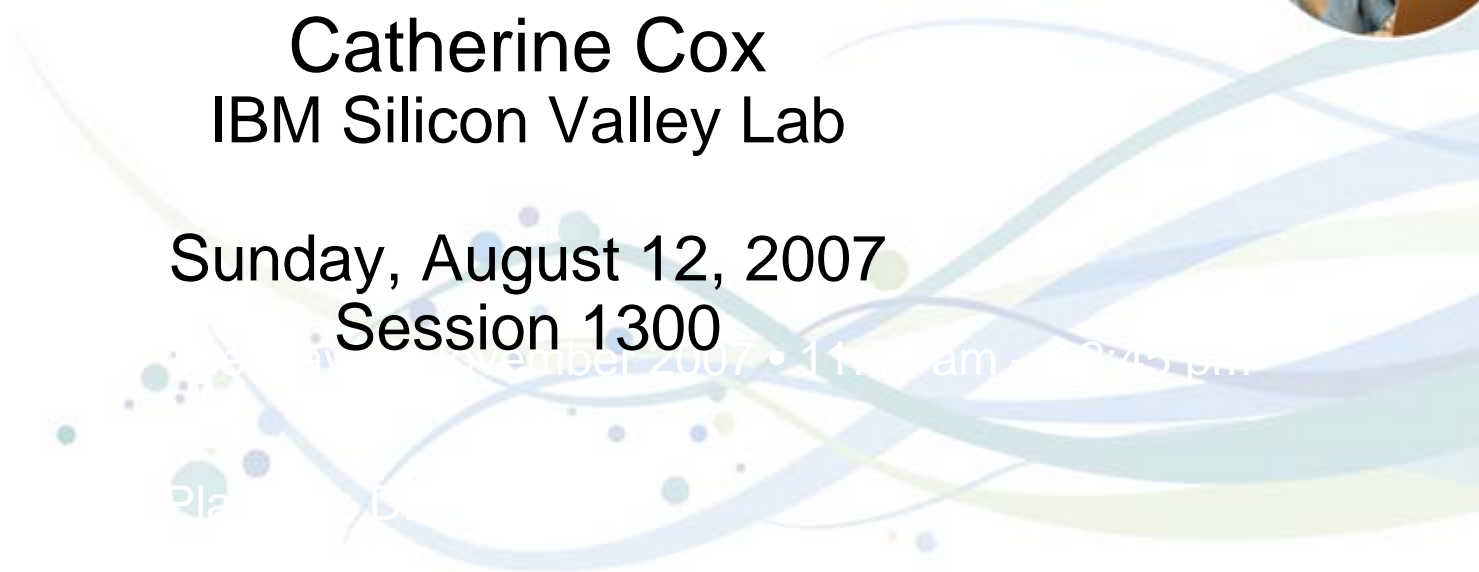


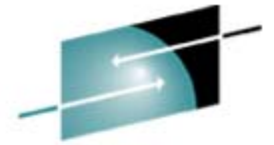


Introduction to DB2® for z/OS

Catherine Cox
IBM Silicon Valley Lab

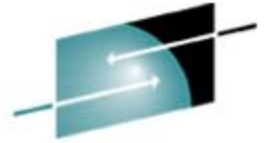
Sunday, August 12, 2007
Session 1300





Agenda

- What is DB2
- SQL
- DB2 system Structure
- Application Considerations
- Organizational Considerations
- Tools and Aids
- Summary

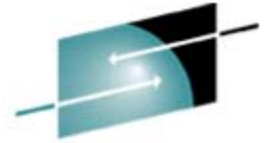


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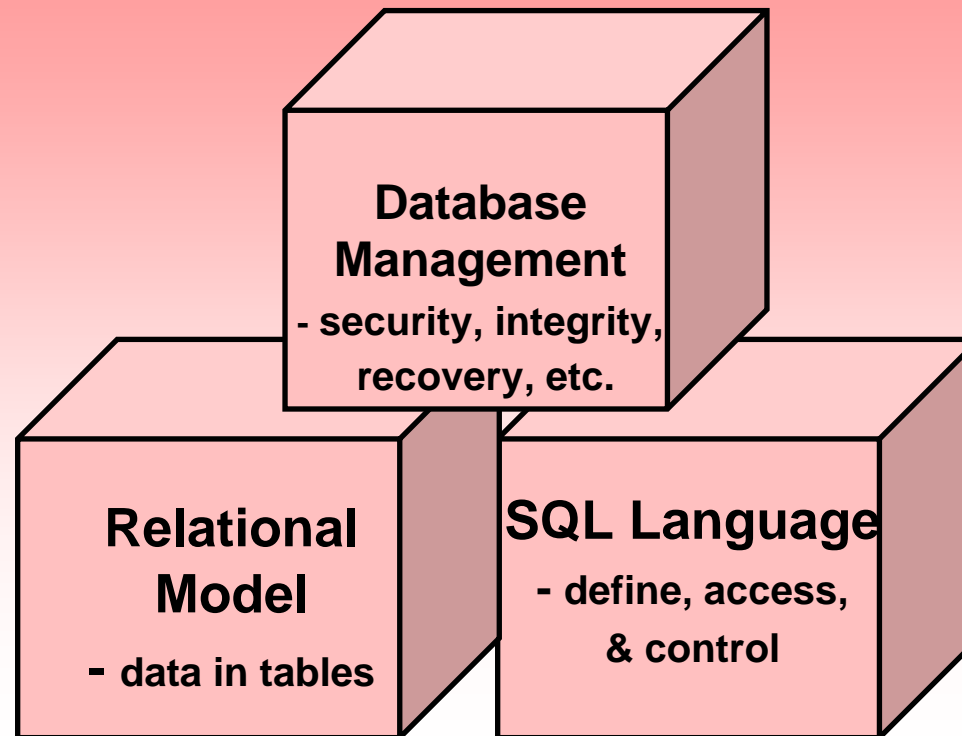
What is DB2?

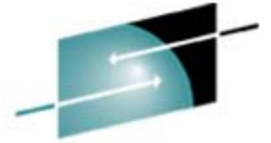




What is DB2?

DB2 is a Relational Database Management System (DBMS)





DB2 Relational DBMS

Data viewed as tables

CUSTOMER

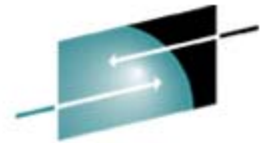
CUST_NBR	CUST_NAME	CUST_REGION	CUST_CREDIT
239	TOTALLY WIRED	NE	A
376	BRIKS	NW	AAA
921	BALLOONS, ETC.	SW	AAA
631	GREAT WORKS	SW	A
227	GRATE DANES	SE	AA
338	TODAY'S WORLD	NW	AA

ITEM

ITEM_NBR	ORDER_NBR
GH1358	A23
HP2052	A56
GH1358	B56
IP1325	A90
GH1358	D45
GH1359	A45

ORDER

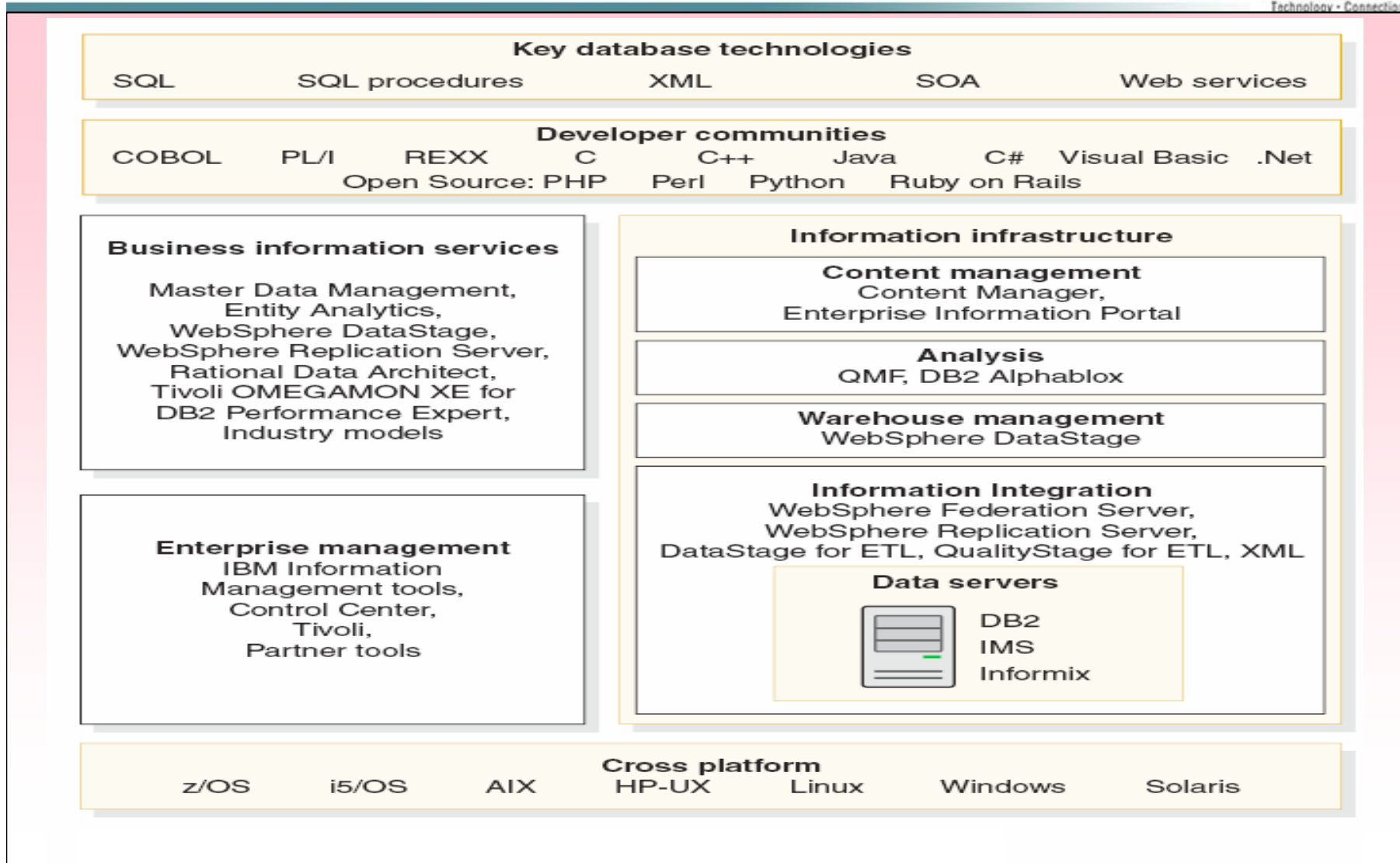
ORDER_NBR	CUST_NBR	ORDER_VALUE
A23	239	15780
B56	376	970
A90	921	3820
A45	631	690

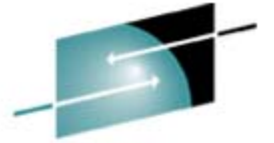


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IBM DB2 Information Management Strategy

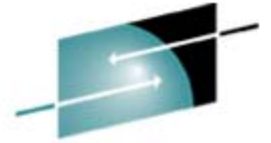




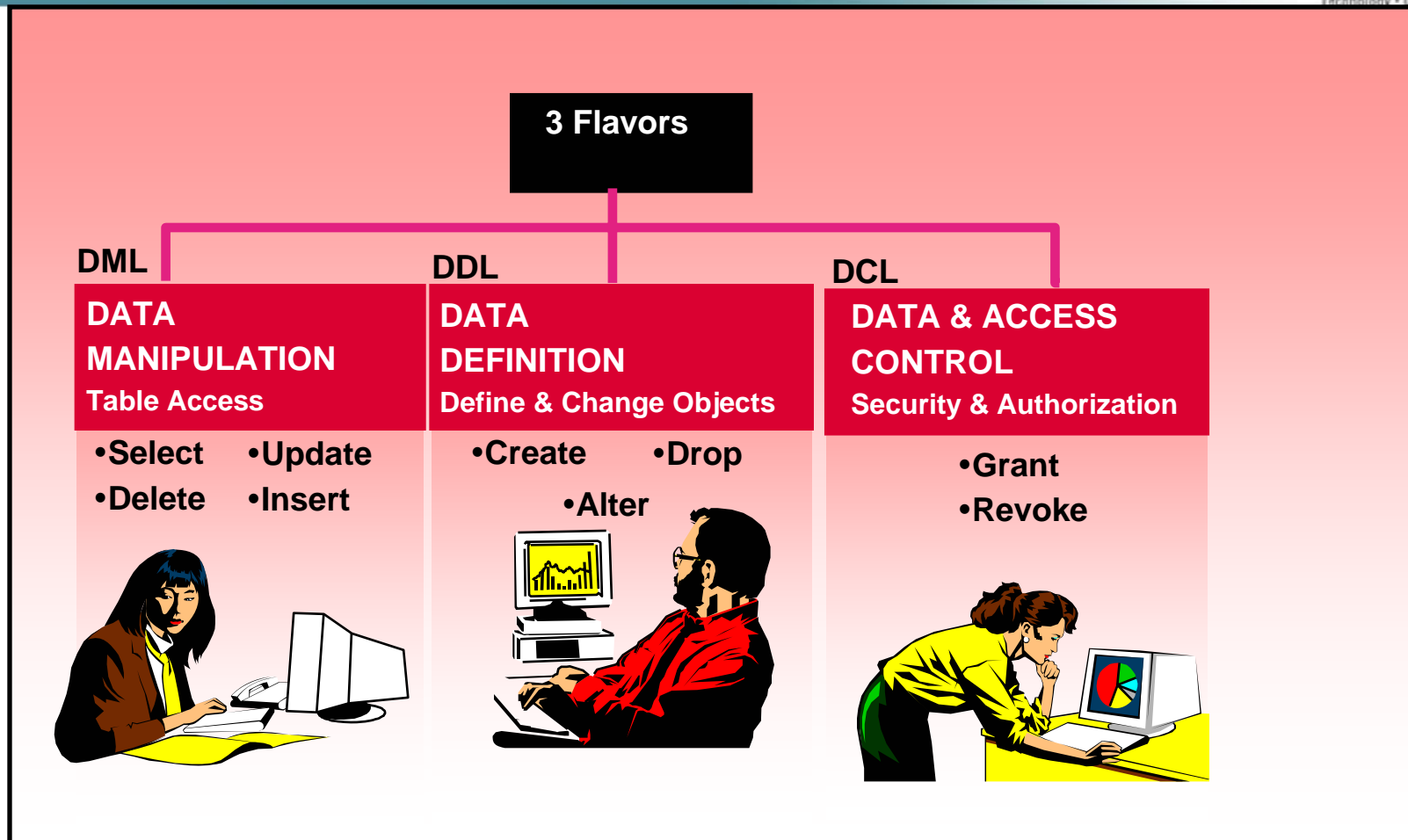
SHARE

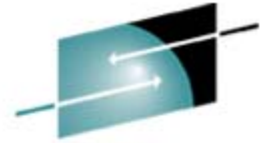
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SQL and Database Structures



Structured Query Language (SQL)





Retrieving Data

```
SELECT *  
FROM CUSTOMER  
WHERE CUST_NBR = 239
```

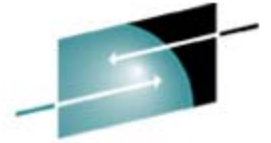
Result:

CUST_NBR	CUST_NAME	CUST_REGION	CUST_CREDIT
239	TOTALLY WIRED	NE	A

- DB2 OPTIMIZER will decide how to access the data

- Look at all records in table

- Use an index (if available and useful)



Adding Data

```
INSERT INTO CUSTOMER  
VALUES (123, 'ACME', 'SW', 'AAA',....)
```

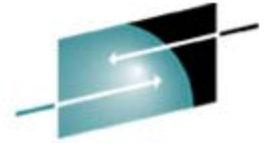
```
LOAD DATA REPLACE  
INTO CUSTOMER  
(CUST_NBR POSITION (2) DECIMAL(9),  
CUST_NAME POSITION (12) CHAR(32), ...
```

CUSTOMER

CUST_NBR	CUST_NAME	CUST_REGION	CUST_CREDIT
239	TOTALLY WIRED	NE	A
376	BRIKS	NW	AAA
921	BALLOONS, ETC.	SW	AAA
631	GREAT WORKS	SW	A
227	GRATE DANES	SE	AA
338	TODAY'S WORLD	NW	AA
123	ACME	SW	AAA



- INSERT - add a single row of data
- LOAD - to add a file full of data



Change & Delete

```
UPDATE CUSTOMER  
SET CUST_CREDIT = 'AA'  
WHERE CUST_NBR = 376
```

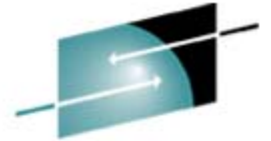
```
DELETE FROM CUSTOMER  
WHERE CUST_NBR = 921
```

CUSTOMER



CUST_NBR	CUST_NAME	CUST_REGION	CUST_CREDIT
239	TOTALLY WIRED	NE	A
376	BRIKS	NW	AA
631	GREAT WORKS	SW	A
227	GRATE DANES	SE	AA
338	TODAY'S WORLD	NW	AA
123	ACME	SW	AAA

- UPDATE implies a SELECT
- UPDATE can change many rows
- DELETE can remove many rows



JOINing Data

Can join 2 or more tables together using a single statement

```
SELECT CUST_NAME, CUST_REGION,  
ORDER_NBR, ORDER_VALUE  
FROM CUSTOMER C, ORDER O  
WHERE C.CUST_NBR = O.CUST_NBR  
ORDER BY CUST_REGION
```

CUSTOMER

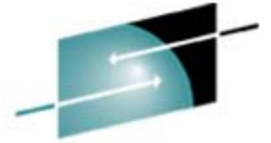
CUST_NBR	CUST_NAME	CUST_REGION	CUST_CREDIT
239	TOTALLY WIRED	NE	A
376	BRIKS	NW	AA
631	GREAT WORKS	SW	A
227	GRATE DANES	SE	AA
338	TODAY'S WORLD	NW	AA
123	ACME	SW	AAA

ORDER

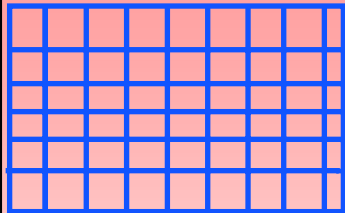
ORDER_NBR	CUST_NBR	ORDER_VALUE
A23	239	15780
B56	376	970
A90	921	3820
A45	631	690

RESULT

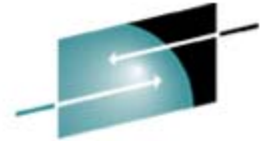
CUST_NBR	CUST_NAME	CUST_REGION	ORD_NBR	ORD_VALUE
239	TOTALLY WIRED	NE	A23	15780
376	BRIKS	NW	B56	970
631	GREAT WORKS	SW	A45	690



Database Constructs: Relationships



- Table: Data in rows and columns
 - Base Table
 - Temporary Table
- Index: Ordered set of data and pointers to rows
- View: "Virtual table" or logical view of data
 - Subset of table
 - Across multiple tables, databases
 - Data for view is not stored
 - Views may be built on views
 - Provides field level and content controls
- Table space: Data sets containing tables
- Database: A logical set of tables and table spaces



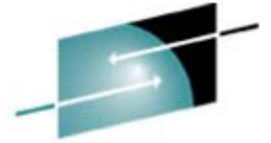
Creating a Table

SQL - Data Definition Language

```
CREATE TABLE CUSTOMER  
(CUST_NBR          DECIMAL (9)  NOT NULL,  
CUST_NAME         CHAR (32)   NOT NULL,  
CUST_REGION       CHAR(2)    NOT NULL,  
CUST_CREDIT       CHAR(3),  
CUST_INIT         TIMESTAMP  NOT NULL, ...
```

Some other data types available:

- INTEGER, DECIMAL (x,y), FLOAT
- DATE, TIME, TIMESTAMP,
- UDT (user defined type)
- and more!



SQL - Data Definition Language

```
CREATE VIEW SW_CUSTOMER AS  
SELECT CUST_NBR, CUST_NAME,  
CUST_CREDIT  
FROM CUSTOMER  
WHERE CUST_REGION='SW'
```

- Only customers in SW
- Only customer number, name & credit

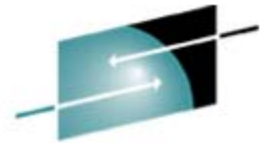
■ **Views can:**

- hide data
- simplify access to data

SQL - Data Definition Language

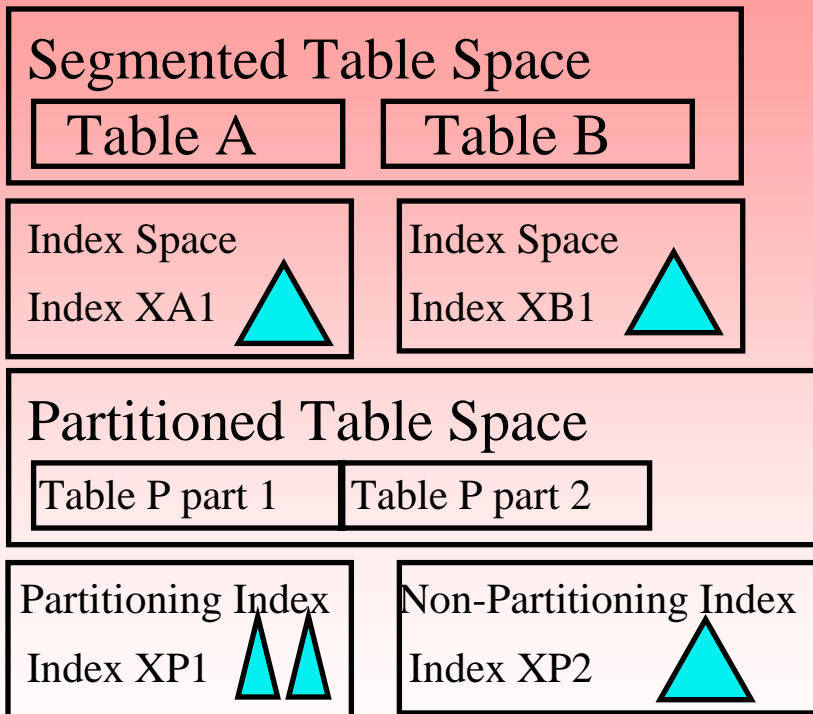
```
CREATE UNIQUE INDEX CUSTOMER_IX  
ON CUSTOMER  
(CUST_NBR ASC, .....)
```

- Indexes are *OPTIONAL*, but often improve performance
- **DBA creates them**
- **DB2 decides when to use them**



DB2 Database Structures

Database

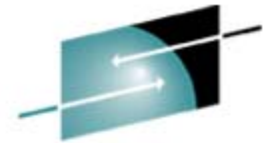


Segmented Tablespace

- Contains Multiple Tables
 - Physical Data Set Logically divided into 'Segments'
 - Each Segment contains data from one table

Tablespace: CUSTSEG

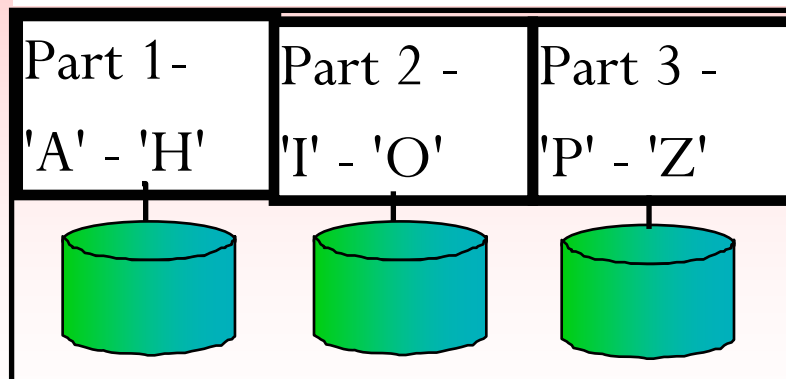
Table A	Table B	Table C
Table A	Table C	Table A
Table B	Table B	Table A



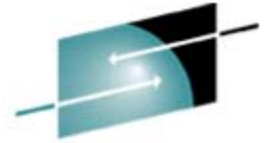
Partitioned Table Space

- Contains a Single Table
 - Divided into 'Partitions' by Range
 - Physical Data Set for each partition
 - Up to 4096 partitions with up to 32 TB of data
 - Ideal for large tables

Tablespace: CUSTPART



Note: DB2 9 for z/OS adds Partition by Growth

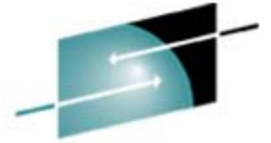


Protecting Data

SQL - Data Control Language

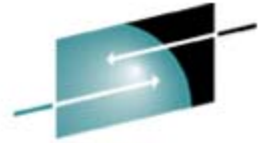
```
GRANT ALL ON CUSTOMER  
TO NATIONAL_SALES, MARY, TED  
  
GRANT SELECT ON SW_CUSTOMER TO  
SW_SALES, JOHN  
  
REVOKE SELECT ON SW_CUSTOMER  
FROM NE_SALES, JANE
```

If you don't "own" a table or view, you must be "GRANTED" access to use a table or view



Protecting Data, cont.

- Integral part of SQL language using GRANT and REVOKE
- Access and execution authorization
- Query language is security language also
 - ▶ Any possible SQL qualification can be used to limit access including restricting on field value, only aggregated data, etc.
- Special administrative authorities - SYSADM, DBADM, DBCNTL, ...
- z/OS Security Server or RACF can be used
 - ▶ To control access to DB2 subsystem
 - ▶ To control non-DB2 access to DB2 data
 - ▶ To define groups of users
 - ▶ An alternative for access control security (grant & revoke)

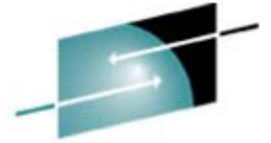


S H A R E

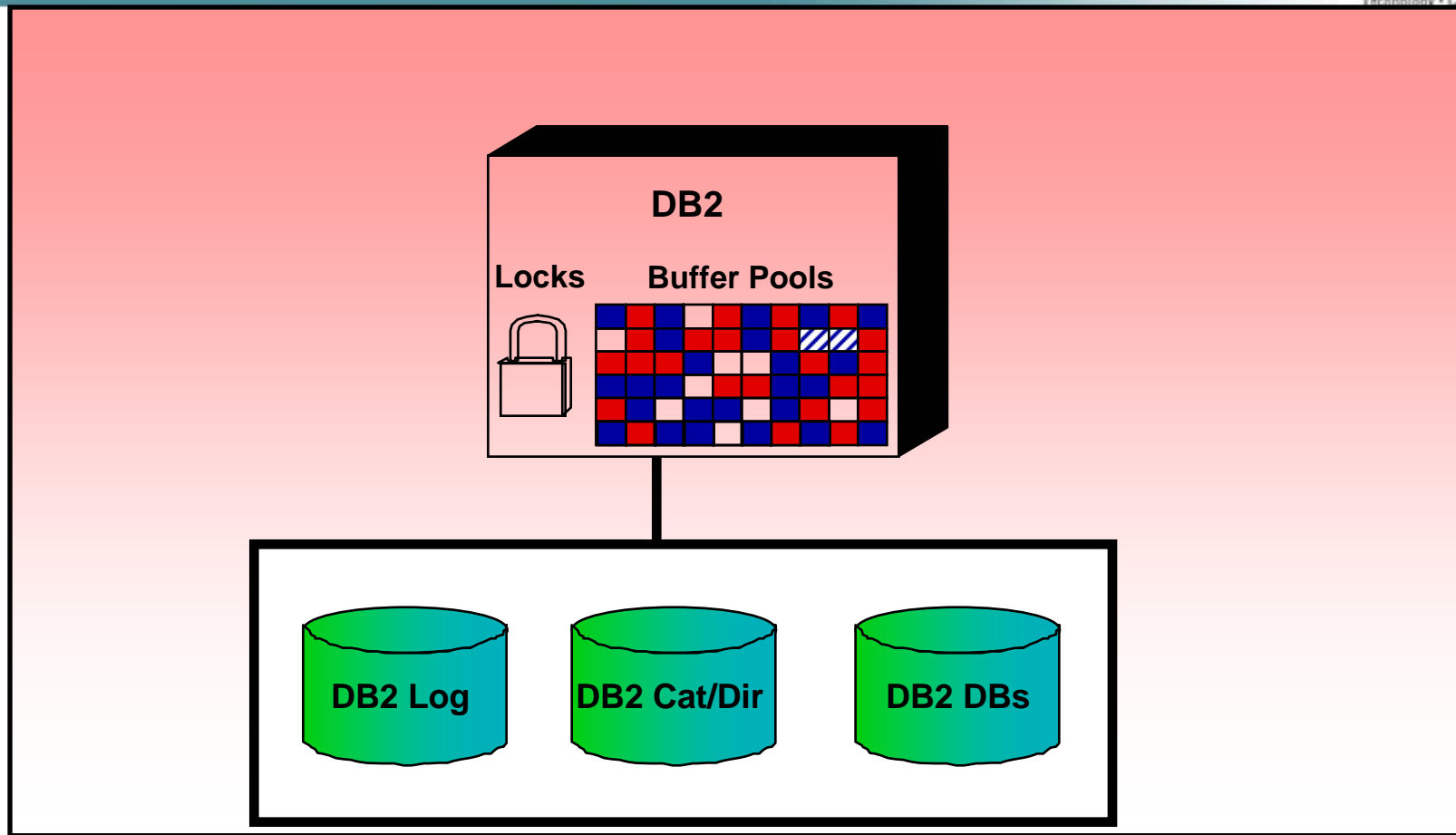
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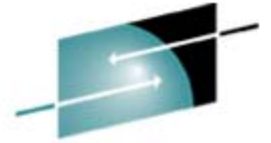
Subsystem Structure





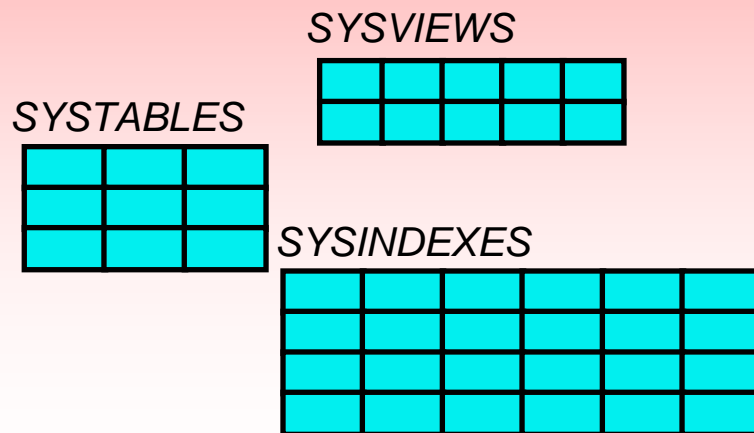
Single DB2 Subsystem

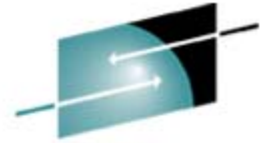




DB2 Catalog

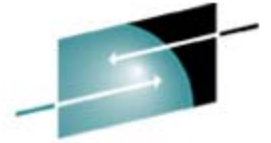
System Tables where DB2 stores info on
TABLES, VIEWS, INDEXES, etc...





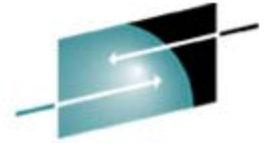
DB2 Catalog (*continued*)

- Many dictionary functions
 - ▶ Descriptive information can be held about data
 - ▶ Where-used information held about columns, tables, views, programs, modules, etc.
- Extensive space management and other operational statistics
- Backup and recovery, reorganization and load history
- Full integrity ensured
 - ▶ Active and non-bypassable
- Can retrieve catalog information
 - ▶ Use full power of SQL language
 - ▶ QMF

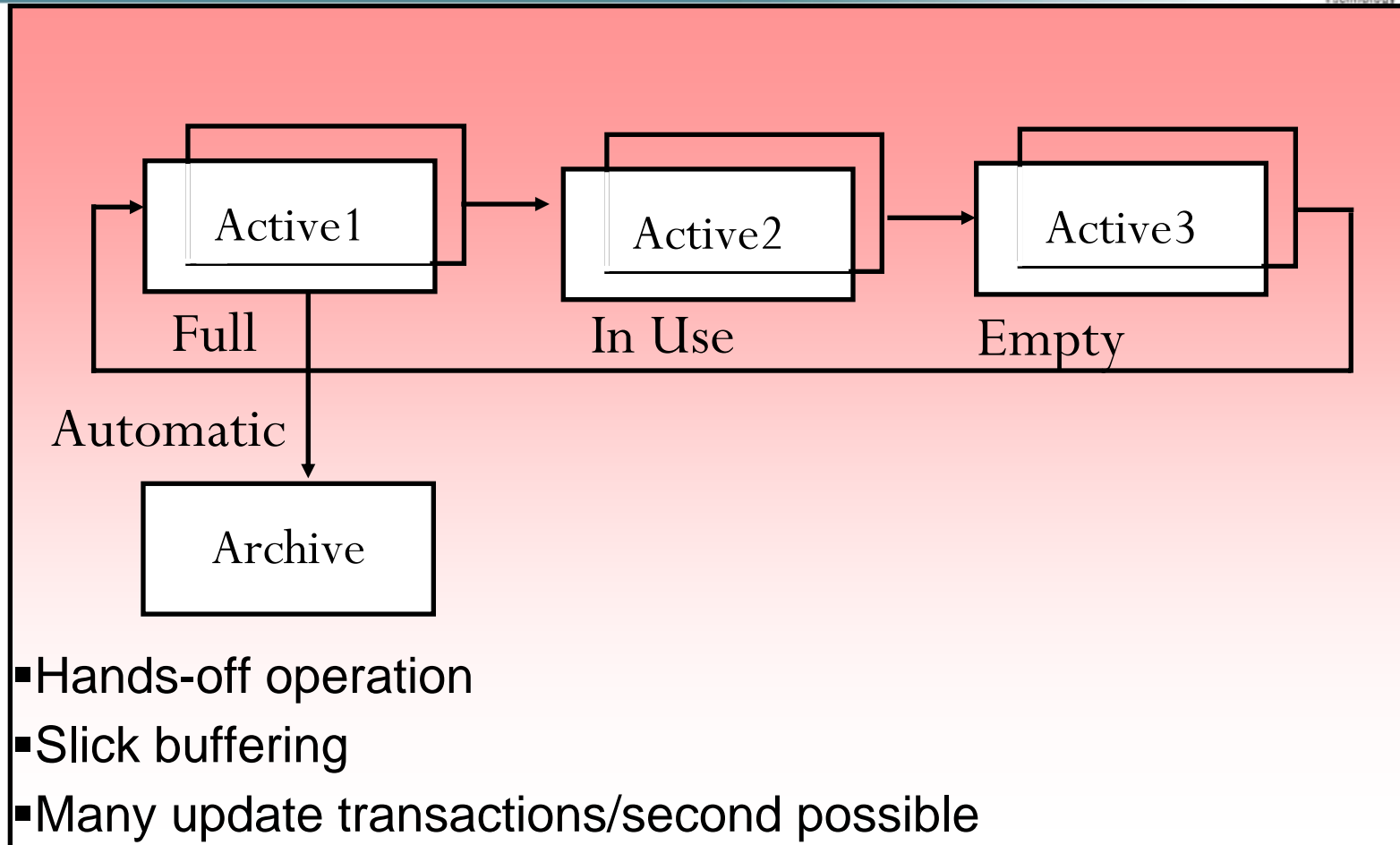


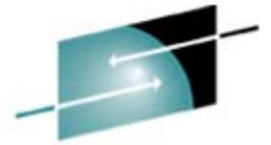
DB2 Buffer Pools

- Used to cache data for good performance
 - ▶ Up to 50 buffer pools with 4KB pages
 - ▶ Up to 10 buffer pools with 8-KB, 16-KB, 32-KB pages
- Pool hash anchor points increase as pool size increases
 - ▶ Small synonym chains
 - ▶ Efficient pool management
 - ▶ More pages kept in storage
 - ▶ Less read I/O (LRU Algorithm)
- Sequential Prefetch
 - ▶ Read a set of pages into the bufferpool with a single I/O
 - ▶ Number of pages read is a function of BufferPool size
 - ▶ Enables high I/O Parallelism

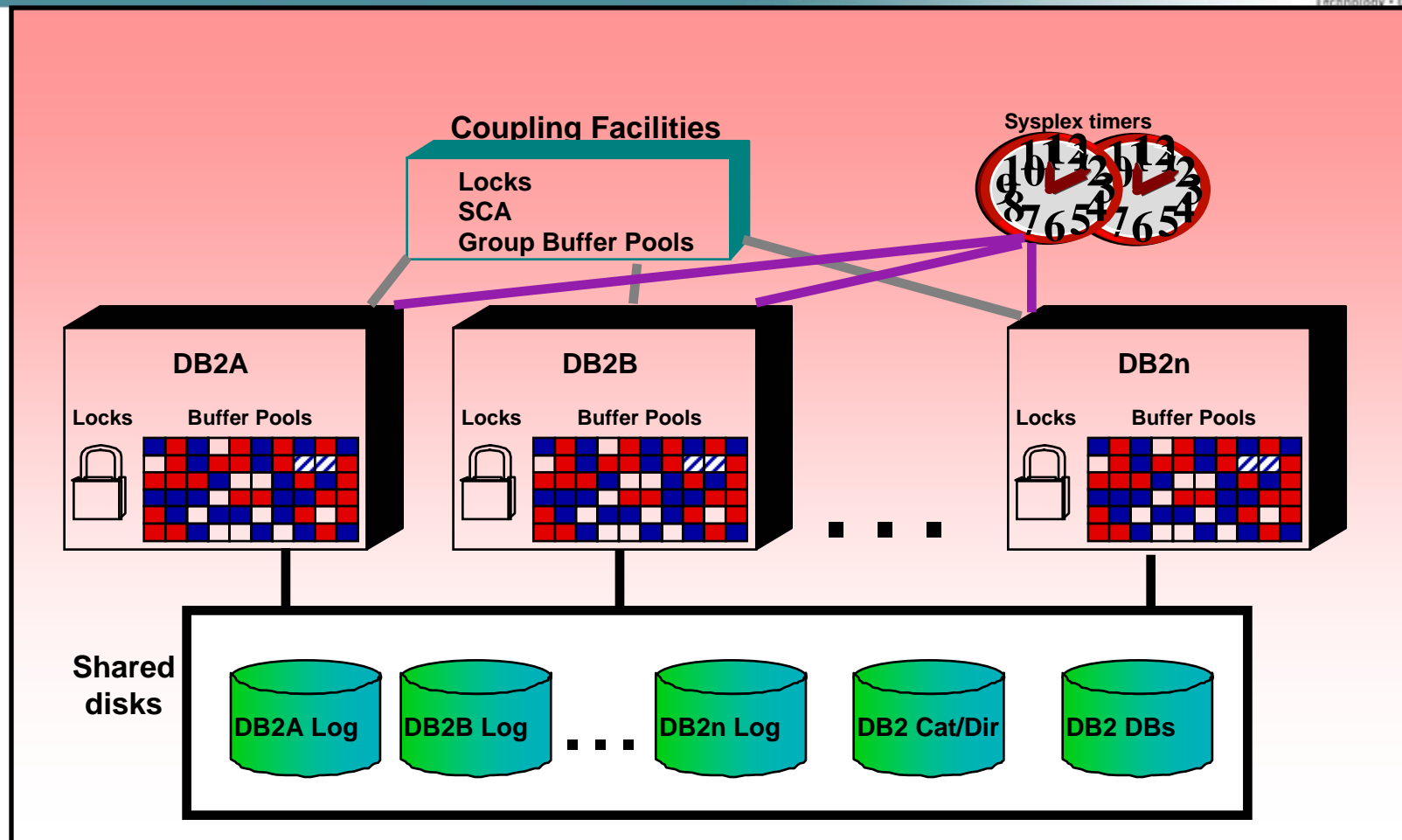


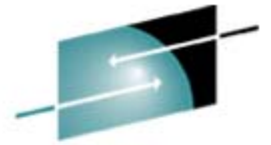
Logging



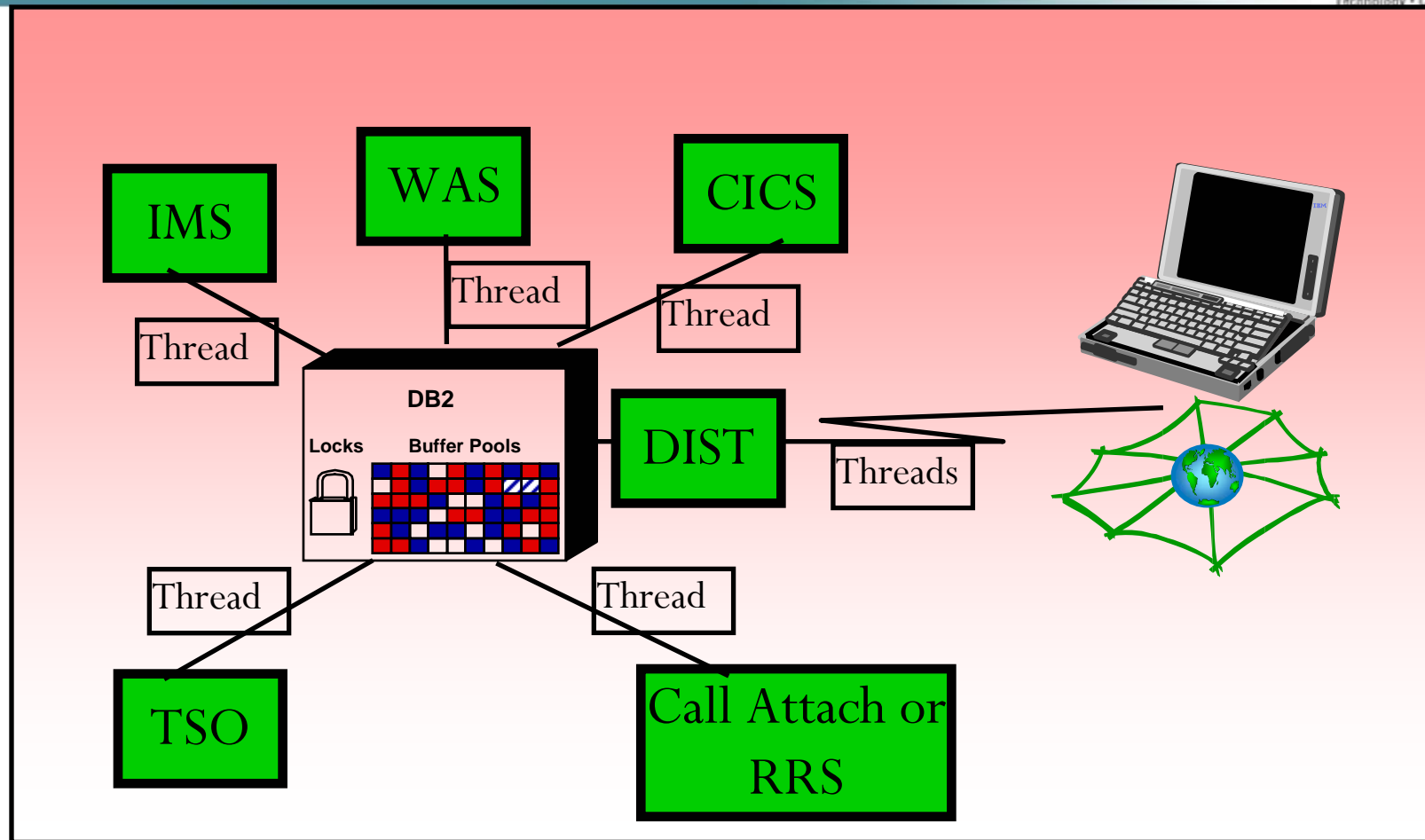


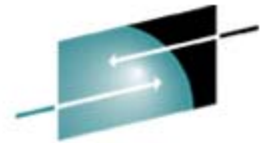
DB2 Parallel Architecture



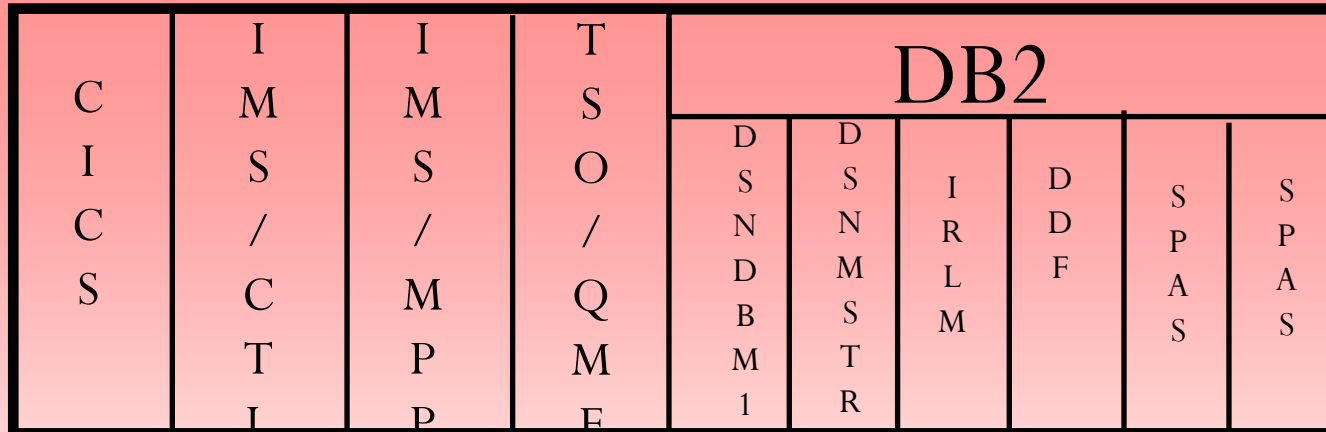


Access Structure

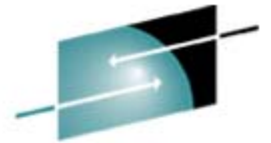




Multi-Address Space Architecture

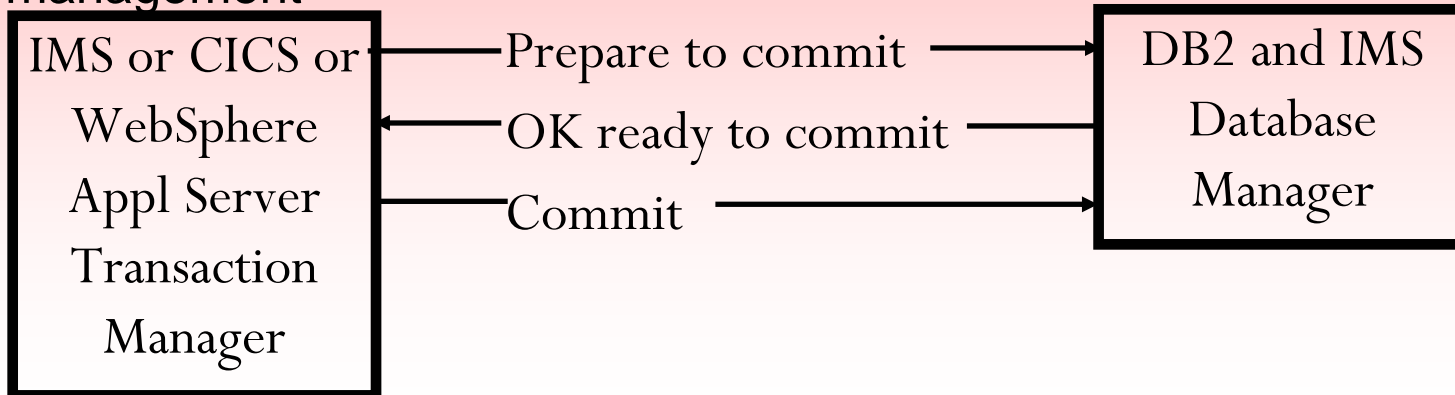


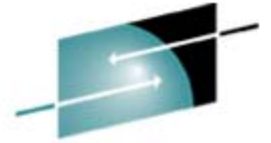
- One IMS can access multiple DB2s concurrently
- One CICS can access one DB2 at a time
- One DB2 can support multiple CICS/IMS subsystems and TSO users concurrently
- One DB2 can support thousands of concurrent distributed requests
- Multiple address spaces are used to handle Stored Procedure Calls
 - ▶ Use WLM managed address spaces



IMS/CICS/WebSphere/RRS DB2 Integration

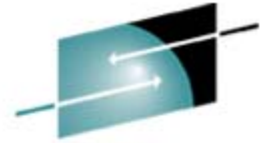
- IMS and DB2 COMMIT/ROLLBACK from same command
- Automatic "in-doubt resolution" on restart after failure of either party
- DB2 commands from IMS, CICS or WebSphere Application Server (RRS)
- Two phase commit protocol for coordinate transaction management





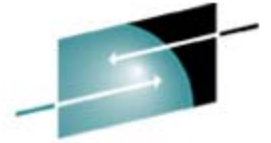
Sophisticated Optimization

- Optimization - Heart of the relational system
- Uses actual statistics (RUNSTATS) to derive a minimum cost access/join strategy
 - ▶ Table sizes/populations
 - ▶ Index available
 - ▶ Index selectivity
 - ▶ Actual data ordering
- Complete independence of DML from access path availability
 - ▶ Preplanned transactions "compiled" for efficiency
 - ▶ Automatic dynamic re-optimization if chosen index no longer present
 - ▶ Transforms some predicates for more efficient processing



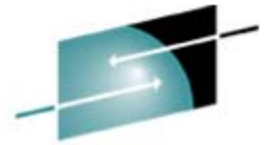
Application Considerations

- Create DB2 Application using the Bind Process
 - ▶ Packages
 - ▶ Plans
- Use Static vs. Dynamic SQL when possible
- Access Path Selection Considerations
 - ▶ Understand Available Algorithms
 - ▶ Assure Availability of Current Statistics



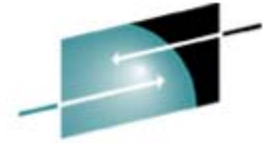
Controls for Data Integrity

- Atomicity, Consistency, Isolation & Durability
- Entity Integrity
- Referential Integrity
- Views
- Stored procedures
- Table check constraints
- Triggers
- Distinct data types & Functions
- Database procedures (exits for validation, conversions)



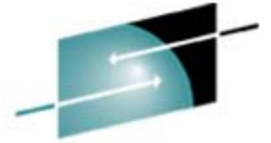
Locking Considerations for Data Integrity

- Scope of a lock - How much is locked
 - ▶ Locksize parameter on table space
 - ▶ Table space, table, partition, page, row
- Type:
 - ▶ S-Shared (eg. read only cursor),
 - ▶ U-Intent to Update (eg. cursor for update of)
 - ▶ X-Exclusive (eg. update)
 - ▶ IS, IX, SIX
- Deadlock detection/resolution
- Timeout



Locking Considerations for Data Integrity (Continued)

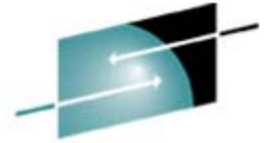
- Duration: How long locks are kept
 - When lock is released -Release Parm on bind (Commit or Deallocate)
 - When lock is Acquired - Acquire parm on bind (Use or Allocate)
- Isolation levels
 - ▶ Cursor Stability: Currentdata yes or no
 - ▶ Read Stability
 - ▶ Repeatable Read
 - ▶ Uncommitted Read



General Locking Tips

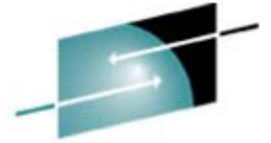
- Commit as soon as practical
 Suggestion: every 2 – 10 seconds
- Code for retry and restart on deadlocks and timeouts
- Row level locking is rarely necessary
- Use cursor stability, currentdata no when possible

See Administration Guide
"Improving Concurrency"



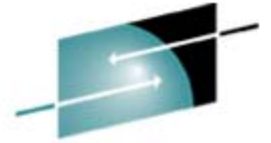
Client/Server DB2 Applications

- Uses Distributed Relational Database Architecture (DRDA) to define the flow of data between DB2 and other database management systems
 - ▶ Supports remote request, remote unit of work, and distributed unit of work
- Support dynamic and static SQL
- Provides distributed two-phase commit
- Database connection pooling is provided and supports up to 150,000 DRDA connections to DB2 per member
- Good performance is provided utilizing
 - ▶ Block Fetch
 - ▶ Stored Procedures



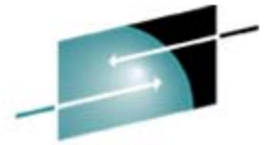
DB2 Access for Java – JDBC and SQLJ

- JDBC and SQLJ are two methods for accessing DB2 data using JAVA
 - Used to write portable application programs independent of any DBMS
 - Applications use Sun's JDBC interface to DB2 by using dynamic SQL and accessing local or remote data
 - Applications use SQLJ to DB2 for embedding static SQL statements in Java applications and servlets.
 - SQLJ and JDBC coexist together
 - One application can create a JDBC connection and then use that connection to run dynamic SQL statements through JDBC and embedded static SQL statements through SQLJ.



Stored Procedures

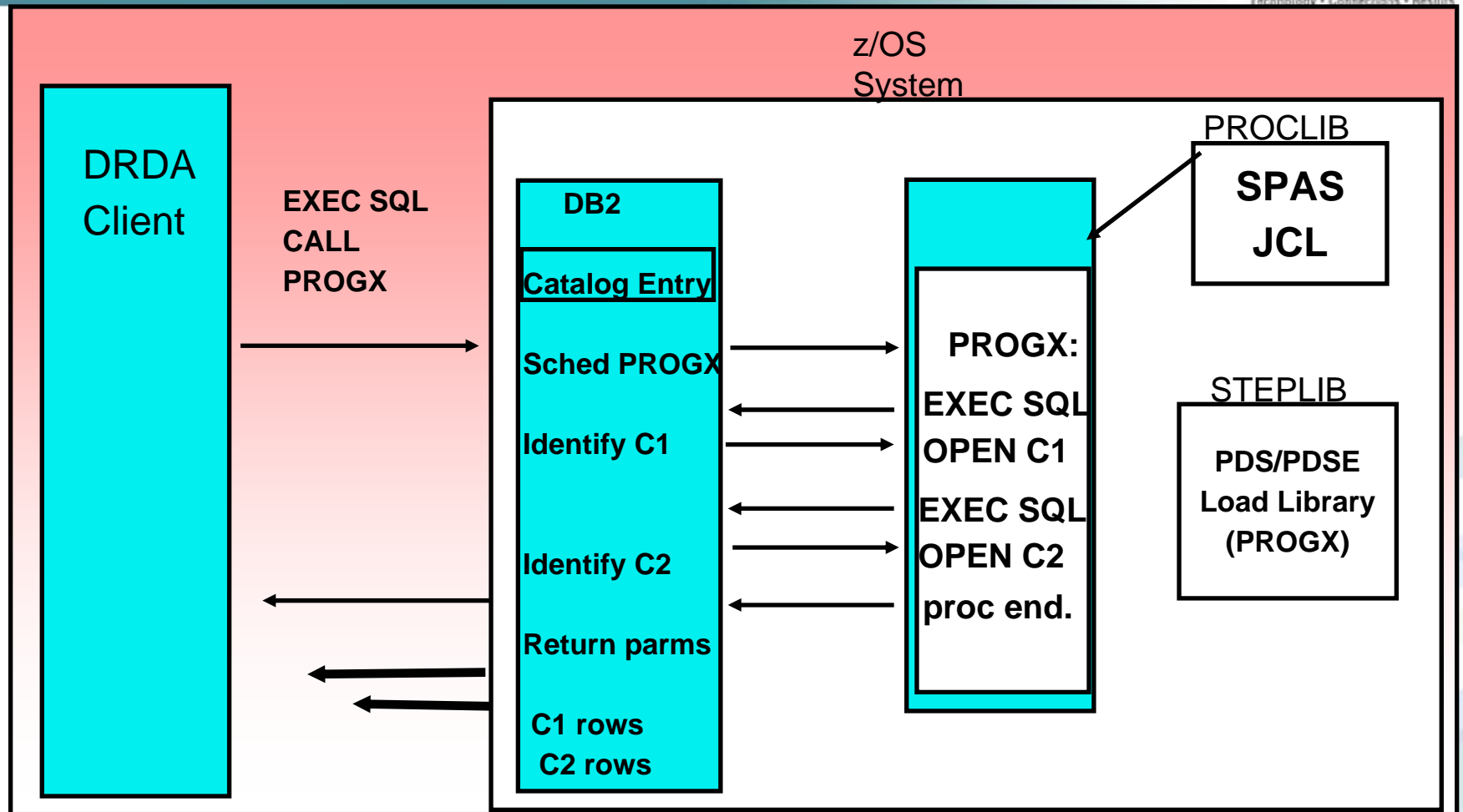
- Programs that reside in DB2 that are invoked, "called" by other programs, including other Stored Procedures
 - ▶ WLM Managed, RRS attach
- Can be written in a wide variety of languages
 - ▶ Assembly, C, C++, Cobol and OO Cobol, JAVA, PL/I, SQL PL
 - ▶ Can be in a different language than that of the calling program
- Can issue static and dynamic SQL
- Can issue DB2 Commands
- Can access VSAM files, IMS databases, CICS transactions, et.al.
- Can return multiple result sets
- Reduces network traffic in a client server environment
- Provides highly reusable code

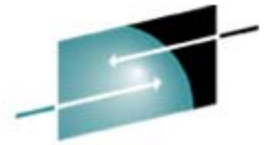


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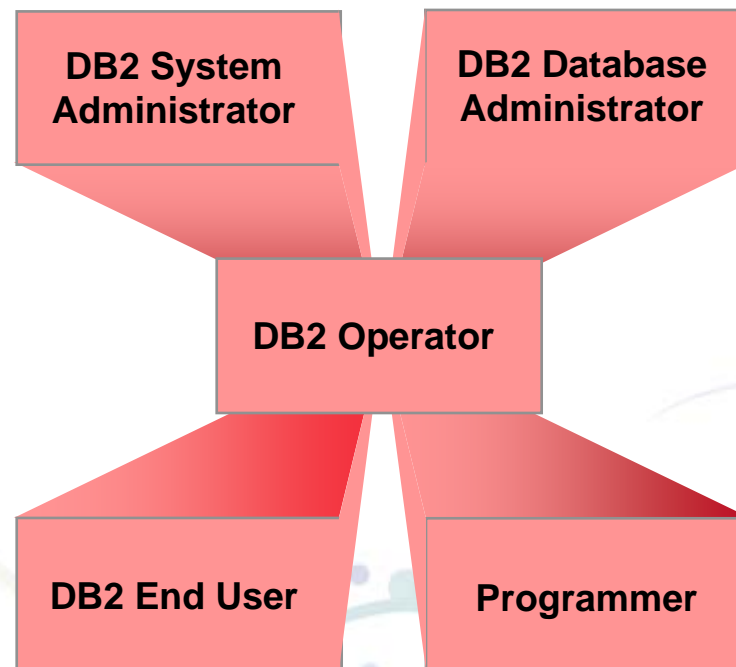
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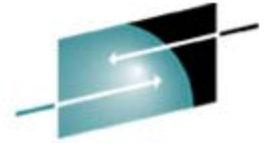
Stored Procedures





DB2 Customer Organizational Roles





DB2 Utilities

- Backup and Recovery
- Rebuild index
- Data/index Reorganization
- Loading/unloading data
- Statistics for query optimization
- Data, index, LOB checking



Today's IBM DB2 Tools for z/OS & Multiplatform Product Portfolio

Utilities Management

- DB2 Utilities Suite
- DB2 Automation Tool
- DB2 Automation Toolkit SAP Edition
- DB2 Cloning Tool
- ✓ DB2 High Performance Unload

Information Integration

- WebSphere Classic Data Event Publisher
- WebSphere Classic Federation Server
- WebSphere Classic Replication Server
- ✓ WebSphere Data Event Publisher
- ✓ WebSphere DataStage
- ✓ WebSphere QualityStage
- ✓ WebSphere Replication Server

Database Administration

- DB2 Administration Tool
- DB2 Object Comparison Tool
- Data Encryption for DB2 and IMS
- DB2 Thread Expert
- DB2 Storage Management Utility
- DB2 Administration Toolkit SAP Edition
- DB2 Audit Management Expert
- DB2 Change Management Expert

Recovery Management

- Application Recovery Tool for IMS and DB2 Databases
- DB2 Archive Log Accelerator
- DB2 Change Accumulation Tool
- DB2 Log Analysis Tool
- DB2 Object Restore Tool
- ✓ DB2 Recovery Expert

Performance Management

- OMEGAMON XE DB2 Performance Expert
- OMEGAMON XE DB2 Performance Monitor
- DB2 Buffer Pool Analyzer
- DB2 Query Monitor
- DB2 SQL Performance Analyzer
- DB2 PerformanceToolkit SAP Edition
- DB2 Performance Expert

Application Management

- DB2 Path Checker
- DB2 Bind Manager
- ✓ DB2 Data Archive Expert
- ✓ DB2 Table Editor
- ✓ DB2 Web Query Tool
- ✓ DB2 Test Database Generator

• Available on zSeries

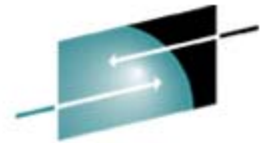
✓ Available on zSeries and multiplatforms (LUW)

→ Currently available only on multiplatforms (LUW)



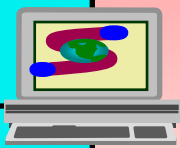


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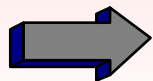
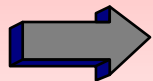
- Where to get Additional Information





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DB2 for z/OS

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IBM boosts price/performance for SAP on the System z9 mainframe

Overview

- [Data serving](#) with IBM's mainframe and DB2 for z/OS helps you reduce cost and complexity in your IT infrastructure, simplify compliance, and leverage your core asset - your data. Learn more about industry-leading innovations:
 - [zIIP enablement is ready for DB2 for z/OS Version 8](#)
 - [System z9](#)
 - [System z9 Integrated Information Processor \(zIIP\)](#)

Editions

- **DB2 for z/OS Product Lifecycle - Updated**
Marketing and support service availability by version
- **DB2 Version 9.1 for z/OS**
Coming soon
- **DB2 Universal Database for z/OS**
Version 8
- **DB2 for z/OS and OS/390**
Version 7- Service ends June 30, 2008

Related software

- WebSphere®
- CICS®

DB2 for z/OS Roadmap Page

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Software > Information Management > DB2 Product Family

DB2 for z/OS

DB2 for z/OS Version 8 information roadmap

Information Management software

Other roadmaps

- Content Manager
- IMS™
- SQL Replication Version 8.2

↓ Product overview ↓ Samples
↓ Planning ↓ Debugging
↓ Installing ↓ Testing
↓ Migrating ↓ Security
↓ Configuring ↓ Monitoring and tuning
↓ Administering ↓ Troubleshooting and Support
↓ Developing ↓ Reference
↓ Scenarios

This roadmap outlines the information resources that are available for installation, administration, and programming for DB2 Universal Database™ for z/OS®, Version 8.

PDF files require Adobe® Reader®

Product overview

- **DB2 UDB for z/OS Version 8: Everything You Ever Wanted to Know, ... and More** (Type: IBM Redbook)
This IBM Redbook explains the capabilities of DB2 Version 8. This information helps you to evaluate the applicability of Version 8 to your environment, as well as to plan for the installation of DB2 V8 or the migration from DB2 V7.
- **Greatest Hits & Myths - Roger Miller** (Type: Presentation; Format: PDF)
This presentation discusses the areas of greatest improvements in Version 8 and reasons for migration to Version 8. The value and effort of Version 8 vary widely for different customers. This presentation also discusses the many rumors about DB2 Version 8.
- **DB2® UDB for z/OS, Version 8 brochure** (Type: Marketing; Format: PDF)
This brochure lists the new features of Version 8.
- **The Official Introduction to DB2 for z/OS** (Type: Book)
This retail book introduces you to DB2 Version 8. By focusing on administration and development, it also helps you prepare for the IBM® DB2 Family Fundamentals certification exam.

Related software

- WebSphere®
- CICS®
- IMS™
- DB2 Connect™
- z/OS®
- Linux on IBM® System z™

Related solutions

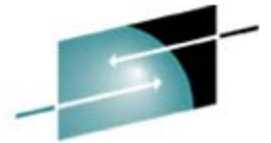
- DB2® and IMS Tools
- Java™ on OS390® and z/OS
- DB2 for Linux™

Related hardware

- IBM TotalStorage
- IBM System z

DB2 Support Page

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DB2 for z/OS

Product support

Primary support resources

Flash 1 Nov, 2006: URGENT: Effects of Daylight Saving Time changes on your systems and applications

Flash 21 Jul, 2006: IBM Software Support Toolbar

Flash 19 Apr, 2006: DB2 for z/OS Version 8 Information Roadmap is Now Available!

[View all Flashes]

Solve a problem

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- [Technotes](#) | [APARs](#)

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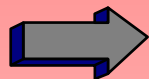
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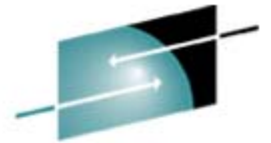


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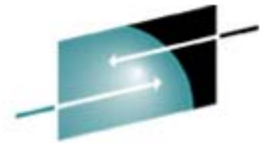
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 - Monitoring and tuning DB2 performance
 - Programming for DB2
 - Troubleshooting for DB2
 - DB2 reference information
- DB2 UDB for z/OS Version 8
- IBM DB2 Tools
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DB2 Version 9.1 for z/OS

DB2 Version 9.1 for z/OS information

Welcome to the DB2® Version 9.1 for z/OS® (DB2 for z/OS) information, where you can find topics that you need to use DB2 for z/OS. By using this information, you can install or migrate to Version 9.1 of DB2 for z/OS, develop and run application programs, and administer and operate DB2 databases and subsystems.

The information in these topics comes from DB2 for z/OS product books. You can view a [table that shows the correspondence](#) between the books and the information center topics.

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[Planning for Version 9.1](#)

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- WebSphere®
- CICS®
- IMS™
- DB2 Connect™
- z/OS®
- Linux on IBM® System z™

Related solutions

- DB2® and IMS Tools
- Java™ on OS390® and z/OS
- DB2 for Linux™

Related hardware

- IBM TotalStorage
- IBM System z

Related services

Events

DB2 Conferences

Upcoming Conferences

- **STG**
5-9 Feb 2007
New Orleans, Louisiana
- **Share**
12-16 Feb 2007
Tampa, Florida
- **IDUG Australia**
2-6 Oct 2007
Melbourne, Australia
- **System z**
16-20 Apr 2007
Munich, Germany
- **IDUG North America**
7-10 May 2007
San Jose, California
- **IM Tech Conf**
21-25 May 2007
Dusseldorf, Germany
- **Share**
13-17 Aug 2007
San Diego, California
- **Information On Demand**
14-19 Oct 2007
Las Vegas, Nevada
- **IDUG Europe**
5-9 Nov 2007
Athens, Greece

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- IBM DB2 Information Management Conferences
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- SHARE
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Information Management software

Communities

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IBM DB2 and IMS Tools

Welcome to the website for IBM® DB2 and IMS Tools. These pages include information on tools for DB2 for z/OS, [DB2 on Linux, UNIX, and Windows](#), IMS, and Information Integration.

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- DB2 QMF
- CICS Tools
- WebSphere MQ Family
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DB2 Tools for Linux, Unix, and Windows

- Visit the DB2 Multiplatform Tools webpage
- Read the DB2 Multiplatform Tools overview fact sheet.
- NEW! DB2 Toolkit for Multiplatforms V1.1 brings together five DB2 Multiplatform

New / Enhanced DB2 z/OS Tools

- Announced March 2006**
- DB2 SQL Performance Analyzer, V3.1
- Announced December 2005**
- DB2 Change Accumulation Tool, V1.4

Information Management software

Portfolio of DB2 & IMS Tools

Introducing z9-109

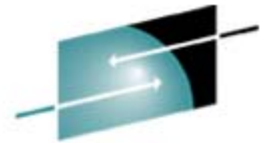
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Highlights

- Register for EMEA IM Tech Con, The Hague May 15
- Register for IDUG NA, Tampa, May 7
- Register for June 8

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DB2 for z/OS and OS/390

DB2® on the mainframe allows you to run powerful enterprise applications and make e-commerce a reality. developerWorks is the technical resource center for DB2 for z/OS® and OS/390®.

Updated 15 Feb 2007

Top story



Use DB2 Version 9.1 for z/OS to implement application session locking

A new feature, "SKIP LOCKED DATA," gives you the capability to implement application-level session locking, allowing intermediate DB2 commits. [More >](#)

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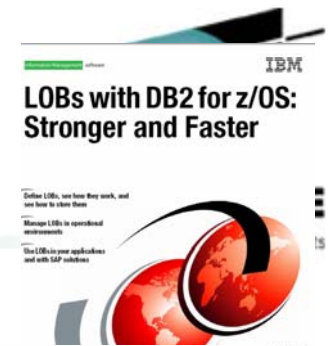
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- DB2 9 for z/OS beta
- New on developerWorks: WebSphe
- Sign up: New dW Information Mana
- New Redbook: Data Integrity with I
- Webcast: DB2 change management

DB2 9 for z/OS RedBooks & RedPapers

- Powering SOA with IBM Data Servers SG24-7259
- LOBs with DB2 for z/OS: SG24-7270
- Securing DB2 & MLS z/OS SG24-6480-01
- DB2 9 Technical Overview SG24-7330
- Enhancing SAP - DB2 9 SG24-7239
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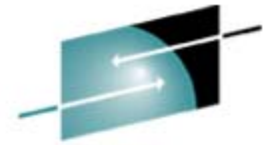


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Summary

- What is DB2
- SQL
- Subsystem Structure
- Application Considerations
- Organizational Considerations
- Where to Get Additional Information
- Summary

