABLE ASN.IBMSNAP_CCPPARMS
SET RETENTION_LIMIT=number_of_minutes,
LAG_LIMIT=number_of_minutes,
COMMIT_INTERVAL=number_of_seconds,
PRUNE_INTERVAL=number_of_seconds
```

If you need to change the values and refresh the tuning parameters while the Capture program is running, enter the **reinit** command after changing the table values. For AS/400, enter the **INZDPRCAP** command; for more information about the **INZDPRCAP** command, see “Reinitializing Capture for AS/400” on page 203.

For information on the structure of the tuning parameters table, see “Chapter 14. Table structures” on page 293.

- Run the AS/400 **CHGDPRCAPA** command. See “Changing Capture program attributes” on page 179 for more information about this command.

### Restrictions when running the Capture program

The following actions cause the Capture program to terminate while it is running. Stop the Capture program if you want to perform any of the following tasks:

- Remove an existing replication source table. If you remove an existing replication source, the Capture program might attempt to insert data into a CD table that no longer exists.
- Make changes (other than ALTER ADD changes) that affect the structure of source tables or CD tables. This includes changes resulting from data definition language or utilities. Structural changes can compromise the data integrity of the copies.

Other Capture program restrictions include:

- If the Capture program shuts itself down, perform a cold start if the database does not have or support an archive log.
- Source tables must be created or altered using the DATA CAPTURE CHANGES option. The DB2 Control Center and DJRA automatically specify these keywords when you define replication sources.
- Capture does not capture any changes made by DB2 utilities, even if you specify LOG=YES.



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## Setting up the Apply program

This section describes setting the Apply program generally. See the appropriate chapter in “Part 3. Operations” on page 173 for your operating system environment for specific information about setting up the Apply program.

### Refreshing target tables with the ASNLOAD exit routine

The Apply program can call the ASNLOAD exit routine whenever it performs a full refresh of a target table. Specify the LOADX parameter to cause the Apply program to call this routine.

You can use the ASNLOAD routine as shipped with the Apply program, or you can modify it. As shipped, the routine uses the DB2 EXPORT utility to export data from the source table and uses the DB2 LOAD utility to fully refresh the target table. You can modify the ASNLOAD routine to call any IBM or vendor utility. See the prolog section of the sample program (ASNLOAD.SMP) in the \sqllib\samples\repl directory for information about how to modify this exit routine.

You must use the ASNLOAD routine to fully refresh tables with referential integrity constraints in order to bypass referential integrity checking.

If your source servers are password protected, you must modify the ASNLOAD routine to provide the password file. However, if the password is administered by DB2 Universal Database Satellite Edition, the ASNLOAD routine does not require a password file, and you can use the IBM-supplied routine.

If your source tables include DATALINK columns, the Apply program does not call the ASNDLCOPY exit routine. If you want external files (pointed to by the DATALINK values) to be copied during a full refresh, you must modify the ASNLOAD routine to call the ASNDLCOPY routine for these columns.

See “Refreshing target tables with the ASNLOAD exit routine for AS/400” on page 221 for information about using the ASNLOAD routine in an AS/400 environment.

### Files generated on Windows and UNIX

When you run the ASNLOAD routine, it generates the following files:

- `ASNA<userid><database_instance_name><cntl_server>.IXF`  
This file contains the data exported from the source.
- `ASNAEXPT<userid><database_instance_name><cntl_server>.MSG`  
This file contains error, warning, or informational messages issued by the EXPORT APIs.

- ASNAIMPT<userid><database\_instance\_name><cntl\_server>.MSG  
This file contains error, warning, or informational messages issued by the LOAD APIs.

### Files generated on OS/2

When you run the ASNLOAD routine, it generates the following files:

- <apply\_qual>.IXF  
This file contains the data exported from the source.
- <apply\_qual>.EXP  
This file contains error, warning, or informational messages issued by the EXPORT APIs.
- <apply\_qual>.LOA  
This file contains error, warning, or informational messages issued by the LOAD APIs.

### Error handling

If an error occurs while the Apply program calls the ASNLOAD routine, or if the routine returns a nonzero return code, the Apply program issues a message, stops processing the current subscription set, and processes the next subscription set.

### Restrictions

You can use the ASNLOAD routine only to refresh point-in-time and user copy tables. Target tables have the following restrictions for the ASNLOAD routine:

- The target-table columns must match both the order and data type of the source tables.
- The target table cannot have a subset of the source columns nor extra columns.
- The source table cannot be defined to include both before and after images because the before images would add extra columns to the target table.

### Using the ASNDONE exit routine

The Apply program can optionally call the ASNDONE exit routine after subscription processing completes, regardless of success or failure. You can modify this routine as necessary; for example, the routine can examine the UOW table to discover rejected transactions and initiate further actions, such as issuing a message or generating an alert. Another use for this exit routine is to deactivate a subscription set that fails (status = -1), and thus avoid retry by the Apply program until the failure is fixed.

See the prolog section of the sample program (ASNDONE.SMP) in the \sqllib\samples\repl directory for information about how to modify this exit routine. For AS/400, the following table indicates where you can find the

source code for this routine:

Compiler language	Library name	Source file name	Member name
C	QDPR	QCSRC	ASNDONE
COBOL	QDPR	QCBLESRC	ASNDONE
RPG	QDPR	QRPGLESRC	ASNDONE

See “Using the ASNDONE exit routine for AS/400” on page 220 for more information about using the ASNDONE exit routine in an AS/400 environment.

*To use the ASNDONE exit routine:*

1. Modify the ASNDONE routine to meet your site’s requirements.
2. Compile the program and place the executable in the appropriate directory.
3. Start the Apply program with the NOTIFY parameter to call the ASNDONE exit routine.

The parameters that the Apply program passes to the ASNDONE exit routine are:

- Set name
- Apply qualifier
- Value for the WHOS\_ON\_FIRST column in the subscription set control table
- Control server name
- Trace option
- Status value

## Using the ASNDLCOPY exit routine

If a subscription set contains DATALINK columns, the Apply program calls the ASNDLCOPY exit routine during processing for a subscription-set member to copy the external file. You can modify this routine as necessary, for example, to change the file transfer protocol.

**Restrictions:** The Apply program does not call the ASNDLCOPY routine if the target table is a CCD table. Also, if you want external files (pointed to by DATALINK values) to be copied during a full refresh, you must modify the ASNLOAD routine to call the ASNDLCOPY routine for these columns.

See the prolog section of the sample program (ASNDLCOPY.SMP) in the \sqlib\samples\repl directory for information about how to set up and modify this exit routine. For AS/400, you can find the sample program in library QDPR, source file QCSRC, member ASNDLCOPY.

*To use the ASNDLCOPY exit routine:*

1. Modify the ASNDLCOPY routine to meet your site's requirements. See "ASNDLCOPY parameters and input".
2. Configure the ASNDLUSER and ASNDLSRVMAP files. See "ASNDLCOPY configuration files" on page 136.
3. Optional: Modify the ASNDLCOPYD file-copy daemon to meet your site's requirements. See "Using the ASNDLCOPYD file-copy daemon" on page 136.
4. Compile the program and place the executable in the appropriate directory.

When the ASNDLCOPY routine completes, it should return a return code to the Apply program. A nonzero return code tells the Apply program that replication failed for one or more of the files; in this case, the Apply program issues a message, skips the current subscription set, and processes the next subscription set. A zero return code tells the Apply program that replication was successful.

Because the Apply program calls the ASNDONE exit routine after subscription processing completes, regardless of success or failure, you can use the routine to perform any necessary clean up if the ASNDLCOPY routine fails to replicate any external files.

The ASNDLCOPY routine creates two files: a log file and a trace file (if trace is enabled). The log file has the following name:

`ASNDLApplyQualSetNameSrcSrvrTgtSrvr.LOG`

where *ApplyQual* is the Apply qualifier, *SetName* is the subscription-set name, *SrcSrvr* is the source-server name, and *TgtSrvr* is the target-server name. The log file contains all messages generated by the ASNDLCOPY routine. The trace file has the following name:

`ASNDLApplyQualSetNameSrcSrvrTgtSrvr.TRC`

The trace file contains any trace information generated by the ASNDLCOPY routine.

### **ASNDLCOPY parameters and input**

The parameters that the Apply program passes to the ASNDLCOPY exit routine are:

- Set name
- Apply qualifier
- Source-table name
- Source-table owner
- Source-server name

- Target-table name
- Target-table owner
- Target-server name
- Input data file
- Result file
- Trace option

The input data file contains a list of link references captured from the source table. The format for this file is:

```
length source_link_reference new_link_indicator
```

The fields are:

*length*

The length of the link reference.

*source\_link\_reference*

The reference to the source link in URL format.

*new\_link\_indicator*

A one-character link indicator. The link indicator is either Y to indicate that the source file should be replicated, or N to indicate that the file should not be replicated (for example, if the file is unchanged from a previous replication).

Use the newline character to indicate the end of the input line.

**Sample input file:**

```
35 HTTP://S1.CDE.COM/data/yy/file1.avi Y
35 HTTP://S2.CDE.COM/data/qq/file2.avi N
```

The result file contains transformed link references that are valid for the target system. The format for this file is:

```
length target_link_reference
```

where *length* is the length of the target link reference, *target\_link\_reference* is the reference to the target link in URL format. If a source file cannot be replicated, the ASNDLCOPY routine should set *length* to 0 in the result file and set *target\_link\_reference* to blanks to ensure that no link is established in the target table.

**Sample result file:**

```
35 HTTP://T1.XYZ.COM/data/yy/file1.avi
35 HTTP://T2.XYZ.COM/data/zz/file2.avi
```

The trace option can be either *yes* or *no*, to specify whether you want tracing.

### **ASNDLCOPY configuration files**

The ASNDLCOPY routine requires two configuration files: ASNDLUSER and ASNDLSRVMAP. The ASNDLUSER file contains the server address (URL format), input port number, output port number, login user ID, and password. The first port number is for the source FTP or file-copy daemon that the ASNDLCOPY routine will connect to for retrieving files and the second port number is for the target FTP or file-copy daemon for sending files. These port numbers can be the same.

#### **Sample ASNDLUSER file:**

```
S1.CDE.COM 21 21 userA xxyyzz
T1.XYZ.COM 21 24 userB xxkxkx
```

The ASNDLSRVMAP file contains the server mappings for link references and an optional directory path map. If you don't specify a directory path map, or if the path mapping cannot be found, the same path name will be used.

#### **Sample ASNDLSRVMAP file:**

```
HTTP://S1.CDE.COM HTTP://T1.XYZ.COM
HTTP://S2.CDE.COM HTTP://T2.XYZ.COM /data/qq /data/zz
```

All fields for a given entry must appear on the same line.

### **Using the ASNDLCOPYD file-copy daemon**

The ASNDLCOPYD file-copy daemon extracts files for the ASNDLCOPY exit routine. It is similar to a standard FTP daemon, but provides the following functions for DATALINK replication:

- A command for extracting file information (such as file size and last modification time)
- A command for retrieving the content of a particular file

**Recommendation:** Use the ASNDLCOPYD file-copy daemon to replicate a DATALINK column that is defined with the "read permission DB" attribute. Whereas standard FTP requires superuser access, the ASNDLCOPYD daemon does not require such access.

You can configure the ASNDLCOPYD file-copy daemon to allow only certain users to log in, and for each user, you can allow access to a subset of directories. See the prolog section of the sample program (ASNDLCOPYD.SMP) in the \sqllib\samples\repl directory for information about how to set up and modify this program. For AS/400, you can find the sample program in library QDPR, source file QCSRC, member ASNDLCOPYD. If you need to add or change user logins, use the ASNDLCOPYD\_CMD tool.

You pass the following parameters to the file-copy daemon:

- Port number to listen to
- Directory that contains configuration files

*To use the ASNDLCOPYD file-copy daemon:*

1. Compile the program and place the executable in the appropriate directory.
2. Create two copies of the executable file (or for UNIX, create two symbolic links) named ASNDLCOPYD\_CHLD and ASNDLCOPYD\_CMD.
3. Modify the configuration files to meet your site's requirements.
4. Start the ASNDLCOPYD daemon, specifying both the port number and the configuration directory.

The ASNDLCOPYD daemon must run with root (administrator) authority.

The ASNDLCOPYD file-copy daemon creates a log file for all the messages generated by the ASNDLCOPYD program. This log file has the following name: ASNDLCOPYDYYYYYMMDDHHMMSS.LOG, where YYYYYMMDDHHMMSS is the time that the daemon started running.

---

## Setting up DB2 DataJoiner

Install DB2 DataJoiner by following the steps described in the *DB2 DataJoiner Planning, Installation, and Configuration Guide*. The Apply program is automatically installed when you install DataJoiner. After you install DataJoiner:

- Create an instance.  
For AIX, identify the Apply user ID as a local client to DataJoiner.
- Set up environment variables.  
If DJRA accesses DataJoiner for AIX, set the DB2CODEPAGE environment variable from your DJRA workstation. The value that you set is based on your country code. For example, if your country code is US, you would:
  1. Select the **My Computer** icon.
  2. Select the **Select System** icon.
  3. From the System Properties folder, select **Environment**.
  4. Type DB2CODEPAGE in **Variable**.
  5. For US, type the value 437 in **User Variables**. For international English, type 850.
- Create DataJoiner databases.  
You must create one DataJoiner database for *each* non-IBM replication source server. You can support many non-IBM replication target servers with one DataJoiner database. The DataJoiner databases that you set up

reside on one DataJoiner instance. You must define server and user mappings for each DataJoiner database that requires access to a source or target.

For every non-IBM source, use the COLLATE USING parameter within the CREATE DATABASE command. Use IDENTITY.

For Windows NT, you can automatically start your DataJoiner instance and DB2 security service:

1. Select **My Computer** from the desktop.
2. Select **Services**.
3. Select the DB2 instance to be used for replication and the DB2 security server.
4. Select **Startup**.

For more information, see *DB2 DataJoiner Planning, Installation, and Configuration Guide*.



---

## Chapter 7. Operating DB2 DataPropagator

This chapter describes how to operate the Capture and Apply programs generally. For information about operating either of these programs (for example, starting, stopping, or scheduling) in a specific operating system environment, see “Part 3. Operations” on page 173. This chapter also describes regular database maintenance, monitoring replication, handling gaps, and modifying your replication configuration.

---

### Operating the Capture program

This section describes what you need to know before you start the Capture program, when you should perform a warm or cold start of the Capture program, and how to stop the Capture program with an event.

#### Before you start the Capture program

Before starting the Capture program, make sure that you complete the following post-installation tasks:

- Define one or more replication sources and subscriptions, as described in “Defining replication sources” on page 105 and “Defining replication subscription sets” on page 112. Defining replication sources and subscriptions creates the following control tables in the source server (where the Capture program runs):
  - ASN.IBMSNAP\_REGISTER (register table)
  - ASN.IBMSNAP\_PRUNCNTL (pruning control table)
  - ASN.IBMSNAP\_CCPPARMS (tuning parameters table)
  - ASN.IBMSNAP\_TRACE (trace table)
  - ASN.IBMSNAP\_WARM\_START (warm start table)
  - ASN.IBMSNAP\_UOW (unit-of-work table)
  - ASN.IBMSNAP\_CRITSEC (critical section table)
  - ASN.IBMSNAP\_PRUNE\_LOCK (prune lock table)

Defining replication sources and subscriptions creates the following control tables in the control server:

- ASN.IBMSNAP\_SUBS\_SET (subscription set table)
- ASN.IBMSNAP\_SUBS\_MEMBR (subscription-targets-member table)
- ASN.IBMSNAP\_SUBS\_STMTS (subscription statements table)
- ASN.IBMSNAP\_SUBS\_COLS (subscription columns table)
- ASN.IBMSNAP\_SUBS\_EVENT (subscription events table)
- ASN.IBMSNAP\_APPLYTRAIL (Apply trail table)

- REG\_EXT (replication source extension table, for AS/400 only)
- AUTHTKN (Apply-qualifier-cross-reference table, for AS/400 only)
- APPLY\_JOB (Apply job table, for AS/400 only)

You can also create these control tables manually by running the DPCNTL.\* file from the RUN SQL Files window.

- Bind the Capture program to the source server from which the Capture program will capture changes. Capture for OS/390 includes bind JCL. Refer to the Capture for OS/390 program directory for information on running the bind program for Capture. For other operating systems, see the configuration section within the operating system-specific chapters (see “Part 3. Operations” on page 173).
- **For OS/390:** Ensure that you apply all relevant PTFs for your DB2 subsystem.
- Ensure that the register table has at least one entry in it by defining a replication source with the DATA CAPTURE CHANGES option. See “Defining replication sources” on page 105 for more information.
- **For Windows NT:** Decide whether you want to use the NT Service Control Manager (SCM) to automatically run the Capture program as an NT service. See “Starting Capture for Windows and OS/2” on page 269 for information about operating the Capture program as an NT service.
- **For VM:** A Capture program ASNPARMS file is provided that contains default values that the Capture program uses. Changing this file modifies the defaults. If you need different values for a specific database, copy the file to the Capture program virtual machine’s A-disk. The following default values are contained in the Capture program ASNPARMS:
  - ENQ\_NAME CAPTURE
  - LANGUAGE ASNLS001
- **For VSE:** The ASNS51CD job control member contains the name of the messages file used. The default is American English. Modify ASNS51CD to issue messages in a different language. See the Capture for VSE program directory for a list of supported languages.
- **For VM and VSE:** By default, the messages are issued in American English (ASNLS001). To issue messages in a different language, change the LANGUAGE parameter in the ASNPARMS file. See the program directory for the Capture program for a list of supported languages.

## Starting or restarting the Capture program

When you start or restart the Capture program, you can include any of the following keywords: COLD, WARM, or WARMNS. If you are starting the Capture program for the first time, specify either COLD or WARM to cold start the Capture program. If you are restarting the Capture program after being shut down or after a failure, specify either WARM or WARMNS to warm start the Capture program. The following sections describe cold and

warm starts, including how the Capture program handles warm starts, when it switches to an automatic cold start, and how to prevent an automatic cold start by forcing a warm start.

### **Cold start**

When you cold start the Capture program, it deletes all rows from the CD tables and the UOW table and begins reading the end of the database log. Specify a cold start by including the COLD keyword when you start the Capture program. A warm start can also become a cold start in certain circumstances; see “Automatic cold start”.

After a cold start, the Apply program performs a full refresh of the target tables. You can specify the LOADX keyword when you start the Apply program to improve the performance of the full refresh, or you can use the technique described in “Loading target tables offline using DJRA” on page 127.

### **Warm start**

When you stop the Capture program or if it fails, it writes information in the warm start control table to enable a warm start. There are cases when the Capture program cannot save warm start information. For example, an operator might cancel the Capture program or stop DB2. In this case, the Capture program uses information in the CD, UOW, or register tables to resynchronize to the time it stopped and thus allow a warm start.

When you restart the Capture program with the WARM or WARMNS keywords, it looks in the warm start table (or in the CD, UOW, or register tables) to determine if it can warm start or if it must cold start. If there is sufficient warm start information, the Capture program warm starts, otherwise it attempts a cold start; see “Automatic cold start”.

After a successful warm start, the Capture program deletes old rows in the warm start table.

### **Automatic cold start**

If the Capture program cannot warm start, it attempts to perform a cold start. But, if you specify the WARMNS keyword, the Capture program does not cold start. The Capture program automatically switches to a cold start when:

- The warm start log sequence number lags behind the current log sequence by more than the LAG\_LIMIT value (as specified in the tuning parameters table) or is not available from the database log.
- You start the Capture program for the first time.

The first time you start the Capture program, you see message ASN0102W, indicating that warm start failed. The Capture program switches to a cold start. You can ignore this message when first starting the Capture program.

In each of these cases, the Capture program issues an informational message and performs a cold start. This cold start also causes a gap in the change data capture sequence because the Capture program jumps to a new position in the database log.

### **Preventing automatic cold start**

To prevent the Capture program from attempting a cold start, specify the WARMNS keyword when starting the Capture program. If the warm start is not possible, instead of cold starting, the Capture program terminates. When the Capture program terminates in this way, the control tables remain intact. You must correct the problem that caused the Capture program to terminate before you attempted to restart it. If you do not correct the problem, the Capture program continues to terminate or performs a cold start every time that you restart it.

### **Starting the Capture and Apply programs for the first time**

If you are starting the Capture program for the first time, or after stopping both the Capture and Apply programs, use the following steps:

1. Define replication sources and subscription sets.  
See “Defining replication sources” on page 105 and “Defining replication subscription sets” on page 112.
2. Start the Capture program.  
Wait for the initialization message that indicates that the Capture program is running. The Capture program does not capture changes until the Apply program starts and completes a full refresh.
3. Start the Apply program.  
The Apply program performs a full refresh for all subscription-set members. When the full refresh is complete, the Capture program begins capturing changes to the source tables.

---

## **Operating the Apply program**

This section describes what you need to know before you start the Apply program and how to use the Apply program for forward recovery. For information about operating the Apply program (for example, starting, stopping, or scheduling) in a specific operating system environment, see “Part 3. Operations” on page 173.

Before you start the Apply program, ensure that:

- The control tables are defined.
- **For Windows and UNIX:** A password file has been created, if necessary, for end-user authentication at the source server. See “Setting up end-user authentication at the source server” on page 265 for more information.
- At least one subscription is created and activated.

- The Apply program package is created.  
See the Apply for OS/390 program directory for information on BIND programs to create the Apply program packages. You must bind the Apply program to both the source and target databases.  
See “Optional: Configuring the Apply program manually for Windows and OS/2” on page 264 for information on bind programs to create the Apply packages for Windows and OS/2.  
See “Optional: Configuring the Apply program manually for UNIX platforms” on page 240 for information on bind programs to create Apply packages for UNIX platforms.  
See “Creating packages to use with remote systems” on page 208 for information about the CRTDPRPKG command, which creates the packages that are necessary for DataPropagator Relational for AS/400 to work with remote systems.
- The Capture program is started, and the ASN0100I initialization message was issued (if you are running a Capture program).
- You have proper authorization.
- **For OS/390:**
  - Ensure that all STEPLIB libraries of the Capture for MVS RUN JCL (if you are running Apply for OS/390) are APF-authorized.
  - Customize and execute the following JCL:
    - The link-edit sample JCL
    - The sample JCL to build the VSAM message file
    - The Apply bind sample JCL
    - The Apply Run/Invocation sample JCL
  - You must have SYSADM or DBADM privileges at the source, control, and target server. You must also have the proper authorization to run the Apply program, including EXECUTE privileges for Apply program packages.
  - You must have DBADM or CONTROL or SELECT authority that meets all requirements for defining a replication source and target.
- **For AS/400:** For Version 5, the Capture program is started on the source server before you start Apply for the first time. The Capture program updates the SYNCHTIME and SYNCHPOINT columns in the ASN/IBMSNAP\_REGISTER table before the Apply program is started. The Apply program assumes that if a GLOBAL record is present in the ASN/IBMSNAP\_REGISTER table, the SYNCHTIME and SYNCHPOINT columns are not null. For Version 1, the Apply program can be started before the Capture program.

---

## Improving Apply performance for Sybase or Microsoft SQL Server

If you run the Apply program using a DBLIB connection for either Sybase or Microsoft SQL Server, and you have a slow network, you can significantly improve your overall replication performance. DB2 DataPropagator can use buffers to hold replicated data and send each buffer over the network rather than sending individual updates. You set the size of the buffers using the **create server option** statement. To take advantage of this improvement:

1. Retrieve the names of the packages for the Apply program. To find your package names, issue the following SQL statement:

```
SELECT PKGNAME
FROM SYSCAT.PACKAGES
WHERE PKGNAME LIKE 'ASN%'
```

The package names change with each release and with each service update, but this query retrieves names that are specific to your service level.

2. If you have an `apply_names.ini` file (in the `sllib` directory), replace the package names with the ones that you retrieved in step 1. If you do not have an `apply_names.ini` file, create one and list the package names. The following lines show an example of an `apply_names.ini` file:

```
ASN6A001+
ASN6B001+
ASN6C001+
ASN6F001+
ASN6I001+
ASN6M001+
ASN6P001
```

3. Create server options for the Apply packet and buffer sizes. Sample sever options for Sybase are:

```
create server option apply_packet_size for server type sybase setting 16384;
create server option apply_buffer_size for server type sybase setting 16384;
```

Sample sever options for Microsoft SQL Server are:

```
create server option apply_packet_size for server type mssqlserver setting 16384;
create server option apply_buffer_size for server type mssqlserver setting 16384;
```

You can set the packet and buffer size to any appropriate value less than or equal to the maximum setting for Sybase or Microsoft SQL Server, and adjust as necessary.

4. Set the following environment variable:  
`DJX_ASYNC_APPLY=TRUE`
5. If you created or changed the `apply_names.ini` file, or if you changed the `DJX_ASYNC_APPLY` variable, you must stop and restart DataJoiner before these changes take effect. To stop and restart DataJoiner, issue the **db2stop** and **db2start** commands.

---

## Performing regular database maintenance

In addition to the regular maintenance that you perform for your databases, running replication requires you to perform the following maintenance:

- Run the REORG utility for CD tables and the unit of work table  
You should reorganize the CD tables and UOW table about once a week if they are heavily used. For DB2 for OS/390 Version 5 or later, specify the PREFORMAT keyword. Preformatting the table space speeds up the Capture program's insert processing. If the table space is compressed, you must also specify the KEEPDICTIONARY keyword.

- Run REORG for target tables  
Because subscription predicates are very selective and can filter out a majority of the transaction updates, there is no general rule for how frequently you should reorganize target tables, but it should be at least as frequently as you reorganize the source tables.

- Delete old rows in the Apply trail control table (ASN.IBMSNAP\_APPLYTRAIL)

At the end of each subscription cycle, the Apply program inserts a row into the Apply trail control table. To prevent this table from growing too large, you need to delete these rows regularly. You can delete these rows whenever you like because although the Apply program writes to this table, it does not read from it. The subscription statistics and error diagnostics written to this table are for your benefit, and they are used by the Replication Monitor. An easy way to manage the growth of this table is to add an SQL statement to the subscription set; for example:

```
DELETE FROM ASN.IBMSNAP_APPLYTRAIL
WHERE LASTRUN < (CURRENT_TIMESTAMP - 7 DAYS);
```

- Prune CCD tables  
Neither the Capture program nor the Apply program automatically prunes CCD tables, and there is no command for pruning these tables. Condensed CCD tables are updated in place, so do not grow continually. Noncondensed CCD tables contain history, which you likely want to retain.

A condensed, noncomplete, internal CCD table grows, and with enough update activity, can approach the size of a complete CCD table. Because only the most recent changes are retrieved from it, there is no value in letting this table grow. To prune transactions that have already been replicated from this table, add an SQL statement to the internal CCD's subscription; for example:

```
DELETE FROM my.internal_ccd
WHERE IBMSNAP_COMMITSEQ <= (SELECT MIN(SYNCHPOINT) FROM ASN.IBMSNAP_PRUNCNTL);
```

This statement prunes the table based on the least active subscriptions, not just those subscriptions that refer to the source associated with the internal CCD table, so you might want to modify the statement for more aggressive pruning.

The following operational procedures typically require exclusive use of DB2 table spaces or the catalog:

REORG  
BIND PACKAGE  
BIND PLAN  
GRANT  
REVOKE

Because these operational procedures do not coexist well with the Capture and Apply programs' issuing dynamic SQL (which implicitly locks catalog tables) or accessing table spaces, you should stop both the Capture and Apply programs when running utilities (and other similar operational procedures) to avoid any possible contention.

---

## Monitoring the replication environment

You can use the Replication Monitor, included with the DJRA, to periodically generate a report that shows how your replication network is working:

- The color-coded report shows you whether your expectations for Capture latency and subscription latency are being met.
- The Replication Monitor keeps historical statistics, so you can determine whether end-to-end subscription latencies, for example, are staying consistent.
- The report file is in HTML format, viewable through your Web browser. You can publish the report on your company's intranet for the benefit of users who need the information but might not have database privileges. After it is produced, the monitor report is completely independent of DB2, requiring no database accesses to read.

To start the Replication Monitor, click **Monitor replication** on the main DJRA window. From the Replication Administration Scheduler window, you can schedule the monitor to run periodically or you can run it once.



---

## Resolving gaps between source and target tables

Occasionally, a gap can occur during the capturing of changed data for a source table. For example, if you shut down the Capture program and then cold start it, it deletes all rows from the CD table. In this case, updates might be made that the Capture program does not capture. Or, any updates that were in the CD table could have been deleted (by the cold start) *before* the Apply program could replicate them.

When a gap exists, the Apply program attempts a full refresh unless the target table is a noncomplete CCD table. If the Apply program cannot perform a full refresh, data integrity could be lost. For noncomplete CCD tables, you can avoid potential data-integrity loss that could result from a cold start of the Capture program by using the following steps:

1. Ensure all changes are replicated to the noncomplete CCD tables.
2. Stop all update activity for the source tables.
3. Cold start the Capture program.
4. Restart update activity for the source tables.

---

## Modifying your replication configuration

After you begin replication, you can change the configuration, including changing replication sources or subscriptions, removing sources or subscriptions, deactivating subscriptions, and cloning subscriptions.

### Viewing or changing existing replication sources

Using either the DB2 Control Center or DJRA, you can view an existing replication source. With the Control Center, if you selected the **Table will be used for update anywhere** check box, you can change the conflict-detection level defined for the replication source. All other fields and controls are unavailable for changes after you successfully define the replication source. With DJRA, you can change the set of columns available for replication.<sup>30</sup>

If you plan to change the replication source definition, use the Capture **REINIT** command. You can also stop or suspend the Capture program and then warm start or reinitialize the Capture program to begin capturing changes for the changed replication source. For information about the Capture program for your operating system environment, see “Part 3. Operations” on page 173.

---

30. You can change the set of columns available for replication only for DB2 sources, not for non-IBM sources.

## Removing replication sources

When you no longer need a replication source, you can remove the object from the DB2 Control Center or DJRA and remove its control information from the control tables.

### Attention:

- Stop the Capture program before deleting a replication source. Do not merely suspend it. You can restart the Capture program after you have finished removing the replication source.
- Although the Control Center removes dependent subscriptions, you should check whether a dependent subscription table is being used as a source for another subscription and cancel any such dependent subscription before you delete a replication source. DJRA does not remove dependent subscriptions, so you must delete any subscriptions that use the source for copying.

The Control Center and DJRA drop the table space for a DB2 replication source if it is empty. DJRA does not drop non-IBM database containers (table spaces, dbspaces, or segments). For the Control Center, you can ensure that the table space is never dropped by changing the settings on the Replication page of the Tools Settings notebook.

## Activating and deactivating subscription sets

From the DB2 Control Center or DJRA, you can control the active status of a subscription set. This feature is useful when you want to temporarily deactivate a subscription set without removing it. When you deactivate a subscription set, the Apply program completes its current processing cycle and then suspends operation for that subscription set. In the Control Center, when you deactivate a subscription set, the icon for the subscription set is greyed out.

## Cloning a subscription set to another server

Using the DB2 Control Center, you can clone a subscription set to another server. Cloning creates a copy of an existing subscription set on a different target server, using a different Apply qualifier. This copy includes only subscription information; it does not include copy table, table space, or index definitions. You can clone one or more subscription sets at a time. The Control Center updates the control tables at the control server.

For information about copying your entire replication environment to another system, see “Copying your replication configuration to another system” on page 127.

## Viewing or changing an existing subscription set

Using the DB2 Control Center, you can change a subset of the subscription-set values, primarily those that do not affect the structure of the target tables. You can change the following values in the Change Replication Subscription window and subwindows:

- The **Row predicate** in the Advanced Subscription notebook. The new predicate is not applied to existing rows in the target table. The Apply program uses the predicate starting with the next subscription cycle for the subscription set. See “Defining the target-table rows” on page 118 for more information and examples.
- The SQL or CALL procedure for before or after copying in the SQL window. See “Defining SQL statements or stored procedures for the subscription set” on page 121 for more information.
- The timing values in the Subscription Timing notebook.
- The data-blocking value in the Subscription Timing notebook. See “Specifying a data-blocking value” on page 122 for more information.

To view or change existing subscription-set members using DJRA, click the **List Members or Add a Column to Target Tables** button. Fill in the required information in the window, such as source-server name and source-table names, then optionally fill in the source-column name or SQL expression and the target-column name to add new columns or add computed columns to the target table.<sup>31</sup>

## Removing subscription sets

Removing a subscription-set definition deletes information about it from the control tables and, optionally, deletes the target tables from the target server. For non-IBM target tables, you can choose whether to drop the nickname and the corresponding target table when you remove the subscription set using DJRA.

Using the DB2 Control Center, select one or more replication subscription objects from the contents pane and select **Remove** from the pop-up menu. Using DJRA, you must first remove all members from the subscription set, then you can remove the empty subscription set.

---

31. You can change the set of columns available for replication only for DB2 sources, not for non-IBM sources.



---

## Chapter 8. Problem determination

When replication fails or executes in an unexpected way, you need to determine the cause of the problem and find a solution that fixes the problem. DB2 DataPropagator provides error messages, trace records, log records, and information stored in the control tables to assist you in the problem-determination task. Using the information provided by the product, you can often fix a problem yourself, but sometimes the best solution is to call IBM Software Support. This chapter includes:

- “Problem determination scenario” on page 152 describes a set of typical steps for problem determination.
- “Problem determination for replication administration” on page 152 describes problems that the DB2 Control Center and DJRA can encounter.
- “Problem determination for the Apply program” on page 153 describes problem-determination tools for the Apply program, including the Apply trail table and the trace and log files.
- “Problem determination for the Capture program” on page 156 describes problem-determination tools for the Capture program, including the trace table, trace file, and the log file.
- “Problem determination for AS/400” on page 159 describes problem-determination tools for the AS/400 environment, including gathering information about active jobs and determining if the journal job is started.
- “Using the Replication Analyzer” on page 163 describes how to analyze the behavior of the Capture program or the Apply program, and can help you diagnose problems, verify replication setup, and tune replication performance.
- “Troubleshooting” on page 166 lists various problems that can occur when running the Capture and Apply programs and how to resolve those problems.
- “Problem-source identification questions” on page 171 lists questions that can help you to research an error condition before calling IBM Software Support.

This book also includes other resources that can help you in problem determination:

- “Chapter 15. Capture and Apply messages” on page 353 describes error messages for the Capture program and the Apply program. “Chapter 16. Replication messages for AS/400” on page 381 describes the error messages for replication in an AS/400 environment.

- “Chapter 14. Table structures” on page 293 describes the Apply trail table and other control tables.

**Recommendation:** When using problem-determination facilities to test or debug your replication scenarios:

- When possible, stop replication activity that is unrelated to the problem area while gathering information about a problem. Stopping other replication activity reduces the volume of data you or IBM Software Support must sift through.
- Set up a test environment to ensure that the solution fixes the problem without introducing new problems.

---

## Problem determination scenario

The following scenario shows how you might trace a replication error using the facilities discussed in this chapter.

After you define replication sources and subscription sets, the SQL statements for your replication requests complete satisfactorily, but the Apply program does not replicate the data successfully. To determine the error, you could:

1. Examine any error messages returned directly to the terminal for the Apply program job or process.
2. Run the Replication Analyzer to verify that the replication setup is correct.
3. Examine the Apply trail table (ASN.IBMSNAP\_APPLYTRAIL) for any indicators of the problem.
4. Examine the Capture program trace table (ASN.IBMSNAP\_TRACE) for indicators from the Capture program’s activity.
5. Examine the log files for the Capture and Apply programs for indicators from their activities.
6. Examine the CD and UOW tables to verify that the Capture program is capturing changes.
7. Rerun the Capture and Apply programs with the trace option and examine the trace file for indicators of the problem.

---

## Problem determination for replication administration

The DB2 Control Center or DJRA can encounter errors when it gathers information from source servers, target servers, or control servers to create the SQL statements for administration and when it is actually running the SQL statements to set up the replication sources and subscription sets. The primary indicators are SQL messages, SQLSTATE codes, and Capture- and Apply-program messages (those that begin with the letters ASN) that accompany the error. See the *DB2 Universal Database Message Reference* (or DB2 message reference for your platform) for more information about DB2 error

messages and SQL states. The ASN messages are also described in “Chapter 15. Capture and Apply messages” on page 353 and “Chapter 16. Replication messages for AS/400” on page 381.

The Capture- and Apply-program messages are issued or recorded in the following locations:

- At the command-line-processor window or console from which you started the Capture program or the Apply program
- In the Apply trail table and the Capture program trace table
- In the trace files for the Capture and Apply programs
- In the log files for the Capture and Apply programs

The Capture and Apply programs can also encounter problems while capturing and replicating changed data, even though the SQL that the DB2 Control Center or DJRA generated for defining replication sources and subscriptions ran without error. You can determine the cause of the errors with information from the following sections: “Problem determination for the Apply program”, “Problem determination for the Capture program” on page 156, and “Troubleshooting” on page 166.

---

## Problem determination for the Apply program

DB2 provides the following problem-determination tools for the Apply program:

### Apply-program messages

These messages describe errors from the Apply program. See “Chapter 15. Capture and Apply messages” on page 353 and “Chapter 16. Replication messages for AS/400” on page 381.

### Apply trail table

This table contains SQLSTATE codes and SQL error codes for a failed replication, as well as audit-trail information for the Apply program.

### Apply-program trace file

This file contains a record of all Apply-program activity. There is one trace file for each Apply-program instance at the server where the Apply program is running. To get a trace file, you must specify one of the trace parameters when you start the Apply program.

### Apply-program log file

This file summarizes the activities of the Apply program and can be a useful diagnosis tool.

## Apply trail table

Each time the Apply program attempts to replicate a subscription set, it inserts a new row in the Apply trail table (ASN.IBMSNAP\_APPLYTRAIL).

This table is located at each control server, along with other control tables, and has one row for each successful or unsuccessful subscription cycle. Because the Apply program appends to this table, you should prune it periodically. For a description of the Apply trail table, see “Apply trail table” on page 336.

For subscription sets that do not replicate successfully, the Apply trail table records the SQL code and the SQLSTATE. Additional SQL codes and states associated with the problem can be found in the Apply program trace file.

*To query the Apply trail table for problem-determination information:*

Use the Replication Analyzer to view information in this table; see “Using the Replication Analyzer” on page 163. You can also query information in the Apply trail table directly to gather problem-determination information for failing subscription sets.

1. Ensure that the data in the Apply trail table is current:
  - Temporarily disable subscription sets that are successful to ensure that rows in the Apply trail table apply only to subscription sets that have problems.
  - Delete all unnecessary rows from the Apply trail table to remove information from past replications.
2. To gather the problem-determination information, execute a query similar to:

```
SELECT TARGET_TABLE, STATUS, SQLSTATE, SQLCODE, SQLERRM, APPERRM, LASTRUN, LASTSUCCESS
FROM ASN.IBMSNAP_APPLYTRAIL
WHERE STATUS <> 0
ORDER BY TARGET_TABLE, LASTRUN DESC, SQLCODE DESC, SQLSTATE ASC
```

This query returns the following columns from the Apply trail table:

**TARGET\_TABLE**

The target table for the current subscription set.

**STATUS**

Contains -1 to indicate the failed subscription set.

**SQLSTATE**

Contains the error SQLSTATE for the failed subscription set.

**SQLCODE**

Contains the error SQLCODE for the failed subscription set.

**SQLERRM**

Contains the text of the error message that corresponds to the SQL code.



## **APPERRM**

Contains the text of the Apply program error message.

3. Read the error message text to determine the database to which the Apply program was connected when the error occurred; for example, did the error occur while the Apply program was connected to the source server or the target server? Refer to the *DB2 SQL Reference* for information on the SQL codes and states.
4. Be sure to reenable subscription sets that were successful.

## **Apply-program trace file**

You can trace the operation of the Apply program to help isolate the causes of certain kinds of replication errors. The Apply program creates a trace file when you include a trace parameter to the Apply program start command. See the Capture and Apply chapter in for your platform in “Part 3. Operations” on page 173 for the syntax of the command.

While tracing its activity, the Apply program records the following kinds of information in the trace file:

- Connections to the control server to obtain information for subscription sets to be processed
- Connections to source servers to retrieve rows to be replicated from the CD table to the target table
- Connections to the target servers to insert, update, and delete rows into and from the target tables

The Apply program inserts error messages and indicators in the trace file at points when it encounters an error.

### ***To create a trace file:***

1. Temporarily disable subscription sets that are successful to reduce the volume of information in the trace file and ensure that data in the trace file only applies to subscription sets that have problems.
2. Start the Apply program with the appropriate trace parameter:

#### **trcflow**

Provides very detailed information that is oriented toward helping IBM Software Support diagnose errors.

#### **trcerr**

Provides less detail and can be a better choice when you are new to replication.

When you specify a trace parameter, you must also specify the name of a trace file (for workstation systems, precede the trace file name with the

greater than symbol (>) to redirect the output to the file). For example, to start Apply for Windows with trace, issue the following command from the command line:

```
asnapply ApplyQual CtlSrvr trcflow > apply.trc
```

where *ApplyQual* is the Apply qualifier, *CtlSrvr* is the control server, and *apply.trc* is the trace file. The trace file is created in the directory from which you start the Apply program.

3. Let replication run until the problem recurs and the Apply program inserts a row into the Apply trail table.
4. Stop the Apply program and restart it without the trace parameter. Be sure to re-enable subscription sets that were successful.
5. View the trace file using any editor. You could also send the file to other systems or print it.

### Apply-program log file

For a summary of the Apply program's activities, you can view the Apply program log file. The log file is in the directory from which you start the Apply program and contains messages issued by the Apply program. Because the information in the Apply program log file is high level, it typically directs you to the Apply trail table for more detailed information.

The name of the log file is *ApplyQual*.APP, where *ApplyQual* is the Apply qualifier associated with the Apply-program instance.

---

## Problem determination for the Capture program

DB2 provides the following problem-determination tools for the Capture program:

### Capture-program messages

These messages describe errors from the Capture program. See "Chapter 15. Capture and Apply messages" on page 353 and "Chapter 16. Replication messages for AS/400" on page 381.

### Trace table

This table contains audit-trail information for the Capture program.

### Capture-program trace file

This file contains a record of all Capture-program activity.

### Capture-program log file

This file summarizes the activities of the Capture program and can be a useful diagnosis tool.

This section also includes problem-determination for the Capture program on the following operating systems: AS/400, OS/390, VM and VSE.

## Capture-program trace table

The Capture program inserts a new row in the trace table (ASN.IBMSNAP\_TRACE) whenever it encounters an event for which it also issues a message. This table is located at the source server and contains basic information about the activities of the Capture program. For a description of the trace table, see “Trace table” on page 316.

### *To query the trace table for problem-determination information:*

Use the Replication Analyzer to view information in this table; see “Using the Replication Analyzer” on page 163. You can also query information in the trace table directly to gather problem-determination information for the Capture program.

1. Ensure that the data in the trace table is current. You might want to delete rows from the table to remove information from past Capture operations. The Capture program deletes all rows from this table when you cold start it, so if you want to keep trace information, you should copy the table before you cold start the Capture program.
2. To gather the problem-determination information for the Capture program, execute a query similar to:

```
SELECT *  
FROM ASN.IBMSNAP_TRACE  
ORDER BY TRACE_TIME
```

This query returns the following columns from the trace table:

#### **OPERATION**

The type of Capture-program operation, such as initialization, capture, or an error condition.

#### **TRACE\_TIME**

The time the current row was inserted into this table.

#### **DESCRIPTION**

The message ID and message text.

For AS/400 systems, this table also includes the following columns:

#### **JOB\_NAME**

The fully-qualified name of the job that wrote the current entry.

#### **JOB\_STR\_TIME**

The starting time for the job listed in the JOB\_NAME column.

## Capture-program trace file

You can trace the operation of the Capture program to help isolate the causes of certain kinds of replication errors. The Capture program creates a trace file when you include a trace parameter to the Capture program start command.

See the Capture and Apply chapter in for your platform in “Part 3. Operations” on page 173 for the syntax of the command.

The Capture program inserts error messages and indicators in the trace file at points when it encounters an error.

To trace problems on AS/400 systems, view the job logs of the control and journal jobs. See “Problem determination for AS/400” on page 159 for more information.

*To create a trace file:*

1. Start the Capture program with the **trace** parameter and redirect the output to a file. For example, to start Capture for Windows with trace, issue the following command from the command line:

```
asnccp SrcSrvr trace > capture.trc
```

where *SrcSrvr* is the source server and *capture.trc* is the trace file. Because this command does not include parameters for the type of start (WARM, WARMNS, or COLD) or for pruning (PRUNE or NOPRUNE), the Capture program uses the defaults (WARM and PRUNE). The trace file is created in the directory from which you start the Capture program.

2. Let replication run until the problem recurs.
3. Stop the Capture program and restart it without the trace parameter.
4. View the trace file using any editor. You could also send the file to other systems or print it.

### **Capture-program log file**

For a summary of the Capture program’s activities, you can view the Capture-program log file. The log file is in the directory from which you start the Capture program and contains messages issued by the Capture program.

The name of the log file is *SrcSrvr.CPP*, where *SrcSrvr* is the name of the source server.

### **Other problem-determination facilities for the Capture program**

For OS/390, VM, and VSE, the Capture program provides the following tools:

#### **Trace buffer**

The Capture program puts a small amount of critical diagnostic data in a wraparound trace buffer during processing. Each trace-buffer entry describes the current status of data capture. If a severe error occurs, the Capture program prints the trace buffer before terminating. The trace buffer supplements the Capture program error message.

#### **Trace output**

When an error occurs, you can run the Capture program with the

TRACE option (see “Capture-program trace file” on page 157). When you use this option, the Capture program writes trace information logic flow to:

SYSPRINT (for OS/390)  
the console (for VM)  
STDOUT (for VSE)

This information can be used by IBM Software Support to diagnose operational problems.

### **Storage dump**

When the Capture program terminates with a severe error, it generates a system dump in the SYS1.DUMP data set. This dump is IPCS readable, contains more diagnostic information than the Capture program trace, and can be used by IBM Software Support to diagnose system problems.

For OS/390, the Capture program also provides:

### **Alert generation**

If a severe error occurs, the Capture program for OS/390 alerts NetView, if NetView is active. The alert uses the NMVT format for a generic alert defined by the SNA generic-alert architecture. If NetView is not available, the Capture program still writes error messages to the MVS console.

---

## **Problem determination for AS/400**

Capture for AS/400 has unique problem determination facilities because of its dependency on journals and journal receivers as its primary source of input. This section describes problem-determination facilities for the Capture program for AS/400 and associated problem-recovery methods: gathering information about active jobs, determining if the journal job is started, and collecting data for problem determination.

### **Gathering information about active jobs**

One of the first steps in problem determination is gathering information about currently active jobs. Issue the Work with Submitted Jobs command (**WRKSBSJOB QZSNDPR**) for a list of all active jobs in the subsystem. If you fail to find a particular job, use the **WRKSBMJOB** command to locate and view the job log for the job. The name of the Capture program control job is QZSNCTL5. The name of the journal job is the same as the journal name (either QSQJRN—the default journal name for SQL collections—or a name that you specified for the journal).

Be sure to record the 6-digit job numbers because you might need them later in the problem-determination process.

## Determining if the journal job is started

If, five minutes (or more) after starting the Capture program, you discover that only one job (QDPRCTL5) is running, check the following conditions:

- If you use the **WRKSBSJOB** or **WRKACTJOB** command to display active jobs, enter option 7 on the command line for job QZSNCTL5. Message ASN2017 might be waiting for a reply.
- Run the **WRKJOB QSQJRN** command (substituting the name of the journal job for your system). The journal job might have started, and subsequently ended for some reason (for example, if the lag limit was exceeded). If you find a recent journal job, display its job log to confirm that it is the right job and to determine why it ended.
- Check if the QDPRCTL5 control job found any replication sources that are eligible for replication. Two conditions make a replication source eligible for replication:
  - The replication source must be included in at least one subscription set.
  - The Apply program must start a full refresh to copy the original contents of the source table to the target table, even if the source table is empty. The full refresh synchronizes the target table with the source table. When the Apply program starts the full refresh, the SYNCHPOINT column in the pruning control table is set to hex zeroes for this replication pair.

When you first issue the **STRDPRCAP** command, there might be replication pairs that meet the first condition, but not the second one. Both conditions must hold before a journal job can start.

Every two minutes (or at the frequency that you specified for the WAIT parameter of the **STRDPRCAP** command), the QZSNCTL5 job wakes up to determine if any replication source exists that meets both conditions. If it finds a replication source that is eligible for replication, it starts the journal job.

To determine if the SYNCHPOINT column in the pruning control table is set to hex zeroes for a particular replication pair, execute the following SQL statement from the source server:

```
SELECT HEX(SYNCHPOINT) FROM ASN/IBMSNAP_PRUNCNTL
WHERE SOURCE_TABLE='SrcTbl' AND SOURCE_OWNER='SrcOwn'
AND SOURCE_VIEW_QUAL=SrcVwQual
```

where *SrcTbl* is the library name, *SrcOwn* is the table name, and *SrcVwQual* is the source-view qualifier for the replication source in question. Both *SrcTbl* and *SrcOwn* are case-sensitive.

## Collecting data for problem determination

The following items are needed for problem determination for the Capture program. The items are listed in order of importance:

1. The job log of the Capture-program control job QDPRCTL5.
2. The job log of the Capture-program journal job.
3. Old journal receivers. They are important because they contain important time-sequence information. Save the journal receivers in a file or keep them if a remote sign-on by IBM Software Support is likely. The journal receivers for the following tables are useful for problem determination:

#### **Control tables**

These include the register table, the register extension table, the pruning control table, the unit-of-work table, the critical section table, and the warm start table. The journal for these tables is ASN/QSQJRN.

#### **Source table**

These journal receivers are kept as long as the Capture program needs them. Make sure that they are not deleted automatically by the system because they are useful for problem determination.

#### **Change data table of the replication source**

Usually, the journal is named QSQJRN and is in the same library as the source table. If it is not, find the library and the name of the journal by issuing a **DSPFD** *lib/sys* command (where *lib* is the library and *sys* is the system name of the CD table). To find the system name of the change data table, execute the following SQL statement:

```
SELECT DBXFIL
FROM QSYS/QADBXREF
WHERE DBXLFI = 'sqlname' AND DBXLIB = 'lib'
```

where *sqlname* is the SQL name of the CD table. Both *sqlname* and *lib* are case sensitive.

4. A formatted dump of the user index QDPR/QZSNINDEX5. Issue the following command before the Capture program ends:  
DMPOBJ QDPR/QZSNINDEX5 \*USRIDX
5. The contents of the rows in the register table and the register extension table that correspond to replication sources that you want to know more about. You can collect this information by executing the following SQL statements:

```
SELECT A.*, HEX(CD_OLD_SYNCHPOINT), HEX(CD_NEW_SYNCHPOINT)
FROM ASN/IBMSNAP_REGISTER A
WHERE SOURCE_OWNER='SrcOwn' AND SOURCE_TABLE='SrcTbl'
```

```
SELECT *
FROM ASN.IBMSNAP_REG_EXT
WHERE SOURCE_OWNER='SrcOwn' AND SOURCE_TABLE='SrcTbl'
```

where *SrcOwn* is the library name and *SrcTbl* is the table name of the replication source in question. Both *SrcOwn* and *SrcTbl* are case sensitive.

6. The contents of the global row in the register table. You can check the progress of the Capture program by executing the following SQL statement:

```
SELECT A.*, HEX(SYNCHPOINT)
FROM ASN/IBMSNAP_REGISTER A
WHERE GLOBAL_RECÖRD = 'Y'
```

7. Entries in the trace table for significant job events. To find entries for the Capture program control job or the Capture program journal job, execute the following SQL statement:

```
SELECT *
FROM ASN/IBMSNAP_TRACE
WHERE SUBSTR(JOB_NAME, 21, 6) = 'jobnum'
ORDER BY TRACE_TIME
```

where *jobnum* is the job number for the job you want to investigate. The DESCRIPTION column provides important information about the job.

### Examples:

To gather trace table entries after 7 a.m., March 31, 2000, execute the following query:

```
SELECT *
FROM ASN/IBMSNAP_TRACE
WHERE TRACE_TIME > '2000-03-31-07.00.00.000000'
ORDER BY TRACE_TIME
```

To retrieve all ASN0303 (data capturing is interrupted...) trace entries after 7 a.m., March 31, 2000, execute the following query:

```
SELECT *
FROM ASN/IBMSNAP_TRACE
WHERE TRACE_TIME > '2000-03-31-07.00.00.000000' AND
      SUBSTR(DESCRIPTION, 1, 7) = 'ASN0303'
ORDER BY TRACE_TIME
```

8. Rows from the warm start table. There is a row for every journal that is used by one or more replication sources. You can retrieve the row for the journal job by executing the following SQL statement:

```
SELECT *
FROM ASN/IBMSNAP_WARM_START
WHERE JRN_LIB='JLib' AND JRN_NAME='JName'
```

where *JLib* is the library name and *JName* is the table name for the journal. Both *JLib* and *JName* are case sensitive.

9. Data from the target server that can help determine how and why the Apply program fails to replicate to the target table:



- The audit trail table
  - The job log of the Apply program
  - The subscription set table and its journal receivers (to find out how some columns changed over time)
10. A formatted dump of the user spaces for the journal jobs. These jobs are in library QDPR and they have the name QDPRxxxxxx, where xxxxxx is the job number of the journal job. Issue the following command before the Capture program ends:
- ```
DMPOBJ QDPR/QDPRxxxxxx *USRSPC
```

---

## Using the Replication Analyzer

The Replication Analyzer analyzes the following tables for correctness, consistency, and efficiency: replication control tables, change data tables, target tables, and target-table indexes. It also checks database parameters for optimal replication performance. You can use the Replication Analyzer to analyze the behavior of the Capture program or the Apply program. It can answer such questions as: "Why is Capture not capturing?" and "why is Apply not applying?" The Replication Analyzer can help diagnose problems, verify replication setup, and offer suggestions for performance tuning.

You can run the Replication Analyzer at any time after replication setup is complete to analyze a failure by the Capture program or the Apply program, or simply to verify your setup. You can find the Replication Analyzer in the \sqlib\bin directory. The bind file for the Analyzer, analyze.bnd, is in the \sqlib\bnd directory, but it is not necessary to bind the program because the Analyzer is autobound for DB2 V6 and V7. If you run the Analyzer with DB2 V5, use the following command to bind the Analyzer:

```
bind analyze.bnd isolation UR
```

**Important:** The Replication Analyzer works only with DataPropagator Version 5 or later; it does not work with DataPropagator Version 1. Contact IBM Software Support if you need a version of the Replication Analyzer that can work with DataPropagator Version 1.

You run the Replication Analyzer from the Windows command line. Type the name of the Replication Analyzer command file (analyze.exe) followed by a list of DB2 alias names of source, target and control servers, separated by blanks (each of these names must be eight or fewer characters in length).

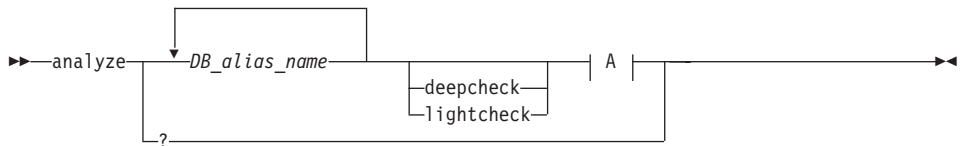
Because the Replication Analyzer runs from the command line, you do not need to have either DJRA or the DB2 Control Center running when you run the Replication Analyzer.

If end-user authentication is required to connect to any server, you must create a password file in the current directory. This file must be named `analyze.pwd` and should contain one or more entries with the following format:

```
SERVER=server_alias USER=userid PWD=password
```

IBM Software Support may ask you to run the Replication Analyzer and send the generated file to someone within IBM to check the output for correctness.

### Syntax:



### A:



### deepcheck

Specifies that the Analyzer perform a more complete analysis, including CD and UOW table pruning information, DB2 for OS/390 tablespace partitioning and compression detail, and analysis of target indexes with respect to subscription keys. The analysis includes all servers. This keyword is optional.

- f** Specifies the directory in which to store the output HTML file. If you do not specify this keyword, the HTML file is created in the current directory. No space is allowed between the keyword (**f**), the equal sign, and the value. This keyword is optional.

### lightcheck

Specifies that all column detail be excluded from the report, thus reducing report generation time, saving resources, and producing a smaller HTML file. This keyword is optional and is mutually exclusive with the **deepcheck** keyword.

- q** Specifies the Apply qualifier to use as a filter to restrict analysis of subscription sets. You can specify the **q** keyword more than once if you want to analyze multiple Apply qualifiers. No space is allowed between the keyword (**q**), the equal sign, and the value. This keyword is optional.

? Shows the syntax of the **analyze** command.

The keywords are not case sensitive.

**Output:** The Replication Analyzer creates an output HTML file, *analyze.htm*, which you can open and view with any Web browser. This file is stored in the same directory from which you run the Analyzer, or in the directory specified by the **f** keyword. Messages from the Analyzer are sent to stdout. The output HTML file contains the following information:

- Contents of replication control tables
- Information about packages and plans, including advice for the ISOLATION level of the package or plan
- Change data table (CD) column analysis
- Consistent Change Data table (CCD) column analysis
- Subscription target key synopsis
- Number of rows in the CD and UOW tables, and the number of rows that are eligible for pruning
- Selected DB2 for OS/390 SYSTABLEPART information
- Subscription history details
- Tablespace information
- Orphan table or view references; these are tables or views that are referenced but do not exist (or their existence cannot be confirmed)
- Incorrect or inefficient indexes
- Incorrect or inefficient tablespace LOCKSIZE values
- Subscription errors, omissions, or anomalies
- Subscription SQL statement errors
- Apply process summary
- Why the Capture program is not capturing
- Capture tuning troubles

Some of this information is only included when the **deepcheck** keyword is specified.

**Examples:**

```
analyze mydb1 mydb2
```

```
analyze mydb1 mydb2 f=mydirectory
```

```
analyze lightcheck mydb1 mydb2
```

```
analyze q=applyqual1 q=applyqual2 deepcheck mydb1 mydb2 f=mydirectory
```

---

## Troubleshooting

This section describes various problems that can occur when running the Capture and Apply programs and how to diagnose the cause of these problems. You should also use the Replication Analyzer to determine general and specific problems with the replication environment.

***Problem:** The Capture for OS/390 program does not start.*

Ensure that APF authorization was performed for all STEPLIB libraries as specified in the RUN JCL.

***Problem:** Capture for VM or Capture for VSE does not start.*

Ensure that:

- Access was given for the database log and directory minidisks. Note that the Capture program issues internal links to these minidisks.
- Access was given to the C Run Time Library.
- \*IDENT authorization was given to the Capture program virtual machine.
- The ASNLMAIN package file was loaded to the database.
- **For VM:** \*IDENT authorization was given to the Capture program virtual machine.

***Problem:** The Capture program is not capturing updates.*

Any of the following errors could prevent the Capture program from capturing updates:

- Proper authorization was not granted to the user ID running the Capture program.
- DATA CAPTURE CHANGES was not specified on the source tables to be captured. At startup, the Capture program checks that registered tables have DATA CAPTURE CHANGES specified. If tables are altered after the Capture program is running, stop and restart the Capture program so that it can find the tables altered to include DATA CAPTURE CHANGES.
- The proper order for starting the Capture and Apply programs was not used:
  1. Define replication sources and subscriptions before starting the Capture program.
  2. Start the Capture program and look for message number ASN0100I (initialization completed) in the system console or in the trace table.
  3. Start the Apply program so that it performs a full refresh before the Capture program starts capturing updates.

Check the trace table for possible error messages.

***Problem:** I'm not sure if the Capture program is running successfully.*

The first time that you start the Capture and Apply programs, the Apply program performs a full refresh to populate the target tables. Then the Capture program writes message ASN0104I to the trace table, providing information related to table owner name, table name, and starting log sequence number value. This information provides a point from which the Capture program starts to capture updates.

Updates captured from then on are placed in CD tables. They are eventually applied to target tables and pruned from the CD tables. After the Capture program runs for some time, you should see rows in the CD tables if changes are made to the sources. Periodically, check the trace table to see the progress made by the Capture program. If it encounters errors, it sends them to the console and also logs them in the trace table. Similarly, the Apply program logs its information in the Apply trail table.

***Problem:** Capture for OS/390 issued message ASN0000E instead of the proper message number.*

Message ASN0000E is a generic message that is issued instead of a proper message if the specified VSAM message file in the RUN JCL was not found. See the Capture for OS/390 program directory for information on installing the VSAM message file.

***Problem:** Capture for VM or Capture for VSE issued message ASN0000E instead of the proper message number.*

Message ASN0000E is a generic message that is issued instead of a proper message if either the default message file, ASNLS001 MSG, or the specified message file in the Capture startup JCL was not found. See the Capture for VM or Capture for VSE program directory for information on installing the message file.

***Problem:** The Capture program terminates.*

The Capture program terminates either because of a severe error, or when you issue the **stop** command. The Capture program terminates with a return code that indicates successful or unsuccessful completion. Return codes are:

- 0 **stop** command issued
- 8 Error during initialization
- 12 Any other severe error

***Problem:** Capture for OS/390 failed while using the LE for OS/390 environment.*

The Capture program runs in the LE for OS/390 environment and the recommended minimum Capture job-step region size when starting Capture is REGION=10M.

**Problem:** *Error message 0509 was issued.*

Error message 0509 occurs because multiple versions of DB2, or DB2 and DataJoiner, are installed on the same system:

- 0509-0306 Cannot load program asncpp for the following errors:
- 0509-0222 Cannot load the library libdb2.a(shr.o)
- 0509-0026 System error: a file or directory does not exist

Ensure that the LIBPATH environment variable is set to the same environment in which the Apply program starts.

**Problem:** *Apply component for DB2 Universal Database stops with an SQLCODE=-330, SQLSTATE=22517, "A string cannot be used, because its characters cannot be translated".*

When copying between DB2 for OS/390 and DB2 on another platform, the CCSID translation can cause an INSERT to fail if a translated value is longer than the DB2 column in which it will be inserted.

If you are running in a mixed environment, ensure that you have installed the latest maintenance for the CCSID support of your DB2 for OS/390 program.

For more information on character translation, see the character conversion appendix in the *DB2 for OS/390: Installation Guide*.

**Problem:** *I received system error 1067 trying to start the Capture or Apply program as a Windows NT Service.*

Error code 1067 occurs under the following circumstances:

- You did not specify the user ID and password and the Capture or Apply program is trying to run on the system account.
- You did not specify the ASNPATH environment variable correctly or you did not reboot the computer after updating the value of ASNPATH.
- There is no NTSERV.ASN file in the path specified by ASNPATH.
- The NTSERV.ASN file does not have the line:  
dbname pathname\asnccp.exe <parameters>

followed by CRLF.

**Problem:** *The ASNSERV.LOG file in ASNPATH tells me that the Apply program was started correctly, but the Apply process terminated.*

To find out why the Apply program terminated, change the syntax of NTSERV.ASN to:

```
...ASNAPPLY APPLYQUAL TRCFILE
```

The trace output will be written to the Apply trace file:

```
<ASNPATH pathname>ApplyQual.TRC
```

**Problem:** *I performed a successful bind, but when running the Apply program, I still get SQLCODE -805, SQLSTATE 51002.*

Make sure that the user ID has EXECUTE privilege on the Apply program packages, and make sure to bind both the Apply program packages to the control, source, and target server databases.

**Problem:** *The DB2 log filled to capacity because I copied a very large table.*

If the error occurred during a full refresh, you can use alternative methods to load large tables. You can either use the ASNLOAD exit routine, or you can perform your own load, as described in “Loading target tables offline using DJRA” on page 127.

If the error occurred while applying changed data, then you can change the data-blocking parameter to break down large blocks of changed data. See “Specifying a data-blocking value” on page 122.

**Problem:** *Capture was cold started, which caused the Apply program to perform a full refresh, but I don't want a full refresh.*

If your target table is very large, and in cases where you decided to use only your own load mechanism, you might want to suppress any future full refreshes of the Apply program. Set the DISABLE\_REFRESH flag to 1 in the register table at the source server for the source table. In this case, the Apply program issues message ASN1016E and copies nothing until you perform a full refresh.

If you want to bypass full refresh and also start capturing data as soon as possible, you can use the offline load function of DJRA. In this case, you do not need to unload and reload the tables, but just run the SQL generated for step 1 and step 4. In addition to disabling full refresh, offline load also deactivates the subscription until you complete step 4. See “Loading target tables offline using DJRA” on page 127.

**Problem:** *A gap was detected, so the Apply program won't perform a full refresh of my target table.*

Force a full refresh by resetting the LASTSUCCESS, SYNCHTIME, and SYNCHPOINT values in subscription set table to null.

**Problem:** *I unsuccessfully tried to start a second Apply program instance.*

You must run each instance with a unique Apply qualifier.

**Problem:** *I received a security violation message, and the Apply program is not authorized to connect to the database.*

The control server name, user ID, and password definitions are case sensitive and must match exactly those specified in the password file. Check your definitions again.

Apply for AS/400 does not use a password file, so it attempts to connect to the database using the user ID specified in the user parameter of the **STRDPRAPY CL** command. Ensure that you correctly set up your DRDA connectivity definitions.

**Problem:** *I received error ASN1003 with SQLCODE = -1032 and SQLSTATE = 57019.*

You must start the database manager before invoking the Apply program.

**Problem:** *Apply receives SQLCODE -206 when fetching the source data.*

If you use a CCD table to stage replication to multiple target tables, ensure that the CD or CCD table includes all the columns expected in all target tables. Subsetting columns or selecting UOW columns to be replicated to the final targets can cause this problem when a CCD table is added to a replication scenario after the target tables are defined.

This problem should only occur if you manually define target tables and do not include all the columns when defining replication sources. You can avoid this problem by defining all target tables (adding to subscription sets) after defining any CD and internal CCD tables. DJRA does not allow columns in a target table that are not in the predefined CD or internal CCD tables; DJRA displays only a valid subset of the columns for the target table.

**Problem:** *SQL1108 error while creating control table using DJRA*

A SQL1108 error results if DB2 DataJoiner is installed on the same Windows NT system as DJRA, and you try to create the control tables in DB2 for OS/390. The problem is caused by a memory collision with the required memory space for ddcs.dll, because this DLL is not loaded during application initialization.



The workaround for this problem is to set the environment variable DB2DBMSADDR (range is between 20000000 to 70000000). This tells DB2 to put its memory in a different virtual address space to avoid collision with the application address space.

---

## Problem-source identification questions

If you call IBM Software Support, you will be asked the following types of questions. You can save time, and perhaps diagnose the error yourself, by researching the answers to these questions:

1. What was occurring at the time of the problem?
2. What has changed recently in the environment?
3. Describe the environment.
4. What is the maintenance level of DB2 Universal Database where the Control Center is installed?
5. On what platform is the Capture program running?
6. What is the maintenance level of the Capture program?
7. What is the maintenance level of DB2 (or non-IBM DBMS) where the Capture program is running?
8. On what platform is the Apply program running?
9. What is the maintenance level of the Apply program?
10. On what release of DB2 (or DB2 DataJoiner) does the Apply program run?
11. What is the maintenance level of DB2 (or DB2 DataJoiner) where the Apply program is running?
12. Is this an occasionally-connected user? A DB2 Satellite user? A DB2 Everywhere user?
13. What ASN messages were issued?
14. Are there other messages in SYSLOG (for AS/400, the QSYSOPR message queue), on the screen, or in the trace file?
15. What is the complete message text for all messages issued? Be sure to note all message numbers, database names, table names, user IDs, and file names that appear in these messages.
16. Where does the failure occur?
  - a. The DB2 Control Center
    - Is the problem with a replication source or subscription set?
    - What messages appear?
    - Can the user successfully connect to the source or target database from a command line or DB2 command window?
  - b. DJRA

- What level of DJRA are you using? Click **Help** → **About** from the main window for this information.
  - If accessing non-IBM data sources, what level of DB2 DataJoiner are you using, and on which platform (AIX or Windows NT)?
  - Did you save the generated script file and the output file?
- c. The Capture program
- Is the Capture program running?
  - If not, what happens when you try to warm start it?
  - Is there error information in the trace table (ASN.IBMSNAP\_TRACE)?
  - Is there error information in the Capture program log file?
  - What is the DB2 configuration?
  - Are data changes successfully inserted into the CD tables?
  - Does the user ID running the Capture program have sufficient privileges to run the Capture program?
- d. The Apply program
- Is the Apply program running?
  - If not, what occurs when the Apply program starts?
  - What messages appear?
  - Is there error information in the Apply trail table (ASN.IBMSNAP\_APPLYTRAIL)?
  - Is there error information in the Apply program log file (for AS/400, in the Apply job log)?
  - Are data changes being successfully replicated to the target table?
  - Do all tables in a subscription set have the same problem?
  - What table types (for example, user copy, point-in-time, CCD) are involved in the failure?
  - Did you start the Apply program with the trace option?
  - Are CALL procedures being used?
  - Is a CCD table being used?

---

## Part 3. Operations

This part of the book describes specific operating instructions for particular operating systems:

“Chapter 9. Capture and Apply for AS/400” on page 175 describes how to operate the Capture and Apply programs on the AS/400 operating system.

“Chapter 10. Capture and Apply for OS/390” on page 225 describes how to operate the Capture and Apply programs on the OS/390 operating system.

“Chapter 11. Capture and Apply for UNIX platforms” on page 239 describes how to operate the Capture and Apply programs on UNIX operating systems.

“Chapter 12. Capture for VM and Capture for VSE” on page 255 describes how to operate the Capture program on the VM and VSE operating systems.

“Chapter 13. Capture and Apply for Windows and OS/2” on page 263 describes how to operate the Capture and Apply programs on the Windows and OS/2 operating systems.



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## Chapter 9. Capture and Apply for AS/400

This chapter describes how to set up and operate the Capture and Apply programs for DB2 DataPropagator for AS/400 Version 7.

Be sure to read the following sections before reading the sections on operating the Capture and Apply programs for AS/400:

- “Coexistence considerations”
- “Setting up the Capture and Apply programs” on page 176
- “Authorization requirements for running the Capture and Apply programs” on page 181
- “Restrictions for running the Capture program” on page 190
- “The journal” on page 191
- “Defining replication sources and subscription sets” on page 196
- “Using a relative record number (RRN) as a primary key” on page 196

---

### Coexistence considerations

You *cannot* run Version 1 of DB2 DataPropagator for AS/400 concurrently with Version 7. If you currently use Version 1, or if you use Version 1 replication components in a Version 5 DB2 DataPropagator for AS/400 environment, you must either:

- Migrate your Version 1 replication environment to Version 5. Instructions are in the *Migration Guide* in the Library page of the DB2 DataPropagator Web site ([www.ibm.com/software/data/dpropr/](http://www.ibm.com/software/data/dpropr/)).
- If your Version 1 replication environment is small (for example, if it contains fewer than 50 source registrations and subscriptions), do not migrate to Version 5. Instead, use the DataJoiner Replication Administration (DJRA) tool to create your replication environment in Version 7.

You should use DJRA for all replication administration tasks. However, both DJRA and the DB2 Control Center provide basic replication administration functions for defining replication sources and subscription sets. Only DJRA provides support for remote journals and the use of a relative record number (RRN) as a primary key.

---

## Setting up the Capture and Apply programs

Setting up the Capture and Apply programs consists of installing DB2 DataPropagator for AS/400 and tuning the Capture program for optimum productivity. This section describes how to set up the Capture and Apply programs.

### Installing DB2 DataPropagator for AS/400

You install DB2 DataPropagator for AS/400 in the same way that you install any other licensed program. Follow these steps for the regular installation:

1. Type `G0 LICPGM` on the AS/400 command line.
2. Select option 11 (Install licensed programs).
3. Page down to locate **DataPropagator Relational for AS/400 (5769DP3)**.

If the window does not contain the product ID number (5769DP3) on the install screen, exit LICPGM and enter `RSTLICPGM` on the AS/400 command line, and then specify 5769DP3 for the product ID.

If the window does contain the ID number, type a 1 next to it and press the Enter key.

### Connecting to an AS/400 server

Before you connect to an AS/400 server from a DB2 for Windows NT or Windows 95 client, make sure that your workstation is set up correctly:

- You have a DB2 UDB or DB2 Client Application Enabler (CAE) client installed on your workstation.
- You have TCP/IP set up on your workstation.

For example, use the following steps to connect to an AS/400 server from a DB2 for Windows NT workstation:

1. Log on to the AS/400 server and locate the relational database:
  - a. Log on to the AS/400 server to which you want to connect.
  - b. Submit a `dsprdbdire` command, and then specify `local` for `*LOCAL`.
  - c. Locate the name of the relational database in the output. For example, in the following output, the database is called DB2400E:

```
MYDBOS2          9.112.14.67
RCHASDPD         RCHASDPD
DB2400E          *LOCAL
RCHASLJN         RCHASLJN
```

2. Catalog the AS/400 database in DB2 for Windows NT:
  - a. From your Windows NT workstation, click **Start->Programs->DB2 for Windows NT->Command Window**. The DB2 CLP command window opens.
  - b. In the command window, type the following three commands in exact order:

```
db2 catalog tcpip node server_name remote server_name server 446 system
server_name ostype OS400
```

```
db2 catalog dcs database rdb_name AS rdb_name
```

```
db2 catalog database rdb_name AS rdb_name at node server_name
authentication dcs
```

Where *server\_name* is the TCP/IP host name of the AS/400 system, and *rdb\_name* is the name of the AS/400 relational database that you found in Step 1 on page 176.

3. In the command window, issue the following command:
 

```
db2 terminate
```
4. Ensure that the AS/400 user profile that you will use to log on to your AS/400 system uses CCSID37:
  - a. Log on to the AS/400 system.
  - b. Type the following command, where *user* is the user profile:
 

```
CHGUSRPRF USRPRF (user) CCSID(37)
```
  - c. To make sure that DB2 for Windows NT and DB2 for AS/400 have been connected, issue the following command:
 

```
db2 connect to rdb_name user user_name using password
```
5. Make sure that the DDM server is started on the AS/400 system by typing:
 

```
STRTCPSVR SERVER(*DDM)
```
6. From your Windows NT workstation, use the Control Center or DJRA to administer the AS/400 database.

## Verifying and customizing your installation of DB2 DataPropagator for AS/400

You should install DB2 DataPropagator for AS/400 before using the replication administration tools, because the installation process issues the **CRTDPRTBL** command to automatically create the replication control tables. These tables are created in the DataPropagator Relational collection (named ASN), if they do not already exist.

The installation program also creates an SQL journal, an SQL journal receiver for this library, and work management objects. Table 8 lists the work management objects that are created.

*Table 8. Work management objects*

| Description           | Object type | Name         |
|-----------------------|-------------|--------------|
| Subsystem description | *SBSD       | QDPR/QZSNDPR |
| Job queue             | *JOBQ       | QDPR/QZSNDPR |
| Job description       | *JOBDD      | QDPR/QZSNDPR |

**A note on work management:** You can alter the default definitions or provide your own definitions. See *OS/400 Work Management V4R3, SC41-5306* for more information about changing these definitions.

### Creating the replication control tables

If your replication control tables are accidentally deleted or corrupted, you can create them manually using the Create DPR Tables (**CRTDPRTBL**) command. You must have \*ALLOBJ authority to run this command.

**Important:** The **CRTDPRTBL** command is the only command that you should use to create AS/400 control tables. Do not use DJRA to create the control tables.

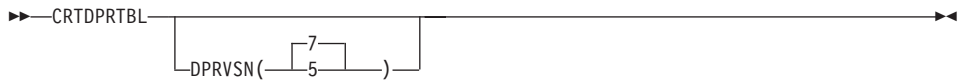


Table 9. CRTDPRTBL command parameter definitions for AS/400

| Parameter | Definition and prompts                                                                                                                                                                                                                                                     |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DPRVSN    | Specifies the version of the control tables to create.<br>7 (default)<br>Specifies Version 7 control tables. The system creates all of the control tables for replication sources and targets along with the default SQL journal.<br>5 Specifies Version 5 control tables. |

## Specifying tuning parameters for Capture for AS/400

To control the performance of the Capture program, you can adjust four tuning parameters on the server by changing the values of columns in the tuning parameters table.

To specify the tuning parameters, do one of the following tasks:

- Update the tuning parameters table manually. See “Specifying tuning parameters for the Capture program” on page 128 for more information.
- Run the **CHGDPRCAPA** command. See “Changing Capture program attributes” on page 179 for more information about this command.
- Customize the DPCNTL.400 file in the DB2 Control Center \sqllib\samples\repl directory before you define the first replication source for a database. You do not need to customize the DPCNTL.400 file if you have already installed DB2 DataPropagator for AS/400.



### Changing Capture program attributes

The Change DPR Capture Attributes (CHGDPRCAPA) command changes the global operating parameters in the tuning parameters table for the Capture program.

You can see the current values of the Capture program attributes if you issue the CHGDPRCAPA command with the F4 key to prompt on the command.

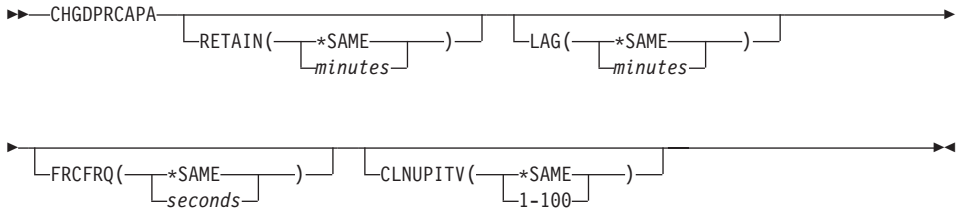


Table 10. CHGDPRCAPA command parameter definitions for AS/400

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RETAIN    | <p>Specifies the new retention limit, which is the number of minutes that data is retained in the CD tables and the UOW table before it is removed.</p> <p>The value of this parameter works with the CLNUPITV parameter. When the CLNUPITV value is reached, data in the CD and UOW tables is removed if the UOW table row shows that the transaction is older than the value of this parameter.</p> <p>Ensure that the Apply intervals are set to copy changed information before the value on the RETAIN parameter is reached. This prevents your tables from becoming inconsistent. If they become inconsistent, the Apply program performs full refreshes.</p> <p><b>*SAME</b> (default)<br/>Specifies that the value remains unchanged.</p> <p><i>minutes</i><br/>Specifies the number of minutes that the CD is retained. The maximum value is 35 000 000. The default value is 10 080 minutes (7 days).</p> |

Table 10. CHGDPRCAPA command parameter definitions for AS/400 (continued)

| Parameter     | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>LAG</b>    | <p>Specifies the new lag limit, which is the number of minutes that the Capture program can fall behind before clearing out the CD tables and starting over with change capture. When the lag limit is reached (that is, when the timestamp of the journal entry is older than the current time minus the lag limit), the Capture program assumes that it is too far behind to catch up. It then initiates a cold start for the tables that it is processing for that journal. The Apply program then performs a full refresh to provide the Capture program with a new starting point. Users typically set this value high so that it has no effect.</p> <p><b>*SAME (default)</b><br/>Specifies that the value remains unchanged.</p> <p><i>minutes</i><br/>Specifies the number of minutes that the CD entries are allowed to fall behind. The maximum value is 35 000 000. The default value is 10 080 minutes (7 days).</p>            |
| <b>FRCFRQ</b> | <p>Specifies approximately how often the Capture program writes changes to the CD and UOW tables.</p> <p>The Capture program makes the changes available to the Apply program either when the buffers are filled or when this time has expired, whichever is sooner.</p> <p>Use this parameter to make source table changes more readily available for the Apply program on servers with a low rate of source table changes.</p> <p>This is a global value, and is used for all defined source tables. Setting this value at a lower number can affect processor usage.</p> <p><b>*SAME (default)</b><br/>Specifies that the value remains unchanged.</p> <p><i>seconds</i><br/>Specifies the number of seconds that the Capture program keeps CD table and UOW table changes in buffer space before making them available for use by the Apply program. This value can range from 30 to 600 seconds. The default value is 180 seconds.</p> |

Table 10. CHGDPRCAPA command parameter definitions for AS/400 (continued)

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CLNUPITV  | <p>Specifies the maximum length of time before the Capture program prunes old records from the CD tables and the UOW table, if it exists. This parameter works with the RETAIN parameter.</p> <p>The value of this parameter is converted from hours to seconds and stored in the PRUNE_INTERVAL column of the tuning parameters table. If the PRUNE_INTERVAL column is changed manually (not using the <b>CHGDPRCAPA</b> command), you might see changes due to rounding when you prompt using the F4 key.</p> <p><b>*SAME</b> (default)<br/>Specifies that the value remains unchanged.</p> <p>1-100<br/>Specifies the maximum number of hours that you want the Capture program to wait before pruning. Valid values are 1-100.</p> |

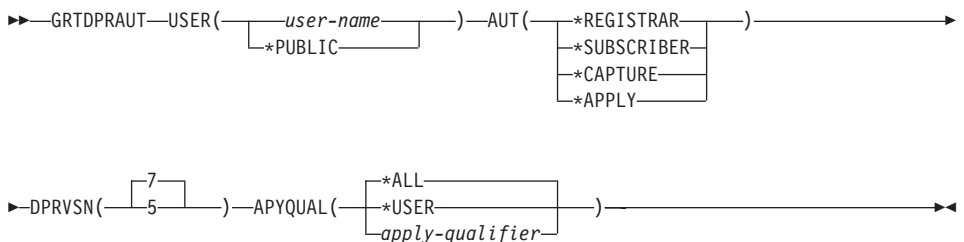
## Authorization requirements for running the Capture and Apply programs

This section describes the commands available for granting and revoking authority to the replication control tables: “Granting authority” and “Revoking authority” on page 189.

### Granting authority

The Grant DPR Authority (**GRTDPRAUT**) command authorizes a list of users to the replication control tables, so that the users can run the Capture and Apply programs. For example, the authority requirements for the user who is running the Capture and Apply programs might differ from the authority requirements for the user who defines replication sources and targets.

You must have **\*ALLOBJ** authority to grant authorities.



## GRTDPRAUT

Table 11. GRTDPRAUT command parameter definitions for AS/400

| Parameter   | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>USER</b> | <p>Specifies the users who have authority.</p> <p><i>user-name</i></p> <p>Specifies the names of up to 50 users who have authority.</p> <p><b>*PUBLIC</b></p> <p>Specifies that *PUBLIC authority is granted to the file, but (if insufficient for the task) is used only for those users who have no specific authority, who are not on the authorization list associated with the file, and whose group profile does not have any authority.</p> |

Table 11. GRTDPRAUT command parameter definitions for AS/400 (continued)

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AUT       | <p>Specifies the type of authority being granted.</p> <p><b>*REGISTRAR</b> (default)<br/>Specifies that the users are granted the authorities to define, change, and remove subscription sets.</p> <p>For a complete list of authorities with AUT(*REGISTRAR), see Table 12 on page 185.</p> <p><b>*SUBSCRIBER</b><br/>Specifies that the users are granted authority to define, change, and remove subscription sets.</p> <p>For a complete list of authorities with AUT(*SUBSCRIBER), see Table 13 on page 186.</p> <p><b>*CAPTURE</b><br/>Specifies that the users are granted authority to run the Capture program.</p> <p>For a complete list of authorities granted with AUT(*CAPTURE), see Table 14 on page 187.</p> <p><b>*APPLY</b><br/>Specifies that the users are granted authority to run the Apply program.</p> <p>The command does not grant authority to any of the objects that reside on other databases accessed by the Apply program.</p> <p>When an Apply process is invoked, the user associated with the DRDA application server job must also be granted *APPLY authority. If the source is an AS/400 server, the <b>GRTDPRAUT</b> command should be run on the source server system, with the application server job user specified on the <b>USER</b> parameter and the Apply qualifier specified on the <b>APYQUAL</b> parameter.</p> <p>Authorities are not granted to the target tables unless the target server is the same as the control server and both reside on the system where the command is run.</p> <p>For a complete list of authorities granted with AUT(*APPLY), see Table 15 on page 188.</p> |
| DPRVSN    | <p>Specifies the version of DB2 DataPropagator for AS/400.</p> <p>7 (default)<br/>Specifies Version 7 of DB2 DataPropagator for AS/400.</p> <p>5 Specifies Version 5 of DB2 DataPropagator for AS/400.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

Table 11. GRTDPRAUT command parameter definitions for AS/400 (continued)

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| APYQUAL   | <p>Specifies the Apply qualifier to be used by the user specified with the USER parameter. This parameter is used only when AUT(*APPLY) or AUT(*SUBSCRIBER) is specified.</p> <p><b>*ALL</b> (default)<br/>Specifies that the user is granted authority to run the Apply program or to define and remove subscriptions for <i>all</i> Apply qualifiers.</p> <p><b>*USER</b><br/>Specifies that the users specified on the USER parameter are granted authority to subscriptions with an Apply qualifier that is the same as the user name.</p> <p><i>apply-qualifier</i><br/>Specifies that the user is granted authority to run the Apply program or define and remove subscriptions for the Apply qualifiers associated with this Apply qualifier.</p> <ul style="list-style-type: none"> <li>The user is granted authority to all replication sources, CD tables, and CCD tables associated with records in the pruning control table that have a value in the APPLY_QUAL column matching the value input with the APYQUAL parameter.</li> <li>The user is granted authority to the subscriptions listed in the subscription-targets-member table that reside on this system.</li> </ul> |

You cannot use the **GRTDPRAUT** command while the Capture or Apply programs are running, or when applications that use the source tables are active because authorizations cannot be changed on files that are in use.

### Examples

**Example 1:** To authorize user USER1 to define and modify replication sources:

```
GRTDPRAUT USER(USER1) AUT(*REGISTRAR) DPRVSN(7)
```

**Example 2:** To authorize user USER1 to define and modify subscriptions:

```
GRTDPRAUT USER(USER1) AUT(*SUBSCRIBER) DPRVSN(7)
```

**Example 3:** To authorize user USER1 to define and modify existing subscriptions associated with Apply qualifier A1:

```
GRTDPRAUT USER(USER1) AUT(*SUBSCRIBER) DPRVSN(7) APYQUAL(A1)
```

**Example 4:** To authorize a user to run the Apply program on the control server system for all subscriptions associated with Apply qualifier A1, where the target server is the same as the control server:

1. Run the following command on the system where the Apply program will run:

```
GRTDPRAUT USER(USER1) AUT(*APPLY) DPRVSN(7) APYQUAL(A1)
```

2. If the application server job on the source server used by the Apply program runs under user profile USER1, run the following command on the source server systems:

```
GRTDPRAUT USER(USER1) AUT(*APPLY) DPRVSN(7) APYQUAL(A1)
```

If the application server job on the source server used by the Apply program runs under a different user profile; for example, QUSER, the command is:

```
GRTDPRAUT USER(QUSER) AUT(*APPLY) DPRVSN(7) APYQUAL(A1)
```

**The levels of authority**

The following tables list the authorities granted when you specify:

- AUT(\*REGISTRAR)
- AUT\*(SUBSCRIBER)
- AUT(\*CAPTURE)
- AUT(\*APPLY)

on the **GRTDPRAUT** command.

The following table lists the authorities granted when you specify the AUT(\*REGISTRAR) parameter on the **GRTDPRAUT** command:

*Table 12. Authorities granted with GRTDPRAUT AUT(\*REGISTRAR)*

| Library | Object            | Type  | Version | Authorizations                                     |
|---------|-------------------|-------|---------|----------------------------------------------------|
| QSYS    | ASN               | *LIB  | 5 7     | *USE, *ADD                                         |
| ASN     | QSQRN             | *JRN  | 5 7     | *OBJOPR,<br>*OBJMGT                                |
| ASN     | IBMSNAP_REGISTER  | *FILE | 7       | *OBJOPR,<br>*READ, *ADD,<br>*UPD, *DLT             |
| ASN     | IBMSNAP_REGISTERX | *FILE | 7       | *OBJOPR,<br>*READ, *ADD,<br>*UPD, *DLT             |
| ASN     | IBMSNAP_REG_EXT   | *FILE | 5 7     | *OBJOPR,<br>*OBJMGT,<br>*READ, *ADD,<br>*UPD, *DLT |

## GRTDPRAUT

Table 12. Authorities granted with GRTDPRAUT AUT(\*REGISTRAR) (continued)

| Library         | Object                 | Type    | Version | Authorizations                                     |
|-----------------|------------------------|---------|---------|----------------------------------------------------|
| ASN             | IBMSNAP_REG_EXTX       | *FILE   | 5 7     | *OBJOPR,<br>*OBJMGT,<br>*READ, *ADD,<br>*UPD, *DLT |
| ASN             | IBMSNAP_UOW            | *FILE   | 5 7     | *OBJOPR,<br>*OBJMGT,<br>*READ, *ADD<br>*DLT        |
| ASN             | IBMSNAP_UOW_IDX        | *FILE   | 5 7     | *OBJOPR,<br>*OBJMGT,<br>*READ, *ADD,<br>*DLT       |
| ASN             | IBMSNAP_PRUNCNTL       | *FILE   | 7       | *OBJOPR,<br>*READ                                  |
| ASN             | IBMSNAP_CCPPARMS       | *FILE   | 5 7     | *OBJOPR,<br>*READ, *UPD                            |
| ASN             | QZSNCTLBLK             | *USRSPC | 5 7     | *CHANGE                                            |
| ASN             | ASN4B*                 | *SQLPKG | 7       | *USE                                               |
| ASN             | ASN4C*                 | *SQLPKG | 7       | *USE                                               |
| QSYS            | Source library         | *LIB    | 5 7     | *USE                                               |
| Source library  | Source table           | *FILE   | 5 7     | *OBJOPR,<br>*READ                                  |
| QSYS            | Control library        | *LIB    | 5 7     | *USE, *ADD                                         |
| Control library | CDtimestamp - CD table | *FILE   | 7       | *USE, *OBJMGT,<br>*OBJEXIST                        |

The following table lists the authorities granted when you specify the AUT(\*SUBSCRIBER) parameter on the **GRTDPRAUT** command:

Table 13. Authorities granted with GRTDPRAUT AUT(\*SUBSCRIBER)

| Library | Object             | Type  | Version | Authorizations |
|---------|--------------------|-------|---------|----------------|
| QSYS    | ASN                | *LIB  | 7       | *USE, *ADD     |
| QSYS    | IBMSNAP_SUBS_SET   | *FILE | 7       | *CHANGE        |
| ASN     | IBMSNAP_APPLYTRAIL | *FILE | 7       | *CHANGE        |
| ASN     | IBMSNAP_SUBS_COL   | *FILE | 7       | *CHANGE        |
| ASN     | IBMSNAP_SUBS_EVENT | *FILE | 7       | *CHANGE        |
| ASN     | IBMSNAP_SUBS_STMTS | *FILE | 7       | *CHANGE        |



*Table 13. Authorities granted with GRTDPRAUT AUT(\*SUBSCRIBER) (continued)*

| <b>Library</b>  | <b>Object</b>                             | <b>Type</b> | <b>Version</b> | <b>Authorizations</b>       |
|-----------------|-------------------------------------------|-------------|----------------|-----------------------------|
| ASN             | IBMSNAP_SUBS_MEMBR                        | *FILE       | 7              | *CHANGE                     |
| ASN             | IBMSNAP_REGISTER                          | *FILE       | 7              | *USE, *UPD                  |
| ASN             | IBMSNAP_REG_EXT                           | *FILE       | 5 7            | *USE, *UPD                  |
| ASN             | IBMSNAP_PRUNCNTL                          | *FILE       | 7              | *USE, *ADD,<br>*DLT         |
| ASN             | ASN4U*                                    | *SQLPKG     | 7              | *USE                        |
| ASN             | ASN4A*                                    | *SQLPKG     | 7              | *USE                        |
| QSYS            | Source library                            | *LIB        | 5 7            | *USE                        |
| Source library  | Source table                              | *FILE       | 5 7            | *OBJOPR,<br>*READ           |
| QSYS            | Control library                           | *LIB        | 7              | *USE                        |
| Control library | ASNtimestampPC -<br>pruning control table | *LIB        | 7              | *USE                        |
| Control library | CD table                                  | *FILE       | 5 7            | *OBJOPR,<br>*READ           |
| Control library | Internal CCD table                        | *FILE       | 5 7            | *OBJOPR,<br>*READ           |
| QSYS            | Target library                            | *LIB        | 7              | *USE, *ADD                  |
| Target library  | Target table                              | *FILE       | 7              | *USE, *OBJMGT,<br>*OBJEXIST |

The following table lists the authorities granted when you specify the AUT(\*CAPTURE) parameter on the **GRTDPRAUT** command:

*Table 14. Authorities granted with GRTDPRAUT AUT(\*CAPTURE)*

| <b>Library</b>  | <b>Object</b>    | <b>Type</b> | <b>Version</b> | <b>Authorizations</b>                              |
|-----------------|------------------|-------------|----------------|----------------------------------------------------|
| QSYS            | ASN              | *LIB        | 5 7            | *USE, *OBJMGT                                      |
| ASN             | IBMSNAP_REGISTER | *FILE       | 5 7            | *USE, *UPD                                         |
| ASN             | IBMSNAP_REG_EXT  | *FILE       | 5 7            | *USE, *UPD                                         |
| QSYS            | Control library  | *LIB        | 5 7            | *USE                                               |
| Control library | CD table         | *FILE       | 5 7            | *OBJOPR,<br>*OBJMGT,<br>*READ, *UPD,<br>*DLT, *ADD |

*Table 14. Authorities granted with GRTDPRAUT AUT(\*CAPTURE) (continued)*

| <b>Library</b>  | <b>Object</b>      | <b>Type</b> | <b>Version</b> | <b>Authorizations</b>                              |
|-----------------|--------------------|-------------|----------------|----------------------------------------------------|
| Control library | CD table           | *FILE       | 5 7            | *OBJOPR,<br>*OBJMGT,<br>*READ, *UPD,<br>*DLT, *ADD |
| ASN             | IBMSNAP_PRUNCNTL   | *FILE       | 7              | *USE, *UPD                                         |
| ASN             | IBMSNAP_CRITSEC    | *FILE       | 7              | *USE                                               |
| ASN             | IBMSNAP_CCPPARMS   | *FILE       | 5 7            | *USE                                               |
| ASN             | IBMSNAP_UOW        | *FILE       | 5 7            | *CHANGE                                            |
| ASN             | IBMSNAP_TRACE      | *FILE       | 7              | *CHANGE                                            |
| ASN             | IBMSNAP_WARM_START | *FILE       | 7              | *CHANGE                                            |
| ASN             | IBMSNAP_AUTHTKN    | *FILE       | 7              | *CHANGE                                            |
| ASN             | QZSBCTKBLK         | *USRSPC     | 5 7            | *CHANGE                                            |
| ASN             | ASNB*              | SQLPKG      | 7              | *USE                                               |
| ASN             | ASNC*              | SQLPKG      | 7              | *USE                                               |

The following table lists the authorities granted when you specify the AUT(\*APPLY) parameter on the **GRTDPRAUT** command:

*Table 15. Authorities granted with GRTDPRAUT AUT(\*APPLY)*

| <b>Library</b> | <b>Object</b>      | <b>Type</b> | <b>Version</b> | <b>Authorizations</b> |
|----------------|--------------------|-------------|----------------|-----------------------|
| QSYS           | ASN                | *LIB        | 5 7            | *USE                  |
| ASN            | IBMSNAP_SUBS_SET   | *FILE       | 7              | *CHANGE               |
| ASN            | IBMSNAP_APPLYTRAIL | *FILE       | 7              | *CHANGE               |
| ASN            | IBMSNAP_SUBS_COLS  | *FILE       | 7              | *USE                  |
| ASN            | IBMSNAP_SUBS_EVENT | *FILE       | 7              | *USE                  |
| ASN            | IBMSNAP_SUBS_STMTS | *FILE       | 7              | *USE                  |
| ASN            | IBMSNAP_SUBS_MEMBR | *FILE       | 7              | *USE                  |
| ASN            | ASNA*              | *SQLPKG     | 7              | *USE                  |
| ASN            | ASNU*              | *SQLPKG     | 7              | *USE                  |
| ASN            | IBMSNAP_REGISTER   | *FILE       | 7              | *USE, *UPD            |
| ASN            | IBMSNAP_REG_EXT    | *FILE       | 5 7            | *USE, *UPD            |
| ASN            | IBMSNAP_UOW        | *FILE       | 5 7            | *USE, *UPD            |
| ASN            | IBMSNAP_PRUNCNTL   | *FILE       | 7              | *USE, *UPD,<br>*ADD   |

Table 15. Authorities granted with GRTDPRAUT AUT(\*APPLY) (continued)

| Library         | Object          | Type  | Version | Authorizations      |
|-----------------|-----------------|-------|---------|---------------------|
| ASN             | IBMSNAP_CRITSEC | *FILE | 7       | *USE, *ADD          |
| ASN             | IBMSNAP_AUTHTKN | *FILE | 7       | *USE, *ADD          |
| QSYS            | Control library | *LIB  | 5 7     | *USE                |
| Control library | CD table        | *FILE | 5 7     | *USE                |
| QSYS            | Target library  | *LIB  | 7       | *USE                |
| Target library  | Target table    | *FILE | 7       | *CHANGE,<br>*OBJMGT |

## Revoking authority

The Revoke DPR Authority (**RVKDPRAUT**) command revokes authority to the replication control tables so that users can no longer define or modify replication sources and subscriptions.

```

▶▶▶ RVKDPRAUT—USER( ( user-name ) )—DPRVSN( ( 7 ) )
                    ( *PUBLIC )

```

The command returns an error message if any of the following conditions exist:

- If a specified user does not exist.
- If the user running the command is not authorized to the specified user profiles.
- If the DB2 DataPropagator for AS/400 control tables do not exist.
- If the user running the command does not have permission to revoke authorities to the DB2 DataPropagator for AS/400 control tables.
- If the Capture or Apply programs are running.

Table 16. RVKDPRAUT command parameter definitions for AS/400

| Parameter     | Definition and prompts                                                                                                                                                                                                                                                                                                                                    |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>USER</b>   | <p>Specifies the users whose authority is revoked.</p> <p><i>user-name</i><br/>Specifies the names of up to 50 users whose authority is revoked.</p> <p><b>*PUBLIC</b><br/>Specifies that authority is revoked from all users without specific authority, who are not on the authorization list, and whose group profile does not have any authority.</p> |
| <b>DPRVSN</b> | <p>Specifies the version of DB2 DataPropagator for AS/400.</p> <p>7 (default)<br/>Revoke authorities for Version 7 of DB2 DataPropagator for AS/400.</p> <p>5 Revoke authorities for Version 5 of DB2 DataPropagator for AS/400.</p>                                                                                                                      |

**Example**

To revoke authorities to the control tables:

```
RVKDPRAUT USER(user-name) DPRVSN(7)
```

**Restrictions for running the Capture program**

If you perform any of the following actions while a Capture journal job is running, it terminates with message ASN2301 or ASN2201 in the job log:

- Delete the subscription row from the register table.
- Prevent the Capture program from gaining normal access by locking any of the control tables, user space, or user indexes needed for data capturing.
- Delete the user space ASN/QZSNCTLBLK.
- Delete the user index QDPR/QZSNINDEX5.
- Drop the index QDPR/IBMSNAP\_UOW\_IDX.
- Delete the message queue QDPR/QZSN5.
- Remove a message from the message queue QDPR/QZSN5 or send an extraneous message to the message queue QDPR/QZSN5.
- Attempt to add new rows to the CD tables or the UOW table when the user's storage limit is exceeded.
- Unsuccessfully attempt to allocate memory.

To keep the Capture program running, use the following guidelines:

- Use the default system-wide delete-journal-receiver support to prevent deletions of required journal receivers. See “Using the delete journal receiver exit routine” on page 194 for more information.
- If you choose to manage journal receivers manually, delete journal receivers used for journaling source tables only if you are certain that all the entries on that receiver were processed by the Capture program.

When conditions make capturing data for a particular source table impossible, the Capture program changes the state of the source table from capturing changes to needing a full refresh. (See Table 20 on page 205 for a list of such conditions.) Other conditions that prevent data capturing for a source table are:

- An ALTER TABLE is performed on the source table or the CD table such that either:
  - A column in the CD table is no longer in the source table.
  - The column in the CD table has different attributes (data type, length) from its counterpart in the source table.

When you need to perform an ALTER TABLE on the source table, ensure that you remove the subscription and define the source table again. Or you can use the **List or Change replication sources** action in DJRA to fix the changed data table. If you defined targets, you can also use the **List members or add a column to target table** action in DJRA to alter the target tables.

- A lock is placed on the source table or the CD table that prevents the Capture program from accessing the needed information.

---

## The journal

DB2 DataPropagator for AS/400 uses the information that it receives from the journals about changes to the data to populate the CD and UOW tables for replication.

DB2 DataPropagator for AS/400 runs under commitment control for most operations and therefore requires journaling on the control tables. (The QSQJRN journal is created when the CRTDPRTBL command creates a collection.)

Administrators must manually create the QSQJRN journal in both the library that contains the replication source control tables and the library that contains the target tables. Administrators must also ensure that all the source tables are journaled correctly.

## Remote journal function

In previous versions of DB2 DataPropagator for AS/400, replication source definitions (including the control tables associated with a source) and the Capture program always resided on the same system. The remote journal function makes it possible to move the replication source definitions and the Capture program and its control tables away from the system on which the source tables reside, leaving more resources available on that system. With the remote journal function, processor usage can be reduced, DASD can be saved, and performance can be improved significantly.

**Important:** The intention of this type of setup is to have the replication source definitions on the same AS/400 system as the replication target.

A replication source definition that refers to a remote source table cannot be subscribed to by other platforms such as the Apply program for OS/390 or the Apply program for UNIX.

To define a replication source with remote journals, select **Define One Table as a Replication Source** from the DJRA main window, select an AS/400 source table, then select the **AS/400 policies** tab. From this tab, select the remote journal checkbox, and enter the remote journal library, remote journal name, and Capture server.

For more information about the remote journal function, see *AS/400 Remote Journal Function for High Availability and Data Replication*, SG24-5189.

## Creating journals for source tables

To set up the source table journals, you must have the authority to create journals and journal receivers for the source tables to be defined.

**Important:** Use a different journal for the source tables than one of those created by DB2 DataPropagator for AS/400 (QSQRN journals) in the ASN library, the source library, the control library, or the target library.

### *To create a source table journal:*

1. Create a journal receiver in a library of your choice using the Create Journal Receiver (**CRTJRNRCV**) command. The following example uses a library named JRNLIB for journal receivers.

```
CRTJRNRCV  JRNRCV(JRNLIB/RCV0001)
           THRESHOLD(50000)
           TEXT('DataPropagator Journal Receiver')
```

Be sure to:

- Place the journal receiver in a library that is saved regularly.

- Choose a journal receiver name that can be used to create a naming convention for future journal receivers, such as RCV0001. You can use the \*GEN option to continue the naming convention when you change journal receivers. This type of naming convention is also useful if you choose to let the system manage the changing of your journal receivers.
2. Create the journal by using the Create Journal (**CRTJRN**) command:

```
CRTJRN  JRN(JRNLIB/DJRN1)
        JRNRCV(JRNLIB/RCV0001)
        MNGRCV(*SYSTEM) DLTRCV(*YES)
        TEXT('DataPropagator Journal')
```

Be sure to:

- Specify the name of the journal receiver that you created in the first step.
- Use the Manage receiver (MNGRCV) parameter to have the system change the journal receiver and attach a new one when the attached receiver becomes too large. If you choose this option, you do not need to use the **CRTJRN** command to detach receivers and create and attach new receivers manually.
- Specify DLTRCV(\*NO) only if you have overriding reasons to do so (for example, if you need to save these journal receivers for recovery reasons). If you specify DLTRCV(\*YES), these receivers might be deleted before you have a chance to save them.

You can use two values on the RCVSIZOPT parameter of the **CRTJRN** command (\*RMVINTENT and \*MINFIXLEN) to optimize your storage availability and system performance. See the *AS/400 Programming: Performance Tools Guide* for more information.

3. Start journaling the source table using the Start Journal Physical File (**STRJRNPf**) command, as in the following example:

```
STRJRNPf FILE(library/file)
          JRN(JRNLIB/DJRN1)
          OMTJRNE(*OPNCLO)
          IMAGES(*BOTH)
```

Specify the name of the journal that you created in step 2. The Capture program requires a value of \*BOTH for the IMAGES parameter.

## Managing journals and journal receivers

The Capture program uses the Receive Journal Entry (**RCVJRNE**) command to receive journals.

### Specifying system management of journal receivers

It is recommended that you let the AS/400 system manage the changing of journal receivers. This is called *system change journal management*. Specify MNGRCV(\*SYSTEM) when you create the journal, or change the journal to

that value. If you use system change journal management support, you must create a journal receiver that specifies the threshold at which you want the system to change journal receivers. The threshold must be at least 5000 KB, and should be based on the number of transactions on your system. The system automatically detaches the receiver when it reaches the threshold size and creates and attaches a new journal receiver, if it can.

### **Specifying user management of journal receivers**

If you specify MNGRCV(\*USER) when you create the journal (meaning you want to manage changing your own journal receivers), a message is sent to the journal's message queue when the journal receiver reaches a storage threshold, if one was specified for the receiver.

Use the **CHGJRN** command to detach the old journal receiver and attach a new one. This command prevents Entry not journaled error conditions and limits the amount of storage space that the journal uses. To avoid affecting performance, do this at a time when the system is not at maximum use.

You can switch journal receiver management back to the system by specifying CHGJRN MNGRCV(\*SYSTEM).

You should regularly detach the current journal receiver and attach a new one for two reasons:

- Analyzing journal entries is easier if each journal receiver contains the entries for a specific, manageable time period.
- Large journal receivers can affect system performance and take up valuable space on auxiliary storage.

The default message queue for a journal is QSYSOPR. If you have a large volume of messages in the QSYSOPR message queue, you might want to associate a different message queue, such as DPRUSRMSG, with the journal. You can use a message handling program to monitor the DPRUSRMSG message queue. For an explanation of messages that can be sent to the journal message queue, see *OS/400 Backup and Recovery*.

### **Using the delete journal receiver exit routine**

When you install DB2 DataPropagator for AS/400 on a V4R2 (or later) system, a *delete journal receiver* exit routine (DLTJRNRVCV) is registered automatically. This exit routine is called any time a journal receiver is deleted, whether or not it is used for journaling the source tables. This exit routine determines whether or not a journal receiver can be deleted. (You no longer need to do this manually. Nor do you need to use the **ANZDPRJRN** command to delete old receivers.)



To take advantage of the delete journal receiver exit routine and leave journal management to the system, specify DLTRCV(\*YES) and MNGRCV(\*SYSTEM) on the **CHGJRN** or **CRTJRN** command.

If the journal that the receiver is associated with has no association with any of the source tables, this exit routine *approves* the deletion of the receiver.

If the journal receiver is used by one or more source tables, this exit routine makes sure that the receiver being deleted does not contain entries that have not been processed by the Capture program. The exit routine *disapproves* the deletion of the receiver if the Capture program still needs to process entries on that receiver.

If you must delete a journal receiver and the delete journal receiver exit routine does not approve the deletion, specify DLTJRNRCV DLTLOPT(\*IGNEXITPGM) to override the exit routine.

**Removing the delete journal receiver exit routine:** If you want to handle the deletion of journal receivers manually, you can remove the delete journal receiver exit routine by issuing the following command:

```
RMVEXITPGM EXITPNT (QIBM_QJO_DLT_JRNRCV)
              FORMAT (DRVC0100)
              PGMNBR(value)
```

*To determine the PGMNBR value for the RMVEXITPGM command:*

1. Issue the **WRKREGINF** command.
2. On the Work with Registration Information window, find the entry for exit point QIBM\_QJO\_DLT\_JRNRCV. Enter 8 in the **Opt** field.
3. On the Work with Exit Programs window, find the entry for Exit Program QZSNDREP in library QDPR. The number that you need is under the Exit Program Number heading.

**Registering the delete journal receiver exit routine for upgraded systems:** If the 5769DP3 version of DB2 DataPropagator for AS/400 was installed on V4R1 and the operating system was upgraded to V4R2 or V4R3 without reinstalling the product, you must register the exit routine with this command:

```
ADDEXITPGM EXITPNT(QIBM_QJO_DLT_JRNRCV)
              FORMAT (DRCV0100)
              PGMNBR(value *LOW)
              CRTEXITPNT (*NO)
              PGM(QDPR/QZSNDREP)
```

---

## Defining replication sources and subscription sets

Before you define source tables as replication sources with DB2 DataPropagator for AS/400, you must be authorized to the control tables.

There are no commands in DB2 DataPropagator for AS/400 for defining replication sources and subscription sets. Use the DB2 DataJoiner Replication Administration tool (DJRA) to define replication sources and subscription sets. Before you define a table as a replication source, the source table must be journaled for both before-images and after-images, and the library where the CD table is created must have a QSQJRN journal.

In DB2 DataPropagator for AS/400, the tables you define as replication sources can contain approximately 2000 columns; the exact number of columns depends on the length of the name of each column. This limitation exists because character strings supplied by the Apply program for AS/400 cannot exceed 32K.

When you define tables as replication sources, the CCSID attributes of CHAR, VARCHAR, GRAPHIC, and VARGRAPHIC columns in the CD table must be the same as the CCSID column attributes of the source table.

---

## Using a relative record number (RRN) as a primary key

In DB2 DataPropagator for AS/400, many source tables do not have a column that can be identified as a primary key column. DB2 DataPropagator requires primary key columns for the Apply program to track which updates are applied to which target table rows. To meet this requirement, DB2 DataPropagator for AS/400 supports the use of *relative record numbers (RRNs)* of source table rows as primary key columns. Both the CD table and the target table have an extra column, `IBMQSQ_RRN`, of type INTEGER. This column has the RRN of the source table row.

Because the RRN of a source table row does not change unless the source table is reorganized, the RRN value can be used as a primary key for the source table row if a source table is not reorganized. Any time that you reorganize a source table (to compress deleted rows, for example), DB2 DataPropagator for AS/400 performs a full refresh of all the target tables.

**Important:** Only the Apply program for AS/400 can be used to maintain copies that contain RRN columns, whether these copies are on an AS/400 or other target DB2 platforms.

To define a replication source with a RRN column, select **Define One Table as a Replication Source** from the DJRA main window, select an AS/400 source table, then select the **AS/400 policies** tab. From this tab, select the RRN checkbox.

## Operating Capture for AS/400

The replication administrator user ID and users who have \*CAPTURE authority can use the commands in this section to perform the following Capture for AS/400 tasks:

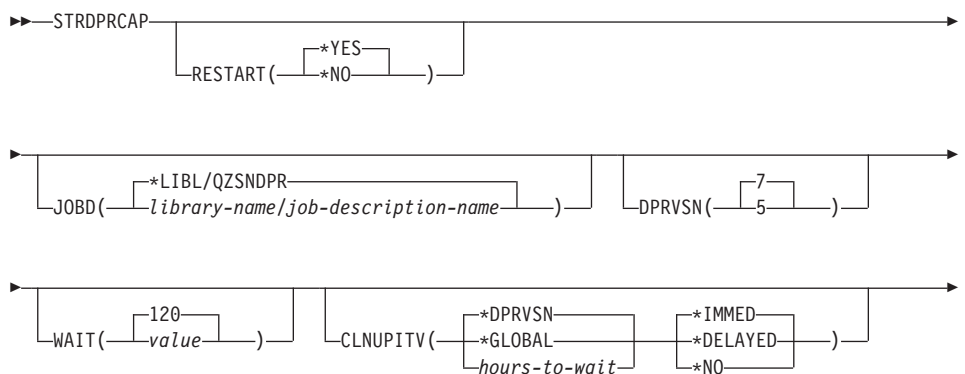
- Starting
- Checking program progress
- Scheduling
- Stopping
- Initializing
- Pruning

This section also describes how the Capture program handles warm and cold starts, in “Warm and cold starts” on page 205.

### Starting Capture for AS/400

Use the Start DPR Capture (**STRDPRCAP**) command to start capturing changes to AS/400 database tables. Because this command processes all replication sources in the register table, make sure that the user running this command has the proper authority.

After you start the Capture program, it runs continuously until you stop it or it detects an unrecoverable error.



## STRDPRCAP

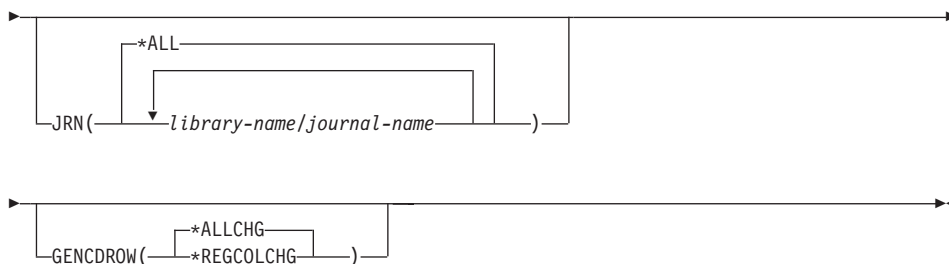


Table 17. STRDPRCAP command parameter definitions for AS/400

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RESTART   | <p>Specifies how the Capture program handles warm and cold starts.</p> <p><b>*YES</b> (default)<br/>The Capture program continues processing the changes from the point where it was when it ended previously. This is also known as a <i>warm start</i> and is the normal mode of operation.</p> <p><b>*NO</b><br/>The Capture program removes all information from the CD tables. The Capture program also removes all information from the UOW table when you specify JRN(*ALL).<br/>All subscriptions for affected source tables are full refreshed before change capturing resumes. This process is also known as a <i>cold start</i>.<br/>At times you might want to cold start a subset of sources. By specifying RESTART(*NO) and JRN(library-name/journal-name), you can cold start the Capture program for specified journals.<br/>When you cold start a subset of sources, the information in the UOW table is not removed. When you use the <b>STRDPRCAP</b> command to cold start a subset of sources, you can end the Capture program after about 15 minutes and warm start it again (this time, starting <i>all</i> the replication sources).</p> |
| JOBID     | <p>Specifies the name of the job description to use when submitting the Capture program.</p> <p><b>*LIBL/QZSNDPR</b> (default)<br/>Specifies the default job description provided with DB2 DataPropagator for AS/400.<br/><i>library-name/job-description-name</i><br/>Represents the name of the job description used for the Capture program.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

Table 17. STRDPRCAP command parameter definitions for AS/400 (continued)

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DPRVSN    | <p>Specifies the version of the Capture program to start.</p> <p>7 (default)<br/>Start Version 7 of the Capture program.</p> <p>5 Start Version 5 of the Capture program.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| WAIT      | <p>Specifies the maximum number of seconds to wait before the Capture program checks its status. You can use this value to tune the responsiveness of the Capture program. A low value reduces the time that the Capture program takes before ending or initializing, but can have a negative effect on system performance. A higher value increases the time that the Capture program takes before ending or initializing, but can improve system performance. A value that is too high can result in decreased responsiveness while the Capture program is performing periodic processing. The amount of the decrease in responsiveness depends on the amount of change activity to source tables and the amount of other work occurring on the system.</p> <p>120 (default)<br/>The Capture program waits 120 seconds.</p> <p><i>value</i><br/>The maximum number of seconds that the Capture program waits. You can specify from 60 to 6000 seconds.</p> |

Table 17. STRDPRCAP command parameter definitions for AS/400 (continued)

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CLNUPITV  | <p>Specifies the maximum amount of time before the Capture program prunes old records from the CD tables and the UOW table, if it exists. This parameter works in conjunction with the RETAIN parameter on the <b>CHGDPRCAPA</b> command.</p> <p><b>*DPRVSN</b> (default)<br/>Specifies the interval. The value is <b>*GLOBAL</b>.</p> <p><b>*GLOBAL</b><br/>Specifies the interval as the same value as that of the PRUNE_INTERVAL column of the tuning parameters table. You can change this value by using the CLNUPITV parameter on the <b>CHGDPRCAPA</b> command.</p> <p><i>hours-to-wait</i><br/>Specifies the interval as a specific number of hours.</p> <p><b>*IMMED</b> (default)<br/>Specifies to prune old records at the beginning of the specified interval (or immediately), and at each interval thereafter.</p> <p><b>*DELAYED</b><br/>Specifies that the Capture program prune old records at the end of the specified interval, and at each interval thereafter.</p> <p><b>*NO</b><br/>Specifies that the Capture program does not prune records.</p> |
| JRN       | <p>Specifies a subset of up to 50 journals that you want the Capture program to work with. The Capture program will start processing all the source tables that are currently journaled to this journal.</p> <p><b>*ALL</b><br/>Specifies that the Capture program will start working with all of the journals that have any source tables journaled to them.</p> <p><i>library-name/journal-name</i><br/>Represents the qualified name of the journal that you want the Capture program to work with.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

Table 17. STRDPRCAP command parameter definitions for AS/400 (continued)

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GENDROW   | Specifies what changes from the journals should be copied into the change data table.<br><br>*ALLCHG<br>All of the insert, update, and delete records from the journal are copied into the change data table.<br><br>*REGCOLCHG<br>The insert, update, and delete changes made to the registered columns are journaled, and the changes are then copied into the change data table. Changes that are made to columns that are not defined for replication will not be captured in the change data tables. |

You can run the **STRDPRCAP** command manually, or you can automatically run the command as a part of the initial program load (IPL startup program). For information about including the **STRDPRCAP** command in a startup program, see *OS/400 Work Management V4R3*, SC41–5306.

If the job description specified with the **JOB** parameter uses job queue **QDPR/QZSNDPR**, and the DB2 DataPropagator for AS/400 subsystem is not active, the **STRDPRCAP** command starts the subsystem. If the job description is defined to use a different job queue and subsystem, you must start this subsystem manually with the Start Subsystem (**STRSBS**) command either before or after running the **STRDPRCAP** command:

```
STRSBS QDPR/QZSNDPR
```

You can set up the system to start the subsystem automatically by adding the **STRSBS** command to the program that is referred to in the **QSTRUPPGM** system value on your system.

## Determining the progress of the Capture program

To determine the progress of the Capture program, you must either determine how much work remains between the last Capture process that was performed and the last Apply process, or use the DJRA Replication Monitor.

If the Capture program has ended, you can determine its progress by inspecting the warm start table. There is one row for each journal used by the source tables. The **LOGMARKER** column provides the timestamp of the last journal entry processed successfully. The **SEQNBR** column provides the journal entry sequence number of that entry.

If the Capture program is still running, you can determine its progress by completing the following tasks:





Table 18. ENDDPRCAP command parameter definitions for AS/400

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OPTION    | <p>Specifies how to end the Capture program.</p> <p><b>*CNTRLD</b> (default)<br/>           Specifies that the Capture program complete all tasks and then end normally.</p> <p>The <b>ENDDPRCAP</b> command might take longer when you specify the <b>*CNTRLD</b> option because the Capture program completes all of its subordinate processes before ending.</p> <p><b>*IMMED</b><br/>           Specifies that the Capture program complete all tasks with the <b>ENDJOB OPTION(*IMMED)</b> command and end normally.</p> |
| DPRVSN    | <p>Specifies the version of the Capture program to end.</p> <p>7 (default)<br/>           Specifies Version 7 of the Capture program.</p> <p>5    Specifies Version 5 of the Capture program.</p>                                                                                                                                                                                                                                                                                                                             |

If you use the **ENDJOB** command, temporary objects might be left in the QDPR library. These objects have the types **\*DTAQ** and **\*USRSPC**, and are named **QDPRnnnnnn**, where **nnnnnn** is the job number of the job that used them. You can delete these objects when the job that used them (identified by the job number in the object name) is not active.

If the job **QDPRCTL5** does not end long after issuing this command, use the **ENDJOB** command with **\*IMMED** option to end this job and all the journal jobs running in the DB2 DataPropagator for AS/400 subsystem. Do not end Apply jobs running in the same subsystem if you want to end only the Capture program.

In rare cases when the job **QDPRCTL5** ends abnormally, the journal jobs created by **QDPRCTL5** might still be left running. The only way to end these jobs is to use the **ENDJOB** command with either the **\*IMMED** or **\*CNTRLD** option.

### Reinitializing Capture for AS/400

The Initialize DPR Capture (**INZDPRCAP**) command initializes the Capture program by directing the Capture program to work with an updated list of source tables.

Source tables under the control of the program can change while the Capture program is running. Use the **INZDPRCAP** command to ensure that the Capture program processes the most up-to-date replication sources.

## INZDPRCAP

If you change the values of the tuning parameters while the Capture program is running, enter the **INZDPRCAP** command to reinitialize the program using the new values.

The Capture program must be running before you run this command.

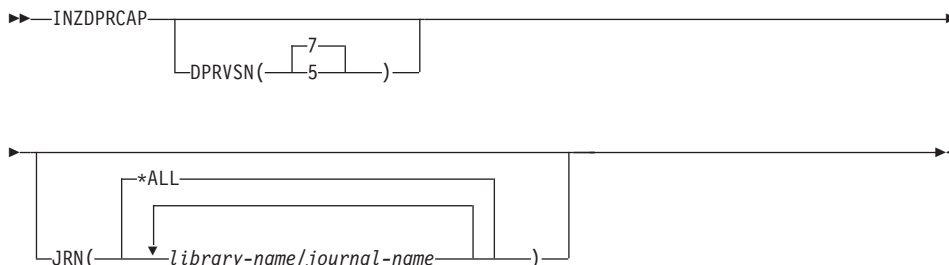


Table 19. INZDPRCAP command parameter definitions for AS/400

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DPRVSN    | Specifies the version of the Capture program to initialize.<br>7 (default)<br>Specifies Version 7 of the Capture program.<br>5 Specifies Version 5 of the Capture program.                                                                                                                                                                                                                                                    |
| JRN       | Specifies a subset of up to 50 journals that you want the Capture program to work with. The Capture program will start processing all the source tables that are currently journaled to this journal.<br>*ALL (default)<br>Specifies that the Capture program works with all the journals.<br><i>library-name/journal-name</i><br>Specifies the qualified name of the journal that you want the Capture program to work with. |

### Pruning the change data and unit-of-work tables and minimizing source server DASD usage

The CLNUPITV parameter on the **STRDPRCAP** command specifies the maximum number of hours that the Capture program waits before pruning old records from the CD tables and the UOW table. For more information about the CLNUPITV parameter, see “Starting Capture for AS/400” on page 197.

Pruning does not recover DASD for you. You have to frequently issue **RGZPFM** (Reorganize Physical File Member) commands against the CD tables

and the UOW tables to recover the DASD. The **RGZPFM** command reclaims deleted space by moving active rows forward. It requires an EXCLRD lock of the file and member, and you must schedule it when Capture and Apply are not running.

**Important:** Issue **RGZPFM** commands once a week.

## Warm and cold starts

The value of the RESTART parameter on the **STRDPRCAP** command controls how the Capture program handles warm and cold starts.

### Warm start process

Warm start information is saved in most cases. Occasionally, warm start information is not saved. In this case, the Capture program uses the CD tables, UOW table, or the pruning control table to resynchronize to the time that it was stopped.

### Automatic cold starts

Sometimes the Capture program automatically switches to a cold start, even if you specified a warm start. On AS/400 systems, cold starts work on a journal-by-journal basis. So, for example, if a journal exceeds the lag limit, all replication sources using that journal are cold-started, whereas replication sources using a different journal are not cold started.

For more information about how the Capture program processes different journal entry types, see Table 20.

---

## How the Capture program processes journal entry types

The following table describes how the Capture program processes different journal entry types.

*Table 20. Capture program processing by journal entry*

| Journal code <sup>3</sup> | Entry type | Description                                         | Processing                                         |
|---------------------------|------------|-----------------------------------------------------|----------------------------------------------------|
| C                         | CM         | Set of record changes committed                     | Insert a record in the UOW table.                  |
| C                         | RB         | Rollback                                            | No UOW row inserted.                               |
| F                         | AY         | Journalized changes applied to physical file member | Issue an ASN2004 message and full refresh of file. |
| F                         | CE         | Change end of data for physical file                | Issue an ASN2004 message and full refresh of file. |
| F                         | CR         | Physical file member cleared                        | Issue an ASN2004 message and full refresh of file. |

Table 20. Capture program processing by journal entry (continued)

| Journal code <sup>3</sup> | Entry type | Description                                                                                             | Processing                                                                                                               |
|---------------------------|------------|---------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| F                         | EJ         | Journaling for physical file member ended                                                               | Issue an ASN2004 message and full refresh of file.                                                                       |
| F                         | IZ         | Physical file member initialized                                                                        | Issue an ASN2004 message and full refresh of file.                                                                       |
| F                         | MD         | Member removed from physical file (DLTLIB, DLTF, or RMVM)                                               | Issue an ASN2004 message and attempt a full refresh.                                                                     |
| F                         | MF         | Storage for physical file member freed                                                                  | Issue an ASN2004 message and full refresh of file.                                                                       |
| F                         | MM         | Physical file containing member moved (Rename Object (RNMOBJ) of library, Move Object (MOVOBJ) of file) | Issue an ASN200A message and attempt a full refresh.                                                                     |
| F                         | MN         | Physical file containing member renamed (RNMOBJ of file, Rename Member (RNMM))                          | Issue an ASN200A message and attempt a full refresh.                                                                     |
| F                         | MR         | Physical file member restored                                                                           | Issue an ASN2004 message and full refresh of file.                                                                       |
| F                         | RC         | Journalled changes removed from physical file member                                                    | Issue an ASN2004 message and full refresh of file.                                                                       |
| F                         | RG         | Physical file member reorganized                                                                        | If the RRRN of the source table is being used as the replication key, issue an ASN2004 message and full refresh of file. |
| J                         | NR         | Identifier for next journal receivers                                                                   | Reset the Capture program.                                                                                               |
| J                         | PR         | Identifier for previous journal receivers                                                               | Increment the unique sequence number counter.                                                                            |
| R                         | DL         | Record deleted from physical file member                                                                | Insert a DLT record in the CD table.                                                                                     |
| R                         | DR         | Record deleted for rollback                                                                             | Insert a DLT record in the CD table.                                                                                     |
| R                         | PT         | Record added to physical file member                                                                    | Insert an ADD record in the CD table.                                                                                    |
| R                         | PX         | Record added directly to physical file member                                                           | Insert an ADD record in the CD table.                                                                                    |

Table 20. Capture program processing by journal entry (continued)

| Journal code <sup>3</sup> | Entry type | Description                                            | Processing  |
|---------------------------|------------|--------------------------------------------------------|-------------|
| R                         | UB         | Before-image of record updated in physical file member | See note 1. |
| R                         | UP         | After-image of record updated in physical file member  | See note 1. |
| R                         | BR         | Before-image of record updated for rollback            | See note 2. |
| R                         | UR         | After-image of record updated for rollback             | See note 2. |

**Notes:**

1. The R-UP image and the R-UB image form a single UPD record in the CD table if the PARTITION\_KEYS\_CHG column in the register table is N. Otherwise, the R-UB image inserts a DLT record in the CD table and the R-UP image inserts an ADD record in the CD table.
2. The R-UR image and the R-BR image form a single UPD record in the CD table if the PARTITION\_KEYS\_CHG column in the register table is N. Otherwise, the R-BR image inserts a DLT record in the CD table and the R-UR image inserts an ADD record in the CD table.
3. The following values are used for the journal codes:
  - C Commitment control operation
  - F Database file operation
  - J Journal or journal receiver operation
  - R Operation on specific record

---

All other journal entry types are ignored by the Capture program.

---

## Operating Apply for AS/400

A replication administrator user ID and users who have \*APPLY authority can use the commands in this section to perform the following Apply for AS/400 tasks:

- Creating packages to use with remote systems
- Starting
- Scheduling
- Stopping

This section also describes two additional Apply program operations:

## INZDPRCAP

- “Using the ASNDONE exit routine for AS/400” on page 220
- “Refreshing target tables with the ASNLOAD exit routine for AS/400” on page 221

### Creating packages to use with remote systems

SQL and DPR packages can be created to use with remote systems. You can create these packages by issuing the following commands:

#### CRTSQLPKG

The Create SQL Package (CRTSQLPKG) command creates the packages that enable you to use Apply for AS/400 with remote systems on platforms other than AS/400. For information about using this command, see *DB2 for AS/400 SQL Programming V4R3* or later.

#### CRTDPRPKG

You can use the Create DPR Packages (CRTDPRPKG) command to create the packages necessary to use DB2 DataPropagator for AS/400 with remote systems. The following paragraphs contain more information about using this command.

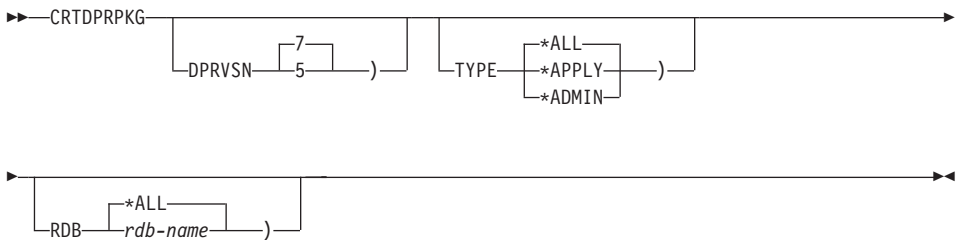


Table 21. CRTDPRPKG command parameter definitions for AS/400

| Parameter | Definition and prompts                                                                                                                                                                                                                          |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DPRVSN    | Specifies the version of the DB2 DataPropagator for AS/400 package to use.<br><br>7 (default)<br>Specifies packages for Version 7 of DB2 DataPropagator for AS/400.<br><br>5 Specifies packages for Version 5 of DB2 DataPropagator for AS/400. |

Table 21. CRTDPRPKG command parameter definitions for AS/400 (continued)

| Parameter   | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TYPE</b> | <p>Specifies which DB2 DataPropagator for AS/400 packages are created.</p> <p><b>*ALL</b> (default)<br/>Specifies to create packages for all the DB2 DataPropagator for AS/400 programs that do remote SQL.</p> <p><b>*APPLY</b><br/>Specifies to create the packages for the programs used by the Apply program.</p> <p><b>*ADMIN</b><br/>Specifies to create the packages for the programs used by the CL commands.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>RDB</b>  | <p>Specifies the relational database where the packages are created. The packages are not created in the following cases:</p> <ul style="list-style-type: none"> <li>• The RDB is on an AS/400 system and the ASN library does not exist on the remote system.</li> <li>• The RDB is not on an AS/400 system and ASN is not defined as an authorization ID on that RDB.</li> </ul> <p><b>*ALL</b> (default)<br/>Specifies to create an SQL package on every RDB that is used as a source server or a target server by DB2 DataPropagator for AS/400.</p> <p><i>rdb-name</i><br/>Represents the name of the relational database. You can use the Work with RDB Directory Entries (<b>WRKRDBDIRE</b>) command to find this name.</p> <p>When prompting on the <b>CRTDPRPKG</b> command, you can press the F4 key to choose from the list of databases in the RDB directory.</p> |

The packages are created using the ASN qualifier. They are created in the ASN library for DB2 UDB for AS/400 platforms. For other platforms, the authorization ID ASN is used.

After creating the DB2 DataPropagator for AS/400 packages, this command grants **\*PUBLIC** authority to the packages to allow them to be used by users of DB2 DataPropagator for AS/400.

The system also produces a spool file that contains the SQL messages associated with each attempt to create a package.

## Before you start the Apply program

Before you start the Apply program, ensure that:

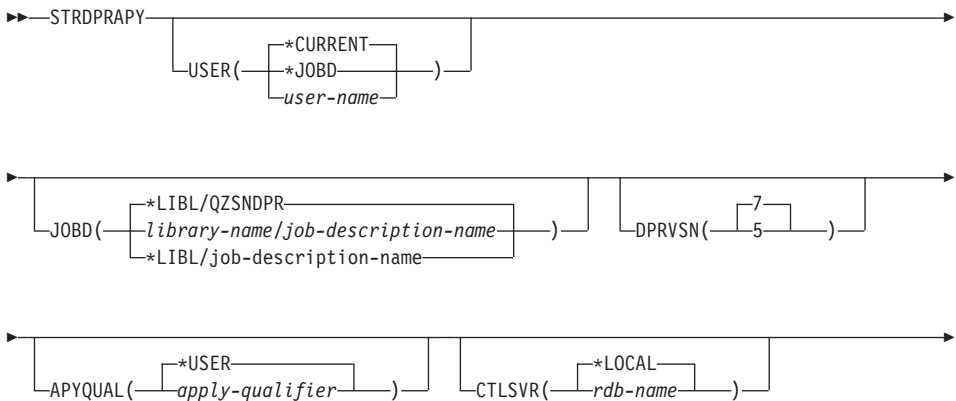
- The control tables have been created. If the tables do not exist, you can use the **CRTDPRCTL** command to create them. For information about the **CRTDPRCTL** command, see “Creating the replication control tables” on page 178.
- You have the proper authorization to run the Apply program. See “Granting authority” on page 181 for more information.
- At least one subscription set has been created and activated.
- All target tables have a primary key index. Differential refresh performance is significantly affected if the primary key index is removed for a subscription.

**Important:** The primary key index is built for you when you define a subscription set. Do not delete it accidentally.

- The Apply program package has been created.
- The Capture program is started on the source server before you start the Apply program for the first time. The Capture program updates the SYNCHTIME and SYNCHPOINT columns of the GLOBAL record in the register table before the Apply program is started. The Apply program assumes that if a GLOBAL record is present in the register table, the SYNCHTIME and SYNCHPOINT columns are not null.

## Starting Apply for AS/400

The Start DPR Apply (**STRDPRAPY**) command starts an instance of the Apply program on the local system. The Apply program continues running until you stop it or an unrecoverable error occurs.





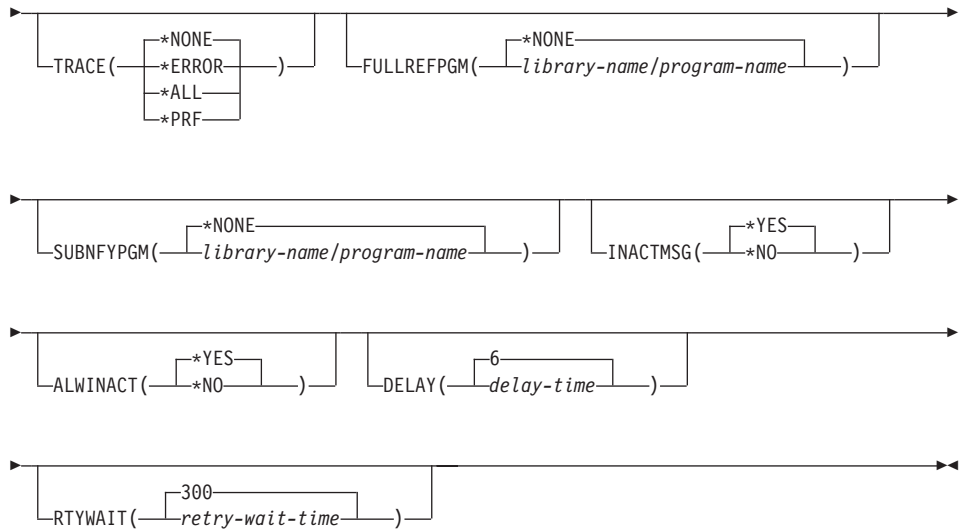


Table 22. STRDPRAPY command parameter definitions for AS/400

| Parameter   | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>USER</b> | <p>Specifies the name of the user ID for which the Apply program is started. When you run this command, you must be authorized (have *USE rights) to the specified user profile.</p> <p>The Apply program runs under the specified user profile. The control tables (in ASN) are located on the relational database specified with the CTLSVR parameter. The same control tables are used regardless of the value specified on the USER parameter.</p> <p><b>*CURRENT</b> (default)<br/>Specifies that the user ID associated with the current job is the user ID associated with this instance of the Apply program.</p> <p><b>*JOB</b><br/>Represents the user ID specified in the job description associated with this instance of the Apply program. The job description cannot specify USER(*RQD).</p> <p><i>user-name</i> (default)<br/>Specifies the user ID associated with this instance of the Apply program. The following IBM-supplied objects are <i>not</i> valid on this parameter: QDBSHR, QDFTOWN, QDOC, QLPAUTO, QLPINSTALL, QRJE, QSECOFR, QSPL, QSYS, or QTSTRQS.</p> <p>When prompting on the <b>STRDPRAPY</b> command, you can press the F4 key to see a list of users who defined subscriptions.</p> |

## STRDPRAPY

Table 22. STRDPRAPY command parameter definitions for AS/400 (continued)

| Parameter      | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>JOB</b>     | <p>Specifies the name of the job description to use when submitting the Apply program.</p> <p><b>*LIBL/QZSNDPR</b> (default)<br/>Specifies the default job description provided with DB2 DataPropagator for AS/400.</p> <p><i>library-name/job-description-name</i><br/>Represents the name of the job description used for the Apply program.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>DPRVSN</b>  | <p>Specifies the version of the Apply program to start.</p> <p>7 (default)<br/>Start Version 7 of the Apply program.</p> <p>5 Start Version 5 of the Apply program.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>APYQUAL</b> | <p>Specifies that an Apply qualifier be used by an Apply program instance. All subscriptions that are grouped together with this Apply qualifier will be run by this Apply program instance.</p> <p><b>*USER</b> (default)<br/>Specifies the user name on the USER parameter as the Apply qualifier.</p> <p><i>apply_qualifier</i><br/>Specifies the name used to group the subscriptions that are to be run by this Apply program instance. You can specify a maximum of 18 characters for the Apply qualifier name. This name follows the same naming conventions as an RDB name. The subscriptions to be run are identified by the records in the subscription set table with this value in the APPLY_QUAL column.</p> <p>When prompting on the STRDPRAPY command, you can press the F4 key to see a list of Apply qualifier names with existing subscriptions.</p> |

Table 22. STRDPRAPY command parameter definitions for AS/400 (continued)

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CTLSVR    | <p>Specifies the control server where the common control tables are located.</p> <p><b>*LOCAL</b> (default)<br/>Specifies that the subscription control tables are located on the local relational database.</p> <p><i>rdb-name</i><br/>Represents the name of the relational database where the control tables are located. You can use the Work with RDB Directory Entries (<b>WRKRDBDIRE</b>) command to find this name.</p> <p>When prompting on the <b>STRDPRAPY</b> command, you can press the F4 key to see a list of available RDB names.</p>                                                                                                                 |
| TRACE     | <p>Specifies whether the Apply program should generate a trace. If the Apply program generates a trace, the trace is output to a spool file called QPZSNATRC.</p> <p><b>*NONE</b> (default)<br/>Specifies that no trace is generated.</p> <p><b>*ERROR</b><br/>Specifies that the trace should contain information for errors only.</p> <p><b>*ALL</b><br/>Specifies that the trace should contain information for errors, execution flow, and SQL statements issued by the Apply program.</p> <p><b>*PRF</b><br/>Specifies that the trace should contain information that can be used to analyze performance at different stages of the Apply program execution.</p> |

Table 22. STRDPRAPY command parameter definitions for AS/400 (continued)

| Parameter         | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>FULLREFPGM</b> | <p>Specifies whether the Apply program should invoke an exit routine to initialize a target table. When the Apply program determines that a target table needs to be full-refreshed, it invokes the specified exit routine rather than doing the full refresh itself.</p> <p>When a full-refresh exit routine is used by the Apply program, the value of the ASNLOAD column in the Apply trail table is Y.</p> <p>For examples and more information, see “Refreshing target tables with the ASNLOAD exit routine for AS/400” on page 221.</p> <p><b>*NONE</b> (default)<br/>Specifies that a full-refresh exit routine is not used.</p> <p><i>library-name/program-name</i><br/>Represents the qualified name of the program that is called when the Apply program determines that it is necessary to do a full refresh of a target table. For example, to call program ASNLOAD in library DATAPROP, the qualified name is DATAPROP/ASNLOAD.</p> |
| <b>SUBNFYPGM</b>  | <p>Specifies whether the Apply program is to invoke an exit routine when it finishes processing a subscription set. Input to the exit routine consists of the set name, Apply qualifier, completion status, and statistics including the number of rejects.</p> <p>The notify program allows you to examine the UOW table to determine the transactions that have been rejected and then allows you to take further actions such as issuing a message or generating an event.</p> <p>For more information, see “Using the ASNDONE exit routine for AS/400” on page 220.</p> <p><b>*NONE</b> (default)<br/>Specifies that an exit routine is not used.</p> <p><i>library-name/program-name</i><br/>Represents the qualified name of the program to be called when the Apply program completes processing a subscription set. For example, to call program APPLYDONE in library DATAPROP, the qualified name is DATAPROP/APPLYDONE.</p>            |

Table 22. STRDPRAPY command parameter definitions for AS/400 (continued)

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| INACTMSG  | <p>Specifies whether the Apply program should generate a message whenever it completes its work and becomes inactive for a period of time.</p> <p><b>*NO</b> (default)<br/>Specifies that no message is generated.</p> <p><b>*YES</b><br/>Specifies that the Apply program generate message ASN1044 before beginning a period of inactivity. Message ASN1044 indicates how long the Apply program will be inactive.</p> |
| ALWINACT  | <p>Specifies whether the Apply program is able to run in an inactive state (sleep).</p> <p><b>*YES</b> (default)<br/>Specifies that the Apply program should sleep if there is nothing to process.</p> <p><b>*NO</b><br/>Specifies that if the Apply program has nothing to process, the job started for the Apply program should end.</p>                                                                              |
| DELAY     | <p>Specifies the delay time (in seconds) at the end of each Apply program cycle when continuous replication is used.</p> <p><b>6</b> Specifies a delay time of 6 seconds.</p> <p><b>delay-time</b><br/>Specifies a delay time between 0 and 6 seconds inclusive.</p>                                                                                                                                                    |
| RTYWAIT   | <p>Specifies in seconds how long the Apply program should wait after it encounters an error before it retries the operation that failed.</p> <p><b>300</b><br/>Specifies a retry wait time of 300 seconds.</p> <p><b>retry-wait-time</b><br/>Specifies a retry wait time between 0 and 35000000 seconds inclusive.</p>                                                                                                  |

You can set up the system to automatically start the subsystem by adding the command that is referred to in the QSTRUPPGM value on your system. If you will use the QDPR/QZSNDPR subsystem, it will be started as part of the STRDPRAPY command processing.

## STRDPRAPY

If the relational database (RDB) specified with the CTLSVR parameter is a DB2 UDB for AS/400 database, the tables on the server are found in the ASN library. If the RDB is not a DB2 UDB for AS/400 database, you can access the tables using ASN as the qualifier.

### **Error conditions when starting the Apply program**

The **STRDPRAPY** command issues an error message if any of the following conditions occur:

- If the user does not exist.
- If the user running the command is not authorized to the user profile specified on the command or the job description.
- If an instance of the Apply program is already active on the local system for this combination of Apply qualifier and control server.
- If the RDB name specified with the CTLSVR parameter is not in the relational database directory.
- If the control tables do not exist on the RDB specified with the CTLSVR parameter.
- If there are no subscriptions defined for the Apply qualifier specified with the APYQUAL parameter.

An Apply instance must be started for each unique Apply qualifier in every subscription set table. You can start multiple Apply processes by specifying a different Apply qualifier each time that you issue the **STRDPRAPY** command. These Apply processes will run under the same user profile.

### **Identifying Apply program jobs**

Each Apply process is identified using both the Apply qualifier and the control server names. When run, the job started for the Apply process does not have sufficient external attributes to correctly identify which Apply process is associated with a particular Apply qualifier and control server combination. Therefore, the job is identified in the following way:

- The job is started under the user profile associated with the USER parameter.
- The first 10 characters of the Apply qualifier are truncated and become the job name.
- DB2 DataPropagator for AS/400 maintains an Apply job control table named IBMSNAP\_APPLY\_JOB in the ASN library on the local system. The table maps the Apply qualifier/control server values to the correct Apply program job.
- You can view the job log. The Apply qualifier and control server names are used in the call to the Apply program.

In general, you can identify the correct Apply program job by looking at the list of jobs running in the QZSNDPR subsystem if both:

- The first 10 characters of the Apply qualifier name are unique.

- The Apply program is started for the local control server only.

### Scheduling Apply for AS/400

Use the **ADDJOBSCDE** command to start the Apply program at a specific time.

### Stopping Apply for AS/400

The End DPR Apply (**ENDDPRAPY**) command ends an instance of the Apply program on the local system.

You should end the Apply program before any planned system down time. You might also want to end the Apply program during periods of peak system activity.

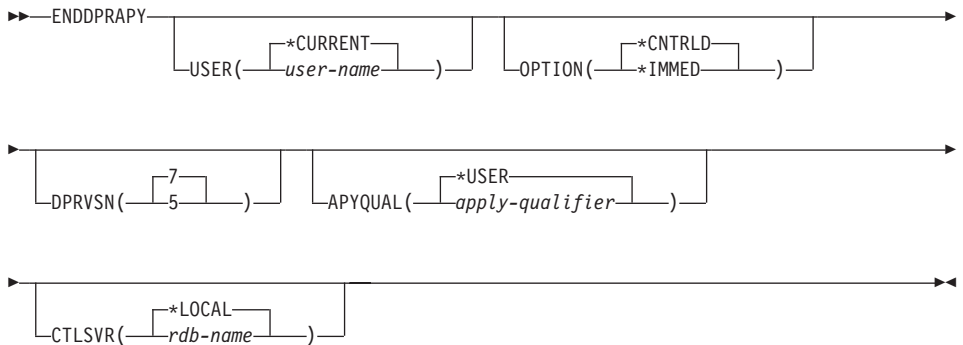


Table 23. ENDDPRAPY command parameter definitions for AS/400

| Parameter   | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>USER</b> | <p>This parameter is ignored unless the APYQUAL parameter has a value of *USER, in which case this is the Apply qualifier associated with the instance of Apply.</p> <p><b>*CURRENT</b> (default)<br/>Specifies the Apply process of the user associated with the current job.</p> <p><i>user-name</i><br/>Specifies the Apply process of the specified user.</p> <p>When prompting on the <b>ENDDPRAPY</b> command you can press the F4 key to see a list of users who defined subscriptions.</p> |

Table 23. ENDDRPAPY command parameter definitions for AS/400 (continued)

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OPTION    | <p>Specifies how to end the Apply process.</p> <p><b>*CNTRLD</b> (default)<br/>Specifies that the Apply process complete all of its tasks before ending. These tasks might take a considerable period of time if the Apply program is completing a subscription.</p> <p><b>*IMMED</b><br/>Specifies that the Apply program complete all of its tasks with the <b>ENDJOB OPTION(*IMMED)</b> command. The tasks end immediately, without any cleanup. Use this option only after a controlled end is unsuccessful, because it can cause undesirable results. (Unless the Apply program was asleep when you issued the <b>ENDDRPAPY</b> command, you should verify the target table contents.)</p> <p>If the Apply program was performing a full refresh to the target table, the target table might be empty as a result of ending the Apply program before the table was refreshed with the source table contents. If the target table is empty, you must force a full refresh for this replication target.</p> <p>You might find that a subscription is considered IN USE (the STATUS column in the subscription set table has a value of 1). If it is, reset the value to 0 or -1. This allows the subscription to be run again by the Apply program.</p> |
| DPRVSN    | <p>Specifies the version of the Apply program to end.</p> <p>7 (default)<br/>Specifies Version 7 of the Apply program.</p> <p>5<br/>Specifies Version 5 of the Apply program.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |



Table 23. ENDDRPAPY command parameter definitions for AS/400 (continued)

| Parameter | Definition and prompts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| APYQUAL   | <p>Specifies the Apply qualifier used by an instance of the Apply program. All subscriptions that are grouped together with this Apply qualifier are run by the instance.</p> <p><b>*USER</b> (default)<br/>Specifies that the user name specified on the USER parameter is the Apply qualifier.</p> <p><i>apply_qualifier</i><br/>Specifies the name used to group the subscriptions that this Apply instance runs. You can specify a maximum of 18 characters for the Apply qualifier name. This name follows the same naming conventions as an RDB name. You identify the subscriptions being run by the records in the subscription set table with this value in the APPLY_QUAL column.</p> <p>When prompting on the ENDDRPAPY command, you can press the F4 key to see a list of Apply qualifier names with existing subscriptions.</p> |
| CTLSVR    | <p>Specifies the name of the relational database where the Version 7 control tables are located.</p> <p><b>*LOCAL</b> (default)<br/>Specifies that the control tables are located on the local relational database.</p> <p><i>rdb-name</i><br/>Specifies that the subscription control tables are located on this relational database. You can use the Work with RDB Directory Entries (WRKRDBDIRE) command to find this name.</p> <p>When prompting on the ENDDRPAPY command, you can press the F4 key to choose from the list of databases in the RDB directory.</p>                                                                                                                                                                                                                                                                       |

The ENDDRPAPY command uses the value of the APYQUAL and CTLSVR parameters to search the Apply job table for the job name, job number, and job user for the referenced Apply program, and ends that job.

ENDDRPAPY issues an error message if the following conditions occur:

- If the Apply job table does not exist or is corrupted.
- If there is no record in the Apply job table for the Apply qualifier and control server name.
- If the Apply job already ended.

- If the user ID running the command is not authorized to end the Apply job.

---

### Additional Apply program operations

This section provides information about performing two additional Apply program functions: using the ASNDONE exit routine and refreshing target tables with the ASNLOAD exit routine.

#### Using the ASNDONE exit routine for AS/400

The ASNDONE exit routine is a program that the Apply program can optionally call after subscription processing completes, regardless of success or failure. A separate subscription notify program can be provided for each Apply qualifier. For general information about the ASNDONE exit routine, see “Using the ASNDONE exit routine” on page 132.

This section provides information about customizing the ASNDONE routine for an AS/400 environment.

When creating your subscription notify program, consider these activation group concerns:

*If the program is created to run with a new activation group:* the Apply program and the subscription notify program will not share SQL resources, such as RDB connections and open cursors. The activation handling code in the AS/400 operating system frees any resources allocated by the subscription notify program before control is returned to the Apply program. Additional resource is used every time that the Apply program calls the subscription notify program.

*If the program is created to run in the caller’s activation group:* it shares SQL resources with the Apply program. Design the program so that you minimize its impact on the Apply program. For example, the program might cause unexpected Apply program processing if it changes the current relational database (RDB) connection.

*If the program is created to run in a named activation group:* it does not share resources with the Apply program. Using a named activation group will avoid the activation group overhead every time the subscription notify program is called. Run time data structures and SQL resources can be shared between invocations. Application cleanup processing is not performed until the Apply program is ended, so the subscription notify program must be designed to ensure that it does not cause lock contention with the Apply program by leaving source tables, target tables, or control tables locked when control is returned to the Apply program.

When you start the Apply program, specify the name of the subscription notify program using the parameter SUBNFYPGM on the **STRDPRAPY** command. For example, if the program is named ASNDONE\_1 and resides in library APPLIB, use the command:

```
SUBNFYPGM(APPLIB/ASNDONE_1).
```

### Refreshing target tables with the ASNLOAD exit routine for AS/400

The ASNLOAD full-refresh exit routine is called by the Apply program:

- When it determines that a full refresh of a target table is necessary.
- If you specify the name of a full refresh program on the FULLREFPGM parameter when you start the Apply program.

When a full refresh of a subscription set is necessary, the Apply program calls the exit routine. The program then performs a full refresh of the target table (if necessary), or of each target table listed in the subscription set.

You can use an exit routine instead of the Apply program to perform a full refresh more efficiently. For example, if you are copying every row and every column from a source table to a target table, you can design a full-refresh exit routine that uses a Distributed Data Management (DDM) file and the Copy File (**CPYF**) CL command to copy the entire file from the source table to the target table.

If the exit routine returns a non-zero return code, the current subscription set being processed by the Apply program fails. Processing of the remainder of the subscription set is discontinued until the next iteration.

#### Guidelines for using ASNLOAD

The source for sample exit routines is included with DB2 DataPropagator for AS/400. The samples for the C, COBOL, and RPG languages are:

| Compiler language | Library name | Source file name | Member name |
|-------------------|--------------|------------------|-------------|
| C                 | QDPR         | QCSRC            | ASNLOAD     |
| COBOL             | QDPR         | QCBLLSRC         | ASNLOAD     |
| RPG               | QDPR         | QRPGLESRC        | ASNLOAD     |

You cannot direct the Apply program to use another program unless you end the Apply program and start it again with another **STRDPRAPY** command.

If you plan to use ASNLOAD, be aware of the following items:

- To avoid interference with the Apply program, compile the exit routine so that it uses a new activation group (not the caller's activation group).
- The exit routine should perform a COMMIT operation.

- The system calls the exit routine to perform a full refresh of each target table associated with the subscription set. You can either:
  - Design the program to distinguish between the different target tables and subscription sets.
  - Associate a single subscription set with a single member to one Apply qualifier.
- You can compile the exit routine with a named activation group or with a new activation group. To get better performance, use a named activation group. With a named activation group, the exit routine must commit or roll back changes as needed. The Apply program will not cause changes to be committed or rolled back (unless it ends).

The exit routine should either explicitly commit changes, or it should be compiled to implicitly commit changes when it completes. Any uncommitted changes when the exit routine completes are not committed until either:

- The Apply program calls another exit routine with the same activation group.
- The job started for the Apply program ends.

## **Required parameters for ASNLOAD**

### **Return code**

Specifies whether the exit routine was successful, indicated by a return code of 0. If the return code is not 0, the Apply program produces an error. If trace is on, the Apply program produces trace output.

### **Reason code**

Specifies a value that can be used to further describe the exit routine failure. If the return code is not 0 and if trace is on, the Apply program includes the reason code information as part of the trace output. The values for the reason code should be specific to your user application.

### **Control server RDB name**

Specifies the RDB name of the database where the subscription set tables are located. The name is padded with blanks.

### **Target server relational database (RDB) name**

Specifies the name of the database where the target table is located. The name is padded with blanks.

### **Target table library**

Specifies the name of the library that contains the target table. If the target server RDB name is not an AS/400 database, this parameter is the authorization ID of the target table, which is obtained from the TARGET\_OWNER column of the row of the subscription member table that is currently processed by the Apply program. The name is padded with blanks.

**Target table name**

Specifies the name of the target table, which is obtained from the TARGET\_TABLE column of the row in the subscription-targets-member table that is currently processed by the Apply program. If the target server is a database for AS/400, the name can be either an SQL table name or an AS/400 system file name. The name is padded with blanks.

**Apply qualifier**

Specifies the qualifier used to start this instance of the Apply program. This value is obtained from the APPLY\_QUAL column of the row in the subscription set table that is currently processed by the Apply program. The name is padded with blanks.

**Subscription set name**

Specifies the name of the subscription set that the Apply program has just completed. This value is obtained from the SET\_NAME column of the row in the subscription set table that is currently processed by the Apply program. The name is padded with blanks.

**Source server RDB name**

Specifies the RDB name of the database where the source table is located. The name is padded with blanks.

**SQL SELECT statement**

Specifies a variable-length SQL statement that you can use to select the source table rows and columns to be copied to the target table. The following table shows the structure of the SQL SELECT statement.

| Offset (Hex or Decimal) | Type      | Field                |
|-------------------------|-----------|----------------------|
| 0                       | BINARY(4) | SQL statement length |
| 4                       | Char(*)   | SQL select statement |

**Trace indicator**

Specifies whether the Apply program generates trace data. The exit routine can use the trace indicator to coordinate its internal trace with the Apply trace.

When the Apply program generates a trace, it prints to a spool file. If the exit routine is running in a separate activation group, the results print to a separate spool file. If the exit routine runs in the caller's activation group, the results print to the same spool file as the Apply trace.

The values for trace indicator are:

**YES**

Trace data is being produced.

**NO**

No trace data is being produced.

**Other**

No trace data is being produced.

---

## Chapter 10. Capture and Apply for OS/390

This chapter describes how to set up and operate the Capture and Apply programs for OS/390. It also contains information specific to replicating DB2 for OS/390 data:

- “Rules for index types” on page 234
- “Using the DB2 ODBC Catalog” on page 235

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### Setting up the Capture and Apply programs

Setting up consists of applying DB2 maintenance; installing the Capture and Apply programs and configuring the source, target, and control servers; and configuring Capture and Apply after you install a new release of DB2.

#### Applying DB2 maintenance

Make sure to apply the correct DB2 maintenance before installing the Capture and Apply for OS/390 programs. To apply the correct DB2 maintenance:

1. Install the maintenance listed in the Service Level Information section of the *DB2 UDB for OS/390 V7 Program Directory* and review the Preventive Service Planning (PSP) buckets before installing Capture or Apply.
2. Install the maintenance listed in the PSP buckets for Capture and for Apply. Refer to the Preventive Service Planning section of the Program Directory.

#### Installing Capture and Apply for OS/390

Capture for OS/390 and Apply for OS/390 are packaged in SMP/E format. The installation sequence for each program consists of:

1. Customizing invocation JCL to suit your environment
2. Using SMP/E to install
3. Providing APF authorization
4. Creating and loading the VSAM messages file
5. Binding to the DB2 subsystem and target or control subsystems that the DB2 subsystem will connect to

See the *DB2 Universal Database for OS/390 Version 7 Program Directory* for complete installation instructions for the Capture and Apply programs.

## Configuring Capture and Apply for OS/390 after installing a new release of DB2

Capture and Apply load modules for OS/390 are automatically link-edited by SMP/E using the DB2 DSN###.SDSNLOAD library specified for your DB2 release. The sample jobs ASNLDEF (Capture) and ASNADEF (Apply) are used during install to define data sets to your SMP/E system. There is one load module per program for each release of DB2, with the suffix representing the DB2 release:

| DB2 release | Capture load module | Apply load module |
|-------------|---------------------|-------------------|
| Version 5.1 | ASNLRP75            | ASNAPV75          |
| Version 6.1 | ASNLRP76            | ASNAPV76          |
| Version 7.1 | ASNLRP77            | ASNAPV77          |

To set up your SMP/E DDDEF entries during installation (in 2 on page 225), refer to the Capture sample library SASNLBSE(ASNLDEF) and the Apply sample library SASNABSE(ASNADEF).

When you installed the Capture or Apply program, each DDDEF entry was set up to point to a corresponding DB2 DSN###.SDSNLOAD library, where ### referred to the product release (710 for Version 7.1, 610 for Version 6.1, and 510 for Version 5.1). If any of the related releases of DB2 were not installed, then the DDDEF entries were set up with the DB2 SDSNLOAD library for "DDDEF(SDSNLD##)" to point to the highest installed level of DB2. For example, if DB2 5.1 was not installed, then DDDEF entries were set up with DDDEF(SDSNLD51) to point to the DSN710.SDSNLOAD library so that SMP/E link-edit will complete with return code 4. Also, the Capture load module ASNLRP75 in run job ASNL2RN5 or the Apply load module ASNAPV75 in run job ASNA2RN5 cannot be executed.

If you install a new release of DB2 after installing the Capture or Apply program:

1. Use the Capture sample DDDEF job SASNLBSE(ASNLDEF), Apply sample DDDEF job SASNABSE(ASNADEF), or both, to change the DB2 DSN###.SDSNLOAD library data set for DDDEF(SDSNLD##) to the new installed level of DB2. Note that SDSNLD## refers to the new DB2 release (51, 61, 71 ) and DSN###.SDSNLOAD refers to the new DB2 release (510, 610, or 710).
2. Run an SMP/E APPLY job to reapply any recent Capture V7 PTF, any recent Apply V7 PTF, or both, using the SMP/E REDO operand.



---

## Operating Capture for OS/390

An administrator can use the commands in this section to perform the following Capture for OS/390 tasks:

- Starting the Capture program
- Scheduling the Capture program
- Stopping the Capture program
- Suspending the Capture program
- Resuming the Capture program
- Reinitializing the Capture program
- Pruning the change data and unit-of-work tables
- Displaying captured log progress

You can submit the commands from TSO or the MVS console.

This section also lists restrictions for running the Capture program.

### Restrictions for running the Capture program

Capture for OS/390 cannot replicate certain types of data. See “General restrictions for replication” on page 77 for a list of restrictions.

Only one instance of the Capture program can run on a subsystem. In a data-sharing environment, only one of any member subsystems in a data-sharing group can run the Capture program. In a data-sharing environment, DB2 presents merged log records from all member subsystems.

### Starting Capture for OS/390

After you start the Capture program, it runs continuously until you stop it or it detects an unrecoverable error. You can start it either with JCL or as a system started task.

#### *To start the Capture for OS/390 program with JCL:*

1. Prepare the JCL for OS/390 by specifying the appropriate optional invocation parameters in the PARM field of the Capture job. Customize the JCL in library SASNLJCL(ASNL2RN#) to meet your site’s requirements.

An example of this line in the invocation JCL is:

```
//ASNL2RNx EXEC PGM=ASNLRPnn,PARM='DB2_subsystem_name NOTERM WARMNS SLEEP=2'
```

where *x* and *nn* indicate the level of the Capture program, as follows:

- For the Capture program running on DB2 for OS/390 Version 5 Release 1, *x* is 5 and *nn* is 75.
- For the Capture program running on DB2 for OS/390 Version 6, *x* is 6 and *nn* is 76.

- For the Capture program running on DB2 for OS/390 Version 7, *x* is 7 and *nn* is 77.
2. Submit the JCL from TSO or from the MVS console. Capture for OS/390 can run either as a batch job or a started task.

**To start the Capture for OS/390 program as a system-started task:**

1. Create a procedure (*procname*) in your PROCLIB. This procedure contains the JCL (for example ASNL2RN5, ASNL2RN6, or ASNL2RN7 in library SASNLJCL) required to run the Capture program.
2. Update module ICHRIN03 (RACF), which associates *procname* with the user ID to be used to start the Capture program. Make sure that the necessary DB2 authorization is granted to this user ID before you start the Capture program.
3. Build this module in SYS1.LPALIB. You must re-IPL the MVS system to activate these changes.
4. From the MVS system console, run the command **start** *procname*.

Table 24 defines the invocation parameters.

*Table 24. Capture invocation parameter definitions for OS/390*

| Parameter                 | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>DB2_subsystem_name</i> | Specifies the name of the DB2 subsystem that can connect to the control server. The default for the subsystem name is DSN. This parameter must be the first parameter.<br><br>For data sharing, do not use the group attach name. Instead, specify a member subsystem name.                                                                                                                                                                                                                              |
| <b>TERM</b> (default)     | Terminates the Capture program if DB2 is terminated.                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>NOTERM</b>             | Keeps the Capture program running if DB2 is terminated with MODE(QUIESCE). When DB2 initializes, the Capture program starts in WARM mode and begins capturing where it left off when DB2 terminated.<br><br>If DB2 terminates via FORCE or due to abnormal termination, the Capture program terminates even if you selected this parameter.<br><br>If you use the NOTERM option and start DB2 with restricted access (ACCESS MAINT), the Capture program will not be able to connect and will terminate. |
| <b>WARM</b> (default)     | The Capture program resumes processing where it ended in its previous run if warm start information is available. If the Capture program cannot warm start, it switches to a cold start.                                                                                                                                                                                                                                                                                                                 |

Table 24. Capture invocation parameter definitions for OS/390 (continued)

| Parameter                | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>WARMNS</b>            | The Capture program resumes processing where it ended in its previous run if warm start information is available. Otherwise, it issues a message and terminates. With <b>WARMNS</b> , the Capture program does not automatically switch to a cold start. The Capture program leaves the trace, UOW, CD, and warm start tables intact. In case of errors, the Capture program terminates instead of switching to a cold start as when <b>WARM</b> is specified. |
| <b>COLD</b>              | The Capture program starts up by deleting all rows in its CD table, UOW table, and trace table during initialization. All subscriptions to these replication sources will be fully refreshed during the next Apply processing cycle. A full refresh is not done if the target is a noncomplete CCD table (see "Resolving gaps between source and target tables" on page 147).                                                                                  |
| <b>PRUNE</b> (default)   | The Capture program automatically prunes the rows in the CD and UOW tables that the Apply program copied at the interval specified in the tuning parameters table. The Capture program also prunes the CD and UOW rows that are older than the retention limit, even though they have not been copied during warm start.                                                                                                                                       |
| <b>NOPRUNE</b>           | Automatic pruning is disabled. The Capture program prunes the CD and UOW tables only when you enter the <b>PRUNE</b> command.                                                                                                                                                                                                                                                                                                                                  |
| <b>NOTRACE</b> (default) | No trace information is written.                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>TRACE</b>             | Writes trace messages to the standard output, SYSPRINT.                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>SLEEP=<i>n</i></b>    | Specifies the number of seconds that the Capture program will wait when it finishes processing the active log, where <i>n</i> is the number of seconds. This parameter is available for the Capture program running on DB2 for MVS Version 4 Release 1 and later with data sharing. The default is <b>SLEEP=0</b> .                                                                                                                                            |
| <b>ALLCHG</b> (default)  | Specifies that an entry is made to the CD table whenever any source table row changes.                                                                                                                                                                                                                                                                                                                                                                         |
| <b>CHGONLY</b>           | Specifies that an entry is made to the CD table when a source table row changes only if the columns defined for replication (CD table columns) change values.                                                                                                                                                                                                                                                                                                  |

## Scheduling Capture for OS/390

Use either the **\$TA JES2** command or the **AT NetView** command to start Capture for OS/390 at a specific time. You must:

1. Create a procedure that calls Capture for OS/390 in the PROCLIB.

2. Modify the ICHRIN03 RACF module (or appropriate definitions for your MVS security package) to associate the procedure with a user ID.
3. Link-edit the module in SYS1.LPALIB.

### Stopping Capture for OS/390

Use the **STOP** command to stop the Capture program gracefully and commit the log records that it processed up to that point. (See *MVS System Commands* for details.)

```
►►F—jobname—,STOP—►►
```

Issue the **STOP** command before:

- Removing an existing replication source
- Opening and modifying an existing replication source
- Shutting down the database

### Suspending Capture for OS/390

Use the **SUSPEND** command to relinquish OS/390 resources to operational transactions during peak periods without destroying the Capture program environment. This command suspends the Capture program until you issue the **RESUME** command.

```
►►F—jobname—,SUSPEND—►►
```

**Important:** Do not use **SUSPEND** when canceling a replication source. Instead, stop the Capture program by entering the **STOP** command.

### Resuming Capture for OS/390

Use the **RESUME** command to resume the suspended Capture program.

```
►►F—jobname—,RESUME—►►
```

### Reinitializing Capture for OS/390

Use the **REINIT** command to begin to capture changes from new source tables if you add a new replication source. The **REINIT** command tells the Capture program to obtain newly added replication sources from the register table.

**REINIT** also rereads the tuning parameters table for any changes made to the tuning parameters.

▶▶—F—*jobname*—,REINIT—▶▶

**Important:** Do not use the **REINIT** command to reinitialize the Capture program after canceling a replication source or dropping a replication source table while the Capture program is running. Instead, stop the Capture program and start it again using the **WARM** or **WARMNS** option.

Before you add a column to a replication source or CD table using the **ALTER TABLE** statement, you must ensure that the Capture program has captured all the changes for the table. After the **ALTER TABLE** statement, you must issue the **REINIT** command.

### Pruning the change data and unit-of-work tables

Use the **PRUNE** command to start pruning the CD and UOW tables.

This command prunes tables once.

▶▶—F—*jobname*—,PRUNE—▶▶

The Capture program issues the message ASN0124I when the command is successfully queued.

If you stop or suspend the Capture program during pruning, you must enter the **PRUNE** command again to resume pruning. Pruning does not resume after you enter the **RESUME** command.

### Displaying captured log progress

Use the **GETLSEQ** command to get the timestamp and current log sequence number. You can use this information to determine how far the Capture program has read the DB2 log.

▶▶—F—*jobname*—,GETLSEQ—▶▶

The Capture program issues the message ASN0125I indicating when the current log sequence number is successfully processed.

---

## Operating Apply for OS/390

An administrator can use the commands in the following sections to perform the following Apply for OS/390 tasks:

- Starting the Apply program
- Scheduling the Apply program

- Stopping the Apply program

You can submit the commands from TSO or an MVS console.

## Starting Apply for OS/390

After you start the Apply program, it runs continuously until:

- You stop it in an orderly way.
- You cancel it.
- An unexpected error or failure occurs.

### *To start the Apply for OS/390 program:*

Prepare the JCL for OS/390 by specifying the appropriate invocation parameters in the PARM field of the Apply job. Customize the JCL to meet your site's requirements. Invocation JCL in library SASNAJCL(ASNA2RN#) is included with the Apply for OS/390 product.

An example of this line in the invocation JCL is:

```
//ASNAJCL EXEC PGM=ASNAJCL,PARM='Apply_qual DB2_subsystem_name DISK'
```

Where *nn* is the level the Apply program, as follows:

- For the Apply program running on DB2 for OS/390 Version 5 Release 1, *nn* is 75.
- For the Apply program running on DB2 for OS/390 Version 6, *nn* is 76.
- For the Apply program running on DB2 for OS/390 Version 7, *nn* is 77.

Table 25 defines the invocation parameters.

*Table 25. Apply invocation parameter definitions*

| Parameter                  | Definition                                                                                                                                                                                                                                               |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Apply_qual</i>          | Specifies the Apply qualifier that the Apply instance uses to identify the subscription sets to be served. The Apply qualifier is case sensitive and must match the value of APPLY_QUAL in the subscription set table. This must be the first parameter. |
| <i>DB2_subsystem_name</i>  | Specifies the name of the DB2 subsystem that can connect to the control server. This parameter must be the second parameter.<br><br>For data sharing, do not use the group attach name. Instead, specify a member subsystem name.                        |
| <i>Control_server_name</i> | Specifies the name of the server where the replication control tables will reside. If you do not specify this parameter, the default is the current server.                                                                                              |

Table 25. Apply invocation parameter definitions (continued)

| Parameter                  | Definition                                                                                                                                                                                                                             |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>LOADXit</b>             | Specifies that the Apply program is to invoke ASNLOAD, an IBM-supplied exit routine that uses the export and load utilities to refresh target tables. Currently, no utility program is available for use by ASNLOAD on DB2 for OS/390. |
| <b>NOLOADXit</b> (default) | Specifies that the Apply program will not invoke ASNLOAD.                                                                                                                                                                              |
| <b>MEMory</b> (default)    | Specifies that a memory file stores the fetched answer set. The Apply program fails if there is insufficient memory for the answer set.                                                                                                |
| <b>DISK</b>                | Specifies that a disk file stores the fetched answer set.                                                                                                                                                                              |
| <b>INAMsg</b> (default)    | Specifies that the Apply program is to issue a message when the Apply program is inactive.                                                                                                                                             |
| <b>NOINAMsg</b>            | Specifies that the Apply program will not issue this message.                                                                                                                                                                          |
| <b>NOTRC</b> (default)     | Specifies that the Apply program does not generate a trace.                                                                                                                                                                            |
| <b>TRCERR</b>              | Specifies that the Apply program generates a trace that contains only error information.                                                                                                                                               |
| <b>TRCFLOW</b>             | Specifies that the Apply program generates a trace that contains error and execution flow information.                                                                                                                                 |
| <b>NOTIFY</b>              | Specifies that the Apply program is to invoke ASNDONE, an exit routine that returns control to the user when the Apply program finishes copying a subscription set.                                                                    |
| <b>NONOTIFY</b> (default)  | Specifies that the Apply program will not invoke ASNDONE.                                                                                                                                                                              |
| <b>SLEEP</b> (default)     | Specifies that the Apply program is to go to sleep if no new subscriptions are eligible for processing.                                                                                                                                |
| <b>NOSLEEP</b>             | Specifies that the Apply program is to stop if no new subscription sets are eligible for processing.                                                                                                                                   |
| <b>DELAY</b> ( <i>n</i> )  | Specifies the delay time (in seconds) at the end of each Apply cycle when continuous replication is used, where <i>n</i> =0, 1, 2, 3, 4, 5, or 6. The default delay time is 6 seconds.                                                 |

Table 25. Apply invocation parameter definitions (continued)

| Parameter           | Definition                                                                                                                                                                                                                                                                                                                                                  |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ERRWAIT( <i>n</i> ) | Specifies the number of seconds that the Apply program waits before retrying after it encounters an error condition, where <i>n</i> is the number of seconds. Do not specify too small a number because the Apply program will run almost continuously and generate many rows in the Apply trail table. The default wait period is 300 seconds (5 minutes). |

## Scheduling Apply for OS/390

Use either the **\$TA JES2** command or the **AT NetView** command to start Apply for OS/390 at a specific time. You must:

1. Create a procedure that calls Apply for OS/390 in the PROCLIB.
2. Modify the ICHRIN03 RACF module (or appropriate definitions for your MVS security package) to associate the procedure with a user ID.
3. Link-edit the module in SYS1.LPALIB.

See *MVS/ESA JES2 Commands* for more information about using the **\$TA JES2** command, and the *NetView for MVS Command Reference* for more information about using the **AT NetView** command.

## Stopping Apply for OS/390

Enter the following MVS STOP command to stop the Apply for OS/390 program:

```
▶▶—P—jobname————▶▶
```

---

## Rules for index types

You can avoid deadlock and timeout problems in your applications if you specify TYPE 2 indexes, because TYPE 2 indexes do not lock index pages. TYPE 2 indexes also enable you to use other functions, such as parallel-query central processor (CP) processing, improved partition independence, row locking, and the ability to read through locks. If you specify TYPE 2 indexes, all specifications of SUBPAGES are ignored, and an error message is issued.

If you do not specify an index type, the index type is determined as follows:

- If the LOCKSIZE is ROW, the default index type is TYPE 2, regardless of the type specified on the installation panel DSNTIPE.
- If the LOCKSIZE is not ROW, the default index type is the type specified in the field DEFAULT INDEX TYPE on the installation panel DSNTIPE. The default value for that field is TYPE 2.



### Recommendations:

- Specify TYPE 2 as the index type for all table indexes. For best performance, bind the Capture program and the Apply packages using isolation UR. When you specify isolation UR, all indexes on the control tables must be TYPE 2 indexes. If source views are being used in subscription sets, and the Apply package is bound using isolation UR, only TYPE 2 indexes over the source tables involved in the source view can be used by the Apply program.
- For DB2 for OS/390 source servers, specify TYPE 2 on every generated CREATE INDEX statement and every CREATE INDEX statement in the DB2 Control Center file DPCNTL.MVS. (DRJA creates TYPE2 indexes automatically.)

---

## Using the DB2 ODBC Catalog

The DB2 ODBC Catalog is designed to improve the performance of ODBC applications. The tables in the DB2 ODBC Catalog are prejoined and indexed to support faster catalog access for ODBC applications. IBM's ODBC driver also supports multiple views of the DB2 ODBC Catalog.

Support for use of the DB2 ODBC Catalog is provided by DB2 DataPropagator Version 5 and later. For information about Version 5 level support, see the *IBM Replication Guide and Reference V5*. Enhancements to the DB2 ODBC Catalog for DB2 DataPropagator Version 6 include:

- Support for the SYSIBM.SYSROUTINES table
- Support for the SQLProcedureColumns ODBC function call

You can eliminate data currency problems by using the DB2 ODBC Catalog tables. DB2 DataPropagator for OS/390 Version 6 can keep data in the DB2 ODBC Catalog synchronized with the contents of the real DB2 catalog table. The Capture program identifies log records that represent changes to the DB2 catalog and records these changed data records in a staging table. The Apply program replicates the changed data records to the DB2 ODBC Catalog tables.

This section describes how to implement the DB2 ODBC Catalog using the automatic mode. The automatic mode automatically replicates any DB2 Catalog changes to the DB2 ODBC Catalog tables.

### Setting up the DB2 ODBC Catalog

The following section provides setup instructions needed to prepare your client and server to run your ODBC queries.

#### Setting up the workstation client

To use the entire DB2 ODBC Catalog, add the entry CLISCHEMA=CLISCHEM to the DB2CLI.INI file. To use your own set of views rather than the entire DB2

ODBC Catalog, add the entry CLISCHEMA=MYSHEMA to the DB2CLI.INI file. The following example contains both statements.

```
[tstcli1x]
uid=userid
pwd=password
autocommit=0
TableType="'TABLE','VIEW','SYSTEM TABLE'"

[tstcli2x]
    Assuming dbalias2 is a database in DB2 for MVS
SchemaList="'OWNER1','OWNER2','CURRENT SQLID'"

[MyVeryLongDBALIASName]
dbalias=dbalias3
SysSchema=MYSHEMA

[RBD2205]
AUTOCOMMIT=1
LOBMAXCOLUMNSIZE=33554431
LONGDATACOMPAT=1
PWD=USRT006
UID=USRT006
DBALIAS=RBD2205
CLISCHEMA=CLISCHEM

[RBD2206]
AUTOCOMMIT=1
LOBMAXCOLUMNSIZE=33554431
LONGDATACOMPAT=1
PWD=USRT006
UID=USRT006
DBALIAS=RBD2206
CLISCHEMA=MYSHEMA
```

You must define views for all the DB2 ODBC Catalog tables when you use your own schema. See Table 26 on page 237 for the list of the DB2 ODBC Catalog tables for which you must define a view. Use the following VIEW MYSCHEMA statement to define the DB2 ODBC Catalog views on CLISCHEM.*table\_name* ODBC tables.

```
CREATE VIEW MYSCHEMA.table_name FROM CLISCHEM.table_name
  where TABLE_SCHEM=MYUSER
```

Where *table\_name* is one of DB2 ODBC Catalog table names.

### Setting up the server

To set up the server, define the following control information for replication:

1. Create the DB2 DataPropagator for OS/390 control tables, if they do not already exist.
  - a. Review the header portion of the ASNL2CN6.SQL file and customize the table spaces according to your site requirements.

- b. Connect to the OS/390 RDB that contains the catalog from which you want to create a new DB2 ODBC Catalog.
  - c. Run the ASNL2CN6.SQL file from either the client or the OS/390 server.
2. Create the source, subscription control, and table space information for the DB2 ODBC Catalog.
    - a. Review the header portion of the ASNL2SY6.SQL, ASNL2RE6.SQL, and ASNL2SU6.SQL files and customize the table spaces according to your site requirements.
    - b. Replace all occurrences of SRCE in the ASNL2SU6.SQL file with the OS/390 RDB name. You can also define additional views on the predefined subscriptions to further qualify the subscriptions.
    - c. Connect to the OS/390 RDB that contains the catalog from which you want to create a new DB2 ODBC Catalog.
    - d. Run the ASNL2SY6.SQL, ASNL2RE6.SQL, and ASNL2SU6.SQL files from either the client or the OS/390 server.
  3. Start the Capture and Apply programs on OS/390. Starting the Capture and Apply programs populates the ODBC Catalog on OS/390.

### DB2 ODBC Catalog tables

Table 26 lists the ODBC function calls that are supported by the DB2 ODBC Catalog and explains how the function calls are implemented by DB2 Universal Database for OS/390 Version 7.

*Table 26. ODBC function calls*

| ODBC function call  | ODBC catalog tables                                                                                                                                                                                      |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SQLColumns          | The SELECT command is issued against preformatted data stored in CLISCHEM.COLUMNNS.<br><br>This call is implemented using the source table SYSIBM.SYSCOLUMNS.                                            |
| SQLColumnPrivileges | The SELECT command is issued against prejoined data stored in CLISCHEM.COLUMNPRIVILEGES.<br><br>This call is implemented with source tables SYSIBM.SYSCOLUMNS, SYSIBM.SYSTABAUTH, and SYSIBM.SYSCOLAUTH. |
| SQLForeignKeys      | The SELECT command is issued against prejoined data stored in CLISCHEM.FOREIGNKEYS.<br><br>This call is implemented with source tables SYSIBM.SYSRELS, SYSIBM.SYSFOREIGNKEYS, and SYSIBM.SYSCOLUMNS.     |
| SQLPrimaryKeys      | The SELECT command is issued against the primary keys stored in CLISCHEM.PRIMARYKEYS.<br><br>This call is implemented with the source table SYSIBM.SYSCOLUMNS.                                           |

Table 26. ODBC function calls (continued)

| ODBC function call  | ODBC catalog tables                                                                                                                                                                                            |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SQLProcedures       | <p>The SELECT command is issued against CLISCHEM.PROCEDURES, which contains only the columns required by the SQLProcedures function.</p> <p>This call is implemented with source table SYSIBM.SYSROUTINES.</p> |
| SQLSpecialColumns   | <p>The SELECT command is issued against prejoined data stored in CLISCHEM.SPECIALCOLUMNS.</p> <p>This call is implemented with source tables SYSIBM.SYSCOLUMNS, SYSIBM.SYSKEYS, and SYSIBM.SYSINDEXES.</p>     |
| SQLTablesPrivileges | <p>The SELECT command is issued against CLISCHEM.TABLEPRIVILEGES.</p> <p>This call is implemented with source table SYSIBM.SYSTABAUTH.</p>                                                                     |
| SQLTables           | <p>The SELECT command is issued against prejoined data stored in CLISCHEM.TABLES.</p> <p>This call is implemented with source table SYSIBM.SYSTABLES.</p>                                                      |
| SQLStatistics       | <p>The SELECT command is issued against prejoined data stored in CLISCHEM.TSTATISTICS.</p> <p>This call is implemented with source tables SYSIBM.SYSTABLES, SYSIBM.SYSINDEXES, and SYSIBM.SYSKEYS.</p>         |
| SQLProcedureColumns | <p>The SELECT command is issued against prejoined data stored in CLISCHEM.PROCEDURECOLUMNS.</p> <p>This call is implemented with source tables SYSIBM.SYSROUTINES and SYSIBM.SYSPARMS.</p>                     |

---

## Chapter 11. Capture and Apply for UNIX platforms

This chapter describes how to set up and operate the Capture and Apply programs on the following UNIX platforms:

- AIX
- HP-UX
- Linux
- NUMA-Q
- Solaris

Be sure to read the following sections before reading the sections on operating the Capture and Apply programs:

- “User ID requirements for running the Capture and Apply programs”
- “Setting up the Capture and Apply programs”

---

### User ID requirements for running the Capture and Apply programs

Before you set up the Capture and Apply programs, you must set up a UNIX user account to run the programs. Ensure that the user ID under which the Capture and Apply programs will run has the required privileges:

- Execute privilege on the Capture and Apply program packages
- DBADM or SYSADM authority for the source, control, and target servers

---

### Setting up the Capture and Apply programs

Setting up consists of configuring the source, target, and control servers. The following sections provide instructions for configuring each server as well as information about setting up end-user authentication at the source server.

#### Configuring the Capture program for UNIX platforms

1. Log on with a user ID that has sufficient privileges.
2. Connect to the source server database by entering:

```
db2 connect to database
```

where *database* is the source server database.

3. Prepare the source server database for roll-forward recovery by issuing the **update database configuration** command and the **backup database** command. For example:

```
db2 update database configuration for database_alias using logretain on  
db2 backup database database_alias
```

or:

```
db2 update database configuration for database_alias using userexit on
db2 backup database database_alias
```

You might need to increase DBHEAP, APPLHEAPSZ, PCKCACHESZ, LOCKLIST, and LOGBUFSZ based on your installation requirements.

4. Optional: The Capture program is bound automatically during execution; however, if you want to specify options or check that all bind processes complete successfully, complete the following steps:
  - a. Change to the directory where the Capture program bind files are located, which is usually *\$HOME/sqllib/bnd*.
  - b. Create and bind the Capture program package to the source server database by entering the following command:

```
db2 bind @capture.lst isolation ur blocking all
```

where *ur* specifies the list in uncommitted read format for greater performance.

These commands create a list of packages, the names of which are in the file CAPTURE.LST.

### Optional: Configuring the Apply program manually for UNIX platforms

**Important:** The Apply package is bound automatically during execution. Therefore, the following steps for binding the Apply package on UNIX are optional. If you want to specify options or check that all bind processes completed successfully, complete the following steps:

1. Log on with a user ID that has sufficient privileges.
2. Change to the directory where the Apply program bind files are located, which is usually *\$HOME/sqllib/bnd*.
3. For each source, target, and control server to which the Apply program connects, do the following steps:
  - a. Connect to the server database by entering:

```
db2 connect to database
```

where *database* is the source, target, or control server .

**Note:** If the server database is cataloged as a remote database, you might need to specify a user ID and password on the **db2 connect to** command. For example:

```
db2 connect to database user userid using password
```

- b. Create and bind the Apply program package to the server database by entering the following commands:

```
db2 bind @applycs.lst isolation cs blocking all grant public
db2 bind @applyur.lst isolation ur blocking all grant public
```

where `cs` specifies the list in cursor stability format, and `ur` specifies the list in uncommitted read format.

Because the Apply program control tables use static SQL calls for the control tables, the Apply bind process searches for the control tables at each server that the Apply program is bound to, regardless of whether these control tables are used at a server.

These commands create a list of packages, the names of which are in the files `APPLYCS.LST` and `APPLYUS.LST`.

## Other configuration considerations for UNIX-based components

Ensure that the user ID from which the Capture and Apply programs are running has write privilege on the directories where you invoke the programs. Write privilege is necessary because both the Capture and Apply programs create files in the invocation directory.

The Capture program creates the following files in addition to the spill files:

*instname***SRCSRVR.ccp**

A log file for the messages issued by the Capture program. These messages are also recorded in the trace table.

*instname***SRCSRVR.tmp**

A file that contains the process ID of this invocation of the Capture program (to prevent multiple Capture programs from being started in the same instance on the same source server).

The Apply program creates the following files:

**APPLYQUAL.app**

A log file for the messages issued by the Apply program. These messages are also recorded in the Apply trail table.

**ASNAPPLYAPPLYQUAL.pid**

A file that contains the process ID of this invocation of the Apply program. This prevents multiple Apply programs from being started with the same Apply qualifier.

For more information about configuration of UNIX-based components, see *IBM DB2 Universal Database for UNIX Quick Beginnings*.

## Setting up end-user authentication at the source server

In some cases you must provide a password file for end-user authentication to occur at the source server. The Apply program uses this file when connecting to the source server. Give read access to only the user ID that will run the Apply program. Environment-specific requirements include:

- If you installed Apply for HP-UX or Apply for Solaris, you must use an `AUTH=SERVER` scheme and provide a password file.

- If you installed Apply for AIX, you must provide a password file if you want to use an AUTHENTICATION=SERVER scheme at any server that the Apply program will connect to. If you use an AUTHENTICATION=CLIENT scheme for all servers, you do not need to provide a password file.

### Creating a password file:

The password file must meet the following criteria:

- Be named *applyqual.PWD*

Where *applyqual* is a case-sensitive string that must match the case and value of the Apply qualifier (APPLY\_QUAL) in the subscription set table exactly.

For example: DATADIR.PWD

This naming convention is the same as the log file name (*APPLYQUAL.app*) and the spill file name (*APPLYQUAL.nnn*), but with a file extension of *.pwd*.

- Reside in the same directory from which you will start the Apply program.
- Include no blank lines or comment lines. Add only the server-name, user ID, and password information. This information enables you to use different passwords or the same password at each server.
- Have one or more records using the following format:

```
SERVER=server_name USER=userid PWD=password
```

Where:

*server\_name*

The name of the source, target, or control server, exactly as it appears in the subscription set table.

*userid*

The user ID that you plan to use to administer that particular server. This value is case-sensitive.

*password*

The password that is associated with *userid*. This value is case-sensitive.

### If you do not create a password file:

The Apply program for UNIX must be able to issue an SQL CONNECT statement without specifying the user ID and password. If the Apply program needs to connect to an OS/390 database with SNA connectivity, these settings are necessary:

- The DB2 for OS/390 database must be cataloged as AUTHENTICATION=CLIENT.



- The login ID must belong to PRIMARY GROUP=SYSTEM.
- SECURITY=SAME for an MVS CPI-C node.
- You specify the following values when you define the LU name by using the VTAM APPL:
  - VERIFY=NONE to indicate that any LU can request an LU-LU session
  - SECACPT=ALREADYV to indicate user ID and password checking at the requester

For more information about authentication and security, refer to the *IBM DB2 Universal Database Administration Guide*.

---

## Operating Capture for UNIX platforms

An administrator can use the commands in this section to operate the Capture program for UNIX platforms. Enter the commands or a key combination from a UNIX command line.

This section explains how to perform the following Capture program tasks:

- “Starting Capture for UNIX platforms” on page 244
- “Scheduling Capture for UNIX platforms” on page 244
- “Setting environment variables for Capture for UNIX platforms” on page 244
- “Stopping Capture for UNIX platforms” on page 247
- “Suspending Capture for UNIX platforms” on page 247
- “Resuming Capture for UNIX platforms” on page 248
- “Reinitializing Capture for UNIX platforms” on page 248
- “Pruning the change data and unit-of-work tables” on page 249
- “Displaying captured log progress” on page 249

This section also lists restrictions for running the Capture program.

### Restrictions for running the Capture program

Some actions cause the Capture program to terminate while it is running. Stop the Capture program before you take any of the following actions:

- Remove an existing replication source.
- Drop a replication source table.
- Make changes that affect the structure of source tables, such as changes resulting from data definition language or utilities. Structural changes can compromise the data integrity of the copies. (Using ALTER ADD to add new columns is an exception.)

The Capture program cannot capture any changes made by DB2 utilities, because the utilities do not log the changes that they make.

## Scheduling Capture for UNIX platforms

Use the **at** command to start the Capture program at a specific time. For example, the following command starts the Capture program at 3:00 p.m. on Friday:

```
at 3pm Friday asncpp warmns noprun
```

## Setting environment variables for Capture for UNIX platforms

You must set two environment variables before you start the Capture program. These variables must also be set when you use any of the following functions:

- Stop the Capture program
- Suspend the Capture program
- Resume the Capture program
- Reinitialize the Capture program
- Prune change data or unit-of-work tables
- Display captured log progress

*To set the environment variables:*

1. Set the environment variable for the DB2 instance name (DB2INSTANCE) as shown:  

```
export DB2INSTANCE=db2_instance_name
```
2. Optional: Set environment variable DB2DBDFT to the source server.

## Starting Capture for UNIX platforms

After you start the Capture program, it runs continuously until you stop it or it detects an unrecoverable error.

*To start the Capture program for a UNIX platform:*

1. Log in and make sure that the user ID under which the Capture program is running has write privilege on the directory.
2. Ensure that you set the DB2 instance name as shown:

```
export DB2INSTANCE=db2_instance_name
```

While the Capture program is running, a file with the name *Database\_instance\_nameDatabase\_name.ccp* is created in the directory from which the Capture program is started. This file is a log file for the messages issued by the Capture program; these messages are also recorded in the trace table.

3. Optional: Set environment variable DB2DBDFT to the source server.
4. Set the LIBPATH environment variable to the directory in which the Capture program starts. Note that in the following examples the language

environment variables depend on the language that you install, and that *db2homedir* is the DB2 instance home directory.

**AIX example:**

```
export LIBPATH=db2homedir/sqllib/lib:/usr/lib:/lib
export LANG=en_US
```

**HP-UX example:**

```
export SHLIB_PATH=db2homedir/sqllib/lib:/usr/lib:/lib
export LANG=en_US
```

**Linux example:**

```
export LD_LIBRARY_PATH=db2homedir/sqllib/lib:/usr/lib:/lib:/db2/linux/lib
export LANG=en_US
```

**NUMA-Q example:**

```
export LD_LIBRARY_PATH=db2homedir/sqllib/lib:/opt/jse3.0/lib
export LANG=en_US
```

**Solaris example:**

```
export LD_LIBRARY_PATH=db2homedir/sqllib/lib:/usr/lib:/lib
export LANG=en_US
export NLS_PATH=/usr/lib/locale/%L/%N:/db2homedir/sqllib/msg/en_US/%N
```

5. Enter the following command:

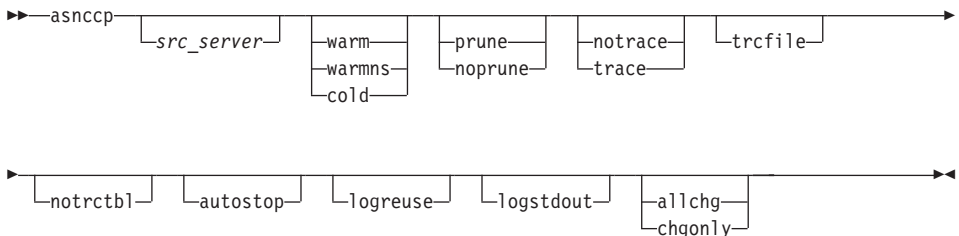


Table 27 defines the invocation parameters.

*Table 27. ASNCCP invocation parameter definitions for UNIX platforms*

| Parameter             | Definition                                                                                                                                                                               |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>src_server</i>     | Source server name must be the first parameter if entered. If not specified, the value from the DB2DBDFT environment variable is used.                                                   |
| <b>warm</b> (default) | The Capture program resumes processing where it ended in its previous run if warm start information is available. If the Capture program cannot warm start, it switches to a cold start. |

Table 27. ASNCCP invocation parameter definitions for UNIX platforms (continued)

| Parameter                | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>warmns</b>            | The Capture program resumes processing where it ended in its previous run if warm start information is available. Otherwise, it issues a message and terminates. With <b>warmns</b> , the Capture program does not automatically switch to a cold start. The Capture program leaves the trace, UOW, CD, and warm start tables intact. In case of errors, the Capture program terminates instead of switching to a cold start as when <b>warm</b> is specified. |
| <b>cold</b>              | The Capture program starts by deleting all rows in its CD table, UOW table, and trace table during initialization. All subscriptions to these replication sources will be fully refreshed during the next Apply processing cycle. A full refresh is not done if the target is a noncomplete CCD table (see “Resolving gaps between source and target tables” on page 147).                                                                                     |
| <b>prune</b> (default)   | The Capture program automatically prunes the rows in the CD and UOW tables that the Apply program has copied, at the interval specified in the tuning parameters table. In addition, the Capture program also prunes the CD and UOW rows that are older than the retention limit even though they have not been copied during warm start.                                                                                                                      |
| <b>noprune</b>           | Automatic pruning is disabled. The Capture program prunes the CD and the UOW tables only when you enter the <b>prune</b> command.                                                                                                                                                                                                                                                                                                                              |
| <b>notrace</b> (default) | No trace information is written.                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>trace</b>             | Writes trace messages to the standard output, stdout, unless <b>trcfile</b> is also specified.                                                                                                                                                                                                                                                                                                                                                                 |
| <b>trcfile</b>           | If both <b>trcfile</b> and <b>trace</b> are specified, the Capture program writes trace output to the trace file (*.trc). If you do not specify this option, the Capture program sends trace output to the standard output, stdout.                                                                                                                                                                                                                            |
| <b>notrctbl</b>          | The Capture program messages are not logged in the trace table.                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>autostop</b>          | The Capture program terminates after it captures all transactions logged before the Capture program was started.                                                                                                                                                                                                                                                                                                                                               |
| <b>logreuse</b>          | The Capture program reuses the log file (*.ccp) by first deleting it and then recreating it when the Capture program is restarted. If you do not specify this option, the Capture program appends messages to the log file, even after the Capture program is restarted.                                                                                                                                                                                       |

Table 27. ASNCCP invocation parameter definitions for UNIX platforms (continued)

| Parameter               | Definition                                                                                                                                                    |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>logstdout</b>        | The Capture program sends all messages to both the standard output (stdout) and the log file.                                                                 |
| <b>allchg</b> (default) | Specifies that an entry is made to the CD table whenever any source table row changes.                                                                        |
| <b>chgonly</b>          | Specifies that an entry is made to the CD table when a source table row changes only if the columns defined for replication (CD table columns) change values. |

## Stopping Capture for UNIX platforms

Use the **stop** command or a key combination to stop the Capture program in an orderly way and commit the log records that it processed up to that point. You must stop the Capture program before removing or modifying an existing replication source.

Before you stop the Capture program, ensure that the environment variables are set (see “Setting environment variables for Capture for UNIX platforms” on page 244). To stop the Capture program, enter the command:

If you set environment variable DB2DBDFT (see step 2 on page 244):

```
▶▶—asnccmd—stop—▶▶
```

or, if you did not set environment variable DB2DBDFT:

```
▶▶—asnccmd—src_server—stop—▶▶
```

## Suspending Capture for UNIX platforms

Use the **suspend** command to relinquish operating system resources to operational transactions during peak periods without destroying the Capture program environment. This command suspends the Capture program until you issue the **resume** command.

Before you suspend the Capture program, ensure that the environment variables are set (see “Setting environment variables for Capture for UNIX platforms” on page 244). To suspend the Capture program, enter the command:

If you set environment variable DB2DBDFT (see step 2 on page 244):

```
►—asnrcmd—suspend—◄
```

or, if you did not set environment variable DB2DBDFT:

```
►—asnrcmd—src_server—suspend—◄
```

**Important:** Do not use the **suspend** command when canceling a replication source. Instead, stop the Capture program.

## Resuming Capture for UNIX platforms

Use the **resume** command to restart the Capture program if you suspended it using the **suspend** command.

Before you resume the Capture program, ensure that the environment variables are set (see “Setting environment variables for Capture for UNIX platforms” on page 244). To resume the Capture program, enter the command:

If you set environment variable DB2DBDFT (see step 2 on page 244):

```
►—asnrcmd—resume—◄
```

or, if you did not set environment variable DB2DBDFT:

```
►—asnrcmd—src_server—resume—◄
```

## Reinitializing Capture for UNIX platforms

Use the **reinit** command to begin to capture changes from new source tables if you add a new replication source or ALTER ADD a column to a replication source and CD table while the Capture program is running. The **reinit** command tells the Capture program to obtain newly added replication sources from the register table.

**reinit** also rereads the tuning parameters table for any changes made to the tuning parameters.

Before you reinitialize the Capture program, ensure that the environment variables are set (see “Setting environment variables for Capture for UNIX platforms” on page 244). To reinitialize the Capture program, enter the command:

If you set environment variable DB2DBDFT (see step 2 on page 244):

```
▶▶—asnclmd—reinit—————▶▶
```

or, if you did not set environment variable DB2DBDFT:

```
▶▶—asnclmd—src_server—reinit—————▶▶
```

**Important:** Do not use the **reinit** command to reinitialize the Capture program after canceling a replication source or dropping a replication source table while the Capture program is running. Instead, stop the Capture program and restart it using the WARM or WARMNS option.

### Pruning the change data and unit-of-work tables

Use the **prune** command to start pruning the CD and UOW tables.

This command prunes tables once.

Before you begin pruning tables, ensure that the environment variables are set (see “Setting environment variables for Capture for UNIX platforms” on page 244). To begin pruning tables, enter the command:

If you set environment variable DB2DBDFT (see step 2 on page 244):

```
▶▶—asnclmd—prune—————▶▶
```

or, if you did not set environment variable DB2DBDFT:

```
▶▶—asnclmd—src_server—prune—————▶▶
```

The Capture program issues the message ASN0124I when the command is successfully queued.

If you stop or suspend the Capture program during pruning, you must enter the **prune** command again to resume pruning. Pruning does not resume after you enter the **resume** command.

### Displaying captured log progress

Use the **getlseq** command to get the timestamp and current log sequence number. You can use this information to determine how far the Capture program has read the DB2 log.

Before you display captured log progress, ensure that the environment variables are set (see “Setting environment variables for Capture for UNIX platforms” on page 244). To display captured log progress, enter the command:

If you set environment variable DB2DBDFT (see step 2 on page 244):

```
▶▶—asnrcmd—getlseq—————▶▶
```

or, if you did not set environment variable DB2DBDFT:

```
▶▶—asnrcmd—src_server—getlseq—————▶▶
```

**Tip:** You can use the DB2 UDB Find Log Sequence Number command (**db2flsn**) to identify the physical log file associated with the log sequence number. You can use this number to delete or archive log files no longer needed by the Capture program. For more information, see the *IBM DB2 Universal Database Command Reference*.

---

## Operating Apply for UNIX platforms

An administrator can use the commands in the following sections to perform the following Apply program tasks:

- “Starting Apply for UNIX platforms” on page 251
- “Scheduling Apply for UNIX platforms” on page 254
- “Stopping Apply for UNIX platforms” on page 254

### Before you start the Apply program

Before you start the Apply program, ensure that:

- You have the proper authorization. See “Authorization requirements for running the Apply program” on page 105 for information about authorization for the Apply program.
- The control tables are defined.
- At least one subscription set is created and activated.
- The Apply package is created.<sup>32</sup>
- A password file was created, if necessary, for end-user authentication at the source server. See “Setting up end-user authentication at the source server” on page 241 for more information.

---

32. Usually the Apply package is created automatically for you; however, if you configure the Apply program manually, you must explicitly bind the Apply package.



- The Capture program is started, and the ASN0100I initialization message was issued (if you are running a Capture program).

## Starting Apply for UNIX platforms

After you start the Apply program, it runs continuously until:

- You stop it in an orderly way.
- You cancel it.
- An unexpected error or failure occurs.

*To start the Apply program on a UNIX platform:*

1. Log on with the user ID that will run the Apply program.
2. Ensure that you set the DB2 instance name as shown:  

```
export DB2INSTANCE=db2_instance_name
```
3. Set the LIBPATH and language environment variables or edit the .profile file in the same environment in which the Apply program starts. Note that in the following examples the language environment variables depend on the language that you install, and that *db2homedir* is the DB2 instance home directory.

### AIX example:

```
export LIBPATH=db2homedir/sqlllib/lib:/usr/lib:/lib
export LANG=en_US
```

### HP-UX example:

```
export SHLIB_PATH=db2homedir/sqlllib/lib:/usr/lib:/lib
export LANG=en_US
```

### Linux example:

```
export LD_LIBRARY_PATH=db2homedir/sqlllib/lib:/usr/lib:/lib:/db2/linux/lib
export LANG=en_US
```

### NUMA-Q example:

```
export LD_LIBRARY_PATH=db2homedir/sqlllib/lib
export LANG=en_US
```

### Solaris example:

```
export LD_LIBRARY_PATH=db2homedir/sqlllib/lib:/usr/lib:/lib
export NLS_PATH= /usr/lib/locale/%L/%N:db2homedir/sqlllib/msg/en_US/%N
export LANG=en_US
```

4. Enter the **asnapply** command and options:

```
▶▶—asnapply—apl_qual—┬──ctrl_serv──┬──loadxit──┬──inamsg──┬──notrc──
                       │                │         │         │         │
                       └──no_loadxit──┘         └──no_inamsg──┘         └──trcerr──
   └──trcflow──
```

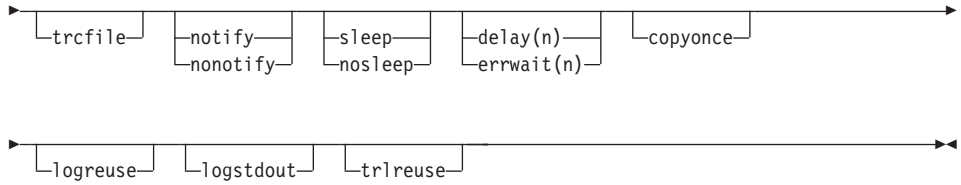


Table 28 defines the invocation parameters.

*Table 28. ASNAAPPLY invocation parameter definitions for UNIX platforms*

| <b>Parameter</b>           | <b>Definition</b>                                                                                                                                                                                                                                        |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>apl_qual</i>            | Specifies the Apply qualifier that the Apply instance uses to identify the subscription sets to be served. The Apply qualifier is case sensitive and must match the value of APPLY_QUAL in the subscription set table. This must be the first parameter. |
| <i>ctrl_serv</i>           | Specifies the name of the server where the replication control tables will reside. If you do not specify this parameter, the default is the default database or the value of DB2DBDFT.                                                                   |
| <b>loadxit</b>             | Specifies that the Apply program is to invoke ASNLOAD, an IBM-supplied exit routine that uses the export and load utilities to refresh target tables.                                                                                                    |
| <b>noloadxit</b> (default) | Specifies that the Apply program will not invoke ASNLOAD.                                                                                                                                                                                                |
| <b>inamsg</b> (default)    | Specifies that the Apply program is to issue a message when the Apply program is inactive.                                                                                                                                                               |
| <b>noinamsg</b>            | Specifies that the Apply program will not issue this message.                                                                                                                                                                                            |
| <b>notrc</b> (default)     | Specifies that the Apply program does not generate a trace.                                                                                                                                                                                              |
| <b>trcerr</b>              | Specifies that the Apply program generates a trace that contains only error information.                                                                                                                                                                 |
| <b>trcflow</b>             | Specifies that the Apply program generates a trace that contains both error and execution flow information.                                                                                                                                              |
| <b>trcfile</b>             | If both trcfile and either trcerr or trcflow are specified, the Apply program writes trace output to the trace file (*.trc). If you do not specify this option, the Apply program sends trace output to the standard output, stdout.                     |

Table 28. ASNAPPLY invocation parameter definitions for UNIX platforms (continued)

| Parameter                   | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>notify</b>               | Specifies that the Apply program is to invoke ASNDONE, an exit routine that returns control to the user when the Apply program finishes copying a subscription set.                                                                                                                                                                                                                                                                               |
| <b>nonotify</b> (default)   | Specifies that the Apply program will not invoke ASNDONE.                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>sleep</b> (default)      | Specifies that the Apply program is to go to sleep if no new subscription sets are eligible for processing.                                                                                                                                                                                                                                                                                                                                       |
| <b>nosleep</b>              | Specifies that the Apply program is to stop if no new subscriptions are eligible for processing.                                                                                                                                                                                                                                                                                                                                                  |
| <b>delay</b> ( <i>n</i> )   | Specifies the delay time (in seconds) at the end of each Apply cycle when continuous replication is used, where <i>n</i> =0, 1, 2, 3, 4, 5, or 6. The default delay time is 6 seconds.                                                                                                                                                                                                                                                            |
| <b>errwait</b> ( <i>n</i> ) | Specifies the number of seconds that the Apply program waits before retrying after it encounters an error condition, where <i>n</i> is the number of seconds. Do not specify too small a number because the Apply program will run almost continuously and generate many rows in the Apply trail table. The default wait period is 300 seconds (5 minutes).                                                                                       |
| <b>copyonce</b>             | The Apply program executes one copy cycle for each subscription set that is eligible at the time the Apply program is invoked, and then the Apply program terminates. An eligible subscription set is such that: <ul style="list-style-type: none"> <li>• ACTIVATE &gt; 0</li> <li>• REFRESH_TIMING = R or B or REFRESH_TIMING = E and the specified event has occurred.</li> </ul> MAX_SYNCH_MINUTES and END_OF_PERIOD are honored if specified. |
| <b>logreuse</b>             | The Apply program reuses the log file (*.app) by first deleting it and then re-creating it when the Apply program is restarted. If you do not specify this option, the Apply program appends messages to the log file, even after the Apply program is restarted.                                                                                                                                                                                 |
| <b>logstdout</b>            | The Apply program sends all messages to both the standard output (stdout) and the log file.                                                                                                                                                                                                                                                                                                                                                       |
| <b>trlreuse</b>             | The Apply program empties the Apply trail table when the Apply program is started.                                                                                                                                                                                                                                                                                                                                                                |

## Scheduling Apply for UNIX platforms

Use the **at** command to start the Apply program at a specific time. For example, the following command starts the Apply program at 3:00 p.m. on Friday:

```
at 3pm Friday asnapply myqual
```

## Stopping Apply for UNIX platforms

Use the **asnastop** command or a key combination to stop the Apply program in an orderly way.

To stop the Apply program, perform the following steps from a window where the Apply program is not running:

1. Set environment variable DB2INSTANCE to the value set when the Apply program was started.
2. Set environment variable DB2DBDFT to the source server specified when the Apply program was started (or the DB2DBDFT value used when the Apply program was started).
3. Enter the command.

```
▶▶—asnastop—apply_qualifier—▶▶
```

---

## Chapter 12. Capture for VM and Capture for VSE

This chapter describes how to set up and operate the Capture for VM and Capture for VSE programs.

---

### Setting up the Capture program

Setting up consists of installing the Capture program and configuring the source servers.

See the *Capture for VM Program Directory* or the *Capture for VSE Program Directory* for Capture program installation instructions.

---

### Operating Capture for VM and Capture for VSE

The administrator can use the commands in this section to operate Capture for VM and Capture for VSE.

This section explains how to perform the following Capture program tasks:

- Starting
- Stopping
- Suspending
- Resuming
- Reinitializing
- Pruning
- Displaying captured log progress

This section also lists restrictions for running the Capture program.

#### Restrictions for running the Capture program

Capture program restrictions are:

- Tables with field procedures for columns (FIELDPROC specified on CREATE or ALTER TABLE) are not supported by Capture for VM or Capture for VSE unless you create a new *one-way* FIELDPROC based on the existing FIELDPROC. The existing FIELDPROC doesn't require any changes. If the corresponding column(s) on the CD table are defined with the new one-way FIELDPROC, and if the FIELDPROC does not change the length of the data, replication can be performed successfully.
- Because the Capture program identifies itself as an APPC/VM resource, you must specify appropriate IUCV VM/ESA<sup>®</sup> System Directory control

statements (such as IUCV \*IDENT RESANY GLOBAL) for virtual machines that run the Capture program. For more information, see the *VM/ESA Planning and Administration Guide*.

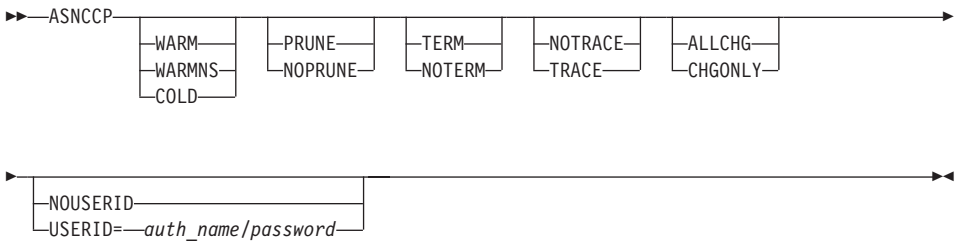
- **For VM only:** There can be only one Capture program per database, and each Capture program runs in its own virtual machine. The Capture program identifies itself as an APPC/VM resource. By default, the resource ID value is CAPTURE. To use a different resource ID or to allow multiple Capture programs to run on the system for different DB2 databases, change the ENQ\_NAME parameter in the ASNPARMS file.
- **For VM only:** The Capture program requires access to the appropriate level of the C Run Time Library. You must issue the GLOBAL LOADLIB SCEERUN command in VM before starting the Capture program.
- **For VSE only:** Only one Capture program can be running per DB2 server for VSE database, and each Capture program runs in its own partition.

## Starting Capture for VM and VSE

After you start the Capture program, it runs continuously until you stop it or it detects an unrecoverable error.

### *To start the Capture program for VM:*

Invoke the ASNCCP module from a VM user ID. Keywords must be separated by one or more blanks:



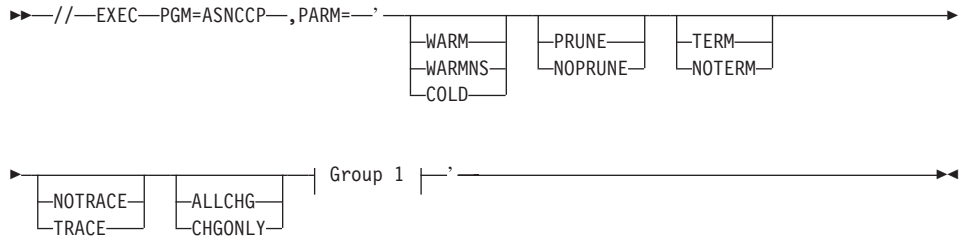
If conflicting invocation parameters are specified, the Capture program uses the value of the last parameter specified. For example, if ASNCCP is started using the COLD TRACE NOTRACE parameter string, no trace information is written (NOTRACE).

Table 29 on page 257 defines the invocation parameters.

### *To start the Capture program for VSE:*

Sample job control member ASNS51BD provides an example of how to start the Capture program. Start the Capture program in a partition like a batch

job. You can specify ASNCCP invocation parameters in the PARM= field, in the order shown, separated by one or more blanks:



### Group 1:

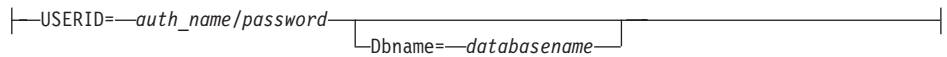


Table 29 defines the invocation parameters.

Table 29. ASNCCP invocation parameter definitions for VM and VSE

| Parameter              | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>WARM</b> (default)  | The Capture program resumes processing where it ended in its previous run if warm start information is available. If the Capture program cannot warm start, it switches to a cold start.                                                                                                                                                                                                                                                        |
| <b>WARMNS</b>          | The Capture program resumes processing where it ended in its previous run if warm start information is available. Otherwise, it issues a message and terminates. With WARMNS, the Capture program does not automatically switch to a cold start. The Capture program leaves the trace, UOW, CD, and warm start tables intact. In case of errors, the Capture program terminates instead of switching to a cold start as when WARM is specified. |
| <b>COLD</b>            | The Capture program starts up by deleting all rows in its CD table, the UOW table, and the trace table during initialization. All subscriptions to these replication sources will be fully refreshed during the next Apply program processing cycle. A full refresh is not done if the target is a noncomplete CCD table (see "Resolving gaps between source and target tables" on page 147).                                                   |
| <b>PRUNE</b> (default) | The Capture program automatically prunes the rows in the CD and UOW tables that the Apply program copied, at the interval specified in the tuning parameters table.                                                                                                                                                                                                                                                                             |

Table 29. ASNCCP invocation parameter definitions for VM and VSE (continued)

| Parameter                        | Definition                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>NOPRUNE</b>                   | Automatic pruning is disabled. The Capture program prunes the CD and UOW tables when you enter the <b>PRUNE</b> command.                                                                                                                                                                                                                                                                                                           |
| <b>TERM</b> (default)            | Terminates the Capture program if the DB2 server is terminated.                                                                                                                                                                                                                                                                                                                                                                    |
| <b>NOTERM</b>                    | Keeps the Capture program running when the DB2 server is terminated. When the DB2 server initializes, the Capture program starts in WARM mode and begins capturing where it left off when DB2 terminated.                                                                                                                                                                                                                          |
| <b>NOTRACE</b> (default)         | No trace information is written.                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>TRACE</b>                     | Writes trace messages to the standard output, stdout.                                                                                                                                                                                                                                                                                                                                                                              |
| <b>ALLCHG</b> (default)          | Specifies that an entry is made to the CD table whenever a source table row changes.                                                                                                                                                                                                                                                                                                                                               |
| <b>CHGONLY</b>                   | Specifies that an entry is made to the CD table when a source table row changes only if the columns defined for replication (CD table columns) change values.                                                                                                                                                                                                                                                                      |
| <b>USERID=auth_name/password</b> | Specifies that the Capture program should connect to the database as user ID <i>auth_name</i> , with password <i>password</i> . The correct password must be provided or an error is returned. The <i>auth_name</i> and <i>password</i> are both from 1 to 8 characters in length.<br><br>For VM/ESA, if you do not specify this parameter, the Capture program connects to the database as the user ID on which you issue ASNCCP. |
| <b>Dbname=databasename</b>       | <b>For VSE only:</b> Identifies the name of the DB2 server for VSE database for which changes are to be captured. The name is from 1 to 18 characters in length. If not specified, the default is the database name as specified in the DBNAME directory or SQLDS if a DBNAME directory is not set up.                                                                                                                             |

## Stopping Capture for VM and VSE

Use the **STOP** command to stop the Capture program gracefully and commit the log records that it processed up to that point.

Issue the **STOP** command before:

- Removing an existing replication source
- Opening and modifying an existing replication source
- Shutting down the database

*To stop the Capture program for VM:*



▶▶—STOP—◀◀

*To stop the Capture program for VSE:*

▶▶—MSG—*partition*—,DATA=STOP—◀◀

where *partition* represents the partition that is running Capture for VSE.

If you stop the Capture program, it shuts itself down and issues an informational message. If it detects an error, the program shuts itself down after cleaning up the data in the affected tables so that the data will not be used. Staging tables are pruned when it is appropriate. In the case of abnormal termination, you must initiate a cold start because the warm start information could not be saved.

### **Suspending Capture for VM and VSE**

Use the **SUSPEND** command to suspend the Capture program until you issue the **RESUME** command.

*To suspend the Capture program for VM:*

▶▶—SUSPEND—◀◀

*To suspend the Capture program for VSE:*

▶▶—MSG—*partition*—,DATA=SUSPEND—◀◀

where *partition* represents the partition that is running Capture for VSE.

You can use this command to suspend the Capture program to improve performance for operational transactions during peak periods without destroying the Capture program run environment.

**Important:** Do not use the **SUSPEND** command when canceling a replication source. Instead, stop the Capture program.

### **Resuming Capture for VM and VSE**

Use the **RESUME** command to resume the suspended Capture program.

*To resume the Capture program for VM:*

▶▶—RESUME—◀◀

*To resume the Capture program for VSE:*

▶▶—MSG—*partition*—,DATA=RESUME—◀◀

where *partition* represents the partition that is running Capture for VSE.

## Reinitializing Capture for VM and VSE

Use the **REINIT** command to reinitialize the Capture program.

*To reinitialize the Capture program for VM:*

▶▶—REINIT—◀◀

*To reinitialize the Capture program for VSE:*

▶▶—MSG—*partition*—,DATA=REINIT—◀◀

where *partition* represents the partition that is running Capture for VSE.

Use the **REINIT** command to begin to capture changes from new source tables if you add a new replication source or ALTER ADD a column to a replication source and CD table while the Capture program is running. The **REINIT** command tells the Capture program to obtain newly added replication sources from the register table.

**REINIT** also rereads the tuning parameters table for any changes made to the tuning parameters.

**Important:** Do not use **REINIT** to reinitialize the Capture program after canceling or dropping a replication source table while the Capture program is running. Instead, stop the Capture program and start it again using the **WARM** or **WARMNS** option.

## Pruning the change data and unit-of-work tables

Use the **PRUNE** command to start pruning the CD and UOW tables if you disabled pruning by using the **NOPRUNE** invocation parameter while starting the Capture program.

This command prunes tables once.

*To prune the tables for VM:*

▶▶—PRUNE—▶▶

*To prune the tables for VSE:*

▶▶—MSG—*partition*—,DATA=PRUNE—▶▶

where *partition* represents the partition that is running Capture for VSE.

During pruning, if you stop or suspend the Capture program, pruning does not resume after you enter the **RESUME** command. You must enter the **PRUNE** command again to resume pruning.

### Displaying captured log progress

Use the **GETLSEQ** command to provide the timestamp and current log sequence number. You can use this number to determine how far the Capture program has read the DB2 log.

*To display captured log progress for the Capture program for VM:*

▶▶—GETLSEQ—▶▶

*To display captured log progress for the Capture program for VSE:*

▶▶—MSG—*partition*—,DATA=GETLSEQ—▶▶

where *partition* represents the partition that is running Capture for VSE.



---

## Chapter 13. Capture and Apply for Windows and OS/2

This chapter describes how to set up and operate the Capture and Apply programs on the following operating systems:

- Windows 32-bit operating systems (such as Windows 95, Windows 98, or Windows NT)
- OS/2

This chapter also describes replication on demand for Windows 32-bit operating systems. For detailed information about replication on demand, see “Replicating on demand (Windows 32-bit operating systems only)” on page 279.

Be sure to read the following sections before reading the sections on operating the Capture and Apply programs:

- “User ID requirements for running the Capture and Apply programs”
- “Setting up the Capture and Apply programs”

---

### User ID requirements for running the Capture and Apply programs

The user ID under which the Capture and Apply programs will run must have the following authorities and privileges:

- Execute privilege on the Capture and Apply program packages
- DBADM or SYSADM authority for the source, control, and target servers

---

### Setting up the Capture and Apply programs

Setting up consists of configuring the source, target, and control servers, and setting up NT services on Windows. The following sections provide instructions for configuring each server, setting up end-user authentication at the source server, and setting up the NT Service Control Manager.

#### Configuring the Capture program for Windows and OS/2

1. Log on with a user ID that has sufficient privileges.
2. Connect to the source server database by entering:

```
DB2 CONNECT TO database
```

where *database* is the source server database.

3. Prepare the source server database for roll-forward recovery by issuing the **UPDATE DATABASE CONFIGURATION** command and the **BACKUP DATABASE** command. For example:

```
DB2 UPDATE DATABASE CONFIGURATION FOR database_alias USING LOGRETAIN ON
DB2 BACKUP DATABASE database_alias
```

or:

```
DB2 UPDATE DATABASE CONFIGURATION FOR database_alias USING USEREXIT ON
DB2 BACKUP DATABASE database_alias
```

You might need to increase DBHEAP, APPLHEAPSZ, PCKCACHESZ, LOCKLIST, and LOGBUFSZ based on your installation requirements.

4. Optional: The Capture program is bound automatically during execution; however, if you want to specify options or check that all bind processes complete successfully, complete the following steps:
  - a. Change to the directory where the Capture program bind files are located, which is usually *drive:\SQLLIB\BND*.
  - b. Create and bind the Capture program package to the source server database by entering the following command:

```
DB2 BIND @CAPTURE.LST ISOLATION UR BLOCKING ALL
```

where UR specifies the list in uncommitted read format for greater performance.

These commands create a list of packages, the names of which are in the file CAPTURE.LST.

### Optional: Configuring the Apply program manually for Windows and OS/2

**Important:** The Apply package is bound automatically during execution. Therefore, the following steps for binding the Apply package on Windows and OS/2 are optional. If you want to specify options or check that all bind processes complete successfully, complete the following steps:

1. Log on with a user ID that has sufficient privileges.
2. Change to the directory where the Apply program bind files are located, which is usually *drive:\SQLLIB\BND*.
3. For each source, target, and control server to which the Apply program connects, do the following steps:
  - a. Connect to the server database by entering:

```
DB2 CONNECT TO database
```

where *database* is the source, target, or control server. If the server database is cataloged as a remote database, you might need to specify a user ID and password on the **DB2 CONNECT TO** command. For example:

```
DB2 CONNECT TO database USER userid USING password
```

- b. Create and bind the Apply program package to the server database by entering the following commands:

```
DB2 BIND @APPLYCS.LST ISOLATION CS BLOCKING ALL GRANT PUBLIC
DB2 BIND @APPLYUR.LST ISOLATION UR BLOCKING ALL GRANT PUBLIC
```

where CS specifies the list in cursor stability format, and UR specifies the list in uncommitted read format.

Because the Apply program uses static SQL calls for the control tables, the Apply bind process searches for the control tables at each server that the Apply program is bound to, regardless of whether these control tables are used at a server.

These commands create a list of packages, the names of which are in the files APPLYCS.LST and APPLYUR.LST.

## Setting up end-user authentication at the source server

For end-user authentication to occur at the source server, you must provide a password file with an AUTH=SERVER scheme. The Apply program uses this file when connecting to the source server. Give read access to only the user ID that will run the Apply program.

### Creating a password file:

The password file must meet the following criteria:

- Be named as shown:

```
applyqual.PWD
```

Where *applyqual* is a case-sensitive string that must match the case and value of the Apply qualifier (APPLY\_QUAL) in the subscription set table exactly.

For example: DATADIR.PWD

This naming convention is the same as the log file name (*applyqual.app*) and the spill file name (*applyqual.nnn*), but with a file extension of .PWD.

- Reside in the directory from which you will start the Apply program.
- Include no blank lines or comment lines. Add only the server-name, user ID, and password information. This information enables you to use different passwords or the same password at each server.
- Have one or more records using the following format:

```
SERVER=server_name USER=userid PWD=password
```

Where:

```
server_name
```

The source, target, or control server, exactly as it appears in the subscription set table.

*userid* The user ID that you plan to use to administer that particular server. On Windows, this value is case-sensitive.

*password*

The password that is associated with the *userid*. On Windows, this value is case-sensitive.

For more information about authentication and security, refer to the *IBM DB2 Universal Database Administration Guide*.

## Setting up the NT Service Control Manager

You can operate the Capture and Apply programs for Windows by using the DB2 command processor or by using the NT Service Control Manager (SCM). The SCM enables you to automatically start the Capture and Apply programs as services from the NT Control Panel.

If you want to operate Capture and Apply as services, you must install the replication service manually (installation is not automatic). The following steps explain how to install the replication service and set it up as an NT service.

In this section, *x:\* refers to the drive and directory containing executable programs. These programs are usually located in the `\sqllib\bin` directory.

*To install the replication service and set up the NT service:*

1. Open a command window, and change to the directory containing the executable file `ASNINST.EXE`.
2. Install the replication service by typing the following command:  
`ASNINST x:\ASNSERV.EXE`
3. Set up the service from the NT Control Panel:
  - a. Double-click the **Services** icon. The NT Services window opens.
  - b. Select **Replication** and click **STARTUP**.
  - c. Ensure that the startup type is automatic.
  - d. Specify the local user ID and password and click **OK**. The user ID must be the one that runs the Capture and Apply programs and has the appropriate DB2 privileges.
4. Add the environment variable `ASNPATH` to specify the location of the Capture and Apply program files:
  - a. Double-click the **System** icon on the NT Control Panel. The System Properties window opens.
  - b. Click the **Environment** tab.
  - c. Type the `ASNPATH` string in the **Variable** field as shown in the following example:  
`ASNPATH=x:`



**Important:** Do not add a backslash to the ASNPATH variable.

- d. Click **OK**.
  - e. Reboot the computer.
5. Create an ASCII file called `ntserv.asn` to run the Capture and Apply programs:
- a. Open a new file and enter the following records:

```
db_name x:\ASNCCP parameters
```

```
db_name x:\ASNAPPLY parameters
```

where *db\_name* specifies the name of the source database for the Capture program and the name of the control database for the Apply program, *x:\* is the location of the programs, and *parameters* specifies one or more invocation parameters (such as the Apply qualifier).

To use the Capture program and Apply program trace facilities, specify the invocation parameters in the file. For example:

```
DBNAME1 C:\SQLLIB\BIN\ASNCCP COLD TRACE<CRLF>
```

```
DBNAME2 C:\SQLLIB\BIN\ASNAPPLY APPLYQUAL DBNAME2 TRCFLOW TRCFILE<CRLF>
```

The TRCFILE invocation parameter is necessary, in addition to the usual trace invocation parameter (such as TRCFLOW), to generate an Apply program trace.

Do not specify an output file name for traces. These will be written to default locations, with default file names, as follows:

- For the Capture program:

```
x:\instancenamedbname.trc
```

- For the Apply program:

```
x:\APPLYtimestamp.trc
```

- b. Save the file to the following location:

```
x:\ntserv.asn
```

The Replication Services program stores all messages in `x:\asnserv.log`. If you encounter any problems, check this log file for error messages.

### *To stop the Capture and Apply programs:*

**Important:** After you start the service, the Capture and Apply programs run independently of ASNSERV. Therefore, stopping ASNSERV does not stop the Capture and Apply programs. Use the **ASNCMD STOP** command in a command window to stop the Capture program. Use the **ASNASTOP** command in a command window to stop the Apply program.

### *To remove the replication service from the NT service:*

To remove Replication Services from the NT Control Panel, run the ASNREMV program.

---

## Operating Capture for Windows and Capture for OS/2

An administrator can use the commands in this section to operate the Capture program on Windows and the Capture program on OS/2. Enter the commands or a key combination from an NT or an OS/2 window.

This section explains how to perform the following Capture program tasks:

- “Starting Capture for Windows and OS/2” on page 269
- “Scheduling Capture for Windows and OS/2” on page 271
- “Setting environment variables for Capture for Windows and OS/2”
- “Stopping Capture for Windows and OS/2” on page 271
- “Suspending Capture for Windows and OS/2” on page 272
- “Resuming Capture for Windows and OS/2” on page 273
- “Reinitializing Capture for Windows and OS/2” on page 273
- “Pruning the change data and unit-of-work tables” on page 274
- “Displaying captured log progress” on page 274

This section also lists restrictions for running the Capture program.

### Restrictions for running the Capture program

Some actions cause the Capture program to terminate while it is running. Stop the Capture program before you take any of the following actions:

- Remove an existing replication source.
- Drop a replication source table.
- Make changes that affect the structure of source tables, such as changes resulting from data definition language or utilities. Structural changes can compromise the data integrity of the copies. (ALTER ADDs of new columns are an exception.)

The Capture program cannot capture any changes made by DB2 utilities, because the utilities do not log changes that they make.

### Setting environment variables for Capture for Windows and OS/2

You must set two environment variables before you start the Capture program. These variables must also be set when you use any of the following functions:

- Stop the Capture program
- Suspend the Capture program
- Resume the Capture program
- Reinitialize the Capture program

- Prune change data or unit-of-work tables
- Display captured log progress

*To set the environment variables:*

1. Set the environment variable for the DB2 instance name (DB2INSTANCE) as shown:

```
SET DB2INSTANCE=db2_instance_name
```

2. Optional: Set environment variable DB2DBDFT to the source server.

## Starting Capture for Windows and OS/2

After you start the Capture program, it runs continuously until you stop it or it detects an unrecoverable error.

*To start the Capture program using the NT Services:*

1. Select **Replication** from the NT Services window.
2. Click the **START** push button. The Capture program starts according to the ASCII file information that you provided.

You can also start the replication service by typing STRTSERV on the NT command line.

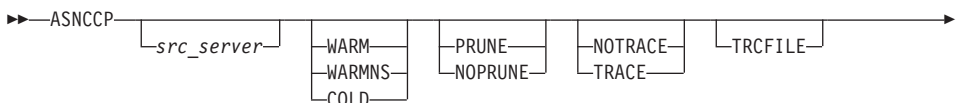
*To start the Capture program using the DB2 command window:*

1. If you created one or more DB2 for NT or DB2 for OS/2 instances, use the **SET** command to set the DB2INSTANCE environment variable to the DB2 for NT or DB2 for OS/2 instance with which you plan to run the Capture program:

```
SET DB2INSTANCE=database_instance_name
```

While the Capture program is running, a file with the name *Database\_instance\_name Database\_name.CCP* (Windows) or *database\_name.CCP* (OS/2) is created in the directory from which the Capture program is started. This file is a log file for the messages issued by the Capture program; these messages are also recorded in the trace table.

2. Optional: Set environment variable DB2DBDFT to the source server.
3. To start the Capture program, enter the **ASNCCP** command from the Windows or OS/2 window where you issued the **SET** command. The syntax is:



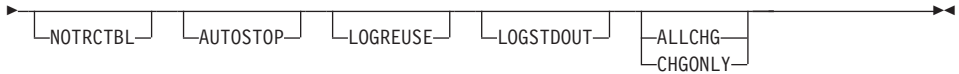


Table 30 defines the invocation parameters.

*Table 30. ASNCCP invocation parameter definitions for Windows and OS/2 platforms*

| Parameter                | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>src_server</i>        | Source server name must be the first parameter if entered. If not specified, the value from the DB2DBDFT environment variable is used.                                                                                                                                                                                                                                                                                                                  |
| <b>WARM</b> (default)    | The Capture program resumes processing where it ended in its previous run if warm start information is available. If the Capture program cannot warm start, it switches to a cold start.                                                                                                                                                                                                                                                                |
| <b>WARMNS</b>            | The Capture program resumes processing where it ended in its previous run if warm start information is available. Otherwise, it issues a message and terminates. With <b>WARMNS</b> , the Capture program does not automatically switch to a cold start. The Capture program leaves the trace, UOW, CD, and warm start tables intact. In case of errors, the Capture program terminates instead of switching to a cold start as when warm is specified. |
| <b>COLD</b>              | The Capture program starts by deleting all rows in its CD table, UOW table, and trace table during initialization. All subscriptions to these replication sources will be fully refreshed during the next Apply processing cycle. A full refresh is not done if the target is a noncomplete CCD table (see “Resolving gaps between source and target tables” on page 147).                                                                              |
| <b>PRUNE</b> (default)   | The Capture program automatically prunes the rows in the CD and UOW tables that the Apply program has copied, at the interval specified in the tuning parameters table. In addition, the Capture program also prunes the CD and UOW rows that are older than the retention limit even though they have not been copied during warm start.                                                                                                               |
| <b>NOPRUNE</b>           | Automatic pruning is disabled. The Capture program prunes the CD and the UOW tables only when you enter the <b>PRUNE</b> command.                                                                                                                                                                                                                                                                                                                       |
| <b>NOTRACE</b> (default) | No trace information is written.                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>TRACE</b>             | Writes trace messages to the standard output, stdout, unless TRCFILE is also specified.                                                                                                                                                                                                                                                                                                                                                                 |

Table 30. ASNCCP invocation parameter definitions for Windows and OS/2 platforms (continued)

| Parameter        | Definition                                                                                                                                                                                                                                                             |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TRCFILE          | If both trcfile and trace are specified, the Capture program writes trace output to the trace file (*.trc). If you do not specify this option, the Capture program sends trace output to the standard output, stdout.                                                  |
| NOTRCTL          | The Capture program messages are not logged in the trace table.                                                                                                                                                                                                        |
| AUTOSTOP         | The Capture program terminates after it captures all transactions logged before the Capture program was started.                                                                                                                                                       |
| LOGREUSE         | The Capture program reuses the log file (*.ccp) by first deleting and then re-creating it when the Capture program is restarted. If you do not specify this option, the Capture program appends messages to the log file, even after the Capture program is restarted. |
| LOGSTDOUT        | The Capture program sends all messages to both the standard output (stdout) and the log file.                                                                                                                                                                          |
| ALLCHG (default) | Specifies that an entry is made to the CD table whenever any source table row changes.                                                                                                                                                                                 |
| CHGONLY          | Specifies that an entry is made to the CD table when a source table row changes only if the columns defined for replication (CD table columns) change values.                                                                                                          |

## Scheduling Capture for Windows and OS/2

**For Windows:** Use the **AT** command to start the Capture program at a specific time. Before you enter the **AT** command, the Windows Schedule Service should already be started. For example, the following command string starts the Capture program for Windows at 15:00 (3:00 p.m.):

```
c:\>AT 15:00 /interactive "c:\SQLLIB\BIN\db2cmd.exe c:\CAPTURE\asnccp.exe warmns"
```

**For OS/2:** Use the Alarms program in the OS/2 Productivity set to start Capture for OS/2 at a specific time.

## Stopping Capture for Windows and OS/2

Use the **STOP** command or a key combination to stop the Capture program in an orderly way and commit the log records that it processed up to that point.

Stop the Capture program before removing or modifying an existing replication source.

**For Windows:** If you started the Capture program as an NT service, the Capture program runs independently of ASNSERV. By selecting **Replication** from the NT Services window and clicking **Stop**, you can stop ASNSERV but not the Capture program. Use the **ASNCMD STOP** command in a command window to stop the Capture program.

**For Windows and OS/2:** Before you stop the Capture program, ensure that the environment variables are set (see “Setting environment variables for Capture for Windows and OS/2” on page 268). To stop the Capture program, enter the command:

If you set environment variable DB2DBDFT (see step 2 on page 269):

```
▶▶—ASNCMD—STOP—▶▶
```

or, if you did not set environment variable DB2DBDFT:

```
▶▶—ASNCMD—src_server—STOP—▶▶
```

## Suspending Capture for Windows and OS/2

Use the **SUSPEND** command to relinquish operating system resources to operational transactions during peak periods without destroying the Capture program environment. This command suspends the Capture program until you issue the **RESUME** command.

Before you suspend the Capture program, ensure that the environment variables are set (see “Setting environment variables for Capture for Windows and OS/2” on page 268). To suspend the Capture program, enter the command:

If you set environment variable DB2DBDFT (see step 2 on page 269):

```
▶▶—ASNCMD—SUSPEND—▶▶
```

or, if you did not set environment variable DB2DBDFT:

```
▶▶—ASNCMD—src_server—SUSPEND—▶▶
```

**Important:** Do not use the **SUSPEND** command when canceling a replication source. Instead, stop the Capture program.

## Resuming Capture for Windows and OS/2

Use the **RESUME** command to restart the Capture program if you suspended it using the **SUSPEND** command.

Before you resume the Capture program, ensure that the environment variables are set (see “Setting environment variables for Capture for Windows and OS/2” on page 268). To resume the Capture program, enter the command:

If you set environment variable DB2DBDFT (see step 2 on page 269):

```
▶▶—ASNCMD—RESUME—▶▶
```

or, if you did not set environment variable DB2DBDFT:

```
▶▶—ASNCMD—src_server—RESUME—▶▶
```

## Reinitializing Capture for Windows and OS/2

Use the **REINIT** command to begin to capture changes from new source tables if you add a new replication source or use **ALTER ADD** to add a column to a replication source and CD table while the Capture program is running. The **REINIT** command tells the Capture program to obtain newly added replication sources from the register table.

**REINIT** also rereads the tuning parameters table for any changes made to the tuning parameters.

Before you reinitialize the Capture program, ensure that the environment variables are set (see “Setting environment variables for Capture for Windows and OS/2” on page 268). To reinitialize the Capture program, enter the command:

If you set environment variable DB2DBDFT (see step 2 on page 269):

```
▶▶—ASNCMD—REINIT—▶▶
```

or, if you did not set environment variable DB2DBDFT:

```
▶▶—ASNCMD—src_server—REINIT—▶▶
```

**Important:** Do not use the **REINIT** command to reinitialize the Capture program after canceling a replication source or dropping a replication source

table while the Capture program is running. Instead, stop the Capture program and restart it using the WARM or WARMNS option.

## Pruning the change data and unit-of-work tables

Use the **PRUNE** command to start pruning the CD and UOW tables.

This command prunes tables once.

Before you prune the change data and unit-of-work tables, ensure that the environment variables are set (see “Setting environment variables for Capture for Windows and OS/2” on page 268). To begin pruning tables, enter the command:

If you set environment variable DB2DBDFT (see step 2 on page 269):

```
▶▶—ASNCMD—PRUNE—————▶▶
```

or, if you did not set environment variable DB2DBDFT:

```
▶▶—ASNCMD—src_server—PRUNE—————▶▶
```

The Capture program issues the message ASN0124I when the command is successfully queued.

If you stop or suspend the Capture program during pruning, you must enter the **PRUNE** command again to resume pruning. Pruning does not resume after you enter the **RESUME** command.

## Displaying captured log progress

Use the **GETLSEQ** command to get the timestamp and current log sequence number. You can use this information to determine how far the Capture program has read the DB2 log.

Before you display captured log progress, ensure that the environment variables are set (see “Setting environment variables for Capture for Windows and OS/2” on page 268). To display captured log progress, enter the command:

If you set environment variable DB2DBDFT (see step 2 on page 269):

```
▶▶—ASNCMD—GETLSEQ—————▶▶
```



or, if you did not set environment variable DB2DBDFT:

▶▶—ASN CMD—src\_server—GETLSEQ—▶▶

**Tip:** You can use DB2 UDB Find Log Sequence Number command (**DB2FLSN**) to identify the physical log file associated with the log sequence number. You can use this number to delete or archive log files no longer needed by the Capture program. For more information, see the *IBM DB2 Universal Database Command Reference*.

---

## Operating Apply for Windows and OS/2

An administrator can use the commands in the following sections to perform the following Apply program tasks:

- “Starting Apply for Windows and OS/2”
- “Scheduling Apply for Windows and OS/2” on page 278
- “Stopping Apply for Windows and OS/2” on page 278

### Before you start the Apply program

Before you start the Apply program, ensure that:

- You have the proper authorization. See “Authorization requirements for running the Apply program” on page 105 for information about authorization for the Apply program.
- The control tables are defined.
- At least one subscription set is created and activated.
- The Apply package is created.<sup>33</sup>
- **For Windows:** A password file has been created for end-user authentication at the source server. See “Setting up end-user authentication at the source server” on page 265 for more information.
- The Capture program is started, and the ASN0100I initialization message was issued (if you are running a Capture program).

### Starting Apply for Windows and OS/2

After you start the Apply program, it runs continuously until:

- You stop it in an orderly way.
- You cancel it.
- An unexpected error or failure occurs.

*To start the Apply program using the NT services:*

---

33. Usually the Apply package is created automatically for you; however, if you configure the Apply program manually, you must explicitly bind the Apply package.

1. Select **Replication** from the NT Services window.
2. Click the **Start** push button. The Apply program starts according to the ASCII file information you provided.

You can also start the replication service by typing `STRTSERV` on the Windows NT command line.

**To start the Apply program on a Windows or OS/2 platform:**

Perform the following steps from a Windows or OS/2 window:

1. Log on with the IBM Replication user ID.
2. Ensure that you set the DB2 instance as shown:  
`SET DB2INSTANCE=db2_instance_name`
3. Enter the **ASNAPPLY** command from the Windows or OS/2 window where you issued the **SET** command:

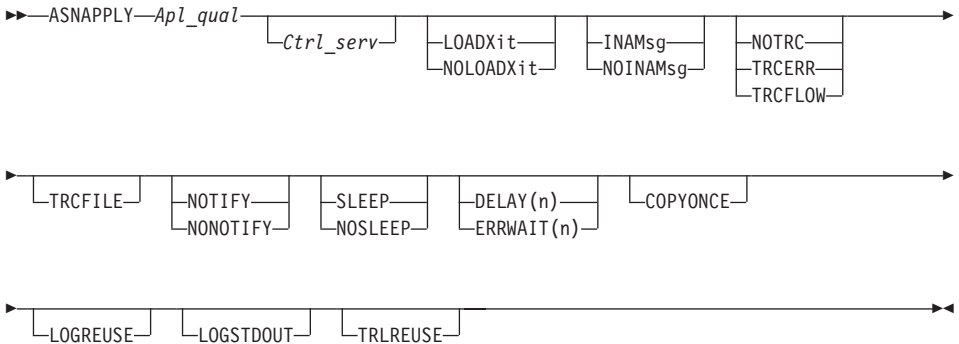


Table 31 defines the invocation parameters.

*Table 31. ASNAPPLY invocation parameter definitions on Windows and OS/2 platforms*

| Parameter        | Definition                                                                                                                                                                                                                                                                |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Apl_qual</i>  | Specifies the Apply qualifier that the Apply instance uses to identify the subscription sets to be served. The Apply qualifier is case sensitive and must match the value of the <code>APPLY_QUAL</code> in the subscription set table. This must be the first parameter. |
| <i>Ctrl_serv</i> | Specifies the name of the server where the replication control tables will reside. If you do not specify this parameter, the default is the default database or the value of <code>DB2DBDFT</code> .                                                                      |

Table 31. ASNAPPLY invocation parameter definitions on Windows and OS/2 platforms (continued)

| Parameter                  | Definition                                                                                                                                                                                                                          |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>LOADXit</b>             | Specifies that the Apply program is to invoke ASNLOAD, an IBM-supplied exit routine that uses the export and load utilities to refresh target tables.                                                                               |
| <b>NOLOADXit</b> (default) | Specifies that the Apply program will not invoke ASNLOAD.                                                                                                                                                                           |
| <b>INAMsg</b> (default)    | Specifies that the Apply program is to issue a message when the Apply program is inactive.                                                                                                                                          |
| <b>NOINAMsg</b>            | Specifies that the Apply program will not issue this message.                                                                                                                                                                       |
| <b>NOTRC</b> (default)     | Specifies that the Apply program does not generate a trace.                                                                                                                                                                         |
| <b>TRCERR</b>              | Specifies that the Apply program generates a trace that contains only error information.                                                                                                                                            |
| <b>TRCFLOW</b>             | Specifies that the Apply program generates a trace that contains both error and execution flow information.                                                                                                                         |
| <b>TRCFILE</b>             | If both trcfile and either trcerr or trcfow are specified, the Apply program writes trace output to the trace file (*.trc). If you do not specify this option, the Apply program sends trace output to the standard output, stdout. |
| <b>NOTIFY</b>              | Specifies that the Apply program is to invoke ASNDONE, an exit routine that returns control to the user when the Apply program finishes copying a subscription set.                                                                 |
| <b>NONOTIFY</b> (default)  | Specifies that the Apply program will not invoke ASNDONE.                                                                                                                                                                           |
| <b>SLEEP</b> (default)     | Specifies that the Apply program is to go to sleep if no new subscription sets are eligible for processing.                                                                                                                         |
| <b>NOSLEEP</b>             | Specifies that the Apply program is to stop if no new subscription sets are eligible for processing.                                                                                                                                |
| <b>DELAY</b> ( <i>n</i> )  | Specifies the delay time (in seconds) at the end of each Apply cycle when continuous replication is used, where <i>n</i> =0, 1, 2, 3, 4, 5, or 6. The default delay time is 6 seconds.                                              |

Table 31. ASNAPPLY invocation parameter definitions on Windows and OS/2 platforms (continued)

| Parameter           | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ERRWAIT( <i>n</i> ) | Specifies the number of seconds that the Apply program waits before retrying after it encounters an error condition, where <i>n</i> is the number of seconds. Do not specify too small a number because the Apply program will run almost continuously and generate many rows in the Apply trail table. The default wait period is 300 seconds (5 minutes).                                                                                       |
| COPYONCE            | The Apply program executes one copy cycle for each subscription set that is eligible at the time the Apply program is invoked, and then the Apply program terminates. An eligible subscription set is such that: <ul style="list-style-type: none"> <li>• ACTIVATE &gt; 0</li> <li>• REFRESH_TIMING = R or B or REFRESH_TIMING = E and the specified event has occurred.</li> </ul> MAX_SYNCH_MINUTES and END_OF_PERIOD are honored if specified. |
| LOGREUSE            | The Apply program reuses the log file (*.app) by first deleting it and then re-creating it when the Apply program is restarted. If you do not specify this option, the Apply program appends messages to the log file, even after the Apply program is restarted.                                                                                                                                                                                 |
| LOGSTDOUT           | The Apply program sends all messages to both the standard output (stdout) and the log file.                                                                                                                                                                                                                                                                                                                                                       |
| TRLREUSE            | The Apply program empties the Apply trail table when the Apply program is started.                                                                                                                                                                                                                                                                                                                                                                |

## Scheduling Apply for Windows and OS/2

**For Windows:** Use the Windows **AT** command to start the Apply program at a specific time. Before you enter the **AT** command, the Windows Schedule Service should already be started. For example, the following command string starts the Apply program for Windows at 15:00 (3:00 p.m.):

```
c:\>AT 15:00 /interactive "c:\SQLLIB\BIN\db2cmd.exe
c:\SQLLIB\BIN\asnapply.exe qualid1 cntldb"
```

**For OS/2:** Use the Alarms program in the OS/2 Productivity set to start the Apply program at a specific time.

## Stopping Apply for Windows and OS/2

Use the **ASNASTOP** command or a key combination to stop the Apply program in an orderly way.

To stop the Apply program, perform the following steps from a window where the Apply program is not running:

1. Set environment variable DB2INSTANCE to the value set when the Apply program was started.
2. Set environment variable DB2DBDFT to the source server specified when the Apply program was started (or the DB2DBDFT value used when the Apply program was started).
3. Enter the command.

▶▶—ASNASTOP—*Apply\_qualifier*—▶▶

### Replicating on demand (Windows 32-bit operating systems only)

On Windows 32-bit operating systems, you can use the **ASNSAT** command to replicate on demand. This command starts the Apply program and, if there are any rows in the registration table, it also starts the Capture program. (You cannot choose whether to start Apply only, Capture only, or both programs.) When the Capture program is started by **ASNSAT**, it runs on the same server as the Apply program. Each program self-terminates after it completes its part of the replication cycle.

The optional Capture and Apply parameters for this command are optimized for the satellite environment. For details on using the **ASNSAT** command in a satellite environment, see *Administering Satellites Guide and Reference*. You can override the optional parameters for the Capture and Apply programs if you want to use the command in a non-satellite environment.

The syntax of the **ASNSAT** command is as follows:

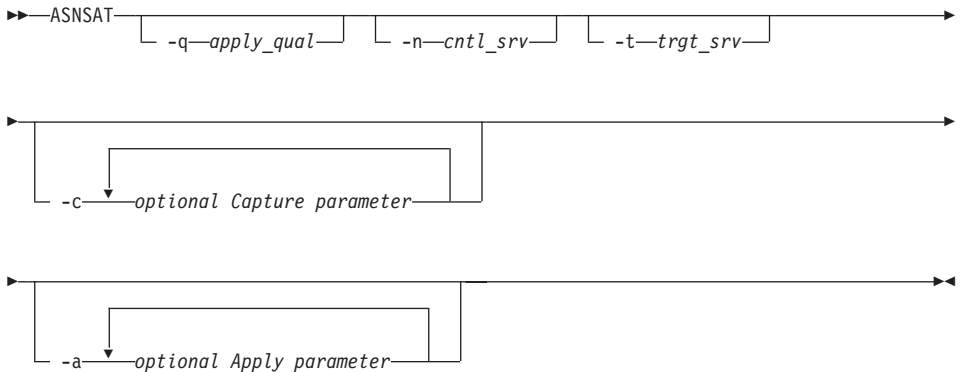


Table 32. ASNSAT options and invocation parameter definitions (only for Windows 32-bit operating systems)

| Option               | Definition                                                                                                                                                                                                                                                              |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -q <i>apply_qual</i> | Specifies the Apply qualifier that the Apply program instance uses to identify the subscriptions to be served. The Apply qualifier is case sensitive and must match the value of the APPLY_QUAL column in the subscription set table. This must be the first parameter. |
| -n <i>cntl_serv</i>  | Specifies the name of the server where the replication control tables will reside. If you do not specify this parameter, the default is the default database or the value of DB2DBDFT.                                                                                  |
| -t <i>trgt_serv</i>  | Specifies the name of the server where the target tables will reside.                                                                                                                                                                                                   |
| -c                   | Specifies the optional invocation parameters for the Capture program. If you do not specify this option, the ASNSAT command uses the following defaults: warm, prune, notrace, logreuse, logstdout, trcfile, notrctbl, and autostop.                                    |
| -a                   | Specifies the optional invocation parameters for the Apply program. If you do not specify this option, the ASNSAT command uses the following defaults: noinam, notrc, nonotify, logreuse, logstdout, trcfile, trlreuse, copyonce, loadx.                                |

For more information about Capture and Apply parameters, see Table 30 on page 270 and Table 31 on page 276 respectively.

## Using DB2 DataPropagator for Microsoft Jet

DataPropagator for Microsoft Jet supports Microsoft Access and Microsoft Jet databases in LAN, occasionally connected, and mobile environments. Without any programming, you can replicate your server data into Microsoft Access tables for both browsing and updating.

DataPropagator for Microsoft Jet is a single executable that contains both the Capture and Apply capability and a portion of the administration facility. DataPropagator for Microsoft Jet runs on a client machine under Microsoft Windows NT or Windows 95, and reaches source databases via DB2 Client Application Enabler (CAE). DataPropagator for Microsoft Jet is packaged as part of DB2 DataJoiner Version 2 Release 2.1.1 (although you do not need to install a DB2 DataJoiner server to use this software) but also works with DB2 Universal Database (DB2 UDB), DB2 Common Server V2, and DB2 Connect. DataPropagator for Microsoft Jet requires the DataJoiner Replication Administration tool (DJRA) at the control point.

DataPropagator for Microsoft Jet replicates relational tables to and from Microsoft Jet databases, and detects and records any update conflicts (using the Microsoft Jet replication model). The *source server* can be DB2 or any

non-DB2 replication sources defined through DB2 DataJoiner. The *control server* must be a DB2 or DB2 DataJoiner database.

Figure 22 illustrates how DataPropagator for Microsoft Jet supports replication of Microsoft Access and Microsoft Jet databases.

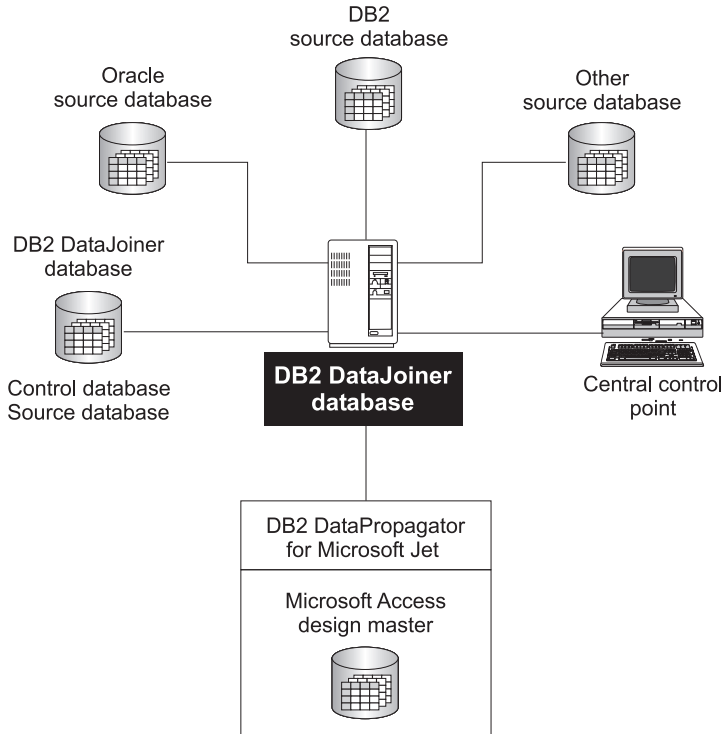


Figure 22. Microsoft Jet database replication. DataPropagator for Microsoft Jet extends IBM's data replication solution by supporting Microsoft Access and Microsoft Jet databases.

### The advantages of using DataPropagator for Microsoft Jet

A small DBMS with a replicated *subset* of a larger corporate database enables service employees and mobile professionals to run meaningful desktop applications while disconnected from a server network. These users connect to their corporate network only occasionally, and usually only long enough to synchronize their desktop database, e-mail, and messaging services with the corporate servers. For more information about subsets, see "Subsetting columns and rows" on page 70.

DataPropagator for Microsoft Jet administration doesn't require a direct connection to a Microsoft Jet database for administration. DJRA maintains control information in the control server database. DataPropagator for Microsoft Jet running on a laptop is able to create Microsoft Jet databases,

tables, and additional columns, and drop tables and old columns based on the current state of the control information in the server. To deploy a Microsoft Jet application, the application, database, and replication software must be installed before you distribute the laptop computers. However, the Microsoft Jet database does not need to be created in advance.

You can define or redefine replication source and subscription definitions for a Microsoft Jet database at any time, using DJRA, before or after you distribute the laptops for asynchronous processing by DataPropagator for Microsoft Jet.

If you have problems with your laptop, you can rebuild your Microsoft Jet database, tables, and contents by deleting the Jet database and resynchronizing using DataPropagator for Microsoft Jet. DataPropagator for Microsoft Jet can automatically rebuild your database.

For more information about usage scenarios involving mobile replication, see “Occasionally connected” on page 22.

### **Data integrity considerations**

Within a network of DB2 databases, DB2 DataPropagator supports an *update-anywhere* model that is able to detect transaction conflicts. DataPropagator for Microsoft Jet supports an update-anywhere model, but with *weaker* row-conflict detection (similar to the standard Microsoft Jet model). If you choose to use DataPropagator for Microsoft Jet, you should be both familiar and comfortable with the standard Microsoft Jet replication model.

DataPropagator for Microsoft Jet reports synchronization conflicts in *conflict tables* in a very similar way to the built-in Microsoft Jet replication feature. This process can result in a loss of updates. If you use the single-user version of the DB2 Universal Database server on your laptop, for example, your application is assured of all-or-nothing transaction semantics when synchronizing with corporate servers. However, if you use Microsoft Jet as your mobile database, synchronization conflicts are handled on a row-by-row basis, so updates might be lost. Therefore, some updates might be flagged as conflicting while other updates propagate to the corporate database. If this situation is not acceptable, you need to program your own resolutions for all potential update conflicts. For more information about how DataPropagator for Microsoft Jet handles conflict errors, see “Error recovery” on page 288. For more information about programming your own resolutions, refer to the appropriate Microsoft documentation.

### **Terminology for DataPropagator for Microsoft Jet replication**

The following terms represent replication concepts as they pertain to Microsoft Jet database replication. For definitions of general replication terms, see “Glossary” on page 407.



**Client** The Windows NT or Windows 95 machine on which DataPropagator for Microsoft Jet is installed.

### **Design Master**

In Microsoft Jet database replication, the original database, which is saved as the master database. Each subsequent copy of the Microsoft Jet database maintained by Microsoft Jet replication on another server is called a Replica.

### **Row-replica**

A type of update-anywhere replica maintained by DataPropagator for Microsoft Jet. Conflicts are detected row by row, not transaction by transaction, as they are for replicas. Row-replica is the only target table type supported by DataPropagator for Microsoft Jet. The source table type can be a DB2, Oracle, Sybase, Informix, or Microsoft SQL Server user table, or a DB2 replica. The source can also be a view of a DB2 user table or replica, including a join view with the restriction that all copied columns must come from only one of the tables referenced in the source view. The other columns in the source view can be referenced in the subscription predicates, but cannot be included in the row-replica.

## **Setting up DataPropagator for Microsoft Jet replication**

To prepare the replication environment, you need to prepare the replication sources, control servers, and client environment. The following sections provide instructions for preparing your replication environment.

### **Preparing the replication source and control servers**

You prepare the server to use DataPropagator for Microsoft Jet just as you would for DB2 DataPropagator. To prepare the server:

1. Create the necessary replication control tables at the control server by using DJRA.
2. Define replication sources by defining the source tables on each source server by using DJRA.
3. Define subscription sets by using DJRA. From the Create Empty Subscription Sets window, select the **Microsoft Jet** check box and enter the Microsoft Jet target server name. The target server name must be different from the control server name in this case.
4. Start the Capture program for each DB2 source server, if applicable.

### **Preparing the client environment**

To prepare the client, install the following software (if it is not already installed):

1. Install DB2 Client Application Enabler (CAE) and configure DB2 connectivity to the source and control servers for the appropriate communication protocols.

2. Configure the DB2 ODBC driver by using the DB2 Client Configuration Assistant window.
3. Install either one of the following:
  - Microsoft Data Access Components (MDAC)
  - Microsoft Access
4. Install the DAO component (downloadable from <http://www.nesbitt.com/bctech.html> or available on the Microsoft Visual C++ Version 5 CD-ROM).
5. Install DataPropagator for Microsoft Jet (during DB2 DataJoiner installation).
  - During installation you will be prompted to set the ASNJETPATH environment variable to specify the directory where DataPropagator for Microsoft Jet can create the log, trace, and password files. The file names are:
    - *Apply\_qual*.LOG. Created by DataPropagator for Microsoft Jet.
    - *Apply\_qual*.TRC. Created by DataPropagator for Microsoft Jet.
    - *Apply\_qual*.PWD. Created by DataPropagator for Microsoft Jet.

DataPropagator for Microsoft Jet also creates the target database in this directory if it does not already exist.

  - Define the Microsoft Jet database source in the ODBC Data Source Administration window, if it is not already defined.

**Providing end-user authentication:** If the source or control server requires authentication, create a password file.

*To create a password file:*

The password file must meet the following criteria:

- Be named *APPLY\_QUAL.PWD*  
 Where: *APPLY\_QUAL* is the Apply qualifier, in uppercase. You specify a value for the Apply qualifier when you define a subscription set.  
 For example: *DATADIR.PWD*  
 Where: *DATADIR* is the Apply qualifier of the subscription set defined at the control server.
- Reside in the directory that is specified by *ASNJETPATH*.
- Contain all server-name/password pairs. This enables you to have a different (or the same) password at each server.
- Have one or more records that use the following format:  
*SERVER=server\_name PWD=password USER=userid*

The file cannot include blank lines or comment lines.

For more information about authentication and security, refer to the *DataJoiner Administration Supplement*.

## Operating DataPropagator for Microsoft Jet

You can use the commands in this section to operate DataPropagator for Microsoft Jet.

This section explains how to perform the following tasks:

- Starting the Capture program at the source server
- Starting DataPropagator for Microsoft Jet at the client
- Stopping DataPropagator for Microsoft Jet at the client
- Troubleshooting DataPropagator for Microsoft Jet at the client

### Starting the Capture program at the source server

Before you start DataPropagator for Microsoft Jet, you must start the Capture program on each DB2 source server, if applicable.

### Starting DataPropagator for Microsoft Jet

Before you start DataPropagator for Microsoft Jet, you must establish any required line or LAN connection. DataPropagator for Microsoft Jet does not directly manage telephone connections, so you need to dial up the server manually or use any software that provides auto-dialing to establish a connection before you call DataPropagator for Microsoft Jet to perform database synchronization.

To start DataPropagator for Microsoft Jet, use the ASNJET command. Enter the ASNJET command from a command prompt.

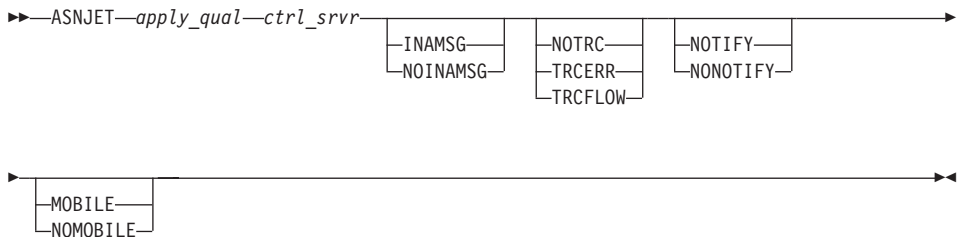


Table 33 defines the parameters.

*Table 33. ASNJET command parameter definitions for DataPropagator for Microsoft Jet*

| Parameter         | Definition                                                          |
|-------------------|---------------------------------------------------------------------|
| <i>apply_qual</i> | Specifies the Apply qualifier that uniquely identifies this client. |
| <i>ctrl_srvr</i>  | Specifies the control server alias.                                 |

Table 33. ASNJET command parameter definitions for DataPropagator for Microsoft Jet (continued)

| Parameter          | Definition                                                                                                                                                                                                                             |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| INAMSG             | Specifies that DataPropagator for Microsoft Jet issue an inactivity message to the log whenever DataPropagator for Microsoft Jet is going to sleep until the next copy cycle. This option is ignored if you specify the MOBILE option. |
| NOINAMSG (default) | Specifies that no inactivity message is issued.                                                                                                                                                                                        |
| NOTRC (default)    |                                                                                                                                                                                                                                        |
| TRCERR             | Specifies that a trace file of minimal information is created.                                                                                                                                                                         |
| TRCFLOW            | Specifies that a trace file of extensive information is created.                                                                                                                                                                       |
| NOTIFY             | Specifies that DataPropagator for Microsoft Jet call the ASNJDONE exit routine at the completion of each subscription set, regardless of success or failure.                                                                           |
| NONOTIFY (default) | Specifies that DataPropagator for Microsoft Jet does not call the ASNJDONE exit routine.                                                                                                                                               |
| MOBILE             | Specifies that DataPropagator for Microsoft Jet run in mobile mode (copy all active subscriptions only once, and then terminate).                                                                                                      |
| NOMOBILE (default) | Specifies that DataPropagator for Microsoft Jet run continuously until it is stopped with the ASNJSTOP command.                                                                                                                        |

**Example 1:** If you enter the following command from a command prompt, DataPropagator for Microsoft Jet is invoked with the Apply qualifier *MYQUAL*, the control server is *CNTLSRVR*, no inactivity message is generated, no trace is produced, the ASNJDONE exit routine is not called, and the active subscriptions are copied only once and then the program exits.

```
ASNJET MYQUAL CNTLSRVR MOBILE
```

**Example 2:** If you enter the following command from a command prompt, DataPropagator for Microsoft Jet is invoked with the Apply qualifier *AQ2*, the control server is *CNTLSRV*, an extensive trace is produced, and the program runs continuously until you stop it with the ASNJSTOP command.

```
ASNJET AQ2 CNTLSRV TRCFLOW NOMOBILE
```

### Stopping DataPropagator for Microsoft Jet

When you start DataPropagator for Microsoft Jet using the MOBILE option, it runs until all active subscriptions are processed, and then terminates by itself. If you want to stop DataPropagator for Microsoft Jet, you can use the

**ASNJSTOP** command to stop the program in an orderly way as soon as the current subscription set is copied and commit the log records processed up to that point.

Use the following command to stop DataPropagator for Microsoft Jet. Enter the ASNJSTOP command from a command prompt.

▶—ASNJSTOP—*apply\_qual*—————▶

Where *apply\_qual* is the Apply qualifier that you used when you started DataPropagator for Microsoft Jet with the ASNJET command.

**Example:** If you enter the following command from a command prompt, DataPropagator for Microsoft Jet stops processing the Apply qualifier MQUAL as soon as the current subscription set is processed.

```
ASNJSTOP MYQUAL
```

You can also use one of the following key combinations from the window where the program is running to stop DataPropagator for Microsoft Jet:

- Ctrl+C
- Ctrl+Break

### **Troubleshooting DataPropagator for Microsoft Jet**

If you encounter errors when you run ASNJET, ensure that:

- All replication sources and subscriptions are defined.
- The Capture program is started on the source server, if applicable.
- The control server and source server are defined as ODBC data sources.
- You supplied a password file in the ASNJETPATH directory.
- If you opened and updated a row-replica target table through Microsoft Access, you closed the table.

For error message information, see “Chapter 15. Capture and Apply messages” on page 353. For more information about troubleshooting, see “Troubleshooting” on page 166.

### **Returning control to users with the ASNJDONE exit routine**

If you specify the NOTIFY parameter when you start DataPropagator for Microsoft Jet with the **ASNJET** command, DataPropagator for Microsoft Jet calls the exit routine ASNJDONE at the completion of each subscription set, regardless of success or failure. ASNJDONE.SMP is a sample program shipped with the product. You can modify it to meet the requirements of your installation. For example, the exit routine can examine the error table to discover rejected updates and initiate further actions, such as issuing a message or generating an alert.

See the prologue section in the sample exit routine ASNJDONE.SMP for instructions on how to modify the sample.

### **Parameters**

The parameters that DataPropagator for Microsoft Jet passes to ASNJDONE are:

#### **Control server**

The control server alias.

#### **Set name**

The name of the set just processed.

#### **Apply qualifier**

The Apply qualifier of this DataPropagator for Microsoft Jet instance.

#### **Trace option**

The trace option specified when DataPropagator for Microsoft Jet was started.

#### **Status value**

Set to a value of 0 for success, and -1 for failure.

### **Error recovery**

If the status value that DataPropagator for Microsoft Jet passes to ASNJDONE is -1, conflicts or errors might have been recorded. You can set the exit routine to examine the error codes and messages in the error message table. (There can be more than one row in the error message table.)

When DataPropagator for Microsoft Jet detects an update conflict between the RDBMS source and row-replica target table, it saves additional information for the ASNJDONE exit routine as follows:

- Inserts a row into the conflict table. (This is not the same conflict table that Microsoft Jet might detect between the Design Master and its Microsoft Jet Replicas.) The conflict table contains the row data that conflicted with the RDBMS update.
- Places the names of the conflict tables in the side information table. Each Microsoft Jet target table has its own conflict table. If a conflict is detected, the update to the row-replica loses while the source server update wins.

For other errors, such as referential integrity checks, DataPropagator for Microsoft Jet places additional information in the error information table, if applicable, to identify the row-replica table and the row that caused the error.

The exit routine can use this information to take remedial action. When the exit routine returns, the status is still -1 in the subscription set table. DataPropagator for Microsoft Jet does not expect any output or return codes from the exit routine.

## **DataPropagator for Microsoft Jet control tables**

DataPropagator for Microsoft Jet requires the following new control tables, in addition to the existing DB2 DataPropagator control tables. For details about the column and index definitions for each of these new control tables, see “Chapter 14. Table structures” on page 293.

### **Control server tables**

#### **Row-replica-target-list table**

Maintains the names of the row replica tables. This allows DataPropagator for Microsoft Jet to maintain a list of known row-replica tables in a stable DB2 or DB2 DataJoiner database. DataPropagator for Microsoft Jet uses this information during schema analysis to determine which, if any, row-replica tables should be deleted because the corresponding subscription member was dropped since the last synchronization.

#### **Subscription-schema-changes table**

Signals modifications to a subscription.

### **Target server tables**

#### **Conflict table**

This table (one per target table, as needed at the target server) contains row data for DataPropagator for Microsoft Jet-detected conflict losers. If there is a conflict between the same row in the Microsoft Jet database (target server) and the source server, the row in the Microsoft Jet database “loses,” so it is added to the conflict table and replaced by the row in the source.

#### **Error information table**

Contains additional information to identify the row-replica table and row that caused an error.

#### **Error messages table**

Contains error codes and error messages.

#### **Error-side-information table**

Contains the names of the conflict tables.

#### **Key string table**

Maps Microsoft Jet table identifiers and row identifiers to primary key values.

#### **Synchronization generations table**

Used to prevent cyclic updates from propagating back to the RDBMS from a Microsoft Jet database.





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## Part 4. Reference information

This part of the book contains the following chapters:

“Chapter 14. Table structures” on page 293 describes the source, control, and target table structures.

“Chapter 15. Capture and Apply messages” on page 353 lists all of the messages issued by all the Capture and Apply programs except those on the AS/400 platform.

“Chapter 16. Replication messages for AS/400” on page 381 lists all of the messages for data replication on the AS/400 platform.



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## Chapter 14. Table structures

This chapter describes the relational database tables that are used for replication.

Table 34 on page 296, Table 35 on page 298, and Table 36 on page 299 provide brief descriptions of the tables listed in this chapter. When you become familiar with the tables, you can use Figure 23 on page 294 and Figure 24 on page 295 as a quick reference for the source and control server tables, table keys, and their parameters.

**Important:** You must *not* use SQL to update some of the control tables (see particular table descriptions for details). Altering control tables inappropriately can cause problems such as unexpected results, loss of data, and reduced replication performance.

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### Tables at a glance

Figure 23 on page 294 and Figure 24 on page 295 show the tables at the source and control servers, table keys, and their parameters.

## Control tables used at the source server

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                 |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
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| <p><b>ASN.IBMSNAP_TRACE</b><br/>(no primary key)</p> <table> <tr> <td>OPERATION</td> <td>CHAR (8) NOT NULL</td> </tr> <tr> <td>TRACE_TIME</td> <td>TIMESTAMP NOT NULL</td> </tr> <tr> <td>DESCRIPTION</td> <td>VARCHAR (254) NOT NULL</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | OPERATION                       | CHAR (8) NOT NULL      | TRACE_TIME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | TIMESTAMP NOT NULL | DESCRIPTION                     | VARCHAR (254) NOT NULL | <p><b>ASN.IBMSNAP_CCPPARMS</b><br/>(no primary key)</p> <table> <tr> <td>RETENTION_LIMIT</td> <td>INT</td> </tr> <tr> <td>LAC_LIMIT</td> <td>INT</td> </tr> <tr> <td>COMMIT_INTERVAL</td> <td>INT</td> </tr> <tr> <td>PRUNE_INTERVAL</td> <td>INT</td> </tr> </table> | RETENTION_LIMIT   | INT                | LAC_LIMIT         | INT                                                                                                                                | COMMIT_INTERVAL   | INT                | PRUNE_INTERVAL    | INT                            |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
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| PRUNE_INTERVAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | INT                             |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| <p><b>ASN.IBMSNAP_WARM_START</b><br/>(no primary key)</p> <table> <tr> <td>SEQ</td> <td>CHAR (10) FOR BIT DATA</td> </tr> <tr> <td>AUTHTKN</td> <td>CHAR (12)</td> </tr> <tr> <td>AUTHID</td> <td>CHAR (18)</td> </tr> <tr> <td>CAPTURED</td> <td>CHAR (1)</td> </tr> <tr> <td>UOWTIME</td> <td>INT</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | SEQ                             | CHAR (10) FOR BIT DATA | AUTHTKN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | CHAR (12)          | AUTHID                          | CHAR (18)              | CAPTURED                                                                                                                                                                                                                                                              | CHAR (1)          | UOWTIME            | INT               | <p><b>ASN.IBMSNAP_CRITSEC</b><br/>(no primary key)</p> <table> <tr> <td>APPLY_QUAL</td> <td>CHAR (18) NOT NULL</td> </tr> </table> | APPLY_QUAL        | CHAR (18) NOT NULL |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SEQ                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | CHAR (10) FOR BIT DATA          |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| AUTHTKN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | CHAR (12)                       |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| AUTHID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | CHAR (18)                       |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| CAPTURED                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | CHAR (1)                        |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| UOWTIME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | INT                             |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| APPLY_QUAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CHAR (18) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| <p><b>ASN.IBMSNAP_REGISTER</b><br/>(SOURCE_OWNER, SOURCE_TABLE, SOURCE_VIEW_QUAL)</p> <table> <tr> <td>SOURCE_OWNER</td> <td>CHAR (18) NOT NULL</td> </tr> <tr> <td>SOURCE_TABLE</td> <td>CHAR (18) NOT NULL</td> </tr> <tr> <td>SOURCE_VIEW_QUAL</td> <td>SMALLINT NOT NULL</td> </tr> <tr> <td>GLOBAL_RECORD</td> <td>CHAR (1) NOT NULL</td> </tr> <tr> <td>SOURCE_STRUCTURE</td> <td>SMALLINT NOT NULL</td> </tr> <tr> <td>SOURCE_CONDENSED</td> <td>CHAR (1) NOT NULL</td> </tr> <tr> <td>SOURCE_COMPLETE</td> <td>CHAR (1) NOT NULL</td> </tr> <tr> <td>CD_OWNER</td> <td>CHAR (18)</td> </tr> <tr> <td>CD_TABLE</td> <td>CHAR (18)</td> </tr> <tr> <td>PHYS_CHANGE_OWNER</td> <td>CHAR (18)</td> </tr> <tr> <td>PHYS_CHANGE_TABLE</td> <td>CHAR (18)</td> </tr> <tr> <td>CD_OLD_SYNCHPOINT</td> <td>CHAR (10) FOR BIT DATA</td> </tr> <tr> <td>CD_NEW_SYNCHPOINT</td> <td>CHAR (10) FOR BIT DATA</td> </tr> <tr> <td>DISABLE_REFRESH</td> <td>SMALLINT NOT NULL</td> </tr> <tr> <td>CCD_OWNER</td> <td>CHAR (18)</td> </tr> <tr> <td>CCD_TABLE</td> <td>CHAR (18)</td> </tr> <tr> <td>CCD_OLD_SYNCHPOINT</td> <td>CHAR (10) FOR BIT DATA</td> </tr> <tr> <td>SYNCHPOINT</td> <td>CHAR (10) FOR BIT DATA</td> </tr> <tr> <td>SYNCHTIME</td> <td>TIMESTAMP</td> </tr> <tr> <td>CCD_CONDENSED</td> <td>CHAR (1)</td> </tr> <tr> <td>CCD_COMPLETE</td> <td>CHAR (1)</td> </tr> <tr> <td>ARCH_LEVEL</td> <td>CHAR (4) NOT NULL</td> </tr> <tr> <td>DESCRIPTION</td> <td>CHAR(254)</td> </tr> <tr> <td>BEFORE_IMG_PREFIX</td> <td>VARCHAR (4)</td> </tr> <tr> <td>CONFLICT_LEVEL</td> <td>CHAR (1)</td> </tr> <tr> <td>PARTITION_KEYS_CHG</td> <td>CHAR (1)</td> </tr> </table> | SOURCE_OWNER                    | CHAR (18) NOT NULL     | SOURCE_TABLE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | CHAR (18) NOT NULL | SOURCE_VIEW_QUAL                | SMALLINT NOT NULL      | GLOBAL_RECORD                                                                                                                                                                                                                                                         | CHAR (1) NOT NULL | SOURCE_STRUCTURE   | SMALLINT NOT NULL | SOURCE_CONDENSED                                                                                                                   | CHAR (1) NOT NULL | SOURCE_COMPLETE    | CHAR (1) NOT NULL | CD_OWNER                       | CHAR (18)          | CD_TABLE                        | CHAR (18) | PHYS_CHANGE_OWNER | CHAR (18) | PHYS_CHANGE_TABLE | CHAR (18) | CD_OLD_SYNCHPOINT | CHAR (10) FOR BIT DATA | CD_NEW_SYNCHPOINT | CHAR (10) FOR BIT DATA | DISABLE_REFRESH | SMALLINT NOT NULL | CCD_OWNER | CHAR (18) | CCD_TABLE | CHAR (18) | CCD_OLD_SYNCHPOINT | CHAR (10) FOR BIT DATA | SYNCHPOINT | CHAR (10) FOR BIT DATA | SYNCHTIME | TIMESTAMP | CCD_CONDENSED | CHAR (1) | CCD_COMPLETE | CHAR (1) | ARCH_LEVEL | CHAR (4) NOT NULL | DESCRIPTION | CHAR(254) | BEFORE_IMG_PREFIX | VARCHAR (4) | CONFLICT_LEVEL | CHAR (1) | PARTITION_KEYS_CHG | CHAR (1) | <p><b>ASN.IBMSNAP_PRUNCNTL</b><br/>(SOURCE_OWNER, SOURCE_TABLE, SOURCE_VIEW_QUAL, APPLY_QUAL, SET_NAME, TARGET_SERVER, TARGET_TABLE, TARGET_OWNER)</p> <table> <tr> <td>TARGET_SERVER</td> <td>CHAR (18) NOT NULL</td> </tr> <tr> <td>TARGET_OWNER</td> <td>CHAR (18) NOT NULL</td> </tr> <tr> <td>TARGET_TABLE</td> <td>CHAR (18) NOT NULL</td> </tr> <tr> <td>SYNCHTIME</td> <td>TIMESTAMP</td> </tr> <tr> <td>SYNCHPOINT</td> <td>CHAR (10) FOR BIT DATA</td> </tr> <tr> <td>SOURCE_OWNER</td> <td>CHAR (18) NOT NULL</td> </tr> <tr> <td>SOURCE_TABLE</td> <td>CHAR (18) NOT NULL</td> </tr> <tr> <td>SOURCE_VIEW_QUAL</td> <td>SMALLINT NOT NULL</td> </tr> <tr> <td>APPLY_QUAL</td> <td>CHAR (18) NOT NULL</td> </tr> <tr> <td>SET_NAME</td> <td>CHAR (18) NOT NULL</td> </tr> <tr> <td>CNTL_SERVER</td> <td>CHAR (18) NOT NULL</td> </tr> <tr> <td>TARGET_STRUCTURE</td> <td>SMALLINT NOT NULL</td> </tr> <tr> <td>CNTL_ALIAS</td> <td>CHAR (8)</td> </tr> </table> | TARGET_SERVER | CHAR (18) NOT NULL | TARGET_OWNER | CHAR (18) NOT NULL | TARGET_TABLE | CHAR (18) NOT NULL | SYNCHTIME | TIMESTAMP | SYNCHPOINT | CHAR (10) FOR BIT DATA | SOURCE_OWNER | CHAR (18) NOT NULL | SOURCE_TABLE | CHAR (18) NOT NULL | SOURCE_VIEW_QUAL | SMALLINT NOT NULL | APPLY_QUAL | CHAR (18) NOT NULL | SET_NAME | CHAR (18) NOT NULL | CNTL_SERVER | CHAR (18) NOT NULL | TARGET_STRUCTURE | SMALLINT NOT NULL | CNTL_ALIAS | CHAR (8) |
| SOURCE_OWNER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | CHAR (18) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SOURCE_TABLE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | CHAR (18) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SOURCE_VIEW_QUAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | SMALLINT NOT NULL               |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| GLOBAL_RECORD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | CHAR (1) NOT NULL               |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SOURCE_STRUCTURE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | SMALLINT NOT NULL               |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SOURCE_CONDENSED                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | CHAR (1) NOT NULL               |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SOURCE_COMPLETE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | CHAR (1) NOT NULL               |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| CD_OWNER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | CHAR (18)                       |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| CD_TABLE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | CHAR (18)                       |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| PHYS_CHANGE_OWNER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | CHAR (18)                       |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| PHYS_CHANGE_TABLE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | CHAR (18)                       |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| CD_OLD_SYNCHPOINT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | CHAR (10) FOR BIT DATA          |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| CD_NEW_SYNCHPOINT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | CHAR (10) FOR BIT DATA          |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| DISABLE_REFRESH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | SMALLINT NOT NULL               |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
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| CCD_OLD_SYNCHPOINT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | CHAR (10) FOR BIT DATA          |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SYNCHPOINT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CHAR (10) FOR BIT DATA          |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SYNCHTIME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | TIMESTAMP                       |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| CCD_CONDENSED                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | CHAR (1)                        |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| CCD_COMPLETE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | CHAR (1)                        |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| ARCH_LEVEL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CHAR (4) NOT NULL               |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | CHAR(254)                       |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| BEFORE_IMG_PREFIX                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | VARCHAR (4)                     |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| CONFLICT_LEVEL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | CHAR (1)                        |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| PARTITION_KEYS_CHG                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | CHAR (1)                        |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| TARGET_SERVER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | CHAR (18) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| TARGET_OWNER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | CHAR (18) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| TARGET_TABLE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | CHAR (18) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SYNCHTIME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | TIMESTAMP                       |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SYNCHPOINT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CHAR (10) FOR BIT DATA          |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SOURCE_OWNER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | CHAR (18) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SOURCE_TABLE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | CHAR (18) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SOURCE_VIEW_QUAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | SMALLINT NOT NULL               |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| APPLY_QUAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CHAR (18) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| SET_NAME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | CHAR (18) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| CNTL_SERVER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | CHAR (18) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| TARGET_STRUCTURE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | SMALLINT NOT NULL               |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| CNTL_ALIAS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CHAR (8)                        |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| <p><b>ASN.IBMSNAP_PRUNE_LOCK</b><br/>(no primary key)</p> <table> <tr> <td>DUMMY</td> <td>CHAR (1)</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | DUMMY                           | CHAR (1)               | <p><b>ASN.IBMSNAP_UOW</b><br/>(IBMSNAP_COMMITSEQ ASC, IBMSNAP_UOWID ASC, IBMSNAP_LOGMAKER ASC)</p> <table> <tr> <td>IBMSNAP_UOWID</td> <td>CHAR (10) FOR BIT DATA NOT NULL</td> </tr> <tr> <td>IBMSNAP_COMMITSEQ</td> <td>CHAR (10) FOR BIT DATA NOT NULL</td> </tr> <tr> <td>IBMSNAP_LOGMARKER</td> <td>TIMESTAMP NOT NULL</td> </tr> <tr> <td>IBMSNAP_AUTHTKN</td> <td>CHAR (12) NOT NULL</td> </tr> <tr> <td>IBMSNAP_AUTHID</td> <td>CHAR (18) NOT NULL</td> </tr> <tr> <td>IBMSNAP_REJ_CODE</td> <td>CHAR (1) NOT NULL WITH DEFAULT</td> </tr> <tr> <td>IBMSNAP_APPLY_QUAL</td> <td>CHAR (18) NOT NULL WITH DEFAULT</td> </tr> </table> | IBMSNAP_UOWID      | CHAR (10) FOR BIT DATA NOT NULL | IBMSNAP_COMMITSEQ      | CHAR (10) FOR BIT DATA NOT NULL                                                                                                                                                                                                                                       | IBMSNAP_LOGMARKER | TIMESTAMP NOT NULL | IBMSNAP_AUTHTKN   | CHAR (12) NOT NULL                                                                                                                 | IBMSNAP_AUTHID    | CHAR (18) NOT NULL | IBMSNAP_REJ_CODE  | CHAR (1) NOT NULL WITH DEFAULT | IBMSNAP_APPLY_QUAL | CHAR (18) NOT NULL WITH DEFAULT |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| DUMMY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | CHAR (1)                        |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| IBMSNAP_UOWID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | CHAR (10) FOR BIT DATA NOT NULL |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| IBMSNAP_COMMITSEQ                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | CHAR (10) FOR BIT DATA NOT NULL |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| IBMSNAP_LOGMARKER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | TIMESTAMP NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| IBMSNAP_AUTHTKN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | CHAR (12) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| IBMSNAP_AUTHID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | CHAR (18) NOT NULL              |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| IBMSNAP_REJ_CODE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | CHAR (1) NOT NULL WITH DEFAULT  |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| IBMSNAP_APPLY_QUAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | CHAR (18) NOT NULL WITH DEFAULT |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| <p><b>ASN.IBMSNAP_REG_SYNCH</b><br/>(no primary key)</p> <table> <tr> <td>TRIGGER_ME</td> <td>CHAR (1) NOT NULL</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | TRIGGER_ME                      | CHAR (1) NOT NULL      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| TRIGGER_ME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CHAR (1) NOT NULL               |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| <p><b>Used by the Capture program</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                 |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| <p><b>Used by the Capture and Apply programs</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                 |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |
| <p><b>Used by Capture triggers</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                 |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                 |                        |                                                                                                                                                                                                                                                                       |                   |                    |                   |                                                                                                                                    |                   |                    |                   |                                |                    |                                 |           |                   |           |                   |           |                   |                        |                   |                        |                 |                   |           |           |           |           |                    |                        |            |                        |           |           |               |          |              |          |            |                   |             |           |                   |             |                |          |                    |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |              |                    |              |                    |           |           |            |                        |              |                    |              |                    |                  |                   |            |                    |          |                    |             |                    |                  |                   |            |          |

Figure 23. Tables used at the source server. The tables used by the Capture program, Apply program, and Capture triggers at the source server.

## Control tables used at the control server by the Apply program

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| <p><b>ASN.IBMSNAP_APPLYTRAIL</b><br/>(no primary key)</p> <table> <tr><td>APPLY_QUAL</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>SET_NAME</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>WHOS_ON_FIRST</td><td>CHAR (1) NOT NULL</td></tr> <tr><td>ASNLOAD</td><td>CHAR (1)</td></tr> <tr><td>MASS_DELETE</td><td>CHAR (1)</td></tr> <tr><td>EFFECTIVE_MEMBERS</td><td>INT</td></tr> <tr><td>SET_INSERTED</td><td>INT NOT NULL</td></tr> <tr><td>SET_DELETED</td><td>INT NOT NULL</td></tr> <tr><td>SET_UPDATED</td><td>INT NOT NULL</td></tr> <tr><td>SET_REWORKED</td><td>INT NOT NULL</td></tr> <tr><td>SET_REJECTED_TRXS</td><td>INT NOT NULL</td></tr> <tr><td>STATUS</td><td>SMALLINT NOT NULL</td></tr> <tr><td>LASTRUN</td><td>TIMESTAMP NOT NULL</td></tr> <tr><td>LASTSUCCESS</td><td>TIMESTAMP</td></tr> <tr><td>SYNCHPOINT</td><td>CHAR (10) FOR BIT DATA</td></tr> <tr><td>SYNCHTIME</td><td>TIMESTAMP</td></tr> <tr><td>SOURCE_SERVER</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>SOURCE_ALIAS</td><td>CHAR 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TARGET_OWNER | CHAR (18) NOT NULL | TARGET_TABLE | CHAR (18) NOT NULL | SQLSTATE | CHAR (5) | SQLCODE | INTEGER | SQLERRP | CHAR (8) | SQLERRM | VARCHAR (70) | APPERRM | VARCHAR (760) | <p><b>ASN.IBMSNAP_SUBS_SET</b><br/>(APPLY_QUAL, SET_NAME, WHOS_ON_FIRST)</p> <table> <tr><td>APPLY_QUAL</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>SET_NAME</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>WHOS_ON_FIRST</td><td>CHAR (1) NOT NULL</td></tr> <tr><td>ACTIVATE</td><td>SMALLINT NOT NULL</td></tr> <tr><td>SOURCE_SERVER</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>SOURCE_ALIAS</td><td>CHAR (8)</td></tr> <tr><td>TARGET_SERVER</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>TARGET_ALIAS</td><td>CHAR (8)</td></tr> <tr><td>STATUS</td><td>SMALLINT NOT NULL</td></tr> <tr><td>LASTRUN</td><td>TIMESTAMP NOT NULL</td></tr> <tr><td>REFRESH_TIMING</td><td>CHAR (1) NOT NULL</td></tr> <tr><td>SLEEP_MINUTES</td><td>INT</td></tr> <tr><td>EVENT_NAME</td><td>CHAR (18)</td></tr> <tr><td>LASTSUCCESS</td><td>TIMESTAMP</td></tr> <tr><td>SYNCHPOINT</td><td>CHAR (10) FOR BIT DATA</td></tr> <tr><td>SYNCHTIME</td><td>TIMESTAMP</td></tr> <tr><td>MAX_SYNCH_MINUTES</td><td>INT</td></tr> <tr><td>AUX_STMTS</td><td>SMALLINT NOT NULL</td></tr> <tr><td>ARCH_LEVEL</td><td>CHAR (4) NOT NULL</td></tr> </table> | APPLY_QUAL | CHAR (18) NOT NULL | SET_NAME | CHAR (18) NOT NULL | WHOS_ON_FIRST | CHAR (1) NOT NULL | ACTIVATE | SMALLINT NOT NULL | SOURCE_SERVER | CHAR (18) NOT NULL | SOURCE_ALIAS | CHAR (8) | TARGET_SERVER | CHAR (18) NOT NULL | TARGET_ALIAS | CHAR (8) | STATUS | SMALLINT NOT NULL | LASTRUN | TIMESTAMP NOT NULL | REFRESH_TIMING | CHAR (1) NOT NULL | SLEEP_MINUTES | INT | EVENT_NAME | CHAR (18) | LASTSUCCESS | TIMESTAMP | SYNCHPOINT | CHAR (10) FOR BIT DATA | SYNCHTIME | TIMESTAMP | MAX_SYNCH_MINUTES | INT | AUX_STMTS | SMALLINT NOT NULL | ARCH_LEVEL | CHAR (4) NOT NULL |
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| EFFECTIVE_MEMBERS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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| LASTSUCCESS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| SYNCHTIME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| TARGET_SERVER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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| TARGET_ALIAS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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| MAX_SYNCH_MINUTES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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| <p><b>ASN.IBMSNAP_SUBS_EVENT</b><br/>(EVENT_NAME, EVENT_TIME)</p> <table> <tr><td>EVENT_NAME</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>EVENT_TIME</td><td>TIMESTAMP NOT NULL</td></tr> <tr><td>END_OF_PERIOD</td><td>TIMESTAMP</td></tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | EVENT_NAME             | CHAR (18) NOT NULL | EVENT_TIME | TIMESTAMP NOT NULL | END_OF_PERIOD | TIMESTAMP         | <p><b>ASN.IBMSNAP_SUBS_MEMBER</b><br/>(APPLY_QUAL, SET_NAME, WHOS_ON_FIRST, SOURCE_OWNER, SOURCE_TABLE, SOURCE_VIEW_QUAL, TARGET_OWNER, TARGET_TABLE)</p> <table> <tr><td>APPLY_QUAL</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>SET_NAME</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>WHOS_ON_FIRST</td><td>CHAR (1) NOT NULL</td></tr> <tr><td>SOURCE_OWNER</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>SOURCE_TABLE</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>SOURCE_VIEW_QUAL</td><td>SMALLINT NOT NULL</td></tr> <tr><td>TARGET_OWNER</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>TARGET_TABLE</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>TARGET_CONDENSED</td><td>CHAR (1) NOT NULL</td></tr> <tr><td>TARGET_COMPLETE</td><td>CHAR (1) NOT NULL</td></tr> <tr><td>TARGET_STRUCTURE</td><td>SMALLINT NOT NULL</td></tr> <tr><td>PREDICATES</td><td>VARCHAR (512)</td></tr> </table> | APPLY_QUAL        | CHAR (18) NOT NULL | SET_NAME          | CHAR (18) NOT NULL | WHOS_ON_FIRST     | CHAR (1) NOT NULL | SOURCE_OWNER   | CHAR (18) NOT NULL | SOURCE_TABLE | CHAR (18) NOT NULL                                                                                                                                                                                                                     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| EVENT_NAME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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| EVENT_TIME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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| END_OF_PERIOD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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| SOURCE_OWNER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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| SOURCE_TABLE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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| SOURCE_VIEW_QUAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       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| TARGET_OWNER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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| TARGET_TABLE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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| TARGET_COMPLETE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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| TARGET_STRUCTURE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       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| PREDICATES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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| <p><b>ASN.IBMSNAP_SUBS_STMTS</b><br/>(APPLY_QUAL, SET_NAME, WHOS_ON_FIRST, BEFORE_OR_AFTER, STMT_NUMBER)</p> <table> <tr><td>APPLY_QUAL</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>SET_NAME</td><td>CHAR (18) NOT NULL</td></tr> <tr><td>WHOS_ON_FIRST</td><td>CHAR (1) NOT NULL</td></tr> <tr><td>BEFORE_OR_AFTER</td><td>CHAR (1) NOT NULL</td></tr> <tr><td>STMT_NUMBER</td><td>SMALLINT NOT NULL</td></tr> <tr><td>EI_OR_CALL</td><td>CHAR (1) NOT NULL</td></tr> <tr><td>SQL_STMT</td><td>VARCHAR (1024)</td></tr> <tr><td>ACCEPT_SQLSTATES</td><td>VARCHAR (50)</td></tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                             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| APPLY_QUAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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| BEFORE_OR_AFTER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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| SET_NAME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               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| WHOS_ON_FIRST                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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| TARGET_OWNER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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| TARGET_TABLE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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| COL_TYPE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               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| TARGET_NAME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| IS_KEY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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| COLNO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  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| EXPRESSION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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Figure 24. Tables used at the control server. The tables used by the Apply program at the control server.

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## List of tables used at the source server

The following table provides a list of tables used at the source server during DB2 replication.

*Table 34. Quick reference for tables used at the source server*

| <b>Table name</b>                                       | <b>Internal name and description</b>                                                                                                                                                                                                                                   | <b>See page</b> |
|---------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Apply-qualifier-cross-reference table (AS/400 specific) | <b>ASN.IBMSNAP_AUTHTKN</b><br>Contains information to support update-anywhere.                                                                                                                                                                                         | 317             |
| Capture enqueue table (VM and VSE specific)             | <b>ASN.IBMSNAP_CCPENQ</b><br>Used to ensure that only one Capture program is running per database.                                                                                                                                                                     | 313             |
| Change data table                                       | <b>CD</b><br>A table that contains changed data information. Created when a replication source is defined.                                                                                                                                                             | 321             |
| Consistent-change-data table                            | <i>userid.target_table</i><br>Contains additional columns to help identify transactions. This table stores the individual operations, transactions, and the approximate times of those transactions.                                                                   | 343             |
| Critical section table                                  | <b>ASN.IBMSNAP_CRITSEC</b><br>Used to prevent circular replication for update-anywhere replication.                                                                                                                                                                    | 315             |
| Pruning control table                                   | <b>ASN.IBMSNAP_PRUNCNTL</b><br>Coordinates synchpoint updates by allowing the Apply program to communicate with the Capture program and coordinates pruning of tables. There is one pruning control table at each source server and one row per source-to-target copy. | 309             |
| Prune lock table                                        | <b>ASN.IBMSNAP_PRUNE_LOCK</b><br>Used to serialize the access of staging tables during a cold start or retention limit pruning.                                                                                                                                        | 316             |

Table 34. Quick reference for tables used at the source server (continued)

| Table name                                 | Internal name and description                                                                                                                                                                                                                                                                      | See page |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| Register table                             | <b>ASN.IBMSNAP_REGISTER</b><br><br>Contains information about replication sources, such as the names of the replication source tables, their attributes, and their corresponding CD and CCD table names.                                                                                           | 301      |
| Register extension table (AS/400 specific) | <b>ASN.IBMSNAP_REG_EXT</b><br><br>An extension of the register table. Contains additional information about replication sources, such as the journal name and the remote source table's database entry name.                                                                                       | 308      |
| Register synchronization table             | <b>ASN.IBMSNAP_REG_SYNCH</b><br><br>When replicating from a non-IBM data source, an update trigger on this table initiates an update of the SYNCHPOINT value for all the rows in the register table before the Apply program reads the information from the register table.                        | 318      |
| Trace table                                | <b>ASN.IBMSNAP_TRACE</b><br><br>Contains Capture program audit trail information.                                                                                                                                                                                                                  | 316      |
| Tuning parameters table                    | <b>ASN.IBMSNAP_CCPPARMS</b><br><br>Contains parameters that you can modify to control the performance of the Capture program.                                                                                                                                                                      | 312      |
| Unit-of-work table                         | <b>ASN.IBMSNAP_UOW</b><br><br>Contains information about committed transactions. Used to maintain transaction consistency.                                                                                                                                                                         | 319      |
| Warm start table                           | <b>ASN.IBMSNAP_WARM_START</b><br><br>Contains information that enables the Capture program to resume capturing from the point in the log or journal where it last stopped. For AS/400 platforms, this table is used to determine the starting time of the RCVJRNE (Receive Journal Entry) command. | 313      |

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## List of tables used at the control server

The following table provides a list of tables used at the control server during DB2 replication.

*Table 35. Quick reference for tables used at the control server*

| <b>Table name</b>                                                 | <b>Internal name and description</b>                                                                                                                                                | <b>See page</b> |
|-------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Apply trail table                                                 | <b>ASN.IBMSNAP_APPLYTRAIL</b><br><br>Contains Apply program audit trail and problem diagnostic information.                                                                         | 336             |
| Subscription columns table                                        | <b>ASN.IBMSNAP_SUBS_COLS</b><br><br>Maps target table or view columns to the corresponding source table or view column or user-defined expression.                                  | 329             |
| Subscription events table                                         | <b>ASN.IBMSNAP_SUBS_EVENT</b><br><br>Contains user-defined event names that control the execution of a subscription set. You modify this table using SQL.                           | 335             |
| Subscription set table                                            | <b>ASN.IBMSNAP_SUBS_SET</b><br><br>Contains processing information for a set of subscription-set members, which are processed by the Apply program as a group.                      | 323             |
| Subscription statements table                                     | <b>ASN.IBMSNAP_SUBS_STMTS</b><br><br>Contains SQL statements or stored procedure calls that are defined in a subscription set.                                                      | 331             |
| Subscription-targets-member table                                 | <b>ASN.IBMSNAP_SUBS_MEMBR</b><br><br>Identifies a source and target table (or view) pair and specifies processing information for that pair.                                        | 326             |
| Row-replica-target-list table<br><br>(Microsoft Jet specific)     | <b>ASN.IBMSNAP_SUBS_TGTS</b><br><br>Maintains the names of the row-replica tables. Row-replica tables are a type of target table used specifically with the Microsoft Jet database. | 333             |
| Subscription-schema-changes table<br><br>(Microsoft Jet specific) | <b>ASN.IBMSNAP_SCHEMA_CHG</b><br><br>Used to signal add or delete modifications to a subscription.                                                                                  | 334             |



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## List of tables used at the target server

The following table provides a list of tables used at the target server.

*Table 36. Quick reference for target tables*

| <b>Table name</b>                                   | <b>Internal name and description</b>                                                                                                                                                                     | <b>See page</b> |
|-----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Base aggregate table                                | <i>userid.target_table.target_table</i><br><br>Contains data aggregated from a source table.                                                                                                             | 345             |
| Change aggregate table                              | <i>userid.target_table</i><br><br>Contains data aggregations based on changes from a source table.                                                                                                       | 346             |
| Consistent-change-data table                        | <i>userid.target_table</i><br><br>Contains additional columns to help identify transactions. This table stores the individual operations, transactions, and the approximate times of those transactions. | 343             |
| Point-in-time table                                 | <i>userid.target_table</i><br><br>Identical to a user copy table, except that the <code>IBMSNAP_LOGMARKER</code> column is included to record a specific commit time from the source server.             | 342             |
| Replica table                                       | <i>userid.target_table</i><br><br>A type of target table used for update-anywhere replication.                                                                                                           | 345             |
| Row-replica table<br>(Microsoft Jet specific)       | <i>userid.target_table</i><br><br>A type of Microsoft Jet target table that can be updated.                                                                                                              | 347             |
| User copy table                                     | <i>userid.target_table</i><br><br>A copy of the user table.                                                                                                                                              | 341             |
| Conflict table<br>(Microsoft Jet specific)          | <b>IBMSNAP_target_name_CONFLICT</b><br><br>Contains row data for DataPropagator for Microsoft Jet-detected conflict losers.                                                                              | 348             |
| Error information table<br>(Microsoft Jet specific) | <b>IBMSNAP_ERROR_INFO</b><br><br>Contains additional information to identify the row-replica table and row that caused an error.                                                                         | 348             |

Table 36. Quick reference for target tables (continued)

| Table name                                                    | Internal name and description                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | See page |
|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| Error messages table<br>(Microsoft Jet specific)              | <b>IBMSNAP_ERROR_MESSAGE</b><br>Contains error codes and error messages. There can be more than one row in this table. Depending on the error code, additional information will be available in the error information, error-side-information, and conflict tables.                                                                                                                                                                                                                                         | 349      |
| Error-side-information table<br>(Microsoft Jet specific)      | <b>IBMSNAP_SIDE_INFO</b><br>Contains the names of the conflict tables.                                                                                                                                                                                                                                                                                                                                                                                                                                      | 349      |
| Key string table<br>(Microsoft Jet specific)                  | <b>IBMSNAP_GUID_KEY</b><br>Maps the Microsoft Jet table identifiers and row identifiers to primary key values when the following actions occur: <ul style="list-style-type: none"> <li>• Rows are deleted from Microsoft Jet database tables.</li> <li>• Deletes are recorded in MSysTombstone with s_Generation, TableGUID and s_GUID (row) identifiers, but without primary key details.</li> <li>• The primary key values are needed to propagate Microsoft Jet database deletes to an RDBMS.</li> </ul> | 349      |
| Synchronization generations table<br>(Microsoft Jet specific) | <b>IBMSNAP_S_GENERATION</b><br>Prevents cyclic updates from propagating back to the RDBMS from a Microsoft Jet database.                                                                                                                                                                                                                                                                                                                                                                                    | 350      |

## Tables used at the source server

This section describes the tables used at the source server and the columns in each table. These tables are created automatically the first time that you define a replication source if you use the Control Center and if they do not already exist on the source server. On the AS/400 platform, these tables are created automatically in the following situations if they do not exist already on the source server:

- When you install DB2 DataPropagator for AS/400.
- When you define the first replication source using the Control Center.

The administration tools use the information in the register, register extension, and pruning control tables to define your source and target tables for replication. After you define your replication sources, the Capture program uses the tuning parameters, capture enqueue, warm start, critical section, trace, and Apply-qualifier-cross-reference tables to control and audit your data. In addition to all the Capture program control and audit tables mentioned, the Capture triggers also use the register synchronization table to control data. The UOW and CD tables track data that has not yet been replicated.

## Register table

This table contains information that you can update by using SQL.

### ASN.IBMSNAP\_REGISTER

The register table contains information about replication sources, such as the names of the replication source tables, their attributes, and their staging table names. A row is automatically inserted into this table every time a new replication source is defined at this server. You must update this table to maintain an external CCD table.

The register table is the place to look if you need to know how you defined your replication sources.

Table 37 provides a brief description of the columns in the register table.

*Table 37. Columns in the register table*

| Column name      | Description                                                                                                                                                                                                                                                                      |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SOURCE_OWNER     | The owner of the source table or view.                                                                                                                                                                                                                                           |
| SOURCE_TABLE     | The source from which data is being captured.                                                                                                                                                                                                                                    |
| SOURCE_VIEW_QUAL | This value is set to 0 for physical tables that are defined as sources and is greater than 0 for views that are defined as sources. This column is used to support multiple subscriptions for different source views with identical SOURCE_OWNER and SOURCE_TABLE column values. |
| GLOBAL_RECORD    | A flag that indicates whether this row is the global record. In the global record, only the SYNCHPOINT and SYNCHTIME columns are set by the Capture program to reflect its progress. If the Capture program has not been running, then there is no global record.                |
|                  | Y This row is the global record.                                                                                                                                                                                                                                                 |
|                  | N This row is not the global record.                                                                                                                                                                                                                                             |

## Register table

Table 37. Columns in the register table (continued)

| Column name                                                            | Description                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SOURCE_STRUCTURE                                                       | A value that identifies the structure of the source table or view:                                                                                                                                                                                                                                                                                                                                                                                       |
|                                                                        | 1 User table                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                                                                        | 3 CCD table                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                                                        | 4 Point-in-time table                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                                                        | 5 Base aggregate table                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                                                                        | 6 Change aggregate table                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                                                                        | 7 Replica table                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                                        | 8 User copy table                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                        | 9 Row-replica table                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| SOURCE_CONDENSED                                                       | A flag that indicates:                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                                                                        | Y For any given primary key, the CCD, replica, and user tables show only one row.                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                        | N All changes must remain, retaining a complete update history.                                                                                                                                                                                                                                                                                                                                                                                          |
| A Valid only for base aggregate or change aggregate tables.            |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| SOURCE_COMPLETE                                                        | A flag that indicates:                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                                                                        | Y The source table contains a row for every primary key value of interest.                                                                                                                                                                                                                                                                                                                                                                               |
| N The source table contains some subset of rows of primary key values. |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| CD_OWNER                                                               | The owner of the change data table or a view.                                                                                                                                                                                                                                                                                                                                                                                                            |
| CD_TABLE                                                               | The name of the change data table or view for captured updates to the source table (set when you define the replication source). This value is used by the Apply program and can be the name of a table or a view. The Capture program inserts one row into the CD table for every committed and uncommitted change to this replication table. The Apply program then joins this table with the UOW table so that only committed changes are replicated. |

Table 37. Columns in the register table (continued)

| Column name       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PHYS_CHANGE_OWNER | The owner of the PHYS_CHANGE_TABLE. For a view defined as a source, this value equals the value of a CD or CCD table referenced in the change data view definition. For non-view replication sources, the value equals the CD_OWNER or the CCD_OWNER column. The Capture program uses this value to properly maintain CD_OLD_SYNCHPOINT and CD_NEW_SYNCHPOINT for view replication sources. The Apply program uses this value to properly maintain CCD_OLD_SYNCHPOINT and SYNCHPOINT for view replication sources that are based on CCD tables that the Apply program maintains.                                                                                                                                       |
| PHYS_CHANGE_TABLE | The name of the physical CD or CCD table. For a view replication source, this value equals the value of the CD or CCD table replication source definition referenced in the change data view definition. For non-view replication sources, the value equals the CD_TABLE or the CCD_TABLE column. The Capture program uses this value to properly maintain CD_OLD_SYNCHPOINT and CD_NEW_SYNCHPOINT for view replication sources. The Apply program uses this value to properly maintain CCD_OLD_SYNCHPOINT and SYNCHPOINT for view replication sources that are based on the CCD tables that the Apply program maintains.                                                                                              |
| CD_OLD_SYNCHPOINT | The approximate SYNCHPOINT value when the Capture program begins to capture changes from the source table. The Capture program sets this value to NULL during a cold start. The Apply program sets this value to NULL for a target replica when cascading a gap condition. If the value is null when the synchpoint column of the pruning control table is set to x'00000000000000000000X', the Capture program sets an initial value, and the same sequence number is reflected back into the SYNCHPOINT column of the pruning control table; this is the sequence number associated with the pruning control table update. Subsequent values are set by the Capture program when old rows are pruned from the table. |
| CD_NEW_SYNCHPOINT | The Capture program advances this column as it inserts new rows into the CD table. If the Capture program did not insert into the change data table recently, then the value does not advance. The Apply program uses this column to see if there are new changes to be replicated.                                                                                                                                                                                                                                                                                                                                                                                                                                    |

## Register table

Table 37. Columns in the register table (continued)

| Column name     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DISABLE_REFRESH | <p>When this column is created, it contains the 0 flag. If you set the flag to 1, the Apply program is not allowed to perform a full refresh of the source server until the flag is set back to 0. This column is used to defer, not eliminate, a full refresh for a subscription. For example, you might want to defer a full refresh when the Capture program starts up cold or a gap in the log is detected. The Apply program will not process subscriptions to this replication source until control table values are updated. This flag prevents full refresh activity from overloading the source database during peak periods. This column is initialized to 0. You can use a program at the source database site to set this flag.</p> <p><b>0</b> Full refreshes are allowed.</p> <p><b>1</b> Full refreshes are prevented.</p> |
| CCD_OWNER       | The owner of the local CCD table.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| CCD_TABLE       | The name of the staging table that contains committed-only captured updates.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

Table 37. Columns in the register table (continued)

| Column name        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CCD_OLD_SYNCHPOINT | <p>This value is set in one of the following ways when the CCD table is initialized:</p> <ul style="list-style-type: none"> <li>• By the administration tool when the CCD table is automatically defined as a source. CCD_OLD_SYNCHPOINT is set to NULL.</li> <li>• By the Control Center when a CCD table is defined as an external replication source table (for example, the table is maintained by IMS DataPropagator). CCD_OLD_SYNCHPOINT is set to MIN(IBMSNAP_COMMITSEQ) of the CCD table.</li> </ul> <p>This column is related to full-refresh processing against CCD tables. The value in this column needs to be changed only when the CCD table is reinitialized or pruned of change data that has not yet been processed by all subscriptions which refer to it (as occurs in retention-limit pruning). This value can be much older than any row remaining in the CCD table, and it is maintained in one of the following ways:</p> <ul style="list-style-type: none"> <li>• Automatically by the Apply program or by another external application that maintains the CCD table.</li> <li>• Manually, for CCD replication sources that are not created and maintained by the Apply program. This is the case for CCD tables that contain changes generated by IMS DataPropagator.</li> </ul> <p>If this column is not maintained, the Apply program using the CCD table as a replication source will not know that the CCD table was reinitialized, so it will fail to reinitialize complete copies of the CCD source.</p> |
| SYNCHPOINT         | <p>In the global row, where the GLOBAL_RECORD column is set to Y, this is the log or journal identifier (synchpoint) of the last log or journal record processed by the Capture program. The Apply program compares this value to the last synchpoint that it processed to see if there are new changes available for replication.</p> <p>For CCD source definitions, this is the equivalent to CD_NEW_SYNCHPOINT and is updated by the Apply program that maintains the CCD table. This column must be set explicitly for a CCD replication source that is not created and maintained by the Apply program. An example is a CCD table of IMS changes generated by IMS DataPropagator.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

## Register table

Table 37. Columns in the register table (continued)

| Column name       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SYNCHTIME         | <p>A source server timestamp. The Capture program or an external program, such as IMS DataPropagator, updates this timestamp whether there are changes to be processed or not.</p> <p>The Apply program uses this value when advanced conflict detection is selected for update-anywhere replication to ensure that the Capture program captured all outstanding changes for a replication source table.</p>                                                                                                         |
| CCD_CONDENSED     | <p>A flag that indicates:</p> <p><b>Y</b> This CCD replication source has only the last captured change for a source table row.</p> <p><b>N</b> This CCD replication source has one row for each source table row change.</p>                                                                                                                                                                                                                                                                                        |
| CCD_COMPLETE      | <p>A flag that indicates:</p> <p><b>Y</b> The CCD table contains a row for every primary key value of interest.</p> <p><b>N</b> The CCD table is initially empty and then is populated as changes are applied.</p>                                                                                                                                                                                                                                                                                                   |
| ARCH_LEVEL        | <p>The architectural level of the definition in the row. This level is defined by IBM, and for Version 7 is 0201.</p>                                                                                                                                                                                                                                                                                                                                                                                                |
| DESCRIPTION       | <p>A field for comments that you enter when defining replication sources.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| BEFORE_IMG_PREFIX | <p>Represents the default character identifying before-image column names in the CD table. The value can be NULL, but must not match any leading character identifying after-image user data column names in the CD table. The length of BEFORE_IMG_PREFIX is:</p> <p><b>1</b> For an ASCII or an EBCDIC single byte prefix character.</p> <p><b>2</b> For an ASCII double byte prefix character.</p> <p><b>4</b> For an EBCDIC DBCS prefix character. This length allows for shift-in and shift-out characters.</p> |



Table 37. Columns in the register table (continued)

| Column name    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CONFLICT_LEVEL | <p>A flag that indicates:</p> <p><b>0</b> The Apply program does not check for conflicts. Data consistency must be enforced by your application design to avoid potential conflicting updates.</p> <p><b>1</b> Standard detection with cascading transaction rejection. The Apply program checks for conflicts based on the changes captured to this point. The Apply program will reverse any conflicting transaction at the replica, as well as any transactions with dependencies on the conflicting transaction. Changes captured after the Apply program begins conflict detection will not be checked during this Apply cycle.</p> <p><b>2</b> Enhanced detection with cascading transaction rejection. The Apply program waits until the Capture program captures all changes from the log or journal (see description of the SYNCHTIME column) and then does a standard conflict detection (CONFLICT_LEVEL = 1). During the wait time, the Apply program holds a LOCK on the source tables to ensure that no changes are made during the conflict detection process.</p> |

## Register table

Table 37. Columns in the register table (continued)

| Column name        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PARTITION_KEYS_CHG | This value is assumed to be the same for all the user table's dependent replicas. A flag indicating:<br><br><b>N</b> Updates to the source table are staged by the Capture program as an update operation and processed by the Apply program as an UPDATE statement to the target table.<br><br><b>Y</b> Updates to the source table are staged by the Capture program as a delete and insert pair. The Apply program processes the delete first and the insert second. When this flag is set, every update to a replication source is stored in the CD table as two rows: a delete row and an insert row. This flag ensures that an update to a key or partitioning column is always processed correctly. Use this flag when: <ul style="list-style-type: none"><li>• The source columns for target table primary keys can be updated at the source table.</li><li>• The source columns for target table partitioning columns were defined in predicates.</li><li>• The target table is a DB2 Universal Database Enterprise - Extended Edition table stored in a multipartition nodegroup.</li></ul> |
| NULL               | If this is the global control row.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

### Register extension table for AS/400

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

#### ASN.IBMSNAP\_REG\_EXT

This table is an AS/400-specific table that provides supplemental information for the register table, ASN.IBMSNAP\_REGISTER. For every register table row, there is a matching row in the register extension table containing a few additional AS/400-specific columns.

This table is maintained by a trigger program (program QZSNJRNL in library QDPR) on the register table (ASN.IBMSNAP\_REGISTER). The trigger is defined at the time the register table is created.

Use this table to complete the information from the register table to track where and how you defined your replication sources on an AS/400 server.

Table 38 provides a brief description of the columns in the register extension table.

*Table 38. Columns in the register extension table*

| Column name      | Description                                                                                                                                                                                                                                                                                                                                                                            |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SOURCE_OWNER     | The owner of the source table or view.                                                                                                                                                                                                                                                                                                                                                 |
| SOURCE_TABLE     | The source from which data is being captured.                                                                                                                                                                                                                                                                                                                                          |
| SOURCE_NAME      | A 10-character source table (or view) system name, used to issue commands.                                                                                                                                                                                                                                                                                                             |
| SOURCE_MBR       | The name of the source table member being captured. Used for issuing Receive Journal Entry ( <b>RCVJRNE</b> ) commands and ALIAS support.                                                                                                                                                                                                                                              |
| SOURCE_TABLE_RDB | When using remote journals, this column contains the database name of the system where the source table actually resides. For non-remote-journal cases, this column is NULL.                                                                                                                                                                                                           |
| JRN_LIB          | The library name of the journal that the source table uses.                                                                                                                                                                                                                                                                                                                            |
| JRN_NAME         | The name of the journal used by a source table. An asterisk followed by nine blanks in this column means that the source table is not currently in a journal. Therefore, it is not possible to capture data for this source table.                                                                                                                                                     |
| FR_START_TIME    | Time at which the full refresh starts. This column is updated by Capture for AS/400, not the administration tool, during operations.                                                                                                                                                                                                                                                   |
| SOURCE_VIEW_QUAL | Supports the view of subscriptions by matching the similar column in the register table. This value is set to equal 0 for physical tables that are defined as a source and is greater than 0 for views that are defined as sources. You must have this column to support multiple subscriptions for different source views with identical SOURCE_OWNER and SOURCE_TABLE column values. |

## Pruning control table

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

### ASN.IBMSNAP\_PRUNCNTL

The pruning control table coordinates the pruning of the change data (CD) tables, which have the potential for unlimited growth. For each new subscription set, the Apply program first updates the pruning control table and then it begins a full refresh of every member of the new subscription set. After the full refresh, the Capture program begins capturing changes from the replication source. When the Capture program begins to capture data, it

## Pruning control table

updates the pruning control table to notify the Apply program. During each Apply cycle, the Apply program updates the pruning control table to indicate the last change applied. The Capture program then uses the information to prune the CD and UOW tables.

The rows in the pruning control table are not deleted during a cold start of the Capture program. The administration tools use the values from the pruning control table to provide a list of copies defined as source tables and views.

There is one pruning control table at each source server and one row in the pruning control table for each subscription-set member.

You can manually prune your table by issuing the **prune** command or have it done automatically by updating the PRUNE\_INTERVAL column in the tuning parameters table. See “Tuning parameters table” on page 312 for more information about using the tuning parameters table.

Use this table to monitor the pruning status of your CD and UOW tables.

Table 39 provides a brief description of each of the columns in the pruning control table.

*Table 39. Columns in the pruning control table*

| Column name   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TARGET_SERVER | The database name of the server where target tables or views are stored.                                                                                                                                                                                                                                                                                                                                                                                                                         |
| TARGET_OWNER  | A qualifier for a target table or view.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| TARGET_TABLE  | The target to which data is being applied.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| SYNCHTIME     | <p>A source server timestamp. The SYNCHTIME value equals the SYNCHTIME field value in the subscription set table. The Capture program or an external program, such as IMS DataPropagator, updates this timestamp whether there are changes to be processed or not.</p> <p>The Apply program uses this value when advanced conflict detection is selected for update-anywhere replication to ensure that the Capture program captures all outstanding changes for a replication source table.</p> |
| SYNCHPOINT    | The SYNCHPOINT value equals the SYNCHPOINT field value in the subscription set table. This value is used to coordinate the pruning of CD tables. The Apply program sets this initial value to hex 0, indicating refresh. If the Apply program sets a nonzero value, the CD table can be eligible for pruning.                                                                                                                                                                                    |

Table 39. Columns in the pruning control table (continued)

| Column name      | Description                                                                                                                                                                                                                                                                                                                                                                 |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SOURCE_OWNER     | The owner of the source table or view.                                                                                                                                                                                                                                                                                                                                      |
| SOURCE_TABLE     | The source from which data is being captured.                                                                                                                                                                                                                                                                                                                               |
| SOURCE_VIEW_QUAL | Supports the view of physical tables by matching the similar column in the register table. This value is set to 0 for physical tables that are defined as sources and is greater than 0 for views that are defined as sources. This column is used to support multiple subscriptions for different source views with identical SOURCE_OWNER and SOURCE_TABLE column values. |
| APPLY_QUAL       | A unique identifier for a group of subscription sets. This case sensitive value is supplied by the user when defining a subscription set. This column is part of the foreign key from the subscription set table. See “Subscription set table” on page 323 for more details.                                                                                                |
| SET_NAME         | An identifier for a group of subscription-set members. This value is supplied when you define a subscription set. This column is part of the foreign key from the subscription set table. See “Subscription set table” on page 323 for more details.                                                                                                                        |
| CNTL_SERVER      | The database name of the control server for the Apply program updating this row.                                                                                                                                                                                                                                                                                            |
| TARGET_STRUCTURE | A value that identifies the type of target table or view: <ol style="list-style-type: none"> <li>1 Source table</li> <li>2 Not available</li> <li>3 CCD table</li> <li>4 Point-in-time table</li> <li>5 Base aggregate table</li> <li>6 Change aggregate table</li> <li>7 Replica table</li> <li>8 User copy table</li> <li>9 Row-replica table</li> </ol>                  |
| CNTL_ALIAS       | The DB2 Universal Database alias corresponding to the control server named in the CNTL_SERVER column.                                                                                                                                                                                                                                                                       |

## Tuning parameters table

### Tuning parameters table

This table contains information that you can update by using SQL.

#### ASN.IBMSNAP\_CCPPARMS

This table contains parameters that you can modify to control the performance of the Capture program. You can set these parameters to modify the length of time that you retain data in the CD table, the amount of time that the Capture program is allowed to lag in processing log records, how often data will be committed, and how often your CD and UOW tables are pruned. These modifications must be done manually because there are no DB2 DataPropagator processes that update this table after it is created. The Capture program can read your modifications only during its start processing; therefore, you should stop and start the Capture program if you want your modifications to take effect.

Table 40 provides a brief description of the columns in the tuning parameters table.

*Table 40. Columns in the tuning parameters table*

| Column name     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RETENTION_LIMIT | The age limit, in minutes, for keeping CD table rows. This value is used with the SYNCHPOINT column of the pruning control table to determine the pruning limit. Any change data rows older than this value are pruned, even if they have not been copied to all targets. Transactions rejected after update conflict detection will have their changes pruned by RETENTION_LIMIT aging, not by normal pruning. The default value is 10 080 minutes (which equals seven days). |
| LAG_LIMIT       | The amount of time, in minutes, that the Capture program is allowed to lag in processing log records before it shuts itself down. During periods of high update frequency, full refreshes can be more economical than updates. The default value is 10 080 (which equals seven days).                                                                                                                                                                                          |
| COMMIT_INTERVAL | The Capture program commit threshold, in seconds, for any inserts, updates, or deletes to the global UOW table and any pruning control tables. The default value is 30.<br><br>On systems that do not support ISOLATION (UR), this value should be less than the DB2 lock timeout value to prevent Apply program instances from timing out due to contention with the Capture program.                                                                                         |

Table 40. Columns in the tuning parameters table (continued)

| Column name    | Description                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PRUNE_INTERVAL | The Capture program commit threshold, in seconds, for automatic or manual pruning of CD and UOW rows that are no longer needed. The default value is 300. Values set lower save space, but increase processing costs. Values set higher require more CD and UOW table space, but decrease processing costs. There is no effect on table space or processing cost when the NOPRUNE option is selected. |

### Capture enqueue table (VM and VSE specific)

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

#### ASN.IBMSNAP\_CCPENQ

The Capture enqueue table is used in the VM and VSE environments only. This table is used to ensure that there is only one Capture program running per database.

Table 41 provides a list and a brief description of the Capture enqueue table column.

Table 41. Capture enqueue table column

| Column name | Description                                    |
|-------------|------------------------------------------------|
| LOCKNAME    | Unique name of the resource for this database. |

### Warm start table

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data. If you delete all the rows from this table, the Capture program will take longer to start because it must calculate a restart position based on the contents of the CD tables, the UOW table, and the control tables.

#### ASN.IBMSNAP\_WARM\_START

This table is created in the same database as the register table and contains information that enables the Capture program to restart from the last log or journal record read. Use the information in this table to avoid a full refresh of your system.

You do not have to recover this table if it is damaged. Simply create an empty table before warm starting the Capture program.

## Warm start table

The following three tables show platform-specific layouts of the warm start table:

- Table 42 shows the layout for all platforms other than VM/VSE and AS/400.
- Table 43 shows the VM/VSE layout.
- Table 44 on page 315 shows the AS/400 layout.

*Table 42. Columns in the warm start table*

| Column name | Description                                                                                                                                                                                                      |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SEQ         | The last captured sequence number from the log or journal record. Used for quickly restarting following a shutdown or failure.                                                                                   |
| AUTHTKN     | The DB2 token for the unit of work associated with the SEQ log or journal record. AUTHTKN length is 12 characters. If you supply a longer value, it is truncated.                                                |
| AUTHID      | The DB2 authorization ID for the unit of work associated with the SEQ log or journal record. AUTHID length is 18 characters. If you supply a longer value, it is truncated.                                      |
| CAPTURED    | A flag indicating whether or not this unit of work was captured.<br><br>Y        This unit of work was captured.<br>N        This unit of work was not captured.                                                 |
| UOWTIME     | The MVS clock, or Windows NT, HP-UX, Sun Solaris, OS/2, and AIX Coordinated Universal Time (UTC) clock indicating when the unit of work associated with the SEQ position was captured (source server timestamp). |

*Table 43. Columns in the warm start table for VM and VSE platforms*

| Column name | Description                                                                                                                    |
|-------------|--------------------------------------------------------------------------------------------------------------------------------|
| SEQ         | The last captured sequence number from the log or journal record. Used for quickly restarting following a shutdown or failure. |
| UOWID       | The unit-of-recovery ID from the log record header for this unit of work.                                                      |
| AUTHID      | The DB2 authorization ID for the unit of work associated with the SEQ log or journal record.                                   |



Table 43. Columns in the warm start table for VM and VSE platforms (continued)

| Column name | Description                                                                                                                                             |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| CAPTURED    | A flag indicating whether or not this unit of work was captured.                                                                                        |
|             | Y      This unit of work was captured.                                                                                                                  |
|             | N      This unit of work was not captured.                                                                                                              |
| UOWTIME     | The VSE and VM time-of-day clock indicating when the unit of work associated with the SEQ log or journal record was captured (source server timestamp). |

For AS/400, the warm start table is used to determine the starting time of the **RCVJRNE** (Receive Journal Entry) command. A row is inserted into the warm start table for each journal that is used by a replication source or a group of replication sources.

Table 44 provides a brief description of the columns in the warm start table for the AS/400 platform.

Table 44. Columns in the warm start table for AS/400 platform

| Column name    | Description                                                                                                                                                                                                                        |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| JRN_LIB        | The library name of the journal.                                                                                                                                                                                                   |
| JRN_NAME       | The name of the journal used by a source table. An asterisk followed by nine blanks in this column means that the source table is not currently in a journal. Therefore, it is not possible to capture data for this source table. |
| JRN_JOB_NUMBER | The job number of the current job for a particular journal. If the journal is not active, this column contains the job number of the last job that was processed.                                                                  |
| LOGMARKER      | The timestamp of the last processed journal entry.                                                                                                                                                                                 |
| UID            | A unique number that is used as a prefix for the contents of the IBMSNAP_UOWID column located in the UOW table.                                                                                                                    |
| SEQNBR         | The sequence number of the last processed journal entry.                                                                                                                                                                           |

### Critical section table

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

ASN.IBMSNAP\_CRITSEC

## Critical section table

This table is used to prevent circular replication in an update-anywhere scenario.

You do not have to recover this table if it is damaged. Simply create an empty table.

Table 45 provides a brief description of the critical section table column.

Table 45. Critical section table column

| Column name | Description                                                                                                                                                                                                                                                                                                                                                                   |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| APPLY_QUAL  | A unique identifier for a group of subscription sets. This value is supplied by the user when defining a subscription set. Each Apply process is started with an APPLY_QUAL value. This value is used during update-anywhere replication to prevent circular propagation of the changes made by the Apply program. See “Subscription set table” on page 323 for more details. |

## Prune lock table

### ASN.IBMSNAP\_PRUNE\_LOCK

The prune lock table is used to serialize the access of staging tables during a cold start or retention limit pruning. (*Retention limit* pruning is pruning after the retention limit is reached. The default retention limit is 10 080, which equals 7 days.) There are no rows in this table. The Capture and Apply programs use this table as a logical lock to serialize their operations during these critical phases. If a prune lock table does not exist, as on DB2 UDB Version 5 servers, the critical section (ASN.IBMSNAP\_CRITSEC) table is locked instead. If a prune lock table does not exist, you can create one to increase the concurrency of update-anywhere subscriptions.

You do not have to recover this table if it is damaged. Simply create an empty table.

## Trace table

### ASN.IBMSNAP\_TRACE

This table contains audit trail information for the Capture program. Everything that is done by the Capture program is recorded in this table, which makes it one of the best places to look if a problem with the Capture program occurs. If you cold start the Capture program, all of the trace table’s entries are deleted, so you might want to save a copy of this table before you issue a cold start command.

The following two tables show platform-specific layouts of the trace table. Table 46 on page 317 shows the layout for all platforms other than AS/400,

and Table 47 shows the AS/400 layout.

Table 46. Columns in the trace table

| Column name | Description                                                                                                                                                                                                                                                                  |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OPERATION   | The type of Capture program operation, for example, initialization, capture, or error condition.                                                                                                                                                                             |
| TRACE_TIME  | The time that a row is inserted into the trace table.                                                                                                                                                                                                                        |
| DESCRIPTION | The message ID followed by the message text. The message can be informational or error. This column contains English-only text. See “Chapter 15. Capture and Apply messages” on page 353 for a detailed description of the correlating message ID in the DESCRIPTION column. |

Table 47. Columns in the trace table for AS/400

| Column name  | Description                                                                                                                                                                                                                                                                                                                |          |             |      |                                  |       |                                                    |       |                |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|------|----------------------------------|-------|----------------------------------------------------|-------|----------------|
| OPERATION    | The type of Capture program operation, for example, initialization, capture, or error condition.                                                                                                                                                                                                                           |          |             |      |                                  |       |                                                    |       |                |
| TRACE_TIME   | The time that a row is inserted into the trace table.                                                                                                                                                                                                                                                                      |          |             |      |                                  |       |                                                    |       |                |
| JOB_NAME     | The fully qualified name of the job that wrote this trace entry.                                                                                                                                                                                                                                                           |          |             |      |                                  |       |                                                    |       |                |
|              | <table border="1"> <thead> <tr> <th>Position</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>1–10</td> <td>QDPRCTL5 or the journal job name</td> </tr> <tr> <td>11–20</td> <td>The ID of the user who started the Capture program</td> </tr> <tr> <td>21–26</td> <td>The job number</td> </tr> </tbody> </table> | Position | Description | 1–10 | QDPRCTL5 or the journal job name | 11–20 | The ID of the user who started the Capture program | 21–26 | The job number |
| Position     | Description                                                                                                                                                                                                                                                                                                                |          |             |      |                                  |       |                                                    |       |                |
| 1–10         | QDPRCTL5 or the journal job name                                                                                                                                                                                                                                                                                           |          |             |      |                                  |       |                                                    |       |                |
| 11–20        | The ID of the user who started the Capture program                                                                                                                                                                                                                                                                         |          |             |      |                                  |       |                                                    |       |                |
| 21–26        | The job number                                                                                                                                                                                                                                                                                                             |          |             |      |                                  |       |                                                    |       |                |
| JOB_STR_TIME | The starting time of the job named in the JOB_NAME column.                                                                                                                                                                                                                                                                 |          |             |      |                                  |       |                                                    |       |                |
| DESCRIPTION  | The message ID followed by the message text. The message ID is the first 7 characters of the DESCRIPTION column. The message text starts at the 9th position of the DESCRIPTION column. Refer to “Chapter 16. Replication messages for AS/400” on page 381 for information about messages.                                 |          |             |      |                                  |       |                                                    |       |                |

### Apply-qualifier-cross-reference table (AS/400 specific)

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

ASN.IBMSNAP\_AUTHTKN

## Apply-qualifier-cross-reference table

The Apply-qualifier-cross-reference table is used in the AS/400 environment only. This table is used during update-anywhere replication to keep track of the jobs run by a particular Apply qualifier. It is pruned by the Capture program based on the retention limit. The default retention limit is 10 080, which equals 7 days.

Table 48 provides a brief description of the columns in the apply-qualifier-cross-reference table.

*Table 48. Columns in the apply-qualifier-cross-reference table*

| Column name       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| APPLY_QUAL        | An Apply qualifier, which is a unique identifier for a group of subscription sets. You supply this value when defining a subscription set. Each Apply process is started with an Apply qualifier. This value is used during update-anywhere replication to prevent circular propagation of the changes made by the Apply program. See “Subscription set table” on page 323 for more details.                                                                                                                                                                                                                                                     |
| IBMSNAP_AUTHTKN   | The job name associated with a transaction. AUTHTKN length is 12 characters. If you supply a longer value, it is truncated. Capture for AS/400 matches this column with the name of the job that issued the transaction to determine if a transaction is issued by either the Apply program or a user application. If the names match, then Capture for AS/400 copies the value from the APPLY_QUAL column to the UOW row. If the names do not match, then Capture for AS/400 sets the APPLY_QUAL column of the UOW row to blank. This column is not automatically copied to other tables; you must select it and copy it as a user data column. |
| IBMSNAP_LOGMARKER | The approximate commit time at the source server.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

## Register synchronization table

**Important:** Altering this table might result in wasteful pruning processing.

### ASN.IBMSNAP\_REG\_SYNCH

There is an update trigger on this table that initiates an update of the SYNCHPOINT value for all the rows in the register table when the Apply program fetches data from a non-IBM data source.

Table 49 on page 319 provides a brief description of the register synchronization table column.

Table 49. Register synchronization table column

| Column name | Description                                                                                  |
|-------------|----------------------------------------------------------------------------------------------|
| TRIGGER_ME  | Y A trigger was initiated to update the SYNCHPOINT value for all rows in the register table. |

### Unit-of-work table

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

#### ASN.IBMSNAP\_UOW

The unit-of-work (UOW) table ensures data integrity by recording transactions that were committed at the source server. The Apply program joins the UOW and CD table based on matching IBMSNAP\_UOWID values to ensure that only committed changes are being copied. The results are ordered by the log or journal record sequence number of the change in the CD table within the committed units of work. If you cold start the Capture program, all of this table's entries are deleted.

**For AS/400:** Capture for AS/400 can start data capturing for only a subset of the replication sources. Therefore, Capture for AS/400 does not delete all the rows in the UOW table if you do a partial cold start.

The Capture program requires that there is one UOW table for each source server. The Capture program inserts one new row into this table for every log or journal record that commits changes to replication sources.

**For AS/400:** There are some user programs that do not use commitment control. In such cases, the Capture program arbitrarily inserts a new UOW row after a number of rows are written to the CD table. This artificial commitment boundary helps reduce the size of the UOW table.

The Capture program also prunes the UOW table based on information inserted into the pruning control table by the Apply program.

**For AS/400:** The UOW table is pruned by retention limits, not by the pruning control table information.

Table 50 on page 320 provides a brief description of the columns in the UOW table.

## Unit-of-work table

Table 50. Columns in the UOW table

| Column name       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IBMSNAP_UOWID     | The unit-of-work identifier from the log record header for this unit of work.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| IBMSNAP_COMMITSEQ | The log record sequence number of the captured commit statement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| IBMSNAP_LOGMARKER | The approximate commit time at the source server.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| IBMSNAP_AUTHTKN   | The authorization token associated with the transaction. This ID is useful for database auditing. For DB2 Universal Database for OS/390, this column is the correlation ID. For DB2 Universal Database for AS/400, this column is the job name of the job that caused a transaction. This column is not automatically copied to other tables; you must select it and copy it as a user data column. This column can be selected as a user data column for a noncomplete CCD target table.                                                                                                                                                                                     |
| IBMSNAP_AUTHID    | The authorization ID associated with the transaction. It is useful for database auditing. AUTHID length is 18 characters. If you supply a longer value, it is truncated. For DB2 Universal Database for OS/390, this column is the primary authorization ID. For DB2 Universal Database for AS/400, this column has the name of the user profile ID under which the application that caused the transaction ran. This column holds a 10-character ID padded with blanks. This column is not automatically copied to other tables; you must select it and copy it as a user data column. This column can be selected as a user data column for a noncomplete CCD target table. |

Table 50. Columns in the UOW table (continued)

| Column name        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IBMSNAP_REJ_CODE   | This value is set only during update-anywhere replication if conflict detection is specified as standard or advanced when you define your replication source. <ul style="list-style-type: none"> <li>0 A transaction with no known conflict.</li> <li>1 A transaction that contains a conflict where the same row in the source and replica tables have a change that was not replicated. When a conflict occurs, the transaction will be reversed at the replica table.</li> <li>2 A cascade-rejection of a transaction dependent on a prior transaction having at least one same-row conflict. When a conflict occurs, the transaction will be reversed at the replica table.</li> <li>3 A transaction that contains at least one referential-integrity constraint violation. Because this transaction violates the referential constraints defined on the source table, the Apply program will mark this subscription set as failed. Updates cannot be copied until the referential integrity definitions are corrected.</li> <li>4 A cascade-rejection of a transaction dependent on a prior transaction having at least one constraint conflict.</li> </ul> |
| IBMSNAP_APPLY_QUAL | This column prevents circular replication during update-anywhere processing. It remains blank for local updates, but contains the name of the associated Apply program for updates that are made by the Apply program for an update-anywhere subscription set. The Capture program derives this value from the critical section table.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## Change data table

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

### CD

Change data (CD) tables record all changes made to a replication source. Committed, uncommitted, and incomplete changes are inserted as rows into the CD table. The CD table works with the UOW table to provide commit information. (See “Staging data” on page 82 for more information.) Pruning of

## Change data table

the CD table rows is coordinated by the pruning control table. (See “Pruning control table” on page 309 for more information.)

CD tables are automatically created when you define a replication source. For each replication source that is enabled for data capture, there is one CD table. If you could start the Capture program, all of the CD table’s entries are deleted.

Manually changing the CD table is not recommended. However, the CD table can be a useful resource for problem determination. Knowing exactly what changes were committed or not committed can help you understand where the Capture program failed.

**Recommendation:** A unique ascending index is strongly recommended for the IBMSNAP\_UOWID and IBMSNAP\_INTENTSEQ columns.

Table 51 provides a list and a brief description of each of the columns in the CD table.

*Table 51. Columns in the CD table*

| Column name       | Description                                                                                                                                                                                                                                                                                                                                                     |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IBMSNAP_UOWID     | Unit-of-work ID for an update. The Apply program uses this column to join the CD table with the UOW table so that only committed changes are replicated.                                                                                                                                                                                                        |
| IBMSNAP_INTENTSEQ | Log or journal record sequence number that uniquely identifies a change. This value is globally ascending.                                                                                                                                                                                                                                                      |
| IBMSNAP_OPERATION | Character value of I, U, or D, indicating an insert, update, or delete record.                                                                                                                                                                                                                                                                                  |
| DATA1             | User column from source table specified when the replication source was defined.                                                                                                                                                                                                                                                                                |
| AFTER-IMAGE       | User column from source table selected when defining a replication source. This column will have the same name, data type, and null attributes as the source column. The after-image column also contains the equivalent source table column value after the change is made.                                                                                    |
| BEFORE-IMAGE      | User column from source table selected when defining a replication source. This column will have the same name, data type, and null attributes as the source column. The name is the source column prefixed with the BEFORE_IMG_PREFIX value from the register table. This column contains the equivalent source table column value before the change was made. |



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## Tables used at the control server

The control server is the DB2 system that you chose to hold your subscription definitions. The following section provides a brief description of the tables used at the control server and the columns in each table. If you are using the Control Center, these tables, which contain information about your subscription definitions, are automatically created when you define a subscription set if they do not already exist.

The subscription set, subscription-targets-member, subscription columns, subscription statements, row-replica, and subscription-schema-changes tables contain information about subscriptions. When a new subscription set is defined, the administration tools simultaneously update rows in the subscription set, subscription columns, subscription-targets-member, and subscription statements tables.

The subscription events and Apply trail tables are used by the Apply program to control and audit your data.

### Subscription set table

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

#### ASN.IBMSNAP\_SUBS\_SET

The subscription set table lists all of the subscription sets defined at the control server and identifies the source and target server pairs that are processed as a group. Rows are inserted into this table when you create your subscription set definition.

Use this table to identify subscription sets that are defined.

Table 52 provides a brief description of the columns in the subscription set table.

*Table 52. Columns in the subscription set table*

| Column name | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| APPLY_QUAL  | Uniquely identifies a group of subscription sets that are processed by the same Apply process. This user-specified value must be unique for the control server where the subscription set table is located. For update-anywhere, this value must be unique at the control server and at the source server. This value is case-sensitive. You must specify this value when you define a subscription set. See “Defining replication subscription sets” on page 112 for more details. |

## Subscription set table

Table 52. Columns in the subscription set table (continued)

| Column name   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SET_NAME      | Identifies a group of source and target tables (subscription-set members) that are processed by the Apply program as a group. This user-specified value must be unique within an Apply qualifier. Changes for subscription members in a set are processed in a single transaction during the Apply processing cycle.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| WHOS_ON_FIRST | The following values are used to control the order of processing in update-anywhere replication scenarios.<br><b>F</b> (first) The target table is the user table or parent replica. The source table is the dependent row-replica and, in the case of update conflicts between the source table and the target table, the source table will have its conflicting transactions rejected. F is not used for read-only subscriptions.<br><b>S</b> (second) The source table is the user table, parent replica, or other source. The target table is the dependent row-replica or other copy and, in the case of update conflicts between the source table and the target table, the target table will have its conflicting transactions rejected. S is used for all read-only subscriptions. |
| ACTIVATE      | The following values are flags set by either the administration tool (0 and 1) or by the Apply program (2).<br><b>0</b> The subscription set is deactivated.<br><b>1</b> The subscription set is active indefinitely.<br><b>2</b> The subscription set is used for a one-time-only subscription execution.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| SOURCE_SERVER | The database name of the source server where the source tables and views are defined.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| SOURCE_ALIAS  | The DB2 Universal Database alias corresponding to the source server named in the SOURCE_SERVER column.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| TARGET_SERVER | The database name of the server where the target tables and views are defined.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| TARGET_ALIAS  | The DB2 Universal Database alias corresponding to the target server named in the TARGET_SERVER column.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

Table 52. Columns in the subscription set table (continued)

| Column name    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| STATUS         | <p>A value that represents in-progress and completed work status for the Apply program.</p> <p><b>-1</b> A failed execution.</p> <p><b>0</b> A successful subscription definition.</p> <p><b>1</b> A pending or in-progress execution. Do not modify this definition or any rows related to this subscription set in other control tables.</p> <p><b>2</b> A continuing execution of a single logical subscription set that was divided according to the MAX_SYNCH_MINUTES control column and is being serviced by multiple subscription cycles. Do not modify this row or any row related to this subscription set in other control tables.</p> |
| LASTRUN        | The estimated time that the last subscription set began. The Apply program sets the LASTRUN value each time a subscription set is processed. It is the approximate time at the control server that the Apply program begins processing the subscription set.                                                                                                                                                                                                                                                                                                                                                                                     |
| REFRESH_TIMING | <p>Sets the timing between statement executions.</p> <p><b>R</b> The Apply program uses the value in SLEEP_MINUTES to determine replication timing.</p> <p><b>E</b> The Apply program checks the time value in the subscription events table to determine replication timing. Before any replication (change capture or full refresh) can begin, an event must occur.</p> <p><b>B</b> Indicates that a subscription set has both relative and event timing specifications. Therefore, this subscription set can be eligible for a refresh based on either the timer or event timing criteria.</p>                                                |
| SLEEP_MINUTES  | Specifies the time (in minutes), of inactivity between subscription set processing when REFRESH_TIMING is R or B.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| EVENT_NAME     | A unique character string used to represent an event. Use this identifier to update the subscription events table when you want to trigger replication for a subscription set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| LASTSUCCESS    | The control server timestamp for the beginning of the last successful processing of a subscription set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## Subscription set table

Table 52. Columns in the subscription set table (continued)

| Column name       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SYNCHPOINT        | The Apply program uses the SYNCHPOINT value from the global row of the register table at the source server if GLOBAL_RECORD is Y. If data blocking is specified in the subscription-set definition, then the SYNCHPOINT value is the log or journal record sequence number of the last change applied during the Apply process.                                                                                                                                                                                                                                                                            |
| SYNCHTIME         | <p>The Capture program or an external program, such as IMS DataPropagator, updates this timestamp whether there are changes to be processed or not.</p> <p>The Apply program uses this value when advanced conflict detection is selected for update-anywhere replication to ensure that the Capture program captured all outstanding changes for a replication source table.</p>                                                                                                                                                                                                                          |
| MAX_SYNCH_MINUTES | A time-threshold limit to regulate the amount of change data to fetch and apply during a subscription cycle. The Apply program breaks the subscription set processing into mini-cycles based on the IBMSNAP_LOGMARKER column in the UOW or CCD table at the source server and issues a COMMIT at the target server after each successful mini-cycle. The limit is automatically recalculated if the Apply program encounters a resource constraint that makes the set limit unfeasible. MAX_SYNCH_MINUTES values that are less than 1 will be treated the same as a MAX_SYNCH_MINUTES value equal to NULL. |
| AUX_STMTS         | The number of SQL statements that you define in the subscription statement table that can run before or after the Apply program processes a subscription set.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| ARCH_LEVEL        | The architectural level of the definition contained in the row. This field identifies the rules under which a row was created. This level is defined by IBM, and for Version 7 is 0201.                                                                                                                                                                                                                                                                                                                                                                                                                    |

## Subscription-targets-member table

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

### ASN.IBMSNAP\_SUBS\_MEMBR

This table or view contains information about the individual source and target table pairs defined for a subscription set. Rows are automatically inserted into this table when you create a subscription set member.

## Subscription-targets-member table

Use this table or view to identify a specific source and target table pair within a subscription set.

Table 53 provides a brief description of the columns in the subscription-targets-member table.

*Table 53. Columns in the subscription-targets-member table*

| Column name   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| APPLY_QUAL    | Uniquely identifies a group of subscription sets that are processed by the same Apply process. This user-specified value must be unique for the control server where the subscription set table is located. For update-anywhere, this value must be unique at the control server and at the source server. This value is case-sensitive. You must specify this value when you define a subscription set.                                                                                                                                                                                                                                                                                                                                                                                           |
| SET_NAME      | Identifies a group of source or target table pairs (subscription-set members) that are processed by the Apply program as a group. This user-specified value must be unique within an Apply qualifier. Changes for subscription members in a set are processed in a single transaction during the Apply processing cycle.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| WHOS_ON_FIRST | The following values are used to control the order of processing in update-anywhere replication scenarios.<br><br><b>F</b> (first) The target table is the user table or parent replica. The source table is the dependent row-replica and, in the case of update conflicts between the source table and the target table, the source table will have its conflicting transactions rejected. F is not used for read-only subscriptions.<br><br><b>S</b> (second) The source table is the user table, parent replica, or other source. The target table is the dependent row-replica or other copy and, in the case of update conflicts between the source table and the target table, the target table will have its conflicting transactions rejected. S is used for all read-only subscriptions. |
| SOURCE_OWNER  | The owner of the source table or view.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| SOURCE_TABLE  | The source from which data is being captured.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

## Subscription-targets-member table

Table 53. Columns in the subscription-targets-member table (continued)

| Column name      | Description                                                                                                                                                                                                                                                                                                                                                                 |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SOURCE_VIEW_QUAL | Supports the view of physical tables by matching the similar column in the register table. This value is set to 0 for physical tables that are defined as sources and is greater than 0 for views that are defined as sources. This column is used to support multiple subscriptions for different source views with identical SOURCE_OWNER and SOURCE_TABLE column values. |
| TARGET_OWNER     | A qualifier for a target table or view.                                                                                                                                                                                                                                                                                                                                     |
| TARGET_TABLE     | The target to which data is being applied.                                                                                                                                                                                                                                                                                                                                  |
| TARGET_CONDENSED | A flag indicating:<br><br>Y For any given primary key, the target table shows only one row.<br><br>N All changes must remain, retaining a complete update history.<br><br>A The target table is a base aggregate or change aggregate tables.                                                                                                                                |
| TARGET_COMPLETE  | A flag indicating:<br><br>Y The target table contains a row for every primary key value of interest.<br><br>N The target table contains some subset of rows of primary key values.                                                                                                                                                                                          |
| TARGET_STRUCTURE | The structure of the target table:<br><br>1 User table<br>3 CCD table<br>4 Point-in-time table<br>5 Base aggregate table<br>6 Change aggregate table<br>7 Replica<br>8 User copy<br>9 Row-replica (Microsoft Jet specific)                                                                                                                                                  |

Table 53. Columns in the subscription-targets-member table (continued)

| Column name | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PREDICATES  | Lists the predicates to be placed in a WHERE clause for the table in the TARGET_TABLE column. This WHERE clause creates a row subset of the source table. Predicates are recognized only when WHOS_ON_FIRST is set to S. The letter A is a predefined correlation-name for the physical source table used in a correlated subquery. Cannot contain an ORDER BY clause because the Apply program cannot generate an ORDER BY clause. Aggregate tables require a dummy predicate followed by a GROUP BY clause as a predicate. |

### Subscription columns table

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

#### ASN.IBMSNAP\_SUBS\_COLS

This table contains information about the columns of the subscription-set members being copied in a subscription set. The subscription columns table contains supplemental information to the subscription-targets-member table.

Rows are automatically inserted or deleted from this table when information contained in one or more columns of a source and target table pair is changed.

Use this table if you need information about specific columns in a subscription-set member.

Table 54 provides a brief description of the columns in the subscription columns table.

Table 54. Columns in the subscription columns table

| Column name | Description                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| APPLY_QUAL  | Identifies the Apply program for the platform instance that will run this subscription set. The value must be unique among all Apply processes maintaining dependent replicas of a user table or parent replica, and unique among all Apply processes sharing a common set of control tables. This value is case sensitive. You must specify this value when you define a subscription set. |
| SET_NAME    | Names a subscription set. This value is unique within an Apply qualifier.                                                                                                                                                                                                                                                                                                                   |

## Subscription columns table

Table 54. Columns in the subscription columns table (continued)

| Column name   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| WHOS_ON_FIRST | <p>The following values are used to control the order of processing in update-anywhere replication scenarios.</p> <p><b>F</b> (first) The target table is the user table or parent replica. The source table is the dependent row-replica and, in the case of update conflicts between the source table and the target table, the source table will have its conflicting transactions rejected. F is not used for read-only subscriptions.</p> <p><b>S</b> (second) The source table is the user table, parent replica, or other source. The target table is the dependent row-replica or other copy and, in the case of update conflicts between the source table and the target table, the target table will have its conflicting transactions rejected. S is used for all read-only subscriptions.</p> |
| TARGET_OWNER  | A qualifier for a target table or view.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| TARGET_TABLE  | The target to which data is being applied.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| COL_TYPE      | <p>A flag indicating:</p> <p><b>A</b> For an after-image column.</p> <p><b>B</b> For a before-image column.</p> <p><b>C</b> For a computed column without an SQL-column-function reference.</p> <p><b>D</b> A DATALINK value or DATALINK indicator column.</p> <p><b>F</b> For a computed column with an SQL-column-function reference.</p> <p><b>L</b> A large object (LOB) column.</p> <p><b>R</b> Signifies a relative record number column, provided by the system and used as a primary key column. Used only by DB2 DataPropagator for AS/400.</p>                                                                                                                                                                                                                                                  |
| TARGET_NAME   | <p>The name of the target table or view column. It does not need to match the source column name.</p> <p>Internal CCD column names cannot be renamed. They must match the CD table column names.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |



Table 54. Columns in the subscription columns table (continued)

| Column name | Description                                                                                                                              |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------|
| IS_KEY      | Y      The column is all or part of the primary key of the target (all condensed copies must have primary keys).                         |
|             | N      The column is not part of a key of the target.                                                                                    |
| COLNO       | The numeric location of the column in the original source, to be preserved relative to other user columns in displays and subscriptions. |
| EXPRESSION  | The source column name or an SQL expression representing the target column.                                                              |

### Subscription statements table

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data. The number of entries for a subscription should be reflected in `ASN.IBMSNAP_SUBS_SET.AUX_STMTS`. If `AUX_STMTS` is zero for a subscription set, the corresponding entries in the subscription statements table are ignored by the Apply program.

#### `ASN.IBMSNAP_SUBS_STMTS`

This table contains the user-defined SQL statements or stored procedure calls that will be executed before or after each subscription-set processing cycle. Execute immediately (EI) statements or stored procedures can be executed at the source or target server only. This table is populated when you define a subscription set that uses SQL statements or stored procedure calls.

Table 55 provides a brief description of the columns in the subscription statements table.

Table 55. Columns in the subscription statements table

| Column name | Description                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| APPLY_QUAL  | Uniquely identifies a group of subscription sets that are processed by the same Apply process. This user-specified value must be unique for the control server where the subscription set table is located. For update-anywhere, this value must be unique at the control server and at the source server. This value is case-sensitive. You must specify this value when you define a subscription set. |

## Subscription statements table

Table 55. Columns in the subscription statements table (continued)

| Column name     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SET_NAME        | Identifies a group of source and target table pairs (subscription-set members) that are processed by the Apply program as a group. This user-specified value must be unique within an Apply qualifier. Changes for subscription-set members in a set are processed in a single transaction during the Apply processing cycle.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| WHOS_ON_FIRST   | The following values are used to control the order of processing in update-anywhere replication scenarios.<br><b>F</b> (first) The target table is the user table or parent replica. The source table is the dependent row-replica and, in the case of update conflicts between the source table and the target table, the source table will have its conflicting transactions rejected. F is not used for read-only subscriptions.<br><b>S</b> (second) The source table is the user table, parent replica, or other source. The target table is the dependent row-replica or other copy and, in the case of update conflicts between the source table and the target table, the target table will have its conflicting transactions rejected. S is used for all read-only subscriptions. |
| BEFORE_OR_AFTER | A value indicating:<br><b>A</b> The statement is executed at the target server after all of the answer-set rows are applied.<br><b>B</b> The statement is executed at the target server before any of the answer-set rows are applied.<br><b>S</b> The statement is executed at the source server before opening the answer-set cursors.<br><b>G</b> The statement is executed at the source server before opening any cursors to either fetch answer-set rows or fetch replication source details.                                                                                                                                                                                                                                                                                        |
| STMT_NUMBER     | Defines the relative order of execution within the scope of BEFORE_OR_AFTER.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

Table 55. Columns in the subscription statements table (continued)

| Column name      | Description                                                                                                                                                                                                                                                                                                                             |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EI_OR_CALL       | <p>A value indicating:</p> <p><b>E</b>      The SQL statement should be run as an EXEC SQL EXECUTE IMMEDIATE.</p> <p><b>C</b>      The SQL statement contains a stored procedure name to run as an EXEC SQL CALL.</p>                                                                                                                   |
| SQL_STMT         | <p>One of the following values:</p> <p><b>Statement</b><br/>The SQL statement should run as an EXEC SQL EXECUTE IMMEDIATE statement if EI_OR_CALL is E.</p> <p><b>Procedure</b><br/>The 8-byte name of an SQL-stored procedure, without parameters or the CALL keyword, that runs as an EXEC SQL CALL statement if EI_OR_CALL is C.</p> |
| ACCEPT_SQLSTATES | <p>One to ten 5-byte SQLSTATE values that you specified when you defined the subscription set. These non-zero values are accepted by the Apply program as a successful execution. Any other values will cause a failed execution.</p>                                                                                                   |

### Row-replica-target-list table (Microsoft Jet specific)

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

#### ASN.IBMSNAP\_SUBS\_TGTS

This table is necessary to identify when a member has been deleted from a subscription set for a Microsoft Jet database target, so that the row-replica table can be deleted from the Microsoft Jet database. The row-replica-target-list table allows DataPropagator for Microsoft Jet to maintain a list of known row-replica tables in a stable DB2 or DataJoiner database. DataPropagator for Microsoft Jet uses this information during schema analysis to determine if any row-replica tables should be deleted because the corresponding subscription-set member was dropped since the last synchronization.

Table 56 on page 334 provides a brief description of the columns in the row-replica-target-list table.

## Row-replica-target-list table

Table 56. Columns in the row-replica-target-list table

| Column name   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| APPLY_QUAL    | Uniquely identifies a group of subscription sets that are processed by the same Apply process. This user-specified value must be unique for the control server where the subscription set table is located. For update-anywhere, this value must be unique at the control server and at the source server. This value is case-sensitive. You must specify this value when you define a subscription set.                                                                                                                                                                                                                                                                                                                                                                                           |
| SET_NAME      | Identifies a group of source and target table pairs (subscription-set members) that are processed by the Apply program as a group. This user-specified value must be unique within an Apply qualifier.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| WHOS_ON_FIRST | The following values are used to control the order of processing in update-anywhere replication scenarios.<br><br><b>F</b> (first) The target table is the user table or parent replica. The source table is the dependent row-replica and, in the case of update conflicts between the source table and the target table, the source table will have its conflicting transactions rejected. F is not used for read-only subscriptions.<br><br><b>S</b> (second) The source table is the user table, parent replica, or other source. The target table is the dependent row-replica or other copy and, in the case of update conflicts between the source table and the target table, the target table will have its conflicting transactions rejected. S is used for all read-only subscriptions. |
| TARGET_OWNER  | A qualifier for a target table or view.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| TARGET_TABLE  | The target to which data is being applied.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| LAST_POSTED   | This column is the timestamp of when this row was inserted into the table. This column is for informational purposes only.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

### Subscription-schema-changes table (Microsoft Jet specific)

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

#### ASN.IBMSNAP\_SCHEMA\_CHG

This table allows DataPropagator for Microsoft Jet to determine if some relevant schema change has occurred since its last synchronization. If a modification is made, DataPropagator for Microsoft Jet will drive a thorough

## Subscription-schema-changes table

analysis of the replication control information. DataPropagator for Microsoft Jet will then create or drop row-replica tables, or columns in row-replica tables, to automatically converge the Microsoft Jet database schema with the schema described by the replication control information. This schema convergence occurs before data synchronization, so that new columns and new tables are copied.

Table 57 provides a brief description of the columns in the subscription-schema-changes table.

*Table 57. Columns in the subscription-schema-changes table*

| Column name  | Description                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| APPLY_QUAL   | Uniquely identifies a group of subscription sets that are processed by the same Apply process. This user-specified value must be unique for the control server where the subscription set table is located. For update-anywhere, this value must be unique at the control server and at the source server. This value is case-sensitive. You must specify this value when you define a subscription set. |
| SET_NAME     | Identifies a group of source and target table pairs (subscription-set members) that are processed by the Apply program as a group. This user-specified value must be unique within an Apply qualifier. Changes for subscription members in a set are processed in a single transaction at the target site during the Apply processing cycle.                                                             |
| LAST_CHANGED | This column is the timestamp of when this row was last changed in this table. This column is for informational purposes only.                                                                                                                                                                                                                                                                            |

## Subscription events table

This table contains information that you update using SQL.

### ASN.IBMSNAP\_SUBS\_EVENT

This table contains information about the event triggers that are copied in a subscription set. The subscription events table contains event names and timestamps associated with the event names. You insert a row into this table when you create a new event to start an Apply process. See “Event timing” on page 124.

Table 58 on page 336 provides a brief description of the columns in the subscription events table.

## Subscription events table

Table 58. Columns in the subscription events table

| Column name   | Description                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EVENT_NAME    | When you replicate events between systems, this column contains a globally unique character string in a global name space configuration. Otherwise, this column contains a control server unique character string.                                                                                                                                                                             |
| EVENT_TIME    | A control server timestamp of a current or future posting time. User applications signalling replication events provide the values in this column.                                                                                                                                                                                                                                             |
| END_OF_PERIOD | <p>A source server timestamp value that acts like an upper boundary. Any transactions that are committed after this period are not replicated until a later event is posted.</p> <p>The only way to prevent eligible change data from replicating during a subscription cycle is to make sure that the value in this column is less than the CURRENT TIMESTAMP value at the source server.</p> |

A unique index on EVENT\_NAME and EVENT\_TIME is created automatically by the administration tool or by the DPCNTL file.

## Apply trail table

### ASN.IBMSNAP\_APPLYTRAIL

The Apply trail table contains audit trail information for the Apply program. This table records a history of updates performed against subscriptions. It is a repository of diagnostic and performance statistics. The Apply trail table is one of the best places to look if a problem occurs with the Apply program. Because this table is not automatically pruned, it is up to you to do so.

Table 59 provides a brief description of the columns in the Apply trail table.

Table 59. Columns in the Apply trail table

| Column name | Description                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| APPLY_QUAL  | Uniquely identifies a group of subscription sets that are processed by the same Apply process. This user-specified value must be unique for the control server where the subscription set table is located. For update-anywhere, this value must be unique at the control server and at the source server. This value is case-sensitive. You must specify this value when you define a subscription set. |

Table 59. Columns in the Apply trail table (continued)

| Column name   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SET_NAME      | Identifies a group of source and target table pairs (subscription-set members) that are processed by the Apply program as a group. This user-specified value must be unique within an Apply qualifier. Changes for subscription members in a set are processed in a single transaction at the target site during the Apply program processing cycle.                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| WHOS_ON_FIRST | <p>The following values are used to control the order of processing in update-anywhere replication scenarios.</p> <p><b>F</b> (first) The target table is the user table or parent replica. The source table is the dependent row-replica and, in the case of update conflicts between the source table and the target table, the source table will have its conflicting transactions rejected. F is not used for read-only subscriptions.</p> <p><b>S</b> (second) The source table is the user table, parent replica, or other source. The target table is the dependent row-replica or other copy and, in the case of update conflicts between the source table and the target table, the target table will have its conflicting transactions rejected. S is used for all read-only subscriptions.</p> |
| ASNLOAD       | <p>Contains one of the following values:</p> <p><b>Y</b> Indicates that the Apply program was started and that the LOADXit parameter and the ASNLOAD exit routine were called to perform a full refresh on a subscription set.</p> <p><b>N</b> Indicates that the ASNLOAD exit routine was not called because either a full refresh was not needed or the Apply program was not started with the LOADXit parameter.</p> <p><b>NULL</b> Indicates that an Apply program error occurred before the Apply program could determine whether the ASNLOAD exit routine should be called.</p>                                                                                                                                                                                                                     |

## Apply trail table

Table 59. Columns in the Apply trail table (continued)

| Column name       | Description                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MASS_DELETE       | <p>A mass delete is always triggered during a full refresh. The following are values for this column:</p> <p><b>Y</b> Indicates that a full refresh was done for a subscription set.</p> <p><b>N</b> Indicates that a full refresh was not done for a subscription set.</p> <p><b>NULL</b> Indicates that an error occurred before the Apply program could determine whether or not a full refresh was needed.</p> |
| EFFECTIVE_MEMBERS | <p>The number of subscription-set members that are changed during an Apply cycle, either by a full refresh or by the replication of inserts, updates, and deletes. This number ranges between zero and the number of defined subscription-set members.</p>                                                                                                                                                         |
| SET_INSERTED      | <p>The total number of rows inserted into subscription-set members during the subscription cycle.</p>                                                                                                                                                                                                                                                                                                              |
| SET_DELETED       | <p>The total number of rows deleted from subscription-set members during the subscription cycle.</p>                                                                                                                                                                                                                                                                                                               |
| SET_UPDATED       | <p>The total number of rows updated in subscription-set members during the subscription cycle.</p>                                                                                                                                                                                                                                                                                                                 |
| SET_REWORKED      | <p>The Apply program reworks changes under the following conditions:</p> <ul style="list-style-type: none"><li>• If an insert fails because the row already exists in the target table, the Apply program converts the insert to an update of the existing row.</li><li>• If the update fails because the row does not exist in the target table, the Apply program converts the update to an insert.</li></ul>    |
| SET_REJECTED_TRXS | <p>The total number of transactions rejected due to an update-anywhere conflict. This column is used only for update-anywhere subscription sets where conflict detection is defined as standard or advanced.</p>                                                                                                                                                                                                   |



Table 59. Columns in the Apply trail table (continued)

| Column name   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| STATUS        | <p>A value that represents in-progress and completed work status for the Apply program.</p> <p>-1      A failed execution.</p> <p>0        A successful subscription definition.</p> <p>1        A pending or in-progress execution. Do not modify this definition or any rows related to this subscription set in other control tables.</p> <p>2        A continuing execution of a single logical subscription that was divided according to the MAX_SYNCH_MINUTES control column and is being serviced by multiple subscription cycles. Do not modify this row or any row related to this subscription set in other control tables.</p> |
| LASTRUN       | The estimated time that the last subscription began. The Apply program sets the LASTRUN value each time a subscription set is processed. It is the approximate time at the control server that the Apply program begins processing the subscription set.                                                                                                                                                                                                                                                                                                                                                                                   |
| LASTSUCCESS   | The control server timestamp for the beginning of the last successful processing of a subscription set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| SYNCHPOINT    | The Apply program uses the SYNCHPOINT value from the global row of the register table at the source server if GLOBAL_RECORD is Y. If data blocking is specified in the subscription definition, then the SYNCHPOINT value is the log or journal record sequence number of the last change applied during the Apply process.                                                                                                                                                                                                                                                                                                                |
| SYNCHTIME     | <p>The Capture program or an external program, such as IMS DataPropagator, updates this timestamp whether there are changes to be processed or not.</p> <p>The Apply program uses this value when advanced conflict detection is selected for update-anywhere replication to ensure that the Capture program has captured all outstanding changes for a replication source table.</p>                                                                                                                                                                                                                                                      |
| SOURCE_SERVER | The database name of DB2 for OS/390, DB2 for VSE, and DB2 for VM where the source tables and views are defined.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| SOURCE_ALIAS  | The DB2 Universal Database alias corresponding to the source server named in the SOURCE_SERVER column.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| SOURCE_OWNER  | The owner of the source table or view.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| SOURCE_TABLE  | The source from which data is being captured.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

## Apply trail table

Table 59. Columns in the Apply trail table (continued)

| Column name      | Description                                                                                                                                                                                                                                                                                                                                                                 |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SOURCE_VIEW_QUAL | Supports the view of physical tables by matching the similar column in the register table. This value is set to 0 for physical tables that are defined as sources and is greater than 0 for views that are defined as sources. This column is used to support multiple subscriptions for different source views with identical SOURCE_OWNER and SOURCE_TABLE column values. |
| TARGET_SERVER    | The database name of the target server where the target tables and views are defined.                                                                                                                                                                                                                                                                                       |
| TARGET_ALIAS     | The DB2 Universal Database alias corresponding to the target server named in the TARGET_SERVER column.                                                                                                                                                                                                                                                                      |
| TARGET_OWNER     | A qualifier for a target table or view.                                                                                                                                                                                                                                                                                                                                     |
| TARGET_TABLE     | The target to which data is being applied.                                                                                                                                                                                                                                                                                                                                  |
| SQLSTATE         | The SQL state code for a failed execution. Otherwise, NULL.                                                                                                                                                                                                                                                                                                                 |
| SQLCODE          | The SQL error code for a failed execution. Otherwise, NULL.                                                                                                                                                                                                                                                                                                                 |
| SQLERRP          | The database product identifier of the server where an SQL error occurred that caused a failed execution. Otherwise, NULL.                                                                                                                                                                                                                                                  |
| SQLERRM          | The SQL error information for a failed execution. Otherwise, NULL.                                                                                                                                                                                                                                                                                                          |
| APPERRM          | The Apply error message ID and text for a failed execution. Refer to “Chapter 15. Capture and Apply messages” on page 353 and “Chapter 16. Replication messages for AS/400” on page 381 for detailed message information. Otherwise, NULL.                                                                                                                                  |

### Apply job table (AS/400 specific)

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

#### IBMSNAP\_APPLY\_JOB

This AS/400-specific table is used to guarantee a unique APPLY\_QUAL value for all instances of the Apply program running at the control server. A row is added to this table every time an instance of the Apply program is started. If you start a new instance of the Apply program with an APPLY\_QUAL value that already exists, the start command fails.

Table 60 provides a brief description of the columns in the Apply job table.

*Table 60. Columns in the Apply job table*

| Column name    | Description                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| APPLY_QUAL     | A unique identifier for a group of subscription sets. This value is supplied by the user when defining a subscription set. Each instance of the Apply program is started with an APPLY_QUAL. This value is used during update-anywhere replication to prevent circular replication of the changes made by the Apply program. See the subscription set table on page “Subscription set table” on page 323 for more details. |
| CONTROL_SERVER | Name of the database where the control tables and view are defined.                                                                                                                                                                                                                                                                                                                                                        |
| USER_NAME      | Name of the user who started a new instance of the Apply program                                                                                                                                                                                                                                                                                                                                                           |
| JOB_NAME       | The fully qualified name of the job that wrote this trace entry: <ul style="list-style-type: none"> <li>• position 1-10: APPLY_QUAL, truncated to 10 characters if necessary</li> <li>• position 11-20: The ID of the user who started the Apply program</li> <li>• position 21-26: The job number</li> </ul>                                                                                                              |
| JOB_NUMBER     | The job number of the current job for a particular journal. If the journal is not active, this column contains the job number of the last job that was processed.                                                                                                                                                                                                                                                          |

### Tables used at the target server

The following section provides a brief description of the types of target tables used at the target server and the columns in each table.

#### User copy table

**Important:** If you use SQL to update this table, you run the risk of losing your updates when a full refresh is performed by the Apply program.

*userid.target\_table*

The user copy table is identical to the point-in-time target table with the exception of the IBMSNAP\_LOGMARKER column, which is not included in the user copy table.

Except for subsetting and data enhancement, a user copy table reflects a valid state of the source table, but not necessarily the most current state. References

## User copy table

to user copy tables (or any other type of target table) reduce the risk of contention problems that results from a high volume of direct access to the source tables. Accessing local user copy tables is much faster than using the network to access remote source tables for each query.

Table 61 provides a brief description of the columns in the user copy table.

*Table 61. Columns in the user copy table*

| Column name                  | Description                                                                                                                                                                                                                 |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>user key columns</i>      | The primary key of the target table, although it is not necessarily a component of the primary key of the source table. You can use predicates to prevent a NULL value from being assigned to the key fields of any copies. |
| <i>user nonkey columns</i>   | The nonkey data columns from the source table or view. The columns from the source table do not need to match these columns, but the data types must match.                                                                 |
| <i>user computed columns</i> | User-defined columns that are derived from SQL expressions. You can use computed columns with SQL functions to convert source data types to different target data types.                                                    |

## Point-in-time table

**Important:** If you use SQL to update this table, you run the risk of losing your updates when a full refresh is performed by the Apply program.

*userid.target\_table*

The point-in-time table is similar to the user copy table, but contains an additional system column (IBMSNAP\_LOGMARKER) containing the approximate timestamp of when the particular row was inserted or updated at the source system. Otherwise, a point-in-time table is much like a past image of the source table. Point-in-time copies reflect a valid state of the source table, but not necessarily the most current state.

Table 62 provides a brief description of the columns in the point-in-time table.

*Table 62. Columns in the point-in-time table*

| Column name             | Description                                                                                                                                                                                                                 |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>user key columns</i> | The primary key of the target table, although it is not necessarily a component of the primary key of the source table. You can use predicates to prevent a NULL value from being assigned to the key fields of any copies. |

Table 62. Columns in the point-in-time table (continued)

| Column name                  | Description                                                                                                                                                              |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>user nonkey columns</i>   | The nonkey data columns from the source table or view. The columns from the source table do not need to match these columns, but the data types must match.              |
| <i>user computed columns</i> | User-defined columns that are derived from SQL expressions. You can use computed columns with SQL functions to convert source data types to different target data types. |
| IBMSNAP_LOGMARKER            | The approximate commit time at the source server. This column is NULL following a full refresh.                                                                          |

### Consistent-change-data table

This table contains information that you can update by using SQL.

*userid.target\_table*

CCD tables are staging tables that contain committed change data (for details, see “Staging data” on page 82). Maintaining CCD tables requires updating the CCD\_OLD\_SYNCHPOINT and SYNCHPOINT columns of the register table.

The CCD table can be:

- A staging table maintained by one Apply program  
The result of a join between the CD and UOW tables can be stored here, so that you perform the join step only once for replicating changes to multiple targets. The CCD table can be maintained on a remote system. The advantage of maintaining your CCD table remotely is that you reduce the work load on your source. You replicate a set of changes from the original source to the CCD table only once. The CCD table then acts as the source and maintains all changes.
- External source table for nonrelational and multivendor data  
External programs can create CCD tables to be used by DB2 DataPropagator as replication sources. An example is IMS DataPropagator, which captures IMS changes and maintains a CCD table so that copies of IMS data can be recreated in a relational database.

For CCD tables:

- The Capture program does not insert data into CCD tables and does not prune them. Instead, your application requirements should determine the history retention period for CCD tables (described in “Staging data” on page 82 ). Therefore, pruning of CCD tables is not automatic by default, but can be easily automated using an SQL statement to be processed after the subscription cycle.

## Consistent-change-data table

- For condensed CCD tables, a unique index is required for user-data primary-key columns to maintain the CCD table.
- An internal CCD table is an alternate source for the original user table. The user table does not include computed columns; therefore, computed columns should not be included in the CCD subscriptions.
- If an external program, other than the Apply program, maintains the external CCD table, the external program must initialize, maintain, and supply the correct values for the control columns.
- Before-image user data columns must be nullable and therefore cannot be part of a primary key for a condensed CCD table.
- Null attributes of the after-image user data columns should match the null attributes of the source.
- Views of change data tables can be included in view replication sources.
- Views that are defined as replication sources can refer only to CCD tables that are complete and condensed.

The originally captured operation code in the `IBMSNAP_OPERATION` column and the sequence numbers `IBMSNAP_INTENTSEQ` and `IBMSNAP_COMMITSEQ` are included in CCD tables. For condensed CCD tables, only the latest values are kept for each row.

### Special cases for condensed CCD tables

Because condensed CCD tables must have a unique index:

- Inserts to a row with a key that already exists will fail. The insert becomes an update.
- Updates to rows that do not exist will fail. The update becomes an insert.
- A delete is always handled as an update and the row remains in the CCD table.

Table 63 provides a brief description of the columns in the CCD table.

*Table 63. Columns in the CCD table*

| Column name                    | Description                                                                                                                                                         |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>IBMSNAP_INTENTSEQ</code> | Log or journal record sequence number that uniquely identifies a change. This value is globally ascending.                                                          |
| <code>IBMSNAP_OPERATION</code> | Character value of I, U, or D, indicating an insert, update, or delete record.                                                                                      |
| <code>IBMSNAP_COMMITSEQ</code> | The log record sequence number of the captured commit statement. This value groups inserts, updates, and deletes by the original transactions for the source table. |
| <code>IBMSNAP_LOGMARKER</code> | The approximate commit time at the source server.                                                                                                                   |

Table 63. Columns in the CCD table (continued)

| Column name                  | Description                                                                                                                                                                                                                 |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>user key columns</i>      | The primary key of the target table, although it is not necessarily a component of the primary key of the source table. You can use predicates to prevent a NULL value from being assigned to the key fields of any copies. |
| <i>user nonkey columns</i>   | The nonkey data columns from the source table. The columns from the source table do not need to match these columns, but the data types must match.                                                                         |
| <i>user computed columns</i> | User-defined columns that are derived from SQL expressions. You can use computed columns with SQL functions to convert source data types to different target data types.                                                    |

## Replica table

This table contains information that you can update by using SQL.

*userid.target\_table*

The replica must have the same primary key as the source table. Because of these similarities, the replica table can be used as a source table for further subscription sets, making the target server a source server as well. Converting a target table into a source table is done automatically when you define a replica target type and specify the CHANGE DATA CAPTURE attribute. See “Defining subscription sets for update-anywhere replication” on page 114 for more information.

Table 64 provides a brief description of the columns in the replica table.

Table 64. Columns in the replica table

| Column name                | Description                                                                                                                                                                                                                 |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>user key columns</i>    | The primary key of the target table, although it is not necessarily a component of the primary key of the source table. You can use predicates to prevent a NULL value from being assigned to the key fields of any copies. |
| <i>user nonkey columns</i> | The nonkey data columns from the source table. The columns from the source table do not need to match these columns, but the data types must match.                                                                         |

## Base aggregate table

*userid.target\_table*

## Base aggregate table

Base aggregate tables are target tables that contain data aggregated from a source table. Functions are performed on data located at the source table, and the result of the function is inserted as a row in the base aggregate table.

For base aggregate tables:

- Before-image user data columns must be nullable.
- If the computation will never generate a null value, then the computed columns should be NOT NULL.
- Null attributes of the after-image user data columns should match null attributes of the source, except for primary key columns, which should always be NOT NULL.

Table 65 provides a brief description of the columns in the base aggregate table.

*Table 65. Columns in the base aggregate table*

| Column name         | Description                                                            |
|---------------------|------------------------------------------------------------------------|
| <i>user columns</i> | Columns computed from the source table.                                |
| IBMSNAP_LLOGMARKER  | The current source server timestamp when the data was last aggregated. |
| IBMSNAP_HLOGMARKER  | The current source server timestamp when the data was last aggregated. |

## Change aggregate table

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

*userid.target\_table*

A change aggregate table is a target table that contains data aggregations based on changes from a source table. This table is similar to the base aggregate table, except that the functions being performed at the source table are done only for changes that occur during a specific time interval. The results of these functions are inserted as rows into the change aggregate table. Before-image user data columns must be nullable in change aggregate tables.

Table 66 on page 347 provides a brief description of the columns in the change aggregate table.



Table 66. Columns in the change aggregate table

| Column name                  | Description                                                                                                                                                                                                                 |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>user key columns</i>      | The primary key of the target table, although it is not necessarily a component of the primary key of the source table. You can use predicates to prevent a NULL value from being assigned to the key fields of any copies. |
| <i>user nonkey columns</i>   | The nonkey data columns from the source table. The columns from the source table do not need to match these columns, but the data types must match.                                                                         |
| <i>user computed columns</i> | User-defined columns that are derived from SQL expressions. You can use computed columns with SQL functions to covert source data types to different target data types.                                                     |
| IBMSNAP_LLOGMARKER           | The oldest IBMSNAP_LOGMARKER or IBMSNAP_LLOGMARKER value present in the (CD+UOW) or CCD table rows being aggregated.                                                                                                        |
| IBMSNAP_HLOGMARKER           | The newest IBMSNAP_LOGMARKER or IBMSNAP_HLOGMARKER value present in the (CD+UOW) or CCD table rows being aggregated.                                                                                                        |

### Row-replica table (Microsoft Jet specific)

**Important:**This table contains information that you can update by using SQL.

*userid.target\_table*

This table is an update-anywhere replica table maintained by DataPropagator for Microsoft Jet. Conflicts are detected row by row, not transaction by transaction, as they are for replica tables. Row-replica is the only type of target table supported by DataPropagator for Microsoft Jet. The source table can be a DB2, Oracle, Sybase, Informix, or Microsoft SQL Server user table, or a DB2 replica. The source can also be a view of a DB2 user table or replica table, including a join view.

Table 67 provides a brief description of the columns in the row-replica table.

Table 67. Columns in the row-replica table

| Column name                | Description                                                                                                                                                                                                                 |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>user key columns</i>    | The primary key of the target table, although it is not necessarily a component of the primary key of the source table. You can use predicates to prevent a NULL value from being assigned to the key fields of any copies. |
| <i>user nonkey columns</i> | The nonkey data columns from the source table. The columns from the source table do not need to match these columns, but the data types must match.                                                                         |

## Row-replica table

### Conflict table (Microsoft Jet specific)

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

#### IBMSNAP\_<target name>\_CONFLICT

This table is a conflict table for tracking synchronization conflicts and errors. This Microsoft Jet database control table mimics Microsoft's conflict tables. This table contains the conflict loser's row data. The columns are the same as the corresponding row-replica table. This table can have more than one row. The conflict table is created along with the row-replica table in the Microsoft Jet database and dropped when the row-replica table is dropped.

Table 68 provides a brief description of the columns in the conflict table.

*Table 68. Columns in the conflict table*

| Column name                        | Description                                                          |
|------------------------------------|----------------------------------------------------------------------|
| <i>target name</i>                 | The corresponding row-replica table's name.                          |
| <i>column names of row-replica</i> | A list of column names found in the corresponding row-replica table. |

### Error information table (Microsoft Jet specific)

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

#### IBMSNAP\_ERROR\_INFO

This table identifies the row-replica table and row that caused the error. This table can have more than one row. The error information table is created along with the Microsoft Jet database and never dropped.

Table 69 provides a brief description of the columns in the error information table.

*Table 69. Columns in the error information table*

| Column name | Description                                                                                               |
|-------------|-----------------------------------------------------------------------------------------------------------|
| TableName   | The name of the row-replica table that is the source of the row that caused the error.                    |
| RowGuid     | The GUID of the row that caused the error.                                                                |
| Operation   | One of the following commands to identify the operation that caused the error: INSERT, UPDATE, or DELETE. |
| Reason      | The DB2 DataPropagator error message number.                                                              |

**Error messages table (Microsoft Jet specific)**

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

**IBMSNAP\_ERROR\_MESSAGE**

This table identifies the nature of an error. It contains the error code and error message. This table can have more than one row. The error messages table is created along with the Microsoft Jet database and never dropped.

Table 70 provides a brief description of the columns in the error messages table.

*Table 70. Columns in the error messages table*

| Column name | Description                                  |
|-------------|----------------------------------------------|
| Reason      | The DB2 DataPropagator error message number. |
| ReasonText  | The DB2 DataPropagator error message text.   |

**Error-side-information table (Microsoft Jet specific)**

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

**IBMSNAP\_SIDE\_INFO**

This table is a conflict table for tracking synchronization conflicts and errors. This Microsoft Jet database control table mimics Microsoft's conflict tables. This table contains the names of the conflict tables created by DataPropagator for Microsoft Jet.

Table 71 provides a brief description of the error-side-information table column.

*Table 71. Error-side-information table column*

| Column name       | Description                                                          |
|-------------------|----------------------------------------------------------------------|
| ConflictTableName | The conflict table name created by DataPropagator for Microsoft Jet. |

**Key string table (Microsoft Jet specific)**

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

**IBMSNAP\_GUID\_KEY**

## Key string table

This table maps the Microsoft Jet table names and row identifiers to primary key values when the following changes occur:

- Rows are deleted from Microsoft Jet database tables.
- Deletes are recorded in MSysTombstone with s\_Generation, TableGUID, and s\_GUID (row) identifiers, but without primary key details.
- The primary key values are needed to replicate Microsoft Jet database deletes to an RDBMS.

When DataPropagator for Microsoft Jet replicates delete actions to another Microsoft Jet database, only the internal row identifier is sent. To replicate delete actions outside of the Microsoft Jet environment, DataPropagator for Microsoft Jet needs to replicate a searched delete, with predicates referencing primary key values. The key string table allows DataPropagator for Microsoft Jet to maintain the key values needed to replicate a delete to an RDBMS, even after the row is physically deleted from the row-replica table.

Table 72 provides a brief description of the columns in the key string table.

*Table 72. Columns in the key string table*

| Column name    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RowReplicaname | Identifies the row-replica table where the row was inserted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| s_GUID         | Identifies the row in the specific row-replica table.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| key_string     | The string of "and-ed" DB2 SQL predicates identifying the key columns and their row values, with character constants delimited by single quotation marks. The column names are taken from the row-replica definition and can contain uppercase letters, lowercase letters or both. The constant values are taken from the rows themselves and the string values can contain uppercase letters, lowercase letters, numeric characters, or any combination of the three. Microsoft Jet database supports ASCII, so the string constants can contain single- or double-byte characters. For example:<br><br>COL1=(character) AND COL2=(character) |

## Synchronization generations table (Microsoft Jet specific)

**Important:** Do *not* use SQL to update this table. Altering this table inappropriately can cause unexpected results and loss of data.

### IBMSNAP\_S\_GENERATION

This table is used to prevent cyclic updates from replicating back to the RDBMS from a Microsoft Jet database. When DB2 is the target, this function is accomplished in a different way, using the APPLY\_QUAL column of the

## Synchronization generations table

critical section table, which results in the Capture Program posting to the APPLY\_QUAL column of the UOW table.

The s\_GENERATION column is maintained by Microsoft Jet and set to the same generation number as any other updates made since the last synchronization. If synchronization is successful, the synchronization generations table will contain one row whose Update\_Type value is F.

Due to the risk of partial failures during a DataPropagator for Microsoft Jet synchronization cycle, and because the WHOS\_ON\_FIRST = S flow is handled before the WHOS\_ON\_FIRST = F flow, multiple RDBMS-to-Jet generations can be posted before any Microsoft Jet database changes replicate to the RDBMS. In such a case, there is the possibility that a list of s\_GENERATION values will need to be skipped over when determining which s\_GENERATION of changes needs to be replicated to the RDBMS.

Table 73 provides a brief description of the columns in the synchronization generations table.

*Table 73. Synchronization generations table*

| Column name | Description                                                                                                                    |
|-------------|--------------------------------------------------------------------------------------------------------------------------------|
| Update_Type | A value that indicates whether a generation of changes is:<br><b>L</b> Local to the Microsoft Jet database<br><b>F</b> Foreign |
| JetSynctime | This is a dummy column, set to the time of a forced Microsoft Jet database synchronization.                                    |

## Synchronization generations table

---

## Chapter 15. Capture and Apply messages

This chapter contains a list of the messages issued by DB2 replication for the Capture and Apply programs on all of the database management systems except DB2 for AS/400. The messages issued by DB2 replication for AS/400 are located in “Chapter 16. Replication messages for AS/400” on page 381. The Replication Administration messages (DBA6001-DBA6110) are listed in the *DB2 Message Reference*.

The replication messages have the following prefixes:

**ASN0** The Capture program. These messages are listed in “Capture program messages”

**ASN1** The Apply program. These messages are listed in “Apply program messages” on page 368

Unless otherwise stated, all error codes described in error messages are internal error codes used by IBM Software Support. Also, unless otherwise stated, error messages are issued with a return code of 8.

You can also obtain explanations for messages by typing the following command at a DB2 command prompt:

```
db2 message_number
```

---

### Capture program messages

When you get a Capture program error, verify that your DB2 maintenance is at the most current level. The Capture program is an application program that uses DB2 APIs. Many Capture program errors are due to DB2 maintenance that is not current.

When you start DB2 with the cold start option, you must also start the Capture program with the cold start option.

**Note:** For SQL errors, see the *DB2 Message Reference* for your platform.

---

**ASN0000S** An internal error occurred for message number “<number>”. The error code is “<error\_code>”. The return code is “<return\_code>”.

**Explanation:** The message file for the Capture program was installed incorrectly, or the language environment variables are not set correctly. This message is displayed because no other Capture program message could be formatted.

**User Response:** Refer to the installation and configuration information in this book pertaining to your platform. Make sure that the message file is installed in the correct directory, and the language environment variables are set correctly. If the language environment variables are set correctly, contact IBM Software Support.

---

**ASN0001E** The Capture program encountered an SQL error.

**Parameters:**

- Routine name is “<name>”
- SQL request is “<request>”
- table name is “<table\_name>”
- SQLCODE is “<sqlcode>”
- SQLERRML is “<sqlerrml>”
- SQLERRMC is “<sqlerrmc>”

**Explanation:** A nonzero SQLCODE was returned when the Capture program issued an EXEC SQL statement.

**User Response:** See the messages and codes publication of the DB2 database manager on your platform for information about SQL return codes that use SQLERRML and SQLERRMC as substitution fields. Contact your DBA for more information.

---

**ASN0002E** The Capture program could not connect to DB2.

**Parameters:**

- Routine name is “<routine>”
- SQLCODE is “<sqlcode>”

**Explanation:** An error occurred when the Capture program issued:

- a CONNECT function to DB2 for VSE & VM
- a CONNECT function to DB2 Call Attachment Facility (CAF)
- an implicit connect to DB2 Universal Database.

**User Response:** See DB2 codes in the messages and codes publication of the DB2 database manager on your platform for the appropriate reason code.

For DB2 for OS/390 errors, see the section in the administration guide that describes the Call Attachment Facility. Contact your DBA for questions and diagnosis.

If you are running Capture under DB2 UDB for UNIX or under DataJoiner for UNIX, ensure that the LIBPATH environment variable is set to the same environment in which the Capture program starts. See “Starting Capture for UNIX platforms” on page 244 for more information.

---

**ASN0003E** The Capture program could not open the plan.

**Parameters:**

- Routine name is “<routine>”
- Return code is “<return\_code>”
- Reason code is “<reason\_code>”
- Subsystem is “<subsystem>”
- Plan name is “<ASNLPLAN>”

**Explanation:** An error occurred when the Capture program tried to open the plan, ASNLPLAN.

**User Response:** See the DB2 Codes section in the messages and codes publication of the DB2 database manager on your platform to find the appropriate reason code. See the section in the administration guide that describes the Call Attachment Facility.

---

**ASN0004E** The Capture program could not start the trace.

**Parameters:**

- Routine name is “<routine>”



- **Return code** is “<return\_code>”
- **Reason code** is “<reason\_code>”

**Explanation:** An error occurred when the START TRACE DB2 command was issued, or when Capture program read the DB2 log.

**User Response:** See the DB2 Codes section of in the messages and codes publication of the DB2 database manager on your platform to find the appropriate reason code. For more information, see either of the following sections in the administration guide: the Call Attachment Facility (CAF) for START TRACE DB2 errors, or the Instrumentation Facility Interface (IFI) for DB2 log read errors, or contact your DBA. If the CAF or the IFI returned a message, it is also printed on the system display console.

**ASN0005E**    **The Capture program encountered an error while reading the DB2 log.**

**Parameters:**

- **Routine name** is “<routine>”
- **LSN** is “<log\_sequence\_number>”
- **Return code** is “<return\_code>”
- **Reason code** is “<reason\_code>”

**Explanation:** An error occurred when the Capture program read the DB2 log. There might be an SQL error.

For Capture program for OS/390, an MVS system dump is generated for this message that is contained in MVS dump data set SYS1.DUMP.

For DB2 DataPropagator, the “<return\_code>” value is for the Asynchronous Read Log API.

For Capture for VSE, the “<return code>” is for the VSE/VSAM GET macro.

For Capture for VM, the “<return code>” is for Diagnose X'A4'.

**User Response:** See the DB2 Codes section in the messages and codes publication of the DB2 database manager on your platform for the appropriate reason code.

For Capture program for OS/390, see the Instrumentation Facility Interface (IFI) section in

the administration guide publication of the DB2 database manager on your platform or contact your DBA.

For Capture for VSE, see the *VSE/VSAM Commands and Macros*, *VSE/ESA System Macro Reference*, and *VSE/ESA V2R3 Messages and Codes* manuals for more information.

For VM/ESA, see the VM/ESA Programming Services for more information.

For Capture on UNIX, Windows, and OS/2, see the active and archived database logs section in the *DB2 UDB Administration Guide* or contact IBM Software Support.

**ASN0006E**    **The Capture program encountered an unexpected log error of unknown log variation. The routine name is “<routine>”.**

**Explanation:** An unexpected log error not reported by either:

- the Instrumentation Facility Interface (IFI) for Capture program for OS/390, or
- the Asynchronous Read Log API for the Capture program

occurred while the Capture program was processing the DB2 log records. The Capture program could not determine the type of SQL update associated with the log record.

For Capture program for OS/390, an MVS system dump is generated for this message that is contained in MVS dump data set SYS1.DUMP.

**User Response:** Contact IBM Software Support.

**ASN0007E**    **The Capture program encountered an unexpected log error of unimplemented data type. The routine name is “<routine>”.**

**Explanation:** An unexpected log error not reported by either:

- the Instrumentation Facility Interface (IFI) for Capture program for OS/390, or
- the Asynchronous Read Log API for the Capture program

occurred while the Capture program was processing the DB2 log records. The Capture program could not determine the type of SQL update associated with the log record.

For Capture program for OS/390, an MVS system dump is generated for this message that is contained in MVS dump data set SYS1.DUMP.

**User Response:** Contact IBM Software Support.

---

**ASN0008I The Capture program was stopped.**

**Explanation:** The IBM Replication administrator stopped the Capture program using one of the valid methods.

**Explanation:** This message is for your information only.

**User Response:** No action is required.

---

**ASN0009E The table was created without the DATA CAPTURE CHANGES (DCC) attribute.**

**Parameters:**

- **Routine name** is "<routine>"
- **Table name** is "<table\_name>"

**Explanation:** The source table was defined without the DCC attribute and the Capture program tried to capture changes for the replication source.

**User Response:**

1. Stop the Capture program.
2. Delete the replication source.
3. Define the replication source again; if you do not have the **Data capture is full-refresh only** check box selected, the DB2 Control Center will alter the source table with the DCC attribute.
4. Start the Capture program.

---

**ASN0010E The Capture program cannot obtain enough storage.**

**Parameters:**

- **Routine name** is "<routine>"
- **Storage required** is "<amount>"

**Explanation:** The Capture program cannot continue processing because not enough free storage is available. Usually 2MB is enough storage.

**User Response:** For Capture program for OS/390, ensure that the REGION parameter has enough storage allocated to run your job. If necessary, contact your OS/390 system programmer to determine the method for requesting sufficient storage.

For Capture for VM, a request to obtain virtual storage could not be satisfied. You might need to increase the size of the virtual machine in which Capture program runs.

For Capture for VSE, all available GETVIS storage has been exhausted. You might need to restart the Capture program after allocating a larger partition.

If you believe enough storage has been allocated, contact IBM Software Support.

---

**ASN0011E The DB2 compression dictionary is not available or the IFCID 306 buffer is invalid.**

**Parameters:**

- **Routine code** is "<routine\_code>"
- **Reason code** is "<reason\_code>"

**Explanation:** In the case of the DB2 compression dictionary not being available, the Capture program attempted to read log records for an old compression dictionary. DB2 for OS/390 only retains one version of the compression dictionary in memory. DB2 can only decompress log records for a compressed table if the compression dictionary used to compress the log records is still the current compression dictionary.

In the case of the IFCID 306 buffer not being

valid, the control information is missing from the buffer.

For Capture program for OS/390, an MVS system dump is generated for this message that is contained in MVS dump data set SYS1.DUMP.

**User Response:** For the DB2 compression dictionary error, to avoid an unwanted cold start of the Capture program, you must capture all log records for a compressed table before creating a new version of the compression dictionary. Use the `KEEPDICTIONARY` option to retain the current version of the compression dictionary during routine REORG processing.

When you want a new compression dictionary for the table, you must synchronize running the REORG utility with running your updated applications and the Capture program as follows:

1. Quiesce your updated applications.
2. Let the Capture program capture all logged updates for the compressed table.
3. Use the REORG utility on the compressed table, creating a new compression dictionary.
4. Release your updated applications.

For the IFCID 306 buffer error, ensure that all DB2 maintenance is current.

If you believe neither of these problems is the case, contact IBM Software Support. Maintenance could be the problem.

---

**ASN0013E** The Capture program required a column that was not defined in the change data (CD) table.

**Parameters:**

- Routine name is "`<routine>`"
- Table name is "`<table_name>`"

**Explanation:** The user did not define a required column in the change data table.

**User Response:** Ensure that the change data table definition is correct. Refer to "Change data table" on page 321 for more information.

---

**ASN0014E** The processing of the Capture program has fallen below a minimum level. The log record lags current time by "`<number>`" seconds. The routine name is "`<routine>`".

**Explanation:** The Capture program terminated because a high DB2 transaction rate caused the Capture program to run slower than the defined minimum level.

**User Response:** Refer to the Capture and Apply chapter for your platform for more information on the lag limit. Then you can:

- Perform a cold start.
- Alternatively, you can increase the lag limit.

---

**ASN0015E** The Capture program encountered a storage allocation error.

**Parameters:**

- Routine name is "`<routine>`"
- Storage required is "`<amount>`"

**Explanation:** A storage allocation error was detected; sufficient storage is not available. The Capture program might have been installed improperly.

For the Capture program on AIX, you might not have set the soft links for the component files to the shared directory.

**User Response:** Determine why storage could not be allocated by looking at the operating system and application task status. Contact your system programmer to determine the method of requesting the storage listed in the error message. Also verify that all C libraries are at the current maintenance level. If you believe enough storage space has been allocated, contact IBM Software Support.

For Capture for AIX, determine whether you have set the soft links for the component files.

For Capture for VM, a request to obtain virtual storage could not be satisfied. You might need to increase the size of the virtual machine in which Capture program runs.

For Capture for VSE, all available GETVIS storage has been exhausted. You might need to restart the Capture program after allocating a larger partition.

For Capture for OS/390 consult the program directory for instructions and verification of the appropriate C library level.

---

**ASN0016E** The Capture program could not begin capturing changes because there was no eligible replication source.

**Parameters:**

- Routine name is "<routine>"
- Table name is "<table\_name>"

**Explanation:** The replication source information in the register table has not been defined.

The Capture program started but could not find source tables that were:

- Enabled with the DATA CAPTURE CHANGES option of the CREATE or ALTER TABLE statement.
- Defined as replication sources with the **Data capture is full-refresh only** check box cleared on the Define as Source window.

**User Response:** Ensure that the register table is defined properly. For more information about the register table, see "Register table" on page 301. Verify that replication sources have been defined.

---

**ASN0017E** The Capture program encountered a severe internal error and could not issue the correct error message. The routine name is "<routine>"; the return code is "<return\_code>"; the error message number is "<error\_message\_num>".

**Explanation:** The Capture program could not retrieve the message from the Capture program error messages file.

**User Response:** Edit the Capture program error messages file. Locate the ASNnnnn error message number to determine which error

message should have been issued. See the information about the error message in this chapter to determine how to resolve the error. Consult the installation instructions for your platform.

---

**ASN0018W** The Capture program did not process updates made to the register table rows. The routine name is "<routine>"; the table name is "<table\_name>".

**Explanation:** The user changed a replication source definition while the Capture program was running and then issued a REINIT command. The register table, which contains a row for each replication source, might not match the other replication source control tables.

**User Response:**

1. Stop the Capture program.
2. Delete the replication source.
3. Redefine the replication source.
4. Start the Capture program.

---

**ASN0019E** The Capture program libraries are not authorized for the Authorized Program Facility (APF).

**Explanation:** The Capture program cannot process the STOP, SUSPEND, RESUME, or REINIT commands because the STEPLIB libraries are not authorized for APF.

**User Response:** Authorize the Capture link library for APF.

---

**ASN0020I** Netview Generic Alerts Interface failure. The Netview return code is "<return\_code>".

**Explanation:** The Network Major Vector Transport (NMVT) could not be sent to Netview by the program because the program interface failed. This is a secondary informational message.

**User Response:** See the Netview programming documentation for a description of the return code to determine the interface error. The

Capture program alerts will not be received by the System Services Control Point (SSCP) until the error is corrected.

---

**ASN0021I** Netview Program to Program Interface unavailable. The Netview return code is "<return\_code>".

**Explanation:** Netview is unavailable. This is a secondary informational message.

**User Response:** See the Netview programming documentation for a description of the return code to determine the Netview problem. For example, the subsystem might not have been started.

---

**ASN0022E** DB2 release "<release>" is not supported. The routine name is "<routine>".

**Explanation:** The Capture program does not support this release of DB2.

**User Response:** Run the Capture program with the appropriate release of DB2.

---

**ASN0023I** The Capture program successfully reinitialized the register table. The table name is "<table\_name>"; the routine name is "<routine\_name>".

**Explanation:** A REINIT command was issued and the updates were successfully made to the Capture program internal control information. This message is for your information only.

**User Response:** No action is required.

---

**ASN0024I** The Capture program did not need to reinitialize the register table. Table "<table\_name>" did not change.

**Explanation:** The REINIT command was issued. No updates were made to the register table since initialization or the last REINIT. This message is for your information only.

**User Response:** No action is required.

---

**ASN0025I** The Capture program reinitialized the register table. Table "<table\_name>" has "<number>" potentially bad row(s).

**Explanation:** This message accompanies ASN0018W. Reinitialization was performed as requested despite potential problems reported in ASN0018W.

**User Response:** See ASN0018W.

---

**ASN0026W** The Capture program could not allocate the trace buffer. The routine name is "<routine>"; the storage required is "<required\_storage>".

**Explanation:** A storage allocation error was detected; not enough storage is allocated for the trace buffer. The trace buffer is an information-only feature of the Capture program and the allocated storage is not required for the Capture program to run.

**User Response:** Contact your system programmer to determine the method of requesting the storage listed in the error message.

For Capture for VM, a request to obtain virtual storage could not be satisfied. You might need to increase the size of the virtual machine in which the Capture program runs.

For Capture for VSE, all available GETVIS storage has been exhausted. You might need to restart the Capture program after allocating a larger partition.

---

**ASN0027W** The Capture program is already active.

**Explanation:** You tried to start more than one the Capture program per DB2 subsystem or database.

For VSE/ESA, Capture for VSE generates a unique lock name for each database. This lock name is already in use, indicating that Capture for VSE is already active for the database.

For VM/ESA, Capture for VM has determined

that the resource ID used as a lock is already in use. The resource ID is specified on the ENQ\_NAME parameter of the CAPTURE ASNPARMs file.

**User Response:** For DB2 for OS/390 subsystems, either run only one instance of the Capture program for all subsystems that are members of a data-sharing group, or run only one instance of the Capture program on any stand-alone system. Display the ENQ resource to determine the unique resource name violation.

For other DB2 database platforms, run only one Capture program per database.

For Capture for VM, you can change the ENQ\_NAME parameter in the CAPTURE ASNPARMs to ensure unique values for each Capture program if you want to run Capture for VM for more than one DB2 database on a system.

---

**ASN0028I The Capture program is suspended by operator command.**

**Explanation:** The IBM Replication administrator suspended the Capture program, and the program has entered a wait state. This message is for your information only.

**User Response:** No action is required.

---

**ASN0029I The Capture program is resumed by operator command.**

**Explanation:** The IBM Replication administrator resumed the Capture program from a suspended state and the Capture program has continued running. This message is for your information only.

**User Response:** No action is required.

---

**ASN0030I The Capture program command entered by the operator was unrecognized.**

**Explanation:** The IBM Replication administrator entered a command not recognized by the Capture program. The only valid commands are:

- STOP

- SUSPEND
- RESUME
- REINIT
- PRUNE
- GETLSEQ

There are no parameters allowed for these commands.

**User Response:** Use only valid Capture program commands.

---

**ASN0031E The Capture program tuning parameters table can have only one row. The routine name is "<routine>"; the table name is "<table\_name>".**

**Explanation:** The tuning parameters table was not defined correctly or has been updated with invalid rows.

**User Response:** Refer to "Tuning parameters table" on page 312 to determine the correct format of this table. Remove any invalid rows.

---

**ASN0033E The Capture program could not reinitialize the register table. The table name is "<table\_name>".**

**Explanation:** The IBM Replication administrator tried to reinitialize the Capture program, but there was an error in the register table. A user might have tried to update a replication source while the Capture program was running or suspended, and the register table might not match the other control tables.

**User Response:** This is a secondary message. See any preceding messages for more information about the error. See the Capture and Apply chapter for your platform for more information about reinitializing the Capture program, and "Register table" on page 301 for information about the register table.

---

**ASN0034E** An incorrect value was supplied for column "<column>" of the Capture program tuning parameters table. The routine name is "<routine>"; the table name is "<table\_name>".

**Explanation:** The tuning parameters table does not have the correct values. Values might be out of range.

**User Response:** Check the lag limit, retention period, and commit frequency. Refer to "Tuning parameters table" on page 312, or to the Capture and Apply chapter for your platform for more information.

---

**ASN0035W** Some rows were found in the register table with an unsupported architectural level. The routine name is "<routine>"; the table name is "<table\_name>".

**Explanation:** The register table version does not match the current version of the Capture program. The current version of the DB2 Control Center is not compatible with the version of the Capture program that you are running.

**User Response:** Refer to "Register table" on page 301 to check the required value for the ARCH\_LEVEL column in the register table. Verify that the value in the register table at the source server is correct. If not, use compatible versions of the DB2 Control Center and the Capture program.

---

**ASN0036E** DB2 was terminated abnormally. The routine name is "<routine>".

**Explanation:** DB2 was terminated while the Capture program was still active.

For OS/390, VSE/ESA, or VM/ESA, DB2 was terminated while Capture program was active and the user did not specify the NOTERM invocation parameter.

**User Response:** Start DB2 and start the Capture program.

---

**ASN0037W** DB2 was terminated in QUIESCE mode. The routine name is "<routine>".

**Explanation:** DB2 was terminated while the Capture program was still active.

**User Response:** Start DB2 and start the Capture program.

---

**ASN0038E** The disconnect to DB2 failed. The routine name is "<routine>"; the return code is "<return\_code>"; the reason code is "<reason\_code>".

**Explanation:** DB2 was stopped in QUIESCE mode, but the user wanted to leave the Capture program running. While terminating the connection to DB2, the Capture program received an error returned code from the Call Attachment Facility (CAF).

**User Response:** Restart the Capture program.

---

**ASN0040E** An error was returned from the FORK function of "<platform>". The error is "<error\_text>".

**Explanation:** An AIX FORK function returned a negative value. "<Error\_text>" describes the error.

**User Response:** See *AIX Calls and Subroutines Reference* for information about FORK functions, use the provided error text to determine the error, or contact IBM Software Support.

---

**ASN0041E** An error was returned while getting the instance name. The reason code is "<reason\_code>".

**Explanation:** The SQLEGENS API of DB2 Universal Database returned an error.

**User Response:** See the *DB2 Universal Database API Reference* for information about the SQLEGENS API to determine the error, or contact IBM Software Support.

---

**ASN0042E** An error was returned from the EXECLP function. The error is "<error\_text>".

**Explanation:** The AIX EXECLP function returned a negative value. "<Error\_text>" describes the error.

**User Response:** See the *AIX Calls and Subroutines Reference* for information about the EXECLP function, or contact IBM Software Support.

---

**ASN0043E** A child process of ASNLMAIN died.

**Explanation:** The child process created by ASNLMAIN terminated. Possible causes include:

- A user stopped the child process.
- There is an AIX system problem.

**User Response:** Check the system processes for conflicts, or contact your AIX system programmer.

---

**ASN0044E** The child process has not called the dummy process after an extended wait.

**Explanation:** The child process was unable to call the dummy routine ASNLPVRF. The installation soft links might not have been set.

**User Response:** Verify whether the installation soft links have been set, check the system for problems, or contact IBM Software Support.

---

**ASN0045E** An error was returned from the MSGRCV function. The error is "<error\_text>".

**Explanation:** The function MSGRCV returned an error. "<Error\_text>" describes the error. This error can be caused by ASNCMD sending a message that ASNCCP could not process.

**User Response:** Use the provided error text to determine the error, or contact IBM Software Support.

---

**ASN0046E** An error was returned from the MSGGET function. The error is "<error\_text>".

**Explanation:** The function MSGGET returned an error. "<Error\_text>" describes the error. This error occurs during message handling. This error can be caused by an ASNCMD process failure.

**User Response:** Use the provided error text to determine the error, or contact IBM Software Support.

---

**ASN0047E** An error was returned from the FTOK function of "<platform>". The error is "<error\_text>".

**Explanation:** The AIX function FTOK returned an error. "<Error\_text>" describes the error.

**User Response:** See *AIX Calls and Subroutines Reference* for information about the FTOK function, use the provided error text to determine the error, or contact IBM Software Support.

---

**ASN0048E** The Capture program could not open the log file. The error is "<error\_text>". The error code is "<error\_code>".

**Explanation:** The Capture program could not open the log file. Some possible reasons are:

- The Capture program log file was deleted.
- The user does not have the correct authorization for the Capture program directory.

**User Response:** Contact your system programmer to determine the error, or contact IBM Software Support.

---

**ASN0050E** The Capture program encountered an error while writing to the error message file.

**Explanation:** An I/O error occurred while writing to the Capture program log file.

**User Response:** Check the trace table for error messages.



---

**ASN0053E An error was returned by the Asynchronous Read Log API (SQLURLOG).**

**Parameters:**

- Initial LSN is "<log\_sequence\_number>"
- FIRSTRead LSN is "<first\_read\_LSN>"
- lastRead LSN is "<last\_read\_LSN>"
- CurActive LSN is "<currently\_active\_LSN>"
- log Recswritten is "<log\_records\_written>"
- log Byteswritten is "<log\_bytes\_written>"

**Explanation:** The Asynchronous Read Log API returned an SQLCODE in the SQL error message that preceded this message. The information in this message provides additional information about the SQL error.

**User Response:** See message ASN0001E for information about SQLCODEs.

---

**ASN0054E The Capture program did not recognize the invocation parameter.**

**Explanation:** An invalid invocation parameter was entered with the ASNCCP command.

**User Response:** Enter a valid invocation parameter.

See the Capture and Apply chapter for your platform for information about valid invocation parameters.

---

**ASN0055E The Capture program encountered an SQLTYPE that is not supported in the origin table.**

**Parameters:**

- Routine Name is "<routine>"
- Column Number is "<column\_num>"

**Explanation:** The Capture program encountered an invalid SQL type. A table might have been defined as a replication source outside the DB2 Control Center that contains unsupported SQL types (for example, binary data types with precision).

**User Response:** Delete the replication source

and use the DB2 Control Center to define replication sources to ensure that only valid types are defined. Or, when manually defining the replication source, ensure that the table contains only supported SQL types. See the messages and codes publication of the DB2 database manager on your platform to determine the invalid SQLTYPE.

---

**ASN0056E ASN.IBMSNAP\_UOW table does not exist.**

**Explanation:** The unit-of-work (UOW) table or the source server database might have been dropped.

**User Response:** Contact IBM Software Support.

---

**ASN0100I The Capture program initialization is successful.**

**Explanation:** This message is for your information only.

**User Response:** No action is required.

---

**ASN0101W The Capture program warm start failed because existing data is too old; a cold start will be attempted.**

**Explanation:** The data in the change data tables is older than the value "<current\_timestamp\_lag\_limit>". A cold start will be performed.

**User Response:** See "Starting or restarting the Capture program" on page 140 for more information about warm and cold starts to determine why the Capture program could not warm start.

---

**ASN0102W The Capture program will switch to cold start because the warm start information is insufficient.**

**Explanation:** A problem occurred during the retrieval of the warm start information. The warm start table data was invalid. A cold start will be performed.

For DB2 Universal Database, an Asynchronous Read Log API error occurred while reading the

log during warm start. For OS/390, an Instrumentation Facility Information (IFI) error occurred while reading the log during warm start.

**User Response:** See “Starting or restarting the Capture program” on page 140 for more information about warm and cold starts to determine why the Capture program could not warm start.

---

**ASN0103I The Capture program started with: “<server\_name>”.**

**Parameters:**

- **SERVER\_NAME** is “<server\_name>”
- **ENQ\_NAME** is “<enq\_name>”
- **START\_TYPE** is “<start\_type>”
- **TERM\_TYPE** is “<term\_type>”
- **PRUNE\_TYPE** is “<prune\_type>”

**Explanation:** This is an informational message that displays the DB2 server name and the Capture program start up options.

For Capture for VSE and VM, the ENQ\_NAME shows the name on which Capture program locks to make sure that there is only one Capture program running for any DB2 database. The lock name can be specified for VM/ESA by changing the ENQ\_NAME parameter value in the CAPTURE ASNPARMs file.

**User Response:** No action is required.

---

**ASN0104I Change capture started for owner “<owner>”, the table name is “<copy\_table>” at log sequence number (LSN) “<log\_sequence\_number>”.**

**Explanation:** The Capture program was started for the table owner and table name at the specified log sequence number (LSN). This message is issued for each origin table for which the Capture program captures changes. This message is for your information only.

**User Response:** No action is required.

---

**ASN0105I Data that has been copied was pruned from the change data table and the unit-of-work table.**

**Explanation:** This message is for your information only.

**User Response:** No action is required.

---

**ASN0106I The Capture program is waiting for DB2 to come up.**

**Explanation:** When the Capture program is initially brought up, if DB2 is not up at that time, the Capture program waits until DB2 is up. After DB2 is up, the Capture program makes the connection and begins to capture changes.

If the NOTERM option is specified in the Capture invocation parameters, and DB2 comes down smoothly, the Capture program waits for it to come back up.

**User Response:** No action is required.

---

**ASN0110E Capture for OS/390 Storage Dump. The Control Address is “<address>”.**

**Explanation:** An MVS system dump was generated for a severe error message. The dump is contained in dump data set SYS1.DUMP. An IPCS readable system dump contains more diagnostic information than the Capture program trace and can be used by IBM to diagnose system problems.

**User Response:** No action is required.

---

**ASN0115I The warm start control information was not supplied. The routine name is “<routine>”; the table name is “<table\_name>”.**

**Explanation:** The warm start table is missing or corrupted. This table provides a faster warm start. The Capture program will warm start.

**User Response:** No action is required.

---

**ASN0116I** The Capture program did not reinitialize the tuning parameters table. The routine name is "<routine>"; the table name is "<table\_name>".

**Explanation:** The REINIT command was issued, but tuning parameter information from the tuning parameters table was not available. The previous tuning parameter values were retained.

**User Response:** No action is required.

---

**ASN0117W** Warm start control information was not saved. The routine name is "<routine>"; the table name is "<table\_name>".

**Explanation:** An error occurred that prevented warm start information from being saved in the warm start table. Warm start will take longer because other tables will be used.

**User Response:** No action is required.

---

**ASN0121E** The Capture program warm start failed because existing data is too old. The Capture program will terminate.

**Explanation:** The time of the warm start information exceeded the lag limit.

**User Response:** No response required; the Capture program will terminate because WARMNS was specified.

---

**ASN0122E** An error occurred while reading the warm start information or DB2 log. The Capture program will terminate.

**Explanation:** A problem occurred while retrieving the warm start information. The warm start table data was invalid or for OS/390, an Instrumentation Facility Interface (IFI) error occurred while reading the log during warm start. When the error is resolved, you can restart using the warm start option.

**User Response:** No response required; the Capture program will terminate because

WARMNS was specified.

---

**ASN0123I** The highest log sequence number of a successfully captured log record is "<log\_sequence\_number>".

**Explanation:** The Capture program saved the highest log sequence number (LSN) in the warm start table. This is the point at which the Capture program finished successfully processing the log data.

**User Response:** No response required; the Capture program will terminate.

---

**ASN0124I** The prune command was accepted; the pruning action is queued.

**Explanation:** The IBM Replication administrator entered the PRUNE command and the Capture program has queued the request. The Capture program will prune the change data (CD) table and the unit-of-work (UOW) table.

**User Response:** No response required.

---

**ASN0125I** The current log sequence number of successfully processed log records is "<log\_sequence\_number>". The log timestamp is "<timestamp>".

**Explanation:** Capture program is processing the DB2 log at the log sequence number provided.

**User Response:** No action is required.

---

**ASN0126E** The Capture program encountered a syntax error. The Capture program will terminate.

**Explanation:** The Capture program encountered the wrong combination of invocation parameters.

**User Response:** Check the Capture and Apply chapter for your platform for more information about the START command.

---

**ASN0130I The user requested that the Capture program start reading from the end of the DB2 log.**

**Explanation:** The user specified the WRMSKPM parameter when invoking the Capture program.

**User Response:** No action is required.

---

**ASN0133I The Capture program reached the end of the mobile transactions.**

**Explanation:** This message is for your information only.

**User Response:** No action is required.

---

**ASN0135E The trial period for the Capture program has expired.**

**Explanation:** The trial period for the DB2 DataPropagator product has ended. You can no longer use this product until you order and install the DataPropagator licensed feature of DB2 for OS/390.

**User Response:** Contact the person responsible for ordering the DB2 DataPropagator product. Note that even though the error message ASN0017E is also issued, you should not follow the suggested action for that message.

---

**ASN0136I The trial version of Capture will end in *nm* days.**

**Explanation:** You are using the trial version of DB2 DataPropagator. After *nm* days have passed, you will no longer be able to use DB2 DataPropagator unless you install the DataPropagator licensed feature of DB2 for OS/390.

**User Response:** None; however you might want to contact the person responsible for ordering the DB2 DataPropagator product.

---

**ASN0137E The product registration module has unexpected content.**

**Explanation:** The content of the registration module (ASNLPR61) for the DB2 DataPropagator feature is not as expected for this version of the

DB2 DataPropagator product. No further use of the product is possible until you provide the correct registration module.

**User Response:** Verify that the DB2 DataPropagator feature was installed without errors. If errors occurred, correct them and try again.

If the DB2 DataPropagator feature installed without error and you are correctly accessing the feature-registration module (ASNLPR61), contact IBM Software Support.

---

**ASN0138E The product trial module has unexpected content.**

**Explanation:** The content of the DB2 DataPropagator trial module is not as expected for this version of the DB2 DataPropagator product. No further use of the product is possible until you provide the correct trial module.

**User Response:** Verify that the DB2 DataPropagator feature was installed without errors. If errors occurred, correct them and try again.

If the DB2 DataPropagator feature installed without error and you are correctly accessing it, contact IBM Software Support.

---

**ASN0139E The Capture program could not open the trace file. The error is "<error\_code>".**

**Explanation:** The user specified the TRCFILE option, but the Capture program could not open the trace file. Possible reasons are:

- The directory specified in the ASNPATH environment variable is incorrect.
- The user does not have the correct authorization for the directory.

**User Response:** Contact your system programmer, or IBM Software Support.

---

---

**ASN0200E An incorrect parameter "<parameter>" was passed to the Capture program.**

**Explanation:** For VM/ESA, one of the following situations caused an error:

- An incorrect parameter was specified on the ASNCCP command.
- The CAPTURE ASNPARMS file contained an invalid parameter.
- An invalid parameter was specified on the :RESID tag in the RESID NAMES file for the :DBNAME. For example, the RESID could be too long.

For VSE/ESA, an invalid parameter was specified on the ASNCCP command.

**User Response:** Verify that the parameters supplied are valid. See the Capture and Apply chapter for your platform for more information about the ASNCCP command.

---

**ASN0201E The Capture program encountered a "<platform>" error. The routine name is "<routine>"; the function name is "<function>"; the return code is "<return\_code>".**

**Explanation:** On VM:

- For the LINK function, Capture program encountered an error while attempting to LINK the minidisks identified in the *database* SQLFDEF file. Where *database* is the database identified with the SQLINIT or SQLGLOB commands, the default of SQLDBA.
- For the FSREAD, FSPOINT, or FSTATE function errors, the Capture program encountered an error while trying to read CAPTURE ASNPARMS or the *database* SQLFDEF file.
- For the XCIDRM function, Capture program was unable to obtain the resource ID it uses as a lock to ensure that only one Capture program is active for a DB2 database. The error may have occurred for the following reasons:

- The virtual machine in which the application is running does not have authority to connect to \*IDENT.
- The virtual machine in which the application is running does not have the authority to declare the resource.

On VSE:

- For the GENCB, MODCB, OPEN, GET, CLOSE, or ENDREQ function errors, the Capture program encountered an error while trying to set up or read the database log or directory.
- For the GETVIS, FREEVIS, or XPCC function errors, the Capture program encountered an error while trying to perform one of these functions.

**User Response:** Correct the error as described in the platform documentation. On VM:

- For the LINK function, see *VM/ESA CP Command and Utility Reference* for more information about the return code.
- For the FSREAD, FSPOINT, or FSTATE function errors, see *VM/ESA CMS Application Reference - Assembler*.
- For the XCIDRM function, see *VM/ESA CPI Communications User Guide* for more information the return code.
- For other functions, refer to the platform product application development and command documentation.

On VSE:

- For the GENCB, MODCM, OPEN, GET, CLOSE, or ENDREQ function errors, see *VSE/ESA Messages and Codes Reference* for more information about the IBM VSE/VSAM macros.
- For the GETVIS, FREEVIS, or XPCC function errors, see *VSE/ESA Systems Macro Reference*.

---

**ASN0202E The USERID parameter was not specified.**

**Explanation:** The USERID parameter is required in the PARM= field on the EXEC job control statement that is passed to the Capture program.

**User Response:** Add the USERID= parameter, specifying the user ID and password in the PARM= field, and resubmit the job.

---

ASN0203I Linking to "<diskname>  
minidisk"<diskowner>"as  
"<vdev>".

**Explanation:** The Capture program is about to issue an internal CP link command to the

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## Apply program messages

---

ASN1000S An internal error occurred for message number "<number>". Its substitution fields are "<substitution\_field\_1>", "<substitution\_field\_2>", "<substitution\_field\_3>", "<substitution\_field\_4>", "<substitution\_field\_5>", "<substitution\_field\_6>", and "<substitution\_field\_7>". The error code is "<error\_code>". The return code is "<return\_code>".

**Explanation:** The message file for the Apply program was installed incorrectly, or the language environment variables are not set correctly. This message is displayed because no other Apply message could be formatted.

**User Response:** Refer to the installation and configuration information in this book pertaining to your platform. Make sure that the message file is installed in the correct directory, and the language environment variables are set correctly. If the language environment variables are set correctly, contact IBM Software Support.

---

ASN1001E The Apply program encountered an SQL error.

**Parameters:**

- **ERRCODE** is "<error\_code>"
- **SQLSTATE** is "<sqlstate>"
- **SQLCODE** is "<sqlcode>"
- **SQLERRM** is "<sqlerrm>"
- **SQLERRP** is "<sqlerrp>"

specified database minidisk.

**User Response:** If prompted, enter the minidisk password.

- **server name** is "<server\_name>"
- **table name** is "<table\_name>"

**Explanation:** An error occurred during the execution of an SQL statement.

**User Response:** Refer to your database message reference for an explanation of the SQL error code.

---

ASN1002E The "<table\_name>" could not be locked. **ERRCODE** is "<error\_code>", **SQLSTATE** is "<sqlstate>", **SQLCODE** is "<sqlcode>", **SQLERRM** is "<sqlerrm>", **SQLERRP** is "<sqlerrp>", **server name** is "<server\_name>", **table name** is "<table\_name>"

**Explanation:** The Apply program could not lock the table.

**User Response:** Refer to your database message reference.

---

ASN1003E The Apply program could not connect to the server "<server>".

**Parameters:**

- **error code** is "<error\_code>"
- **SQLSTATE** is "<sqlstate>"
- **SQLCODE** is "<sqlcode>"
- **SQLERRM** is "<sqlerrm>"
- **SQLERRP** is "<sqlerrp>"

**Explanation:** The Apply program attempted to

connect to the database and received a failing return code. There are many reasons why the Apply program could not connect to the database. For example, the Apply program would receive a failing return code if the database was down or too many users were accessing it.

**User Response:** Look up the SQLCODE in the DB2 messages and codes manual to determine why the connection failed. See “Setting up end-user authentication at the source server” on page 241 for more information.

Refer to your database message reference for an explanation of the SQL error code.

---

**ASN1004I The trial version of Apply will end in *nn* days.**

**Explanation:** You are using the trial version of DB2 DataPropagator. After *nn* days have passed, you will no longer be able to use DB2 DataPropagator unless you install the DataPropagator licensed feature of DB2 for OS/390.

**User Response:** None; however you might want to contact the person responsible for ordering the DB2 DataPropagator product.

---

**ASN1005E The trial period for the Apply program has expired.**

**Explanation:** The trial period for the DB2 DataPropagator product has ended. You can no longer use this product until you order and install the DataPropagator licensed feature of DB2 for OS/390.

**User Response:** Contact the person responsible for ordering the DB2 DataPropagator product.

---

**ASN1006E The product registration module has unexpected content.**

**Explanation:** The content of the registration module (ASNAPR61) for the DB2 DataPropagator feature is not as expected for this version of the DB2 DataPropagator product. No further use of the product is possible until you provide the correct registration module.

**User Response:** Verify that the DB2 DataPropagator feature was installed without errors. If errors occurred, correct them and try again.

If the DB2 DataPropagator feature installed without error and you are correctly accessing the feature-registration module (ASNAPR61), contact IBM Software Support for assistance.

---

**ASN1007E The product trial module has unexpected content.**

**Explanation:** The content of the DB2 DataPropagator trial module is not as expected for this version of the DB2 DataPropagator product. No further use of the product is possible until you provide the correct trial module.

**User Response:** Verify that the DB2 DataPropagator feature was installed without errors. If errors occurred, correct them and try again.

If the DB2 DataPropagator feature installed without error and you are correctly accessing it, contact IBM Software Support for assistance.

---

**ASN1008E The subscription set with Apply qualifier “<qualifier>” and set name “<set\_name>” is not defined correctly. ERRCODE is <error\_code>”.**

**Explanation:** The subscription set is not defined correctly.

**User Response:** Make sure that the WHOS\_ON\_FIRST column in the subscription set table is specified correctly.

---

**ASN1009E There is no subscription set defined for Apply qualifier “<qualifier>”.**

**Explanation:** There is no subscription set defined for Apply qualifier “<qualifier>”.

**User Response:** Define at least one subscription set for Apply qualifier “<qualifier>”.

---

**ASN1010E** The Apply program could not insert row "<row>" into the audit trail table due to the following error: "<error\_code>".

**Explanation:** This is an SQL return code indicating that the audit trail table was not set up with the same structure as the table in "Apply trail table" on page 336.

**User Response:** Refer to "Apply trail table" on page 336 and your database SQL manual.

---

**ASN1011E** The copy request has incompatible source and target attributes. The error code is "<error\_code>".

**Explanation:** This is an SQL error code indicating that the attributes of the target table must be compatible with the attributes of the source table.

**User Response:** Refer to the SOURCE\_STRUCTURE column in the register table for the compatibility of the source and target attributes.

---

**ASN1012E** The source table structure is invalid. The error code is "<error\_code>".

**Explanation:** This is an SQL return code indicating that the source table structure in the register table was not set up according to the SOURCE\_STRUCTURE column in the register table.

**User Response:** Refer to "Register table" on page 301, the SOURCE\_STRUCTURE column in the register table for valid source table structures.

---

**ASN1013E** The target table structure is invalid. The error code is "<error\_code>".

**Explanation:** The target table structure in the subscription-targets-member table was not valid.

**User Response:** Refer to "Subscription-targets-member table" on page 326 for valid target table structure.

---

**ASN1014E** The Apply program could not find a source for the copy request because it could not find the change data table. The error code is "<error\_code>".

**Explanation:** The change data table was not defined in the register table because either the Apply program did not find the change data table name in the register table or the source table was not registered correctly.

**User Response:** Refer to "Register table" on page 301 and verify that the change data table is correctly defined in the register table (CD\_OWNER, CD\_TABLE).

---

**ASN1015I** The Apply program is waiting for the Capture program at server "<server\_name>" to advance the global SYNCHTIME. Verify that the Capture program is running.

**Explanation:** This message is for your information only.

**User Response:** Verify that the Capture program is running.

---

**ASN1016I** Refresh copying has been disabled. The error code is "<error\_code>".

**Explanation:** While attempting to perform a full refresh, the Apply program encountered a DISABLE\_REFRESH column in the register table which was set on.

**User Response:** Either turn off the DISABLE\_REFRESH column or bypass the Apply program and perform a manual refresh.

---

**ASN1017E** Apply could not find any target column names. The error code is "<error\_code>".

**Explanation:** The Apply program could not find any columns in the subscription columns table.

**User Response:** Redefine the subscription set and subscription-set members (see "Chapter 6.

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Setting up your replication environment" on page 93 for instructions).

---

**ASN1018I** The Apply program is processing subscription set "`<set_name>`" ("`<whos_on_first>`"). "`<set_number>`" of "`<total_sets>`".

**Explanation:** This message is for your information only.

**User Response:** No action is required.

---

**ASN1019E** The target table does not have any key columns. The error code is "`<error_code>`".

**Explanation:** The Apply program could not find key column names in one of the columns requiring a primary key.

**User Response:** Redefine the subscription set and the subscription-set members (see "Chapter 6. Setting up your replication environment" on page 93 for instructions).

---

**ASN1020S** The Apply program could not reserve a storage block. The error code is "`<error_code>`".

**Explanation:** The Apply program could not obtain the required (memory) storage.

**User Response:** Contact IBM Software Support.

---

**ASN1021S** The Apply program could not read the work file. The error code is "`<error_code>`".

**Explanation:** The Apply program could not read the work file due to a system error.

**User Response:** Determine if the problem is caused by lack of space and contact your system administrator to obtain what is needed.

---

**ASN1022S** The Apply program could not write into the work file. The error code is "`<error_code>`".

**Explanation:** Either the user does not have the proper access authority for one or all of the files or not enough space is left after writing to the target file.

**User Response:** Determine whether the problem is caused by a lack of access authority or a lack of space and contact your system administrator to obtain what is needed.

---

**ASN1023S** The Apply program could not open the work file. The error code is "`<error_code>`".

**Explanation:** The Apply program could not open the work file.

**User Response:** Contact IBM Software Support.

---

**ASN1024S** The Apply program could not close the work file. The error code is "`<error_code>`".

**Explanation:** The Apply program could not close the work file.

**User Response:** Contact IBM Software Support.

---

**ASN1025I** The Apply program completed processing for subscription set "`<set_name>`" ("`<whos_on_first>`"). The return code is "`<return_code>`".

**Explanation:** This message is for your information only.

**User Response:** No action is required.

---

**ASN1026I** The Apply program encountered an error while trying to bind. SQLSTATE is "`<sqlstate>`", SQLCODE is "`<sqlcode>`".

**Explanation:** An error occurred during the execution of bind.

**User Response:** Refer to your database message reference.

---

**ASN1029E** The SQL statement could not execute. The error code is "<error\_code>".

**Explanation:** The execution of the SQL statement specified by the user was not successful.

**User Response:** Refer to SQLSTATE, SQLCODE, SQLERRO, and SQLERRM in the apply trail table and in your database SQL manual for detailed information.

---

**ASN1030S** The Apply program encountered an OS/2 error. The error code is "<error\_code>"; the return code is "<return\_code>".

**Explanation:** The execution of an OS/2 API failed.

**User Response:** For more information on the return code, refer to the *OS/2 WARP Control Program Programming Reference*.

---

**ASN1031E** The SQL statement is empty. The error code is "<error\_code>".

**Explanation:** The SQL statement is an empty string.

**User Response:** Specify the SQL statement to be executed.

---

**ASN1032S** The Apply program log file could not be opened. The error code is "<error\_code>"; the return code is "<return\_code>".

**Explanation:** The Apply program could not open the log file.

**User Response:** For more information on the return code, refer to the manual that describes problem determination for your particular platform.

---

**ASN1033E** The Apply program could not write to the Apply log file. The error code is "<error\_code>"; the return code is "<return\_code>".

**Explanation:** The Apply program could not write to the log file.

**User Response:** For more information on the return code, refer to the manual that describes problem determination for your particular platform.

---

**ASN1035E** The Apply program could not access the subscription columns table.

**Parameters:**

- error code is "<error\_code>"
- SQLSTATE is "<sqlstate>"
- SQLCODE is "<sqlcode>"
- SQLERRM is "<sqlerrm>"
- SQLERRP is "<sqlerrp>"
- server name is "<server\_name>"
- table name is "<table\_name>"

**Explanation:** An error occurred during the execution of an SQL statement.

**User Response:** Refer to your database message reference for SQL.

---

**ASN1036E** The column type "<col\_type>" for expression "<expression>" is invalid. The error code is "<error\_code>".

**Explanation:** The value for the COL\_TYPE column in the subscription columns table is invalid.

**User Response:** Change the value to A, B, C, D, F, L, or R.

---

**ASN1037E** The Apply program could not obtain the date and time. The error code is "<error\_code>"; the return code is "<return\_code>".

**Explanation:** The OS/2 API DosGetDateTime failed.

**User Response:** For more information on the return code, refer to the *OS/2 WARP Control Program Programming Reference*.

---

**ASN1038E** No column names or expressions were specified in the subscription columns table.

**Explanation:** Column names or expressions for a copy statement must be specified.

**User Response:** Refer to "Chapter 6. Setting up your replication environment" on page 93 for more information about requirements for subscription definitions.

---

**ASN1039S** The Apply program plan, "<plan\_name>", could not be opened.

**Parameters:**

- error code is "<error\_code>"
- return code is "<return\_code>"
- reason code is "<reason\_code>"

**Explanation:** The Apply program plan could not be opened.

**User Response:** Refer to the *Apply for OS/390 Program Directory*.

---

**ASN1040S** The Apply program encountered an OS/390 error. The error code is "<error\_code>"; the return code is "<return\_code>".

**Explanation:** Execution of an OS/390 system operation failed.

**User Response:** Refer to your OS/390 system library information.

---

**ASN1041I** The Apply program was started using subsystem name: "<subsystem>".

**Explanation:** This is not an error message, however, you should make sure that the displayed subsystem name is valid.

**User Response:** Verify that the subsystem name is valid.

---

**ASN1042W** There are too many invocation parameters.

**Explanation:** The number of parameters you specified when you invoked the Apply program exceeds the maximum allowed.

**User Response:** Refer to the Capture and Apply chapter for your platform for information on the appropriate number of invocation parameters.

---

**ASN1043E** There is already one Apply instance running with this Apply program qualifier "<qualifier>". The error code is "<error\_code>"; the reason code is "<reason\_code>".

**Explanation:** Verification attempt failed.

**User Response:** Make sure that only one instance of the Apply program is running under this user ID on this subsystem or database.

---

**ASN1044I** The Apply program will become inactive for "<number>" minutes and "<number>" seconds.

**Explanation:** This message is for your information only.

**User Response:** No action is required.

---

**ASN1045I** The Apply program was started using database "<database>".

**Explanation:** This message is for your information only.

**User Response:** No action is required unless this is not the intended database.

---

**ASN1046S** The Apply program libraries are not authorized for the Authorized Program Facility (APF).

**Explanation:** The Apply program libraries must be APF authorized.

**User Response:** Authorize the Apply program libraries.

---

**ASN1048E** The execution of a copy statement failed. See the Apply trail table for full details: "<text>".

**Explanation:** A copy statement could not execute. In the message, "<text>" identifies the "<copy\_server>", "<copy\_owner, copy\_table, stmt\_number>", and "<cntl\_server>".

**User Response:** Check the APPERRM fields in the audit trail table to determine why the copy statement failed.

---

**ASN1049S** The Apply program encountered a system error. The error code is "<error\_code>". The return code is "<return\_code>".

**Explanation:** Execution of a system operation failed.

**User Response:** Refer to the system library information for your platform.

---

**ASN1050E** The Apply program encountered an invalid operation while updating the target table. The error code is "<error\_code>". The invalid operation to be applied is "<operation>".

**Explanation:** The operation field of a row fetched from the source table is not valid.

**User Response:** Contact IBM Software Support.

---

**ASN1051E** The Apply program detected a gap between the source "<source>" table and the target table. The error code is "<error\_code>".

**Explanation:** The Apply program has detected that the Capture program lost change data before the Apply program could copy it. For example, the Capture program might have been cold started.

**User Response:** Check the control tables to determine why the gap is present. Take proper action to preserve data integrity before you reset the control table information to execute the definition again.

---

**ASN1052E** The Apply program could not find the ASNLOAD program.

**Explanation:** The Apply program cannot find the ASNLOAD program in the current directory.

**User Response:** Make sure that ASNLOAD is in the directory from which you are invoking the Apply program.

---

**ASN1053E** The execution of the ASNLOAD program failed. The return code is "<return\_code>".

**Explanation:** The ASNLOAD program detected an error.

**User Response:** Refer to the messages files generated by the EXPORT and IMPORT utilities. (Note that these files names are different for Apply for OS/2 and Apply for AIX.)

---

**ASN1054S** The Apply program could not find the registration information for source owner "<src\_ownr>", source table "<src\_tbl>", and source view qualifier "<src\_view\_qual>".

**Explanation:** The source table registration is incorrect or incomplete.

**User Response:** Drop the registration and redo it. Also make sure that the registration

information is in both the register table and the pruning control table.

---

**ASN1055S**    **The Apply program could not find the prune control information for source owner “<src\_ownr>”, source table “<src\_tbl>”, source view qualifier “<src\_view\_qual>”, target owner “<tgt\_ownr>”, and target table “<tgt\_tbl>”.**

**Explanation:** The source table registration is incorrect.

**User Response:** Drop the subscription and redo it.

---

**ASN1056E**    **The Apply program could not connect to the server due to lack of user ID/password. The error code is “<error\_code>”.**

**Explanation:** The Apply program could not find the password and user ID to connect to the server.

**User Response:** Make sure that the Apply program password file exists. The Apply program password file resides in the same directory from which you start the Apply program. If you are using DB2 Universal Database Satellite Edition, make sure that the password and user ID are defined to the client systems.

---

**ASN1057E**    **The Apply program could not read the password in the Apply password file. The error code is “<error\_code>”.**

**Explanation:** The Apply program found no password.

**User Response:** If you want to use the AUTHENTICATION=SERVER scheme, you must provide a password, as described in the Apply program section in the Capture and Apply chapter for your platform.

---

**ASN1058E**    **The Apply program could not close the password file. The error code is “<error\_code>”.**

**Explanation:** The Apply program could not close the password file.

**User Response:** Contact IBM Software Support.

---

**ASN1059E**    **The Apply program detected invalid syntax for line “<line>” in the password file. The error code is “<error\_code>”.**

**Explanation:** The Apply program could not recognize a line in the password file.

**User Response:** Correct the syntax error in the password file. See the Apply program section in the Capture and Apply chapter for your platform.

---

**ASN1060E**    **The dynamic allocation for the temporary work file failed. The error code is “<error\_code>”.**

**Explanation:** A system error was encountered during dynamic allocation.

**User Response:** Contact IBM Software Support.

---

**ASN1061E**    **An invalid keyword parameter was specified. The error code is “<error\_code>”.**

**Explanation:** An invalid invocation parameter was specified and ignored by the Apply program.

**User Response:** Correct the invocation parameter. See the Apply program section in the Capture and Apply chapter for your platform.

---

**ASN1063E**    **A subscription set cannot have more than 200 members. The error code is “<error\_code>”.**

**Explanation:** The number of subscriptions has exceeded the maximum allowed number of 200.

**User Response:** Remove excess members from the subscription set.

---

**ASN1066S** An internal Apply program error occurred. The error code is "<error\_code>".

**Explanation:** An internal Apply program error occurred.

**User Response:** Contact IBM Software Support.

---

**ASN1067E** The Apply program has detected update conflicts and compensated rejected transactions. See the unit-of-work table for details. The error code is "<error\_code>".

**Explanation:** More than one application updated the same row in a table from different locations. Some transactions have been rejected and compensated.

**User Response:** Refer to "Unit-of-work table" on page 319 for details.

---

**ASN1068E** The Apply program has deactivated the subscription due to an RI violation. The error code is "<error\_code>".

**Explanation:** A referential integrity violation was detected when copying data from the source table to a replica. The Apply program has terminated and the subscription has been deactivated.

**User Response:** Correct the referential integrity error and reactivate the subscription.

---

**ASN1069E** The Apply program has detected a referential integrity violation and compensated the rejected transactions. See the unit-of-work table for more details. The error code is "<error\_code>".

**Explanation:** A referential integrity violation was detected when replicating data from the replica to the user table.

**User Response:** See the unit-of-work table for more details.

---

**ASN1070E** The Apply program could not lock the target table.

**Parameters:**

- **ERRCODE** is "<error\_code>"
- **SQLSTATE** is "<sqlstate>"
- **SQLCODE** is "<sqlcode>"
- **SQLERRM** is "<sqlerrm>"
- **SQLERRP** is "<sqlerrp>"
- **server name** is "<server\_name>"
- **table name** is "<table\_name>"

**Explanation:** The Apply program could not lock the target tables before it was to check update conflicts.

**User Response:** Verify that all the target tables are available before restarting Apply.

---

**ASN1071E** The Apply program could not reposition the work file. The error code is "<error\_code>".

**Explanation:** The Apply program has detected an error while reading the temporary work file.

**User Response:** Contact IBM Software Support.

---

**ASN1072E** The Apply program could not find the ASNDONE program.

**Explanation:** The Apply program could not find the user exit program, ASNDONE.

**User Response:** Verify that the ASNDONE program is located in the correct directory.

---

**ASN1073E** The execution of the ASNDONE program failed. The return code is "<return\_code>".

**Explanation:** An error occurred while calling the user exit program, ASNDONE.

**User Response:** Contact IBM Software Support.

---

---

**ASN1074E** The Apply program could not find the ASNDLCOPY program.

**Explanation:** The Apply program did not find the ASNDLCOPY program in the current search path.

**User Response:** Add the ASNDLCOPY program to the search path and run the Apply program again.

---

**ASN1075E** The ASNDLCOPY program failed. The return code is "<error\_code>".

**Explanation:** The ASNDLCOPY program detected an error.

**User Response:** Refer to the log file that was generated by the ASNDLCOPY program for detailed information. The name of the log file is asndlxxx.log.

---

**ASN1076E** The Apply program cannot read the format of the result file that was generated by the ASNDLCOPY program.

**Explanation:** The result file that was generated by the ASNDLCOPY program is not in an expected format.

**User Response:** If you modified the ASNDLCOPY program, check that your changes are not causing the invalid format. If your changes are not the cause of the problem, check that your machine has enough space for the result file.

---

**ASN1077S** The Apply program encountered an invalid DATALINK column value while updating the target table. The error code is "<error\_code>".

**Explanation:** The DATALINK column field of a row fetched from the source table is not valid.

**User Response:** Contact IBM Software Support.

---

**ASN1097I** The Apply program stopped due to the above error.

**Explanation:** The error reported previously caused the Apply program to stop.

**User Response:** Fix the error reported before this message.

---

**ASN1100I** A user has stopped the Apply program.

**Explanation:** A user issued the STOP command to stop the Apply program.

**User Response:** No action is required.

---

**ASN1109I** Not all of the Jet database changes are applied due to an RI violation.

**Explanation:** There was at least one change in the row-replica target list table that violates the referential integrity (RI) of the source table.

**User Response:** Refer to the Microsoft Jet-specific error information and error messages tables for more details. See "Error information table (Microsoft Jet specific)" on page 348.

---

**ASN1110I** The Apply program created Jet database "<db\_name>".

**Explanation:** The target database <db\_name> was created.

**User Response:** No action is required.

---

**ASN1111I** The Apply program converted Jet Database "<db\_name>" to a Design Master.

**Explanation:** The database that you specified is now a Design Master from which all Microsoft Jet Replicas will be created.

**User Response:** No action is required.

---

---

**ASN1115I** ODBC call was successful with sqlcode "<sqlcode>", sqlstate "<sqlstate>", and message "<message>".

**Explanation:** The ODBC call was successful, but a message was issued. This message is for your information only.

**User Response:** No action is required.

---

**ASN1116E** ODBC call failed. sqlcode "<sqlcode>", sqlstate "<sqlstate>", and message "<message>".

**Explanation:** An error occurred during the execution of an ODBC operation against either the DB2 ODBC driver or the Microsoft Jet ODBC driver.

**User Response:** Refer to the appropriate ODBC reference for more information.

---

**ASN1130E** Execution of DAO call failed. ERRCODE "<error\_code>", DAO error number "<error\_number>", and DAO error message "<error\_message>".

**Explanation:** An error occurred during a Microsoft Data Access Object (DAO) execution.

**User Response:** Refer to the Microsoft DAO reference for more information.

---

**ASN1135E** File operation failed. File name is "<file\_name>", error code is "<error\_code>".

**Explanation:** Open, close, read, or write operations failed.

**User Response:** Verify that the user has authority for the file operation. Also verify that there is enough space in the system.

---

**ASN1207E** The subscription for "<subscription>" was not activated.

**Explanation:** The selected subscription is inactive.

**User Response:** Either activate the subscription or select another one.

---

**ASN1210E** An Apply qualifier must be specified following the keyword -q.

**Explanation:** You must specify an Apply qualifier following the keyword -q.

**User Response:** Specify an Apply qualifier following the keyword -q.

---

**ASN1212E** A read-only set name "<set\_name>" is found following the keyword "<keyword>".

**Explanation:** A read-only set name was specified following the keyword U or D.

**User Response:** Specify only replica for the keywords U and D.

---

**ASN1221I** Set "<set\_name>" has been successfully refreshed with "<number>" rows at "<time>".

**Explanation:** This message is for your information only.

**User Response:** No action is required.

---

**ASN1222I** Set "<set\_name>" has successfully inserted "<number>" rows, deleted "<number>" rows, updated "<number>" rows at "<time>".

**Explanation:** This message is for your information only.

**User Response:** No action is required.

---

**ASN1223E** The Apply program could not copy for set "<set\_name>".

**Explanation:** The Apply program encountered a problem while copying.

**User Response:** Refer to the apply trail table to determine the cause of the error.



---

**ASN1242E** A SQL error occurred. ERRCODE is "<error\_code>", SQLSTATE is "<sqlstate>", SQLCODE is "<sqlcode>", SQLERRM is "<sqlerrm>", SQLERRP is "<sqlerrp>", table name is "<table\_name>".

**Explanation:** This message is for your information only.

**User Response:** No action is required.

---

**ASN1243E** There is no eligible subscription in the ASN.IBMSNAP\_SUBS\_SET table.

**Explanation:** Either a subscription set has not been selected or the apply qualifier is invalid.

**User Response:** Verify the subscription names and apply qualifier.

---

**ASN1244E** User has not selected any set.

**Explanation:** A subscription set has not been selected from the ASNMOBIL dialog.

**User Response:** Select at least one subscription set from ASNMOBIL dialog.

---

**ASN1303E** The ASNSAT program encountered an incorrect invocation keyword. The keyword is "<keyword>".

**Explanation:** An unknown keyword parameter was specified.

**User Response:** Specify the correct keyword parameter.

---

**ASN1304E** The ASNSAT program terminated due to a Capture error.

**Explanation:** The Capture program returned an error.

**User Response:** Determine the error from the Capture log file.

---

---

**ASN1305E** The ASNSAT program terminated due to an Apply error.

**Explanation:** The Apply program returned an error.

**User Response:** Determine the error from the Apply log file.

---

**ASN1309E** Cannot find default control database name.

**Explanation:**

**Satellite**

The default control server, SATCTLDB, is not found from the database directory.

**Non-Satellite**

The user did not specify the default control server name in DB2DBDFT.

**User Response:** Specify the control server name following the -n keyword.

---

**ASN1310E** The ASNSAT program encountered a system error while attempting to invoke the Capture program. Return code is "<return\_code>".

**Explanation:** An operating system error occurred while calling ASNCCP.

**User Response:** Make sure that the Capture program is in the execution path.

---

**ASN1311E** The ASNSAT program encountered a system error while attempting to invoke the Apply program. Return code is "<return\_code>".

**Explanation:** An operating system error occurred while calling ASNAPPLY.

**User Response:** Make sure that the Apply program is in the execution path.

---

---

**ASN1312E** The default target server, DB2DBDFT, is not set.

**Explanation:** The user did not specify the target server name, and the ASNSAT program could not determine the default database name from DB2DBDFT.

**User Response:** Specify the target server name following the -t keyword.

---

**ASN1314E** An SQL error occurred while ASNSAT was getting the default Apply qualifier. SQLSTATE is "<sqlstate>", SQLCODE is "<sqlcode>".

**Explanation:** The user did not specify the Apply qualifier. The ASNSAT program encountered an error while retrieving the USER special register.

**User Response:** Specify the Apply qualifier following the -q keyword.

---

**ASN1315E** Cannot connect to database server. SQLSTATE is "<sqlstate>", SQLCODE is "<sqlcode>".

**Explanation:** An error occurred while attempting to connect to the target database.

**User Response:** Refer to your database message reference.

---

**ASN1316E** ASNSAT encountered an error while trying to bind. The SQLSTATE is "<sqlstate>", SQLCODE is "<sqlcode>".

**Explanation:** An error occurred while attempting to auto bind.

**User Response:** Make sure that the bind file exists in the sqllib\bnd directory.

---

**ASN1317E** An SQL error occurred while ASNSAT was getting the CD\_TABLE value from ASN.IBMSNAP\_REGISTER table. SQLSTATE is "<sqlstate>", SQLCODE is "<sqlcode>".

**Explanation:** An SQL error occurred while selecting from the register table.

**User Response:** Refer to your database message reference.

---

**ASN1318E** An SQL error occurred while ASNSAT attempted to get the DB2 node type. SQLSTATE is "<sqlstate>", SQLCODE is "<sqlcode>".

**Explanation:** An error occurred while retrieving the node type configuration parameter.

**User Response:** Refer to your database message reference.

---

## Chapter 16. Replication messages for AS/400

This chapter contains a list of messages issued by DB2 replication for AS/400 for the Capture and Apply programs; the trigger programs for the register table, the pruning control table, and the critical section table; and the delete receiver exit routine.

The replication messages have the following prefixes:

**ASN1** The Apply program. These messages are listed in “Apply for AS/400 messages”

**ASN2** The Capture program. These messages are listed in “Capture for AS/400 messages” on page 386

### **ASN3–ASN6**

Other replication messages for AS/400 (these include the messages issued by the trigger programs for the register table, the pruning control table, and the critical section table, and messages issued by the delete receiver exit routine). These messages are listed in “Other replication messages for AS/400” on page 390

Unless otherwise stated, all error codes “<error\_code>” described in error messages are internal error codes used by IBM Software Support. Also, unless otherwise stated, error messages are issued with a return code of 8.

You can also obtain explanations for messages by typing the following command at a DB2 command prompt:

*db2 message\_number*

---

### Apply for AS/400 messages

---

**ASN1001**    **The Apply program encountered an SQL error.**

**Explanation:** The SQL was statement was not successful.

**User Response:** Check the messages in the job log to determine the cause of the problem. Try the request again.

---

**ASN1002**    **Critical section table not available.**

**Explanation:** The Apply program could not lock the critical section table.

**User Response:** Try the request again when the critical section table is available.

---

**ASN1003     Apply program could not connect to server "<server\_name>".**

**Explanation:** The Apply program tried to connect to server "<server\_name>" but was not successful.

**User Response:** Ensure the connection to the server is active. Check the messages in the job log to determine the cause of the problem. Try the request again.

---

**ASN1011     Copy request attributes not compatible.**

**Explanation:** The attributes of the target table must be compatible with the attributes of the base table.

**User Response:** Change the incompatible copy request values.

---

**ASN1036     The column type is not valid.**

**Explanation:** The column type "<col\_type>" for expression "<expression>" is not valid. The error code is "<error\_code>".

**User Response:** Change the column type to a valid value. The valid column types are: 'A' is an after-image column. 'B' is a before-image column. 'C' is a computed column without SQL column functions. 'F' is a computed column with SQL column functions. 'R' is a relative record number after-image key column.

---

**ASN1050     Refresh operation not valid.**

**Explanation:** The Apply program encountered an operation during refresh that is not valid. The operation is "<operation>". Error code "<error\_code>".

**User Response:** Record the message number, operation code and error code, and contact your system administrator.

---

**ASN1054     Registration information not found.**

**Explanation:** The Apply program could not find the registration information for source owner

"<src\_ownr>", source table "<src\_tbl>", and source view qualifier "<src\_view\_qual>". The error code is "<error\_code>".

**User Response:** Examine the subscription and registration information. The data in the ASN.IBMSNAP\_PRUNCNTL table does not correspond to the data in the ASN.IBMSNAP\_REGISTER table for source owner "<src\_ownr>", source table "<src\_tbl>", and source view qualifier "<src\_view\_qual>". The user should remove the source table registration and try adding the source table registration again.

---

**ASN1055     Prune control information not found.**

**Explanation:** The Apply program could not find the prune control information for source owner "<src\_ownr>", source table "<src\_tbl>", source view qualifier "<src\_view\_qual>", target owner "<tgt\_ownr>", and target table "<trt\_tbl>". The error code is "<error\_code>".

**User Response:** Examine the subscription and registration information. The data in the ASN.IBMSNAP\_PRUNCNTL table does not correspond to the data in the ASN.IBMSNAP\_REGISTER table for source owner "<src\_ownr>", source table "<src\_tbl>", and source view qualifier "<src\_view\_qual>". The user should remove the source table registration and try adding the source table registration again.

---

**ASN1063     Maximum number of set members exceeded.**

**Explanation:** The number of subscriptions has exceeded the maximum allowed number of 200. The error code is "<error\_code>".

**User Response:** Remove excess members from the subscription set.

---

**ASN1066     Synchpoint could not be determined.**

**Explanation:** The synchpoint value for the set could not be determined because an internal

Apply error occurred. The error code is "<error\_code>".

**User Response:** Record the message number and error code, and contact your system administrator.

---

**ASN1067 Update conflicts detected.**

**Explanation:** More than one application updated the same row in a table from different locations. Some transactions have been rejected and compensated. The error code is "<error\_code>".

**User Response:** See the unit of work table (ASN.IBMSNAP\_UOW) for details. The user should refer to the product information for an explanation of the values in the IBMSNAP\_REJ\_CODE column.

---

**ASN1068 Referential integrity violation detected.**

**Explanation:** A referential integrity violation was detected when copying data from the source table to a replica. The subscription has been deactivated. The error code is "<error\_code>".

**User Response:** Correct the referential integrity error and reactivate the subscription.

---

**ASN1069 Referential integrity violation detected.**

**Explanation:** A referential integrity violation was detected when replicating data from the replica to the user table. All of the affected units of work have been marked in the unit of work table (ASN.IBMSNAP\_UOW) and compensated. The subscription has been deactivated. The error code is "<error\_code>".

**User Response:** Correct the referential integrity error and reactivate the subscription.

---

**ASN1070 Target table not available.**

**Explanation:** The Apply program could not lock target table "<tgt\_tbl>" in library "<library>" on server "<server>" to check for update conflicts. The error code is "<error\_code>".

**User Response:** The user should verify that all the target tables are available before restarting the Apply program.

---

**ASN1071 Internal error in Apply program.**

**Explanation:** The Apply program detected an error while reading the temporary work file. The error code is "<error\_code>".

**User Response:** The user should record the message number and error code, and contact their system administrator. The 7E00470E, 7F004714, and 81004706 error codes, indicate that the Apply program cannot read the format of the file that was generated by the ASNDLCOPY program. If you modified the ASNDLCOPY program, check to see if your changes are causing the invalid format.

---

**ASN1073 Program "<program>" in library "<library>" failed.**

**Explanation:** The set completion notification (ASNDONE) user exit program "<exit\_program>" in library "<library>" failed. The reason code is "<reason\_code>", and the return code is "<return\_code>". The error code is "<error\_code>". This message also indicates that the DATALINK file copy (ASNDLCOPY) user exit program "<exit\_program>" in library "<library>" failed. The reason code is "<reason\_code>", the return code is "<return\_code>", and the error code is "<error\_code>".

**User Response:** If the reason code is -999, the resolve system pointer (RSLVSP) MI instruction failed, or the call to the set completion notification (ASNDONE) user exit program failed. The user should refer to the job log to obtain information about the failure. If the reason code is not -999, the user should refer to the documentation for the set completion notification (ASNDONE) user exit program "<exit\_program>" in library "<library>" for an explanation of the reason code and return code values. If the exit program is ASNDLCOPY, refer to the log file that was generated by the ASNDLCOPY program for detailed information.

---

**ASN1110 Row could not be inserted into apply trail table.**

**Explanation:** The Apply program could not insert a row into the apply trail table (ASN.IBMSNAP\_APPLYTRAIL). The table structure of the apply trail table is not correct. The error code is "<error\_code>".

**User Response:** The user should refer to the product information to obtain the correct table structure for the ASN.IBMSNAP\_APPLYTRAIL table. The ASN.IBMSNAP\_APPLYTRAIL table must be changed to have the table structure that is documented in the product information.

---

**ASN1112 Source table structure is not valid.**

**Explanation:** The value in the SOURCE\_STRUCTURE column in the register table (ASN.IBMSNAP\_REGISTER) is not valid. The error code is "<error\_code>".

**User Response:** The source table structure for the registration must be changed to a valid value. A list of valid source table structure values can be found in the product information.

---

**ASN1113 Target table structure is not valid.**

**Explanation:** The value in the TARGET\_STRUCTURE column in the subscription targets table (ASN.IBMSNAP\_SUBS\_MEMBER) is not valid. The error code is "<error\_code>".

**User Response:** The target table structure for the subscription must be changed to a valid value. A list of valid target table structure values can be found in the product information.

---

**ASN1114 Change data table not found.**

**Explanation:** The Apply program could not find a source for the copy request because it could not find the change data table. The change data table was not defined in the register table (ASN.IBMSNAP\_REGISTER). The error code is "<error\_code>".

**User Response:** A change data table must be correctly defined in the register table

(ASN.IBMSNAP\_REGISTER) for the source table. The CD\_OWNER and CD\_TABLE columns must be specified for the registered table.

---

**ASN1115 Apply program waiting for global SYNCHTIME to advance.**

**Explanation:** The Apply program is waiting for the Capture program at server "<server>" to advance the global SYNCHTIME. The error code is "<error\_code>".

**User Response:** Verify that the Capture program is running.

---

**ASN1117 No target column names were supplied.**

**Explanation:** The Apply program could not find any columns in the subscription columns table (ASN.IBMSNAP\_SUBS\_COLS). The error code is "<error\_code>".

**User Response:** Redefine the replication subscription.

---

**ASN1120 Storage block could not be reserved.**

**Explanation:** The Apply program could not reserve a storage block. The error code is "<error\_code>".

**User Response:** Record the message number and error code, and contact your system administrator.

---

**ASN1121 Apply program could not read from work file.**

**Explanation:** The Apply program could not read a record from the work file. The user probably does not have the proper access authority for one or all of the files. The error code is "<error\_code>".

**User Response:** Determine whether the problem is caused by a lack of access authority and contact your system administrator to obtain what is needed.

---

**ASN1122     Apply program could not write into work file.**

**Explanation:** The Apply program could not write a record to the work file. Either the user does not have the proper access authority for one or all of the files or not enough space is left in the work file for the record. The error code is "<error\_code>".

**User Response:** Determine whether the problem is caused by a lack of access authority or a lack of space and contact your system administrator to obtain what is needed.

---

**ASN1123     Work file could not be opened.**

**Explanation:** The Apply program could not open the work file. The error code is "<error\_code>".

**User Response:** Record the message number and error code, and contact your system administrator.

---

**ASN1124     Work file could not be closed.**

**Explanation:** The Apply program could not close the work file. The error code is "<error\_code>".

**User Response:** Record the message number and error code, and contact your system administrator.

---

**ASN1129     SQL statement was not successful.**

**Explanation:** The SQL statement that the user specified to run as an EXECUTE IMMEDIATE SQL statement was not successful. The error code is "<error\_code>".

**User Response:** Refer to the previous messages in the job log and the apply trail table (ASN.IBMSNAP\_APPLYTRAIL) for detailed information.

---

**ASN1135     Subscription columns table not available.**

**Explanation:** The subscription columns table (ASN.IBMSNAP\_SUBS\_COLS) could not be accessed.

**User Response:** Check the messages in the job log to determine the cause of the problem. Try the request again when the ASN.IBMSNAP\_SUBS\_COLS table is available.

---

**ASN1138     No column names or expressions supplied.**

**Explanation:** No column names or expressions were specified in the subscription columns table (ASN.IBMSNAP\_SUBS\_COLS). Column names or expressions must be supplied for a subscription. The error code is "<error\_code>".

**User Response:** Specify column names or expressions for the subscription request.

---

**ASN1140     OS/400 system operation failed.**

**Explanation:** The Apply program encountered an error on an OS/400 system operation. The error code is "<error\_code>". The return code is "<return\_code>".

**User Response:** Record the message number and error code, and contact your system administrator.

---

**ASN1148     Subscription was not successful.**

**Explanation:** The subscription did not run successfully. The error code is "<error\_code>".

**User Response:** Check the messages in the job log or the apply trail table (ASN.IBMSNAP\_APPLYTRAIL) to determine why the subscription failed. Correct the error and try the request again.

---

**ASN1151     Subscription was not successful.**

**Explanation:** The Apply program determined that a gap exists between the source table "<src\_tbl>" and the target table. The error code is "<error\_code>".

**User Response:** Check the control tables to determine why the gap is present. Take proper action to preserve data integrity before you reset the control table information to run the definition again.

---

**ASN1B08**    **The subscription set with Apply qualifier "<qual\_name>" and set name "<set\_name>" is not defined correctly. ERRCODE is "<error\_code>". Explanation: The subscription set is not defined correctly.**

**Explanation:** The subscription set is not defined correctly.

---

## Capture for AS/400 messages

---

**ASN200A**    **User table "<table\_name>" registration not satisfied. The registration probably should be removed.**

**Explanation:** There are many reasons that data capturing for a replication source cannot continue. Depending on the severity, you can receive either an ASN2004 or an ASN200A message.

Because a journal job is usually responsible for capturing data from several replication sources, the journal job is not affected by these messages. These messages were generated due to a specific replication source. After sending the ASN2004 or ASN200A message, the Capture journal job continues processing other replication sources. The program ends only if the last erring replication source is the last journal job processing.

**User Response:** Use the DSPMSGD command to determine the conditions that caused this message. For example:

```
DSPMSGD ASN200A QDPR/QDPRMSG
```

---

**ASN2002**    **Turning Parameter table not found.**

**Explanation:** The journal job in the capture process has ended unexpectedly.

**User Response:** Make sure that the WHOS\_ON\_FIRST column in ASN.IBMSNAP\_SUBS\_SET is specified correctly.

---

**ASN1B09**    **There is no subscription set defined for Apply qualifier "<qual\_name>".**

**Explanation:** Define at least one subscription set for Apply qualifier "<qual\_name>".

**User Response:** Define at least one subscription set for Apply qualifier "<qual\_name>".

---

**User Response:** Check the job log of the referenced job to determine why that job ended unexpectedly. End the capture process (ENDDPRCAP command) and start it again (STRDPRCAP command).

---

**ASN2004**    **User table "<table\_name>" registration not satisfied. The registration probably should be removed.**

**Explanation:** See ASN200A. This message was displayed because the user table "<user\_table>" in library "<library>" is registered in the Register table, or the Change Data Control table, but it could not be processed because of reason code "<reason\_code>". The reason codes and their meanings are located in the following list:

**60**        Either the physical file "<file\_name>" in library "<library>" has been renamed or the member name for member "<member>" in that file has been changed.

**70**        Either the physical file "<file\_name>" in library "<library>" has been deleted or member "<member>" has been removed from that file.

**140**       Either the library "<library>" has been renamed or the physical file



"<file\_name>" has been moved from that library to a different library.

**User Response:** Use the DSPMSGD command to determine the conditions that caused this message.

---

**ASN2017 Starting point not found for journal "<table\_name>" (C I G R).**

**Explanation:** One of the first tasks in the Capture control job is to establish the starting point with which to resume journal entry processing. The journal receiver containing entries corresponding to that starting point must be online. If that receiver is deleted prematurely, the control job sends message ASN2017 to ask you how you want to proceed.

Response **I** tells the control job to ignore the fact that a receiver is missing. Data capturing resumes using the current receiver chain. If you respond **I**, you are responsible for the integrity of the replication. The Capture program can not guarantee that all of the changes are made to the replication targets.

Response **C** cancels the Capture control job.

Response **R** retries establishing the starting point.

**User Response:** In most cases, a response of **G** is appropriate. (Cold start all the replication sources using this journal.)

---

**ASN2019 Not authorized to Tuning Parameters table.**

**Explanation:** You are not authorized to the IBMSNAP\_CCPPARMS table in library ASN.

**User Response:** Ask the security officer to grant authority (GRTDPRAUT command) to you.

---

**ASN2028 Internal error in Capture program.**

**Explanation:** The Capture control job detected an internal error and posted a reason code.

**User Response:** Record the reason code and contact your system administrator.

---

**ASN2029 Internal error in Capture program.**

**Explanation:** The Capture program detected an unexpected exception.

**User Response:** Record the exception code and contact your system administrator. Refer to the job log for additional information relating to that exception.

---

**ASN2030 Cannot submit job.**

**Explanation:** The Capture controlling job could not submit a subordinate journal job to process changes.

**User Response:** Check the messages in the job log to determine the problem. Correct the errors and try the request again. If the problem recurs, contact the system administrator.

---

**ASN2037 Cannot send data queue message to job.**

**Explanation:** The Capture controlling job could not send message to the data queue of a subordinate job because the data queue is not empty.

**User Response:** To resume normal operation, end data capture environment by issuing the ENDDPRCAP command and start it again by issuing the STRDPRCAP command. It may be necessary to end that subordinate job by using the end-immediate option to allow the capture environment to be ended completely.

---

**ASN2038 Too many registrations for journal.**

**Explanation:** For the named journal, the number of base tables that are being actively captured exceeds the limit of 300.

**User Response:** Remove some registrations. If this is not possible, create a new journal and have some registrations changed to use the new journal.

---

**ASN2039 Lag limit exceeded.**

**Explanation:** Exceeding the lag limit causes the Capture component to send an ASN2039 message to the job log and to the system operator message queue.

**User Response:** By gathering system performance data, you can better determine what action might be necessary. Some possible solutions are:

- To increase the lag limit.
- To prioritize (by using a lower numerical value) the Capture jobs to a level identical to or higher than that of the interactive jobs.
- To reschedule the work load to a time period when the demand on the system is less, or to move some of the work load to a different system.
- To add more resources to the system (a system upgrade).

---

**ASN2042 No registrations were found to process.**

**Explanation:** No registrations in the IBMSNAP\_REGISTER table met the selection criteria provided on the Start DPR Capture (STRDPRCAP) command.

**User Response:** Change the selection criteria or specify \*ALL on the JRN keyword and try the request again.

---

**ASN2043 No registrations for the specified journal.**

**Explanation:** The journal specified for the JRN keyword on either the STRDPRCAP command or the INZDPRCAP command is not one that has any tables registered in the table IBMSNAP\_REGISTER in library ASN. The journal will be ignored.

**User Response:** Check for possible misspelling of the journal name. If this is the case, reissue the command with the correct name.

---

**ASN2045 Data changes not captured for table.**

**Explanation:** User table is registered in the Register table but it could not be processed.

**User Response:** Correct the problem and try the request again.

---

**ASN2046 Not authorized to Unit of Work table.**

**Explanation:** You are not authorized to the IBMSNAP\_UOW table in library ASN.

**User Response:** Ask the security officer to grant authority to you by issuing the command GRTPRAUT specifying AUT(\*CAPTURE).

---

**ASN2047 Not authorized to index of Pruning Control table.**

**Explanation:** You are not authorized to index IBMSNAP\_PRUNCNTLX in library ASN.

**User Response:** Ask the security officer to grant authority to you by issuing the command GRTPRAUT specifying AUT(\*CAPTURE).

---

**ASN2048 Not authorized to Capture Trace table.**

**Explanation:** You are not authorized to the IBMSNAP\_TRACE table in library ASN.

**User Response:** Ask the security officer to grant authority to you by issuing the command GRTPRAUT specifying AUT(\*CAPTURE).

---

**ASN2049 Not authorized to Warm Start table.**

**Explanation:** You are not authorized to the IBMSNAP\_WARM\_START table in library ASN.

**User Response:** Ask the security officer to grant authority to you by issuing the command GRTPRAUT specifying AUT(\*CAPTURE).

---

**ASN2050      Registration Extension table not found.**

**Explanation:** The IBMSNAP\_REG\_EXT table was not found in library ASN.

**User Response:** Restore the ASN library from the previous save volume or call the QZSNCRCTC program (CALL QDPR/QZSNCRCTC) or restore the IBM DataPropagator Relation Capture and Apply for OS/400 licensed program (5769-DP2).

---

**ASN2051      Not authorized to Registration Extension table.**

**Explanation:** You are not authorized to the IBMSNAP\_REG\_EXT table in library ASN.

**User Response:** Ask the security officer to grant authority (GRTPRAUT command) to you.

---

**ASN2052      Not authorized to index of Register Extension table.**

**Explanation:** You are not authorized to index IBMSNAP\_REG\_EXTX in library ASN.

**User Response:** Ask the security officer to grant authority to you by issuing the command GRTPRAUT specifying AUT(\*CAPTURE).

---

**ASN2053      Not authorized to index of Unit of Work table.**

**Explanation:** You are not authorized to index IBMSNAP\_UOW\_IDX in library ASN.

**User Response:** Ask the security officer to grant authority to you by issuing the command GRTPRAUT specifying AUT(\*CAPTURE).

---

**ASN2055      Not able to find full refresh start time.**

**Explanation:** The attempt to start Capture for Version 5 failed. The program is not able to find the full refresh starting time for source table.

**User Response:** The full refresh starting time is kept in the table ASN/IBMSNAP\_REG\_EXT. There should be a row in that table for each source table. The FR\_START\_TIME column in

that row should have a valid time stamp. If this is not the case, there may be a few possibilities. One of which is that the row in table ASN/IBMSNAP\_REG\_EXT has been updated incorrectly. The other is that the table ASN/IBMSNAP\_PRUNCNTL does not have program QZSNCAP5 in library QDPR as its trigger program.

---

**ASN2056      Registration for source table is invalid.**

**Explanation:** There is a registration entry for the source table in question. That table name is an SQL alias name. It has been altered since it was first registered. It is now based on a different physical file (or physical file member) from the one it was based on at the time of registration. This difference cannot be tolerated.

**User Response:** If the alias name that was registered has been changed since the registration, change it back to the way it was when you registered it. If you cannot change it back, delete the registration and re-register it.

---

**ASN2057      Not authorized to Authenticity Token table.**

**Explanation:** You are not authorized to the IBMSNAP\_AUTHTKN table in library ASN.

**User Response:** Ask the security officer to grant authority to you by issuing the command GRTPRAUT specifying AUT(\*CAPTURE).

---

**ASN2058      Not authorized to Critical Section table.**

**Explanation:** You are not authorized to the IBMSNAP\_CRITSEC table in library ASN.

**User Response:** Ask the security officer to grant authority to you by issuing the command GRTPRAUT specifying AUT(\*CAPTURE).

---

**ASN2201      Internal error in Capture program.**

**Explanation:** An error occurred in the Capture program.

**User Response:** Check the job log to determine

the cause of the problem. Record the reason code and contact your system administrator.

---

**ASN2301 Internal error in Capture program.**

**Explanation:** This message is sent by the journal job as an escape message before the journal job ends. A condition exists that makes it impossible to continue capturing data.

**User Response:** Check the job log to determine the cause of the problem. To aid in problem determination, use the DSPMSGD command to determine the conditions that caused this message to be displayed. For example:

DSPMSGD ASN2301 QDPR/QDPRMSG

Record the reason code and contact your system administrator.

---

**ASN2501 Not authorized to register table.**

**Explanation:** You are not authorized to the ASN/IBMSNAP\_REGISTER table.

**User Response:** Ask the security officer to grant authority to you or use the GRTPRAUT command with \*REGISTRAR.

---

## Other replication messages for AS/400

The other replication messages include:

### Messages from trigger programs for the register table

DataPropagator puts database triggers on the register table (table ASN/IBMSNAP\_REGISTER). This trigger is called when any replication administration tool tries to insert, update, or delete a register table row. It is also called when someone tries to work with the register table directly.

The purpose of this trigger program is to maintain the register extension table (table ASN/IBMSNAP\_REG\_EXT, which exists only on AS/400). A secondary purpose of this trigger is to maintain the journal list in Capture program's primary control table.

The messages issued from the trigger program may appear in any job that works on behalf of the replication administration tools.

### Messages from trigger programs for the prune control table

DataPropagator puts database triggers on the pruning control table (table ASN/IBMSNAP\_PRUNCNTL). This trigger is called when any Apply program tries to insert, update, or delete a pruning control table row.

The triggers are needed to reduce CPU overhead of the Capture program and to maintain the FR\_START\_TIME column in the register extension table (table ASN/IBMSNAP\_REG\_EXT).

These messages will most likely appear in the Apply job log (or the equivalent of the job log on other platforms).

### Messages from trigger program for the critical section table

DataPropagator puts database triggers on the critical section table (table ASN/IBMSNAP\_CRITSEC). This trigger is called when any Apply program tries to insert, update, or delete a critical section table row.

The triggers are needed to support update anywhere.

The messages will most likely appear in the Apply job log (or the equivalent of the job log on other platforms).

### Messages from the delete receiver exit routine

The delete receiver exit routine errors are from the delete receiver exit routine QZSNDREP in library QDPR. This routine is called when a user tries to delete a journal receiver. It is usually called from a database server job, QDBSRC0x, which handles automatically deleting unneeded journal receivers. When the automated deleting of receivers seems to be not working, use the **WRKACTJOB** command to find any messages in these server jobs' job logs. You might find one of the listed messages or you might find other messages sent by the operating system.

---

**ASN3050**     **Change data table "<table\_name>" not found.**

**Explanation:** The change data table referred to in the Register table was not found.

**User Response:** Remove the registration for that source table. Then register the source table and try the STRDPRCAP command again.

---

**ASN3053**     **Source table not found.**

**Explanation:** There is a registration entry found for the named source table. That source table is not found.

**User Response:** Delete the registration for that source table and register the source table again when appropriate.

---

**ASN4501**     **Register table not found.**

**Explanation:** The table ASN/IBMSNAP\_REGISTER is not found.

**User Response:** Restore the ASN library from the previous save volume or run the CRTDPRTBL command or restore the IBM DataPropagator Relational Capture and Apply for OS/400 licensed program (5769-DP2).

---

**ASN4502**     **Register table index not found.**

**Explanation:** The index ASN/IBMSNAP\_REGISTERX is not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN4503**     **Pruning control table not found.**

**Explanation:** The table ASN/IBMSNAP\_PRUNCNTL is not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN4504**     **Pruning Control index not found.**

**Explanation:** The index ASN/IBMSNAP\_PRUNCNTLX is not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN4505 Trace table not found.**

**Explanation:** The table ASN/IBMSNAP\_TRACE is not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN4506 Warm start table not found.**

**Explanation:** The table ASN/IBMSNAP\_WARM\_START is not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN4507 Critical section table not found.**

**Explanation:** The table ASN/IBMSNAP\_CRITSEC is not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN4508 Critical section index not found.**

**Explanation:** The index ASN/IBMSNAP\_CRITSECX is not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN4509 Index for the unit of work table not found.**

**Explanation:** The index ASN/IBMSNAP\_UOW\_IDX is not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN4510 Register extension index not found.**

**Explanation:** The index ASN/IBMSNAP\_REG\_EXTX is not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN4525 Apply qualifier cross reference table not found.**

**Explanation:** The table ASN/IBMSNAP\_AUTHTKN is not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN4526 Apply qualifier cross reference table index not found.**

**Explanation:** The index ASN/IBMSNAP\_AUTHTKNX is not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN4527 Unit of work table not found.**

**Explanation:** The table ASN/IBMSNAP\_UOW was not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN4529 Unit of work index not found.**

**Explanation:** The index ASN/IBMSNAP\_UOW\_IDX is not found.

**User Response:** Restore the ASN library from the previous save volume or run the Create DPR Tables command (CRTDPRTBL).

---

**ASN6063 Failed to update the PCB.**

**Explanation:** The trigger program for Register table issued a QUSCHGUS AP call in an attempt to update the user space QZSNCTLBLK in library ASN. The API call failed with an exception.

**User Response:** Record the reason code and try to correct the problem. If the problem recurs,

contact your system administrator.

---

**ASN6064**      **Number of journals exceeds the limit.**

**Explanation:** An attempt was made to add an entry to the journal list in user space QZSNCTLBLK in library ASN. It has a limit of 500 entries. That limit is exceeded.

**User Response:** Reduce the number of journals that all registered source tables use to be less than the allowed limit.

---

**ASN6065**      **Attempt to convert base table name to system name failed.**

**Explanation:** An attempt was made to convert the base table name from the SQL name to system name for the subject source table. The conversion attempt failed.

**User Response:** Make sure the source table exists before retrying the request.

---

**ASN6068**      **Cannot find a matching row in IBMSNAP\_REG\_EXT.**

**Explanation:** An attempt was made to read a matching row for the named source table in table IBMSNAP\_REG\_EXT. The matching row was not found.

**User Response:** Ignore the error if you are trying to remove a registration. If you are not trying to remove a registration, insert a row in table IBMSNAP\_REG\_EXT with VERSION set to 5. SOURCE\_OWNER and SOURCE\_TABLE are set to the appropriate values. SOURCE\_NAME is set to the system name of the source table. JRN\_NAME and JRN\_LIB should have the journal name and its library name of the journal the source table uses. SOURCE\_TABLE\_RDB should be NULL if the source table is in the same system, and should have the RDB name of the system where the source table is at otherwise. SOURCE\_VIEW\_QUAL is set to the corresponding value in the registration.

---

**ASN6069**      **Error detected in trigger program for IBMSNAP\_REGISTER.**

**Explanation:** An error occurred in the trigger program (QZSNJRNL) for the Register table for Data Propagator Relational/400. This trigger program is needed to maintain a list of journals that all the registered base table in the system use. Additional message may be found in the job log which can help determine the cause of the problem.

**User Response:** Check the job log of the job that sent this message. Correct the problem and try the request again.

---

**ASN6071**      **Internal error in trigger program for IBMSNAP\_REGISTER.**

**Explanation:** An error occurred in the trigger program (QZSNJRNL) for the Register table for DataPropagator Relational/400. This trigger program is needed to maintain a list of journals that all the registered base tables in the system use. Check the job log for possible additional messages which can help determine the cause of the problem.

**User Response:** Record the reason code and contact your system administrator.

---

**ASN2401**      **Internal error in trigger program.**

**Explanation:** An error occurred in the trigger program for Pruning Control table IBMSNAP\_PRUNCNTL in library ASN.

**User Response:** Record the reason code and try to correct the problem. For example, for reason code 60 (Could not find a matching row for source table in index ASN/IBMSNAP\_REG\_EXTX) and reason code 90 (Could not find a matching row for source table in table ASN/IBMSNAP\_REGISTER) your action could be to register the source table before trying to insert a row in the Prune Control table. For some other reason codes, it is possible that the referenced table is temporarily unavailable. Your action could be just to retry the task at a later time. If the problem recurs, contact your system administrator.

---

**ASN2403 Internal error in trigger program.**

**Explanation:** An error occurred in the trigger program for Pruning Control table IBMSNAP\_PRUNCNTL in library ASN.

**User Response:** Record the reason code and try to correct the problem. If the problem recurs, contact your system administrator.

---

**ASN2023 Error occurred on file.**

**Explanation:** An error occurred when processing the named file.

**User Response:** Check the messages in the job log to determine the problem. Correct the errors and try the request again.

---

**ASN6022 Failed to read the journal list from the PCB.**

**Explanation:** Attempt to read the journal list from the user space QZSNCTLBLK in library ASN (the Primary Control Block) failed.

**User Response:** Check the message in the job log to determine the problem. Correct the errors and try the request again.

---

**ASN6025 Could not open table.**

**Explanation:** See message(s) in the job log for additional information about the reason why the open failed.

**User Response:** Correct the problem and try the request again.

---

**ASN6067 Program QZSNDREP gets an unexpected exception.**

**Explanation:** The DataPropagator for AS/400 registered an exit program for deletion of journal receivers. This delete receiver exit program (QZSNDREP) gets an exception unexpectedly.

**User Response:** Check the job log of the job that sent this message. Contact your system administrator.

---

**ASN6068 Cannot find a matching row in IBMSNAP\_REG\_EXT.**

**Explanation:** See above under "Messages from Trigger Program for Register Table".

**User Response:** See above under "Messages from Trigger Program for Register Table".



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## Part 5. Appendixes



---

## Appendix A. Starting the Capture and Apply programs from within an application

Instead of using the `asnccp` command to start the Capture program or the `asnapply` command to start the Apply program, you can start the Capture and Apply programs from within your application by calling routines. To use these routines you must specify the `AUTOSTOP` option for the Capture program and the `COPYONCE` option for the Apply program because only synchronous execution is supported with this API.

This chapter describes the routines and the return codes, and it gives a sample routine that starts the Capture and Apply programs.

---

### Starting the Capture program using a routine

You can start the Capture program from within your application by calling this routine:

```
#ifndef ASN_INCLUDE
#define ASN_INCLUDE

#define MAXASNPARMLENGTH 128

struct asnParm
{
    short byteCount;
    char val[MAXASNPARMLENGTH];
};

struct asnParms
{
    int parmCount;
    struct asnParm **parms;
};

int asnCapture(struct asnParms *pAsnParms);
#endif
```

This routine returns the following return codes:

- 0**        The program ran successfully.
- 1**       The program did not run successfully.

---

## Starting the Apply program using a routine

You can start the Apply program from within your application by calling this routine:

```
#ifndef ASN_INCLUDE
#define ASN_INCLUDE

#define MAXASNPARMLENGTH 128

struct asnParm
{
    short byteCount;
    char val[MAXASNPARMLENGTH];
};

struct asnParms
{
    int parmCount;
    struct asnParm **parms;
};

int asnApply(struct asnParms *pAsnParms);

#endif
```

This routine returns the following return codes:

- 0        The Apply program ran successfully.
- 1        The Apply program ran successfully; however, a conflict was detected in at least one subscription set. As a result, one or more rejected transactions were compensated.
- 1       The Apply program did not run successfully.

---

## Sample routine that starts the Capture and Apply programs

The following sample routine starts the Capture and Apply programs:

```
#include <stdlib.h>
#include <string.h> /* for strcpy, strlen */
#include <asn.h> /* replication API parameters */

/* helper function to dump out parameter contents */
int printParms( const struct asnParms parms )
{
    int count = 0;
    if( parms.parmCount > 0 )
    {
        for( count=0; count<parms.parmcount>val );
            printf( "    bytes = %d\n", parms.parms[count]->byteCount );
    }
    return(0);
}
```

```

        else
            return(-1);
    }

int main(int argc, char** argv)
{
    struct asnParms captureParms;
    struct asnParms applyParms;
    struct asnParm *currParm;
    int rc = 0;
    int count = 0;

    /* allocate and initialize capture parameter structure */
    captureParms.parmCount = 4;
    captureParms.parms =
        (struct asnParm **)malloc(captureParms.parmCount * sizeof(struct asnParm*));

    currParm = (struct asnParm *)malloc(sizeof(struct asnParm));
    strcpy( currParm->val, "SRCESRV" );
    currParm->byteCount = strlen( currParm->val );
    captureParms.parms[0] = currParm; /* first capture parameter */

    currParm = (struct asnParm *)malloc(sizeof(struct asnParm));
    strcpy( currParm->val, "WARM" );
    currParm->byteCount = strlen( currParm->val );
    captureParms.parms[1] = currParm; /* second capture parameter */

    currParm = (struct asnParm *)malloc(sizeof(struct asnParm));
    strcpy( currParm->val, "NOPRUNE" );
    currParm->byteCount = strlen( currParm->val );
    captureParms.parms[2] = currParm; /* third capture parameter */

    currParm = (struct asnParm *)malloc(sizeof(struct asnParm));
    strcpy( currParm->val, "AUTOSTOP" );
    currParm->byteCount = strlen( currParm->val );
    captureParms.parms[3] = currParm; /* fourth capture parameter */

    rc = printParms( captureParms ); /* print parameters out to verify */

    rc = asnCapture(&captureParms);
    if( rc!=0 )
        printf("Capture failed with rc = %d\n", rc );
    else
        printf("Capture completed successfully\n" );

    /* allocate and initialize capture parameter structure */
    applyParms.parmCount = 3;
    applyParms.parms =
        (struct asnParm **)malloc(applyParms.parmCount * sizeof(struct asnParm*));

    currParm = (struct asnParm *)malloc(sizeof(struct asnParm));
    strcpy( currParm->val, "APPLYQUAL" );
    currParm->byteCount = strlen( currParm->val );
    applyParms.parms[0] = currParm; /* first capture parameter */

```

```

currParm = (struct asnParm *)malloc(sizeof(struct asnParm));
strcpy( currParm->val, "CNTLSRV" );
currParm->byteCount = strlen( currParm->val );
applyParms.parms[1] = currParm; /* second capture parameter */

currParm = (struct asnParm *)malloc(sizeof(struct asnParm));
strcpy( currParm->val, "COPYONCE" );
currParm->byteCount = strlen( currParm->val );
applyParms.parms[2] = currParm; /* third capture parameter */

rc = asnApply(&applyParms);
if( rc!=0 )
    printf("Apply failed with rc = %d\n", rc );
else
    printf("Apply completed successfully\n" );

for(count = 0; count<= captureParms.parmCount; count++)
    free( captureParms.parms[count] );
free( captureParms.parms );

for(count = 0; count<= applyParms.parmCount; count++)
    free( applyParms.parms[count] );
free( applyParms.parms );

return(rc);
}

```

---

## Appendix B. Education and services for DB2 data replication

This appendix describes the services and education available for DB2 data replication.

---

### Services

IBM and IBM Business Partners offer consulting and services supporting the DB2 data replication solution. Customized services are available in addition to service offerings that help you:

- Plan and design your application.
- Install, configure, and integrate the products.
- Evaluate operational and tuning considerations.
- Evaluate application and data migration.
- Educate and train staff.

For additional information on IBM products and services, contact your IBM software provider, or, in the U.S. and Canada, call 1-800-IBM-3333.

---

### Education

The following classes are provided by IBM Education and Training:

- Data Replication: Basic Usage (DW140)
- Data Replication: Advanced Usage (DW150)

Details about these courses can be found at the following site on the World Wide Web: <http://www.ibm.com/software/data/dpropr/education.html>

#### **General Education Information on the Web**

IBM Education and Training information is available on the Web. You can access the entire curriculum of courses directly from the IBM Global Campus Web site: <http://www.training.ibm.com/ibmedu>

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**IBM Employees:** For complete course descriptions, see the EDUCATION application on HONE or MSE.





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---

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This book describes intended programming interfaces that allow the customer to write programs to obtain the services of IBM Replication. This information is identified where it occurs by an introductory statement to a chapter or section.

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## Glossary

### A

**after-image.** The updated content of a source table column that is recorded in a change data table, or in a database log or journal. Contrast with *before-image*.

**Apply program.** A program that is used to refresh or update a target table, depending on the applicable source-to-target rules. Contrast with *Capture program* and *Capture trigger*.

**Apply qualifier.** A case-sensitive character string that identifies subscription sets that are unique to an instance of the Apply program.

**archive log.** The set of log files that are closed and are no longer needed for normal processing. These files are retained for use in roll-forward recovery. Contrast with *active log*.

**audit trail.** Data, in the form of a logical path linking a sequence of events, used for tracing the transactions that affected the contents of a record.

### B

**base aggregate table.** A type of target table that contains data aggregated from a source table or a point-in-time table at intervals.

**before-image.** The content of a source table column prior to a refresh, as recorded in a change data table, or in a database log or journal. Contrast with *after-image*.

**binary large object (BLOB).** A sequence of bytes, where the size of the sequence ranges from 0 to 2 gigabytes. This string does not have an associated code page and character set. Image, audio, and video objects are stored in BLOBs.

**BLOB.** Binary large object.

**blocking.** An option that is specified when binding an application. It allows caching of

multiple rows of information by the communications subsystem so that each FETCH statement does not require the transmission of one row for each request across the network. Contrast with *data blocking*.

### C

**Capture program.** A program that reads database log or journal records to capture data about changes made to DB2 source tables. Contrast with *Apply program* and *Capture trigger*.

**Capture trigger.** A mechanism that captures delete, update, and insert operations performed on non-IBM source tables. Contrast with *Capture program* and *Apply program*.

**cascade rejection.** The process of rejecting a replication transaction because it is associated with a transaction that had a conflict detected and was itself rejected.

**CCD table.** Consistent-change-data table.

**CD table.** Change data table.

**change aggregate table.** A type of target table that contains data aggregations based on changes recorded for a source table.

**change data (CD) table.** A replication control table at the source server that contains changed data for a replication source table.

**character large object (CLOB).** A sequence of characters (single-byte, multibyte, or both) where the length can be up to 2 gigabytes. This data type can be used to store large text objects. Also called character large object string.

**client.** Any program (or workstation that it is running on) that communicates with and accesses a database server.

**CLOB.** Character large object.

**cold start.** The process of starting the Capture program using an initial program load procedure. Contrast with *warm start*.

**complete CCD table.** A CCD table that contains all the rows that satisfy the source view and predicates from the source table or view. Contrast with *noncomplete CCD table*.

**condensed.** A table attribute indicating that the table contains current data rather than a history of changes to the data. A condensed table includes no more than one row for each primary key value in the table. As a result, a condensed table can be used to supply current information for a refresh.

**condensed CCD table.** A CCD table that contains only the most current value for a row. This type of table is useful for staging changes to remote locations and for summarizing hot-spot updates. Contrast with *noncondensed CCD table*.

**conflict detection.** In update-anywhere replication configurations;

- The process of detecting constraint errors.
- The process of detecting if the same row was updated in the source and target tables during the same replication cycle. When a conflict is detected, the transaction that caused the conflict is rejected. See also *enhanced conflict detection*, *standard conflict detection*, and *row-replica conflict detection*.

**consistent-change-data (CCD) table.** A type of target table that is used for auditing or staging data or both. See also *complete CCD table*, *condensed CCD table*, *external CCD table*, *internal CCD table*, *noncomplete CCD table*, and *noncondensed CCD table*.

**Control Center.** A graphical user interface that shows database objects (such as databases and tables) and their relationship to each other. From the Control Center you can perform tasks on DB2 database objects. Contrast with *DJRA tool*.

**control server.** The database location of the applicable subscription definitions and Apply program control tables.

**control table.** A table in which replication source and subscription definitions or other replication control information is stored.

## D

**database log.** A set of primary and secondary log files consisting of log records that record all changes to a database. The database log is used to roll back changes for transactions that are not committed and to recover a database to a consistent state.

**database management system (DBMS).** Synonym for database manager.

**database manager.** A computer program that manages data by providing the services of centralized control, data independence, and complex physical structures for efficient access, integrity, recovery, data currency control, privacy, and security.

**database server.** A functional unit that provides database services for databases.

**data blocking.** The process of specifying how many minutes worth of change data will be replicated during a subscription cycle. Contrast with *blocking*.

**DataJoiner Replication Administration (DJRA) tool.** DJRA tool.

**DBCLOB.** Double-byte character large object.

**DBMS.** Database management system.

**delimited identifier.** A sequence of characters enclosed within quotation marks ("). The sequence must consist of a letter followed by zero or more characters, each of which is a letter, a digit, or the underscore character.

**differential refresh.** A process in which only changed data is copied to the target table, replacing existing data. Contrast with *full refresh*.

**distinct type.** A user-defined data type that is internally represented as an existing type (its source type), but is considered to be a separate

and incompatible type for semantic purposes. See also *user-defined type (UDT)*.

**DJRA tool.** A database administration tool that you can use to perform various replication administration tasks. Unlike the Control Center, the DJRA tool can also be used to administer replication for non-IBM databases. Contrast with *Control Center*.

**double-byte character large object (DBCLOB).** A sequence of double-byte characters, where the size can be up to 2 gigabytes. This data type can be used to store large double-byte text objects. Also called *double-byte character large object string*. Such a string always has an associated code page.

## E

**enhanced conflict detection.** Conflict detection that guarantees data integrity among all replicas and the source table. The Apply program locks all replicas or user tables in the subscription set against further transactions, and begins detection after all changes made prior to locking have been captured. See also *conflict detection, standard conflict detection*, and *row-replica conflict detection*.

**event timing.** The most precise method of controlling when to start a subscription cycle. Requires that you specify an event and the time when you want the event processed. Contrast with *interval timing* and *on-demand timing*.

**external CCD table.** A CCD table that can be subscribed to directly. It has its own row in the register table, where it is referenced as SOURCE\_OWNER and SOURCE\_TABLE. Contrast with *internal CCD table*.

## F

**full refresh.** A process in which all of the data of interest in a user table is copied to the target table, replacing existing data. Contrast with *differential refresh*.

## G

**gap.** A situation in which the Capture program is not able to read a range of log or journal records, so there is potential loss of change data.

**group.** In Satellite Edition, a collection of satellites that share characteristics such as database configuration and the application that runs on the satellite.

## H

**hot-spot updates.** Updates made repeatedly to the same rows over a short period of time.

## I

**internal CCD table.** A CCD table that cannot be subscribed to directly. It does not have its own row in the register table; it is referenced as CCD\_OWNER and CCD\_TABLE in the row for the associated replication source. Contrast with *external CCD table*.

**interval timing.** The simplest method of controlling when to start a subscription cycle. You must specify a date and a time for a subscription cycle to start, and set a time interval that describes how frequently you want the subscription cycle to run. Contrast with *event timing* and *on-demand timing*.

## J

**join.** A relational operation that allows for retrieval of data from two or more tables based on matching column values.

## K

**key.** A column or an ordered collection of columns that are identified in the description of a table, index, or referential constraint.

## L

**large object (LOB).** A sequence of bytes, where the length can be up to 2 gigabytes. It can be any of three types: BLOB (binary), CLOB (single-byte character or mixed) or DBCLOB (double-byte character).

**LOB.** Large object.

**local database.** A database that is physically located on the workstation in use. Contrast with *remote database*.

**lock.** (1) A means of serializing events or access to data (2) A means of preventing uncommitted changes made by one application process from being perceived by another application process and for preventing one application process from updating data that is being accessed by another process

**locking.** The mechanism used by the database manager to ensure the integrity of data. Locking prevents concurrent users from accessing inconsistent data.

## M

**member.** See *subscription-set member*.

## N

**nickname.** A name that is defined in a DB2 DataJoiner database to represent a physical database object (such as a table or stored procedure) in a non-IBM database.

**noncomplete CCD table.** A CCD table that is empty when it is created and has rows appended to it as changes are made to the source. Contrast with *complete CCD table*.

**noncondensed CCD table.** A CCD table that contains the history of changes to the values for a row. This type of table is useful for auditing purposes. Contrast with *condensed CCD table*.

**nullable.** The condition where a value for a column, function parameter, or result can have

an absence of a value. For example, a field for a person's middle initial does not require a value.

**null value.** A parameter for which no value is specified.

## O

**object.** (1) Anything that can be created or manipulated with SQL—for example, tables, views, indexes, or packages. (2) In object-oriented design or programming, an abstraction consisting of data and operations associated with that data.

**ODBC.** Open Database Connectivity.

**ODBC driver.** A driver that implements ODBC function calls and interacts with a data source.

**on-demand timing.** A method for controlling the timing of replication for occasionally connected systems. Requires that you use the ASNSAT program to operate the Capture and Apply programs. Contrast with *event timing* and *interval timing*.

**Open Database Connectivity (ODBC).** An API that allows access to database management systems using callable SQL, which does not require the use of an SQL preprocessor. The ODBC architecture allows users to add modules, called database drivers, that link the application to their choice of database management systems at run time. Applications do not need to be linked directly to the modules of all the supported database management systems.

**ordinary identifier.** In SQL, a name that is made up of a letter, which might be followed by zero or more characters, each of which is a letter (a-z and A-Z), a symbol, a number, or the underscore character.

## P

**package.** A control structure produced during program preparation that is used to execute SQL statements.

**point-in-time table.** A type of target table whose content matches all or part of a source



table, with an added system column that identifies the approximate time when the particular row was inserted or updated at the source system.

**predicate.** An element of a search condition that expresses or implies a comparison operation.

**primary key.** A unique key that is part of the definition of a table. A primary key is the default parent key of a referential constraint definition.

## R

**RDBMS.** Relational database management system.

**referential constraint.** The referential integrity rule that the nonnull values of the foreign key are valid only if they also appear as values of a parent key.

**referential integrity.** The state of a database in which all values of all foreign keys are valid.

**refresh.** A process in which all of the data of interest in a user table is copied to the target table, replacing existing data. See also *full refresh* and *differential refresh*.

**registration.** See *replication source*.

**registration process.** The process of defining a replication source. Contrast with *subscription process*.

**rejected transaction.** A transaction containing one or more updates from replica tables that are out of date in comparison to the source table.

**replica target table.** A replication table at the target server that is a type of update-anywhere target table.

**replication.** The process of maintaining a defined set of data in more than one location. It involves copying designated changes for one location (a source) to another (a target), and synchronizing the data in both locations.

**replication source.** A database table or view that is defined as a source for replication. This

type of table can accept copy requests and is the source table in a subscription set. See also *subscription set*.

**remote database.** A database that is physically located on a workstation other than the one in use. Contrast with *local database*.

**row-replica.** A type of update-anywhere replica maintained by DataPropagator for Microsoft Jet without transaction semantics.

**row-replica conflict detection.** Conflict detection done row by row, not transaction by transaction, as is done for DB2 replicas.

## S

**satellite.** An occasionally connected client machine that has a DB2 server that synchronizes with its group at the satellite control database.

**Satellite Administration Center.** A user interface that provides centralized administrative support for satellites.

**satellite control server.** A DB2 Universal Database system that contains the satellite control database, SATCTLDB.

**serialization.** (1) The consecutive ordering of items. (2) In DB2 Universal Database for AS/400, the process of controlling access to a resource to protect the integrity of the resource.

**source server.** The database location of the replication source and the Capture program.

**source table.** A table that contains the data that is to be copied to a target table. The source table can be a replication source table, a change data table, or a consistent-change-data table. Contrast with *target table*.

**spill file.** A temporary file created by the Apply program that is used as the source for updating data to multiple target tables.

**staging table.** A CCD table that can be used as the source for updating data to multiple target tables.

**standard conflict detection.** Conflict detection in which the Apply program searches for conflicts in rows that are already captured in the change data tables of the replica or user table. See also *conflict detection*, *enhanced conflict detection*, and *row-replica conflict detection*.

**subscription.** See *subscription set*.

**subscription cycle.** A process in which the Apply program retrieves changed data for a given subscription set, replicates the changes to the target table, and updates the appropriate replication control tables to reflect the progress it made.

**subscription process.** A process in which you define subscription sets and subscription-set members. Contrast with *registration process*.

**subscription set.** The specification of a group of source tables, target tables, and the control information that governs the replication of changed data. See also *subscription-set member*.

**subscription-set member.** A member of a subscription set. There is one member for each source-target pair. Each member defines the structure of the target table and which rows and columns will be replicated from the source table.

## T

**target server.** The database location of the target table. Normally this is also the location of the Apply program.

**target table.** The table on the target server to which data is copied. It can be a user copy table, a point-in-time table, a base aggregate table, a change aggregate table, a consistent-change-data table, or a replica table.

**temporary table.** A table created during the processing of an SQL statement to hold intermediate results.

**transaction.** An exchange between a workstation and a program, two workstations, or two programs that accomplishes a particular

action or result. Examples are the entry of a customer's deposit and the updating of the customer's balance.

**trigger.** In DB2, an object in a database that is invoked indirectly by the database manager when a particular SQL statement is run.

**two-phase commit.** A two-step process by which recoverable resources and an external subsystem are committed. During the first step, the database manager subsystems are polled to ensure that they are ready to commit. If all subsystems respond positively, the database manager instructs them to commit.

## U

**UDT.** User-defined type.

**uncommitted read (UR).** An isolation level that allows an application to access uncommitted changes of other transactions. The application does not lock other applications out of the row that it is reading unless the other application attempts to drop or alter the table.

**Unicode.** An international character encoding scheme that is a subset of the ISO 10646 standard. Each character supported is defined using a unique 2-byte code.

**unit-of-work (UOW) table.** A replication control table at the source server that contains commit records read from the database log or journal. The records include a unit-of-recovery ID that can be used to join the unit-of-work table and the change data table to produce transaction-consistent change data. For DB2, the unit-of-work table optionally includes the correlation ID, which can be useful for auditing purposes.

**UR.** Uncommitted read.

**user copy table.** A target table whose content matches all or part of a source table and contains only user data columns.

**user-defined type (UDT).** A data type that is not native to the database manager and was created by a user. See also *distinct type*.

**user table.** A table created for and used by an application before it is defined as a replication source. It is used as the source for updates to read-only target tables, consistent-change-data tables, replicas, and row-replica tables.

## V

**view.** A logical table that consists of data that is generated by a query.

## W

**warm start.** A start of the Capture program that allows reuse of previously initialized input and output work queues. Contrast with *cold start*.

**work file.** A temporary file used by the Apply program when processing a subscription set.



---

# Index

## Special Characters

-1032 170  
-206 170  
-330 168  
-741 82  
-805 169  
\$TA JES2 command 234

## Numerics

0509 168  
1067 168  
1108 170  
22517 168  
51002 169  
57019 170

## A

activating subscription sets 148  
active log size 63  
ADDEXITPGM command 195  
ADDJOBSCDE command 217  
administration  
    authorization requirements 104  
    timing recommendation 61  
administration interfaces  
    Control Center 5  
    DJRA (DataJoiner Replication Administration) tool 5  
    overview 5  
after-image columns 10, 72  
aggregate tables 15  
    *See also* base aggregate tables,  
    change aggregate tables 15  
analyzing  
    Apply program performance 56, 163  
    Capture program performance 56, 163  
ANZDPRJRN command 194  
APF authorization 143, 166  
application data prerequisites 51  
Applications  
    starting Capture program from 397  
Apply job tables 340  
apply\_names.ini file 144  
Apply program  
    Apply qualifier 13  
    authorization requirements 105  
    capacity planning 61

Apply program (*continued*)  
    configuring 44, 142  
    connectivity 65  
    data blocking 68  
    for AS/400  
        installing 176  
        invocation parameters 210  
        operating 207  
        scheduling 217  
        setting up 175, 176  
        starting 210  
        stopping 217  
        using remotely 207  
    for OS/390  
        installing 225  
        invocation parameters 232  
        operating 225, 231  
        scheduling 234  
        setting up 225  
        starting 232  
        stopping 234  
    for UNIX platforms  
        binding 240  
        configuring 240  
        invocation parameters 252  
        operating 239, 250  
        scheduling 254  
        setting up 239  
        starting 251  
        stopping 254  
    for Windows and OS/2  
        binding 44, 264  
        configuring 264  
        invocation parameters 276  
        operating 263, 275  
        scheduling 278  
        Service Control Manager for Windows 266  
        setting up 263  
        starting 275  
        stopping 278  
    full versus differential refresh 10  
    gap detection 147  
    introduction 7  
    log file 156  
    messages 152, 368  
    mini-cycles 68  
    operating 142  
    performance 144

Apply program (*continued*)  
    post-installation tasks 142  
    problem determination 153  
    processing cycle 124  
    processor requirements 61  
    push and pull configurations 66  
    run-time processing  
        statements 74  
    setting up 131  
    spill files, storage requirements 62, 65  
    starting  
        after Capture program cold start 142  
        example for Windows 45  
        instructions 142  
        overview 54  
        starting with event 114  
        stopping example for Windows 49  
    synchronization with Capture triggers 88  
    trace files 155  
    user ID 105  
Apply qualifier 13, 40  
Apply-qualifier-cross-reference tables 317  
Apply trail tables  
    description 336  
    problem determination 153  
archived log restrictions 77  
archiving information, example 24  
AS/400 server  
    connecting to 176  
ASCII tables 79  
ASN0000E message 167  
ASNAPPLY command  
    for UNIX platforms 251  
    for Windows and OS/2 276  
ASNARUN command 232  
ASNCCP command  
    for UNIX platforms 245  
    for VM and VSE 256  
    for Windows and OS/2 269  
ASNCMD command  
    for UNIX platforms 247  
    for Windows and OS/2 271  
ASNDLCOPY exit routine  
    configuration files 136

- ASNDLCOPY exit routine
  - (continued)
  - input 134
  - parameters 134
  - using 133
- ASNDLCOPYD file-copy daemon
  - using 136
- ASNDONE exit routine
  - for AS/400 220
  - rejected transactions 108
  - using 132
- ASNJDONE exit routine 287
- ASNJET command 285
- ASNJSTOP command 286
- ASNL2RNx command 227
- ASNLOAD exit routine
  - error handling 132
  - files generated 131, 132
  - for AS/400
    - parameters 222
    - samples 221
  - refreshing point-in-time tables 131
  - restrictions 132
- ASNSAT command 279
- ASNSTOP command
  - for UNIX platforms 254
  - for Windows and OS/2 278
- asynchronous replication
  - scheduling 17
  - suitable configurations 19
  - unsuitable configurations 19
- AT command
  - Apply program
    - for UNIX platforms 254
    - for Windows 278
  - Capture program
    - for UNIX platforms 244
    - for Windows 271
- AT NetView command
  - Apply for OS/390 234
  - Capture for OS/390 229
- auditing
  - archive information 24
  - cold start 88
  - data usage 88
  - gap in data 88
  - using CCD tables 83, 86
- authentication, end-user
  - for DataPropagator for Microsoft Jet 284
  - for UNIX platforms 241
  - for Windows and OS/2 265
- authorization requirements
  - Capture and Apply programs 104
  - for AS/400 181
- B**
  - base aggregate tables
    - defining 116
    - description 345
    - introduction 15
  - before-image columns
    - auditing 88
    - change-aggregate tables 118
    - introduction 10
    - replicating 72
    - restrictions 73
  - binary data types 78
  - binary large object (BLOB) 74, 79
  - BIND PACKAGE utility 56
  - binding
    - Apply program
      - for UNIX platforms 240
      - for Windows and OS/2 264
    - Capture program
      - for UNIX platforms 240
      - for Windows 44
      - for Windows and OS/2 264
    - host RDBMSs 94
  - BLOB (binary large object) 74, 79
  - blocking factor 68, 122
- C**
  - CALL procedures
    - before and after run-time processing 74
    - defining for subscription set 121
  - capacity planning 61
  - Capture enqueue tables 313
  - Capture program
    - authorization requirements 104
    - capacity planning 61
    - cold start
      - automatic 141
      - first 142
      - preventing 142
    - configuring 43, 139
    - connectivity 65
    - error recovery 158
      - for AS/400 159
    - errors 156
    - for AS/400
      - attributes, changing 179
      - authorization requirements 181
      - cold start, automatic 205
      - cold start parameter 205
  - Capture program (continued)
    - for AS/400 (continued)
      - current receiver size 63
      - error recovery 159
      - initializing 203
      - installing 176
      - journal entry types 205
      - journals and journal receivers, managing 193
      - operating 197
      - performance options 179
      - problem determination 159
      - progress, determining 201
      - pruning 205
      - restrictions 190
      - scheduling 202
      - setting up 175, 176
      - starting 197
      - starting automatically 201
      - stopping 202
      - tuning parameters 178, 179
      - warm start parameter 205
    - for OS/390
      - alert generation 159
      - captured log progress 231
      - cold start parameter 228
      - installing 225
      - operating 225, 227
      - pruning 231
      - reinitializing 230
      - restrictions 227
      - resuming 230
      - scheduling 229
      - setting up 225
      - starting 227
      - stopping 230
      - suspending 230
      - warm start parameter 228
    - for UNIX platforms
      - binding 240
      - cold start parameter 245
      - configuring 239
      - log progress, displaying 249
      - log sequence number 249
      - operating 239, 243
      - pruning 249
      - reinitializing 248
      - restrictions 243
      - resuming 248
      - scheduling 244
      - setting environment variables 244
      - setting up 239
      - starting 244, 397
      - stopping 247

- Capture program (*continued*)
    - suspending 247
    - warm start parameter 245
  - for VM and VSE
    - active log size 63
    - cold start parameter 257
    - log progress, displaying 261
    - log sequence number 261
    - operating 255
    - pruning 260
    - reinitializing 260
    - restrictions 255
    - resuming 259
    - setting up 255
    - starting 256
    - stopping 258
    - suspending 259
    - warm start parameter 257
  - for Windows and OS/2
    - binding 43, 264
    - cold start parameter 270
    - configuring 263
    - log progress, displaying 274
    - log sequence number 274
    - operating 263, 268
    - pruning 274
    - reinitializing 273
    - restrictions 268
    - resuming 273
    - scheduling 271
    - Service Control Manager for Windows 266
    - setting environment variables 268
    - setting up 263
    - starting 269
    - stopping 271
    - suspending 272
    - warm start parameter 270
  - gap detection 147
  - introduction 6
  - log file 158
  - messages 152, 353
  - nonrelational data sources, identifying 87
  - operating 139
  - post-installation tasks 139
  - problem determination 156
  - processor requirements 61
  - pruning
    - CD tables 88
      - example 48
  - reinit command 106
  - replication sources, recognizing new 106
- Capture program (*continued*)
    - restrictions 130
    - setting up 128
    - staging data 82
    - starting
      - example for Windows 45
      - instructions 139
      - overview 54
    - stopping
      - example for Windows 49
    - storage dump 159
    - trace buffer 158
    - trace file 157
    - trace output 159
    - trace table problem determination 157
    - user ID 104
    - warm start 141, 142
  - Capture triggers
    - capturing changes 80
    - introduction 6, 80
    - maintaining CCD tables 16
    - pre-existing triggers 81
    - relationships to other tables 81
    - synchronization with Apply program 88
  - captured log progress
    - for OS/390 231
    - for UNIX platforms 249
    - for VM and VSE 261
    - for Windows and OS/2 274
  - cascade full refresh 85
  - CCD (consistent-change-data) tables
    - as replication sources 84, 111
    - attributes of 82
    - Capture triggers 80
    - change-capture mechanisms 16
    - complete 83
    - condensed 83, 343
    - defining 111, 116
    - description 82, 343
    - external 85, 126
    - internal 85
    - internal CCD for multiple targets 87
    - local 83
    - maintaining external 126
    - non-IBM data sources 87
    - noncomplete 83
    - noncondensed 83
    - nonrelational data sources 87
    - pruning 88, 145
    - remote 83
    - restriction 20
    - staging changed data 82
  - CCD (consistent-change-data) tables (*continued*)
    - types of 15, 84
    - unique indexes 83
    - update-anywhere replication 82
    - with DB2 Enterprise - Extended Edition 77
  - CCSID translation 168
  - CD (change data) tables
    - description 82, 321
    - maximum size 64
    - pruning 88
    - storage requirements 64
  - change aggregate tables
    - defining 116
    - description 346
    - introduction 15
  - change-capture
    - components 6
    - for CCD tables 16
    - process
      - restarting 55
      - starting 54
  - change data (CD) tables
    - description 82, 321
    - maximum size 64
    - pruning 88
    - storage requirements 64
  - changing
    - replication sources 147
    - subscription sets 149
  - character large object (CLOB) 74, 79
  - CHGDPRCAPA command 179
  - CHGJRN command 194
  - classes, education 401
  - clients, satellite 22
  - CLOB (character large object) 74, 79
  - cloning subscription sets 148
  - CNTRLSVR.REX file 100
  - cold start
    - automatic 141
    - Capture program
      - for AS/400 205
      - for OS/390 228, 257
      - for UNIX platforms 245
      - for Windows and OS/2 270
      - general 141, 353
    - first 142
    - gaps 147
    - preventing 142
  - columns
    - after-image 10, 72
    - available for replication 70
    - before-image 10, 72
    - changing definition 117

- columns (*continued*)
  - computed 74, 118
  - creating new in target table 118
  - defining in target table 116
  - names, restrictions 73
  - primary key, specifying 117
  - relative record numbers on
    - AS/400 196
  - removing from target table 117
  - renaming 73, 117
  - subsetting
    - DB2 Control Center 116
    - DJRA 118
    - introduction 13
    - planning 70
- commands
  - \$TA JES2
    - Apply for OS/390 234
    - Capture for OS/390 229
  - ADDEXITPGM 195
  - ADDJOBSCDE 217
  - ANZDPRJRN 194
  - ASNAPPLY
    - for UNIX platforms 251
    - for Windows and OS/2 276
  - ASNARUN 232
  - ASNCCP
    - for UNIX platforms 245
    - for VM and VSE 256
    - for Windows and OS/2 269
  - ASNCMD
    - for UNIX platforms 247
    - for Windows and OS/2 271
  - ASNJET 285
  - ASNJSTOP 286
  - ASNL2RNx 227
  - ASNSAT 279
  - ASNSTOP
    - for UNIX platforms 254
    - for Windows and OS/2 278
  - AT
    - Apply for UNIX platforms 254
    - Apply for Windows 278
    - Capture for UNIX platforms 244
    - Capture for Windows 271
  - AT NetView
    - Apply for OS/390 234
    - Capture for OS/390 229
  - BIND PACKAGE 56
  - CHGDPRCAPA 179
  - CHGJRN 194
  - CRTDPRPKG 207
  - CRTDPRTBL 178, 210

- commands (*continued*)
  - CRTJRN 193
  - CRTJRNRCV 192
  - CRTSQLPKG 207
  - DB2FLSN
    - for UNIX platforms 249
  - DBFLFSN
    - for Windows and OS/2 274
  - DSPJRN 202
  - ENDDPRAPY 217
  - ENDDPRCAP 202
  - ENDJOB 203
  - GETLSEQ
    - for OS/390 231
    - for UNIX platforms 249
    - for VM and VSE 261
    - for Windows and OS/2 274
  - GRTPRAUT 181
  - INZDPRCAP 203
  - LOADX 45
  - PRUNE
    - for OS/390 231
    - for UNIX platforms 249
    - for VM and VSE 260
    - for Windows and OS/2 274
  - RCVJRNE 193
  - REINIT
    - for OS/390 230
    - for UNIX platforms 248
    - for VM and VSE 260
    - for Windows and OS/2 273
    - replication sources, recognizing new 106
  - REORG 56
  - RESUME
    - for OS/390 230
    - for UNIX platforms 248
    - for VM and VSE 259
    - for Windows and OS/2 272
  - REVOKE 56
  - RGZPFM 56
  - RMVEXITPGM 195
  - RUNSTATS 56
  - RVKDPRAUT 189
  - SBMJOB 202
  - STOP
    - for OS/390 230
    - for UNIX platforms 247
    - for VM and VSE 258
    - for Windows and OS/2 271
  - STRDPRAPY 210
  - STRDPRCAP 197
  - STRJRNPf 193
  - STRSBS 201

- commands (*continued*)
  - SUSPEND
    - for OS/390 230
    - for UNIX platforms 247
    - for VM and VSE 259
    - for Windows and OS/2 272
  - WRKRDBDIRE 209, 219
  - WRKREGINF 195
  - WRKSBJOB 159
  - WRKSBSJOB 159
  - commit interval 129
  - communication
    - log-based 8
    - trigger-based 9
  - complete CCD tables 15, 83
  - components
    - See also* Apply program, Capture program, Capture triggers, Control Center, DJRA (DB2 DataJoiner Replication Administration) tool 3
    - administration interfaces 5
    - communication between 7
    - introduction 3
  - computed columns 74, 118
  - concepts
    - after-image columns 10
    - Apply qualifier 13
    - before-image columns 10
    - change capture 6
    - column subsetting 13
    - conflict detection 11
    - control tables 4
    - differential-refresh copying 10
    - full-refresh copying 10
    - joins 14
    - logical servers 4
    - replication 10
    - replication sources 10
    - row subsetting 13
    - subscription-set members 11
    - subscription sets 11
    - subsetting source tables 13
    - table partitioning 13
    - target tables 14
    - unions 14
    - user tables 10
    - views as sources 13
  - condensed CCD tables
    - introduction 15
    - overview 83
    - updating 343
  - configuration, replication
    - changing 55
    - copying 55



- configuration, replication *(continued)*
  - modifying 147
  - operating 55
  - planning, overview 51
  - setting up, overview 53
- configuring
  - Apply program
    - for UNIX platforms 240
    - for Windows and OS/2 264
  - Capture program
    - for UNIX platforms 239
    - for Windows and OS/2 263
  - connectivity 65, 94
  - Control Center for host RDBMSs 94
- conflict detection
  - levels of 11, 106
  - mobile environment 107
  - overview 107
- conflict tables 289, 348
- connecting
  - to AS/400 server 176
- connectivity 65, 94
- consistent-change-data (CCD) tables
  - as replication sources 84, 111
  - attributes of 82
  - Capture triggers 80
  - change-capture mechanisms 16
  - complete 83
  - condensed 83, 343
  - defining 111, 116
  - description 82, 343
  - external 85, 126
  - internal 85
  - internal CCD for multiple targets 87
  - local 83
  - maintaining external 126
  - non-IBM data sources 87
  - noncomplete 83
  - noncondensed 83
  - nonrelational data sources 87
  - pruning 88, 145
  - remote 83
  - staging changed data 82
  - types of 15, 84
  - unique indexes 83
  - update-anywhere replication 82
- consolidating data 24
- constraints, referential 53
- consulting and services 401
- Control Center
  - authorization requirements 104
  - capacity planning 61
  - columns, defining 116
- Control Center *(continued)*
  - configuring for host RDBMSs 94
  - connectivity 65
  - introduction 5
  - processor requirements 61
  - replication sources
    - changing 147
    - defining 105
    - removing 148
  - rows, defining 118
  - setting preferences 95
  - setting up replication 93
  - SQL statements and stored procedures 121
  - subscription sets
    - activating 148
    - changing 149
    - cloning 148
    - deactivating 148
    - defining 112
    - removing 149
    - timing 123
  - target-table type, choosing 115
  - tutorial 35
  - user-defined tables 120
- control servers
  - for DB2 replication 4
  - location of 52
- control tables
  - Apply job 340
  - Apply-qualifier-cross-reference 317
  - Apply trail 336
  - at the control server 298, 323
  - at the source server 296, 300
  - at the target server 299, 341
  - authorization requirements for AS/400 196
  - base aggregate 345
  - Capture enqueue 313
  - CCD target 343
  - CD 321
  - change aggregate 346
  - conflict 289, 348
  - creating
    - DJRA 102
    - DPCNTL files 100
    - for AS/400 178
  - critical section 315
  - CRTDPRTBL command 177
  - customizing, example 38
  - DataPropagator for Microsoft Jet 289
  - error information 289, 348
  - error messages 289, 349
- control tables *(continued)*
  - error-side-information 289, 349
  - granting authority for AS/400 181
  - introduction 4
  - key string 289, 349
  - location of 52
  - point-in-time 342
  - prune lock 316
  - pruning control 309
  - pruning of, overview 55
  - quick reference
    - at a glance 293
    - control server 298
    - source server 296
    - target server 299
  - register 301
  - register extension 308
  - register synchronization 318
  - replica 345
  - revoking authority for AS/400 189
  - row-replica 347
  - row-replica-target-list 289, 333
  - storage requirements 63
  - subscription columns 329
  - subscription events 335
  - subscription-schema-changes 289, 334
  - subscription set 323
  - subscription statements 331
  - subscription-targets-member 326
  - synchronization
    - generations 289, 350
  - trace 316
  - tuning parameters 312
  - UOW 319
  - user copy 341
  - warm start 313
  - warm start for VSE and VM 313
- copies, types of refresh 10
- copying replication
  - configuration 127
- creating control tables
  - CRTDPRTBL command 177
  - DJRA 102
  - DPCNTL files 100
- critical section tables 315
- CRTDPRPKG command 207
- CRTDPRTBL command 178, 210
- CRTJRN command 193
- CRTJRNRCV command 192
- CRTSQLPKG command 207
- current receiver size 63, 193

- customizing
  - DJRA 99
  - SQL files 103
  - SQL for control tables 101
  - table names 95
- D**
- data
  - accessing continuously 28
  - consolidation configuration 20
  - distributing to remote sites 25
  - distribution configuration 19
  - IMS, distributing 27
  - manipulating source 13
  - manipulating target 69
  - prerequisites 51
- data blocking 68
- data compression restrictions 77
- data consistency 125
- data currency 123
- data encryption restrictions 78
- data integrity
  - DataPropagator for Microsoft Jet 282
  - resolving gaps 147
- data manipulations 13, 69
- data restrictions 77
- data sharing 122
- data types, restrictions 78
- databases
  - maintenance tasks 56, 145
  - non-IBM target tables 52
- DATALINK values
  - ASNDLCOPY exit routine 133
  - ASNDLCOPYD file-copy daemon 136
  - link control level 112
  - planning 75
- DataPropagator for Microsoft Jet
  - ASNJDONE parameters 288
  - ASNJET parameters 285
  - control tables 289
  - data integrity 282
  - error recovery 288
  - operating 285
  - setting up 283
  - starting 285
  - stopping 286
  - terminology 282
  - troubleshooting 287
- DataPropagator NonRelational
  - maintaining CCD tables 16
- DB2 Control Center
  - See* Control Center 5
- DB2 DataJoiner
  - restrictions 79
  - setup 137
- DB2 DataJoiner Replication
  - Administration (DJRA) tool
    - See* DJRA (DB2 DataJoiner Replication Administration) tool 5
- DB2 Extenders
  - restrictions 75
- DB2 File Manager 75
- DB2 for OS/390
  - Apply program
    - operating 225
  - Capture program
    - operating 225
  - CCSID translation 168
  - data sharing 122
  - DB2 ODBC Catalog 235
  - index types 234
  - password verification 66
- DB2 ODBC Catalog
  - function calls 237
  - setting up server 236
  - setting up workstation
    - client 235
  - tables 237
  - Version 6 enhancements 235
- DB2 Tools Settings notebook 95
- DB2FLSN command
  - for UNIX platforms 249
  - for Windows and OS/2 274
- DB2INSTANCE
  - starting Capture for UNIX 244
  - starting Capture for Windows and OS/2 269
- DBCLOB (double-byte character large object) 74, 79
- DBLIB connections
  - improving performance 144
  - Microsoft SQL Server 96
- deactivating subscription sets 148
- decision support systems 29
- defining
  - replication source joins 108
  - replication sources 105
  - subscription sets 40
- delete journal receiver exit routine 194
- Design Master 283
- designing
  - overview 51
  - replication configurations 19
  - unsuitable configurations 19
- detecting a gap 147
- diagnosing errors 151
- differential-refresh copying 10
- distinct data type 79
- distributing
  - data to remote sites 25
  - IMS data 27
- DJRA (DB2 DataJoiner Replication Administration) tool
  - authorization requirements 104
  - capacity planning 61
  - columns, defining 118
  - connectivity 65
  - control tables, creating 102
  - customizing 99
  - editing
    - logic 99
    - SQL 103
  - installing 98
  - introduction 5
  - offline load 127
  - overview 96
  - preferences 99
  - processor requirements 61
  - promote functions 127
  - Replication Monitor 146
  - replication sources
    - changing 147
    - defining 105
    - removing 148
  - rows, defining 119
  - running SQL 104
  - setting up replication 96
  - SQL
    - editing 103
    - running 104
  - SQL statements and stored procedures 122
  - subscription sets
    - changing 149
    - defining 113
    - removing 149
    - timing 123
  - target-table type, choosing 116
  - targets supported 96
  - using for AS/400
    - defining replication sources and subscription sets 196
    - relative record numbers 175, 196
    - Replication Monitor 201
- DJX\_ASYNC\_APPLY variable 144
- double-byte character large object (DBCLOB) 74, 79
- DPCNTL files 101
- DPNCNTL files 101

DPREPL.DFT file 95  
DSPJRN command 202  
dummy WHERE clause 119  
dump, storage 159

## E

EDITPROC 77  
education  
    custom classes 401  
    IBM Global Campus URL 401  
ENDDPRAPY command 217  
ENDDPRCAP command 202  
ENDJOB command 203  
environment  
    copying, overview 55  
    planning, overview 51  
    setting up, overview 53  
environment Analyzer 163  
environment variables  
    Capture program  
        for UNIX platforms 244  
        for Windows and OS/2 268  
error information tables 289, 348  
error messages tables 289, 349  
error recovery  
    AS/400 159  
    Capture and Apply  
        programs 152  
    DataPropagator for Microsoft  
        Jet 288  
        for OS/390, VM, and VSE 158  
error-side-information tables 289,  
    349  
errors, diagnosing 151  
event-based timing 17, 124  
examples  
    *See also* replication  
    configurations 23  
    CD table, pruning 64  
    spill file size, setting 65  
    SQL for columns 117  
    WHERE clauses 25, 119  
exit routines  
    ASNDLCOPY  
        configuration files 136  
        input 134  
        parameters 134  
        using 133  
    ASNDONE  
        for AS/400 220  
        using 132  
    ASNJDONE 287  
    ASNLOAD  
        for AS/400 221  
        using 131

exit routines (*continued*)  
    delete journal receiver  
        (AS/400) 194  
external CCD tables 126  
    overview 85  
    planning multiple targets 87

## F

FIELDPROC  
    restrictions, general 77  
    restrictions for Capture for VM  
        and VSE 255  
files  
    apply\_names.ini 144  
    CNTRLSVR.REX 100  
    DPCNTL 101  
    DPNCNTL 101  
    spill 62, 65  
    SRCESVR.REX 100  
    TARGSVR.REX 100  
    TBLSPACE.REX 99  
fragmentation  
    horizontal 71  
    update-anywhere  
        replication 107  
    vertical 70  
full-refresh copying  
    Apply for AS/400 196, 214  
    external CCD table 85  
    forcing in Apply for OS/390 169  
    internal CCD table 85  
    introduction 10  
    suppressing in Apply for  
        OS/390 169

## G

gap detection 88, 147  
generated SQL  
    editing 103  
    running 104  
GETLSEQ command  
    for OS/390 231  
    for UNIX platforms 249  
    for VM and VSE 261  
    for Windows and OS/2 274  
global record 301  
GROUP BY clause 118  
GRTPRAUT command 181

## H

history data 88  
horizontal subsets 71  
host RDBMSs, configuring the  
    Control Center 94  
hot-site backup 19

## I

IBM Software Support 171  
IMS DataPropagator  
    data distribution example 27  
    using CCD tables 87  
index types, rules for OS/390 234  
Informix  
    restrictions 80  
initializing Capture program for  
    AS/400 203  
installation  
    Capture and Apply programs  
        for AS/400 176  
        for OS/390 225  
        for UNIX platforms 241  
        for VM and VSE 255  
    DJRA 98  
    restrictions 90  
    services and consulting 401  
internal CCD tables  
    overview 85  
    planning multiple targets 87  
interval-based timing 17  
invocation parameters  
    Apply program  
        for AS/400 210  
        for OS/390 232  
        for UNIX platforms 252  
        for Windows and OS/2 276  
    Capture program  
        for AS/400 197  
        for OS/390 228  
        for UNIX platforms 245  
        for VM and VSE 256  
        for Windows and OS/2 269  
INZDPRCAP command 203

## J

joins  
    defining as sources 108  
    for targets 14  
    planning to use 53  
    replicating 71  
journal receivers  
    creating for source tables 192  
    current, size 63  
    delete journal receiver exit  
        routine 194  
    managing 193  
    system management 193  
    threshold 193  
    user management 194  
journaling requirements 62  
journals  
    creating 193

- journals (*continued*)
  - default message queue 194
  - entry types 205
  - managing 193
  - problem determination 160
  - QSQRN journal 191
  - remote journal function 192
  - starting 193
  - use 191
- K**
- KEEPDICTIONARY keyword 145
- key string tables 289, 349
- key-update
  - restrictions 76
- L**
- lag limit 129
- large object (LOB) 74, 79
- large replication jobs 68
- LE for OS/390 environment 168
- legacy data sources 27
- LOADX command
  - ASNLOAD exit routine 131
  - example 45
- LOB (large object) 74, 79
- local cache for committed
  - changes 85
- local CCD tables 83
- log-based communication 8
- log file
  - Apply program 156
  - Capture program 158
- log records, archived before
  - captured 63
- log sequence number
  - for OS/390 231
  - for UNIX platforms 249
  - for VM and VSE 261
  - for Windows and OS/2 274
- logging requirements 62
- logic, editing DJRA 99
- logical partitioning keys
  - description 109
  - row subsets 71, 81
- logical servers 4
- LONG VARCHAR data type 79
- LONG VARGRAPHIC data type 78
- M**
- maintenance
  - database 145
  - overview of tasks 56
- MAX\_SYNCH\_MINUTES 68, 122
- members, subscription-set 11

- messages
  - Apply for AS/400 381
  - Apply program 353, 368, 381
  - Capture for AS/400 386
  - Capture program 353, 368
  - delete receiver exit program 394
  - for problem determination 152
  - Trigger Program for Critical
    - Section Table 394
  - Trigger Program for Prune
    - Control Table 393
  - Trigger Program for Register
    - Table 390
- Microsoft Jet 280
- Microsoft SQL Server
  - DBLIB connections 96
  - improving performance 144
  - restrictions 79
- migration
  - planning 89
  - services and consulting 401
- mini-cycles
  - Apply program 68
  - defining for subscription set 122
- mobile replication
  - see also* Microsoft Jet 280
- monitoring
  - Capture program progress for
    - AS/400 201
  - introduction 56
  - replication environment 146
- multi-tier staging 85
- multiple source tables 24
- multiple target tables 87
- N**
- network connectivity 65
- non-DB2 distributed data store 32
- non-DB2 reports
  - query database 33
- non-IBM data sources 87
- noncomplete CCD tables 15, 83
- noncondensed CCD tables 15, 83
- nonrelational data sources 87
- NT Service Control Manager
  - Apply for Windows 266
  - Capture for Windows 266
- NT Services
  - starting Apply program 275
  - starting Capture program 269
- O**
- Object Rexx 98
- occasionally connected environments
  - See also* satellite replication,
    - Microsoft Jet 22

- occasionally connected
  - environments (*continued*)
    - description 22
    - example configuration 31
    - introduction 22
- offline load 127
- on-demand timing 18
- operating
  - Apply program
    - example 54
    - for AS/400 207
    - for OS/390 231
    - for UNIX platforms 250
    - for Windows and OS/2 275
    - overview 142
  - Capture program
    - example 54
    - for AS/400 197
    - for OS/390 227
    - for UNIX platforms 243
    - for VM and VSE 255
    - for Windows and OS/2 268
    - overview 139
  - DataPropagator for Microsoft
    - Jet 285
    - overview 55
  - options, performance 128
  - ORA-04081 message 81
- Oracle
  - restrictions 79
- overview 22
- P**
- parameter definitions
  - DataPropagator for Microsoft
    - Jet 285, 288
- partitioning key 78
- password files
  - creating, example 44
  - for Apply program
    - for UNIX platforms 242
    - for Windows and OS/2 265
- password verification, DB2 for
  - OS/390 66
- performance
  - improving 144
  - options 128
  - troubleshooting, introduction 56
- planning
  - active log size 63
  - capacity 61
  - conflict detection 107
  - migration 89
  - multiple target tables 87
  - network 65
  - overview 51

- planning (*continued*)
    - security 104
    - services and consulting 401
    - staging data 82, 85, 87
    - storage requirements 61
  - point-in-time tables
    - defining 115
    - description 342
    - introduction 15
  - predicates, defining for target tables 118
  - PREDICATES column capacity 71
  - preferences, setting
    - DB2 Control Center 95
    - DJRA 99
  - PREFORMAT keyword 145
  - primary keys
    - logical partitioning 109
    - relative record numbers for AS/400 196
  - problem determination
    - administration 152
    - alert generation for OS/390 159
    - Apply program 153
    - Apply trail table 153
    - Capture program
      - for AS/400 159
      - for OS/390, VM, and VSE 158
    - Capture program trace table 157
      - collecting data (AS/400) 160
      - errors
        - Capture program 156
        - IBM Software Support 171
        - journal 160
        - log file
          - Apply program 156
          - Capture program 158
        - scenario 152
        - storage dump 159
        - trace buffer 158
        - trace file
          - Apply program 155
          - Capture program 157
        - trace output 159
        - WRKSBMJOB command 159
        - WRKSBSJOB command 159
  - programming interface
    - information 404
  - promote functions 127
  - PRUNE command
    - for OS/390 231
    - for UNIX platforms 249
    - for VM and VSE 260
    - for Windows and OS/2 274
  - prune interval 129
  - prune lock tables 316
  - pruning
    - Capture program
      - for AS/400 205
      - for OS/390 231
      - for UNIX platforms 249
      - for VM and VSE 260
      - for Windows and OS/2 274
    - CCD tables 145
    - CCD tables, with Capture triggers 88
    - CD tables 88
    - control tables 55, 309
    - example 48
    - UOW tables 88, 319
  - push and pull Apply program configurations
    - choosing a configuration 68
    - description 66
- ## Q
- questions, problem determination 171
- ## R
- RCVJRNE command 193
  - read dependencies 108
  - real-time replication 19
  - receiver size, current 63
  - referential constraints 53, 78
  - referential integrity 125
  - refresh
    - differential 10
    - full 10
    - suppressing for Apply for OS/390 169
  - register extension tables 308
  - register synchronization tables 318
  - register tables 126, 301
  - REINIT command
    - for OS/390 230
    - for UNIX platforms 248
    - for VM and VSE 260
    - for Windows and OS/2 273
  - reinitializing Capture program
    - for OS/390 230
    - for UNIX platforms 248
    - for VM and VSE 260
    - for Windows and OS/2 273
  - relative record numbers
    - as primary key for AS/400 196
    - push configuration 68
    - support for AS/400 175
  - relative timing 123
  - remote
    - Apply program
      - for AS/400 207
    - remote CCD tables 83
    - remote journal
      - restrictions 78
    - remote journal function 192
    - remote journaling 68
    - removing
      - replication sources 148
      - subscription sets 149
    - renaming columns 73, 117
    - REORG utility 56, 145
    - replica tables
      - See also* row-replica tables 16
      - defining 116
      - description 345
      - introduction 16
    - Replication Analyzer 56, 163
    - replication configurations
      - accessing data continuously 28
      - auditing archive information 24
      - data consolidation 20, 24
      - data distribution 19, 25
      - decision support systems 29
      - examples of 23
      - IMS data, distributing 27
      - occasionally connected systems 22, 31
      - replicating operational data 33
      - retrieving data 32
      - typical 19
      - update-anywhere 21
    - replication environment
      - copying 127
      - operating 55
      - setting up 53
      - starting to replicate 54
      - updating 55
    - replication messages 353, 381
    - Replication Monitor
      - introduction 56
      - overview 146
      - using for AS/400 201
    - replication sources
      - CCD (consistent-change-data) tables as 84
      - changing 147
      - DATALINK values 75
      - defining
        - example 36, 39
        - for AS/400 196
        - joins 108
        - overview 105
      - introduction 10

- replication sources (*continued*)
    - large objects 74
    - removing 148
    - setting up, overview 53
    - subsetting 13
    - viewing 147
  - restrictions
    - archived log 77
    - AS/400 78
    - ASCII tables 79
    - Capture program
      - for AS/400 190
      - for OS/390 227
      - for UNIX platforms 243
      - for VM and VSE 255
      - for Windows and OS/2 268
      - general 130
    - CCD tables as sources 20
    - column names, limits 73
    - data compression 77
    - data encryption 78
    - data types 78
    - DB2 DataJoiner 79
    - DB2 Enterprise - Extended Edition 77
    - EDITPROC 77
    - FIELDPROC 77, 255
    - for DB2 Extenders large objects 75
    - general 77
    - Informix 80
    - key-update 76
    - Microsoft SQL Server 79
    - MVS 77
    - Oracle 79
    - partitioning key 78
    - referential constraints 78
    - remote journal 78
    - stored procedures 78
    - Sybase 79
    - table-name length 77
    - Unicode tables 79
    - utility program 78
    - VALIDPROC 78
    - views 72
    - VM & VSE 77
    - WHERE clause 118
  - RESUME command
    - for OS/390 230
    - for UNIX platforms 248
    - for VM and VSE 259
    - for Windows and OS/2 272
  - resuming Capture program
    - for OS/390 230
    - for UNIX platforms 248
  - resuming Capture program (*continued*)
    - for VM and VSE 259
    - for Windows and OS/2 273
  - retention limit 128
  - REVOKE utility 56
  - Rexx 98
  - RGZPFM command 56
  - RMVEXITPGM command 195
  - row-replica tables
    - See also* replica tables 16
    - description 283, 347
    - introduction 16
  - row-replica-target-list tables 289, 333
  - rows
    - defining in target table 118
    - subsetting
      - DB2 Control Center 118
      - DJRA 119
      - introduction 13, 71
  - run-time processing 74, 121
  - RUNSTATS utility 56
  - RVKDPRAUT command 189
- ## S
- satellite clients 22
  - satellite replication 22
  - satellites 22
  - SBMJOB command 202
  - scenarios
    - problem determination 152
    - typical 19
    - using Control Center 35
  - scheduling
    - Apply program
      - for AS/400 217
      - for OS/390 234
      - for UNIX platforms 254
      - for Windows and OS/2 278
    - Capture program
      - for AS/400 202
      - for OS/390 229
      - for UNIX platforms 244
      - for Windows and OS/2 271
    - subscription sets 123
    - timing
      - event 124
      - relative 123
  - security 104
  - servers
    - control 4
    - logical 4
    - source 4
    - target 4
  - Service Control Manager
    - Apply for Windows 266
    - Capture for Windows 266
  - services and consulting 401
  - setting environment variables
    - Capture program
      - for UNIX platforms 244
      - for Windows and OS/2 268
  - setting up
    - Apply program
      - for AS/400 175
      - for OS/390 225
      - for UNIX platforms 239
      - for Windows and OS/2 263
    - Capture program
      - for AS/400 175
      - for OS/390 225
      - for UNIX platforms 239
      - for VM and VSE 255
      - for Windows and OS/2 263
    - replication
      - DB2 Control Center 93
      - DJRA 96
      - replication criteria 53
  - source servers
    - introduction 4
    - password file for 44
  - source tables
    - See* replication sources 10
  - spill files 62, 65
  - SQL
    - editing 103
    - errors 353
    - files, customizing 39, 103
    - running DJRA 104
    - statements
      - defining for subscription set 121
      - run-time processing 74
  - SQLCODEs
    - 1032 170
    - 206 170
    - 330 168
    - 741 82
    - 805 169
    - 1108 170
  - SQLSTATES
    - 22517 168
    - 51002 169
    - 57019 170
  - SRCESVR.REX file 100
  - staged replication 111
  - staging data 82

- staging table
    - See also* CCD (consistent-change data) tables 116
    - defining 116
  - starting
    - Apply program
      - for AS/400 210
      - for OS/390 232
      - for UNIX platforms 251
      - for Windows and OS/2 275
      - using NT Services 275
      - with event 114
    - Capture program
      - for AS/400 197
      - for OS/390 227
      - for UNIX platforms 244, 397
      - for VM and VSE 256
      - for Windows and OS/2 269
      - general 140
      - using NT Services 269
    - change capture 54
    - DataPropagator for Microsoft Jet 285
  - STOP command
    - for OS/390 230
    - for UNIX platforms 247
    - for VM and VSE 258
    - for Windows and OS/2 271
  - stopping
    - Apply program
      - for AS/400 217
      - for OS/390 234
      - for UNIX platforms 254
      - for Windows and OS/2 278
    - Capture program
      - for AS/400 202
      - for OS/390 230
      - for UNIX platforms 247
      - for VM and VSE 258
      - for Windows and OS/2 271
    - DataPropagator for Microsoft Jet 286
  - storage
    - active log size 63
    - Apply spill files 62, 65
    - CD table 64
    - control tables 63
    - database log and journal
      - data 62
    - dump 159
    - planning 61
    - target tables 63
    - UOW table 65
  - stored procedures 74, 78, 121
  - STRDPRAPY command 210
  - STRDPRCAP command 201
  - STRJRNPf command 193
  - STRSBS command 201
  - subscription columns tables 329
  - subscription cycle 68
  - subscription events tables
    - description 335
    - populating 124
  - subscription-schema-changes tables 289, 334
  - subscription-set members
    - introduction 11
    - setting up, overview 53
  - subscription set tables 323
  - subscription sets
    - activating 148
    - changing 149
    - cloning 148
    - continuous 123
    - data consistency 125
    - deactivating 148
    - defining
      - columns 116
      - Control Center or DJRA 112
      - example of 40
      - for AS/400 196
      - mini-cycles 122
      - rows 118
      - run-time processing 121
      - target-table structure 116
      - target-table type 115
      - update-anywhere replication 114
    - introduction 11
    - referential integrity 125
    - removing 149
    - run-time processing statements 74
    - setting up, overview 53
    - timing
      - changing 125
      - event-based 124
      - interval 123
      - relative 123
  - subscription statements tables 331
  - subscription-targets-member tables 326
  - subscriptions
    - See* subscription sets, subscription-set members 11
  - subsetting
    - columns 70, 116
    - horizontal 71
    - rows 71, 118
    - source tables 70
  - subsetting (*continued*)
    - target tables 116
  - subsystems
    - See* logical servers 4
  - suppressing full-refresh copying for OS/390 169
  - SUSPEND command
    - for OS/390 230
    - for UNIX platforms 247
    - for VM and VSE 259
    - for Windows and OS/2 272
  - suspending Capture program
    - for OS/390 230
    - for UNIX platforms 247
    - for VM and VSE 259
    - for Windows and OS/2 272
  - Sybase
    - restrictions 79
  - Sybase, improving performance 144
  - synchronization generations
    - tables 289, 350
  - synchronous replication 17, 19
  - SYS1.DUMP data set 159
  - system change journal
    - management 193
- ## T
- table partitioning
    - See* column subsetting, row subsetting 13
  - table space, specifying in logic 99
  - table structures 293
  - tables
    - See also* control tables, source tables, target tables 14
    - Apply job 340
    - Apply-qualifier-cross-reference 317
    - Apply trail 153, 336
    - base aggregate 345
    - Capture enqueue 313
    - change aggregate 346
    - change data (CD) 82, 321
    - complete, condensed CCD tables 85
    - complete, noncondensed CCD tables 86
    - conflict 348
    - consistent-change-data (CCD) 82, 343
    - critical section 315
    - customizing names 95
    - DB2 ODBC Catalog 237
    - error information 348
    - error messages 349
    - error-side-information 349

- tables (*continued*)
  - key string 349
  - Microsoft Jet target server 289
  - noncomplete, condensed CCD
    - tables 86
  - noncomplete, noncondensed CCD
    - tables 86
  - point-in-time 342
  - prune lock 316
  - pruning control 309
  - register 301
  - register extension 308
  - register synchronization 318
  - replica 345
  - row-replica 347
  - row-replica-target-list 333
  - staging 82
  - structures 293
  - subscription columns 329
  - subscription events 335
  - subscription-schema-changes 334
  - subscription set 323
  - subscription statements 331
  - subscription-targets-member 326
  - synchronization generations 350
  - target types 14
  - trace 157, 316
  - tuning parameters 128, 312
  - unit-of-work (UOW) 319
  - user 16
  - user copy 15, 341
  - warm start 313
- target servers, introduction 4
- target tables
  - aggregate 15
  - base aggregate 15, 345
  - CCD (consistent-change-data)
    - description 82, 343
    - introduction 15
  - change aggregate 15, 346
  - columns, defining 116
  - fragmenting 70
  - in non-IBM databases 52
  - offline load 127
  - point-in-time 15, 342
  - replica 16, 345
  - row-replica 16, 347
  - rows, defining 118
  - storage requirements 63
  - structure, specifying 116
  - table structures, quick
    - reference 299
  - type, specifying 115
  - types of 14
- target tables (*continued*)
  - update anywhere, defining 106
  - user 16
  - user copy 15, 341
  - user defined 119
  - TARGSVR.REX file 100
  - tasks, overview 49
  - TBLSPACE.REX file 99
  - terminology
    - DataPropagator for Microsoft Jet 282
    - DB2 DataPropagator 1
  - three-tier replication
    - configuration 111
  - timing
    - event-based 17, 124
    - interval-based 17
    - on-demand 18
    - subscription sets
      - changing 125
      - setting 123
  - Tools Settings notebook 95
  - trace files
    - Apply program 155
    - Capture program 157
    - problem determination 157
  - trace tables
    - description 316
    - problem determination 157
  - transaction identification 89
  - trigger-based communication 9
  - troubleshooting
    - Capture and Apply programs 166
    - DataPropagator for Microsoft Jet 287
    - introduction 56
    - services and consulting 401
  - tuning parameters
    - Capture for AS/400 178, 203
    - specifying 128
  - tuning parameters tables 312
  - tutorial for Windows NT 35
- U**
  - Unicode tables 79
  - unions for targets 14
  - unit-of-work (UOW) tables
    - Capture triggers 80
    - description 319
    - pruning 319
    - storage requirements 65
  - UOW (unit-of-work) tables
    - Capture triggers 80
    - description 319
    - storage requirements 65
- update-anywhere replication
  - CCD (consistent-change-data)
    - tables 82
  - conflict detection 107
  - defining sources 106
  - defining subscription sets 114
  - example configuration 30
  - fragmentation for 107
  - introduction 21
  - updated primary key columns 109
  - updates
    - as inserts and deletes 109
    - asynchronous 17
    - conflicts 107
    - event-based timing 17
    - interval-based timing 17
    - on-demand timing 18
    - scheduling 16
    - synchronous 17
  - user copy tables
    - defining 115
    - description 341
    - introduction 15
  - user-defined data types 79
  - user-defined tables 119
  - user ID
    - Apply program 105
    - Capture program 104
    - requirements
      - for UNIX 239
      - Windows and OS/2 263
  - user-oriented identification 89
  - user tables
    - as targets 16
    - introduction 10
  - utilities
    - BIND PACKAGE 56
    - REORG 56
    - REVOKE 56
    - RUNSTATS 56
  - utility program restrictions 78
- V**
  - VALIDPROC 78
  - vertical subsets 70
  - views
    - defining as sources 13, 108
    - description 71
    - double delete 72
    - restrictions 72
- W**
  - warm start, Capture program
    - for AS/400 198, 205
    - for OS/390 228
    - for UNIX platforms 245



- warm start, Capture program
  - (*continued*)
  - for VM and VSE 257
  - for Windows and OS/2 270
  - forcing 142
  - general 141
- warm start tables
  - description 313
  - for Capture for VSE and VM 313
- WARMNS keyword 142
- Web pages 89
- WHERE clause
  - dummy 119
  - examples 119
  - filtering rows 119
  - PREDICATES column
    - restriction 71
  - restrictions 118
  - row subsets 71
- WRKRDBDIRE command 209, 219
- WRKREGINF command 195
- WRKSBJOB command 159
- WRKSBSJOB command 159



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Printed in the United States of America  
on recycled paper containing 10%  
recovered post-consumer fiber.

SC26-9920-00



Spine information:



IBM® DB2® Universal  
Database

DB2 Replication Guide and Reference

Version 7