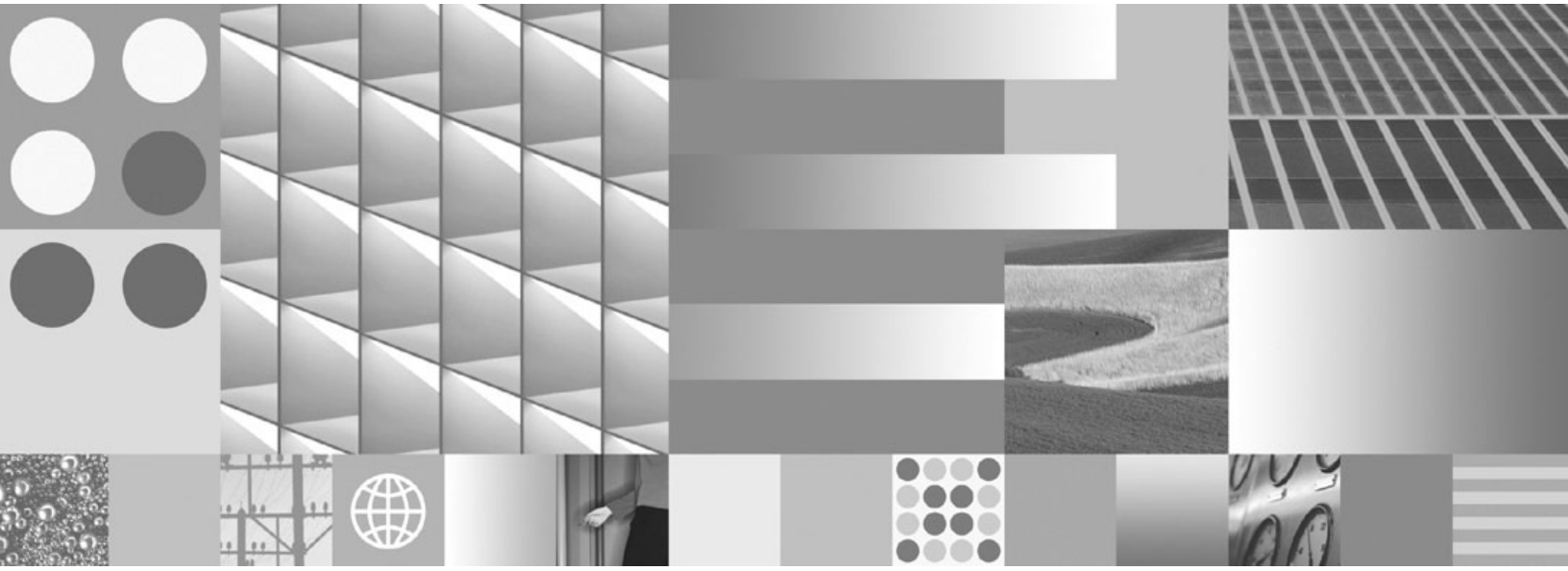
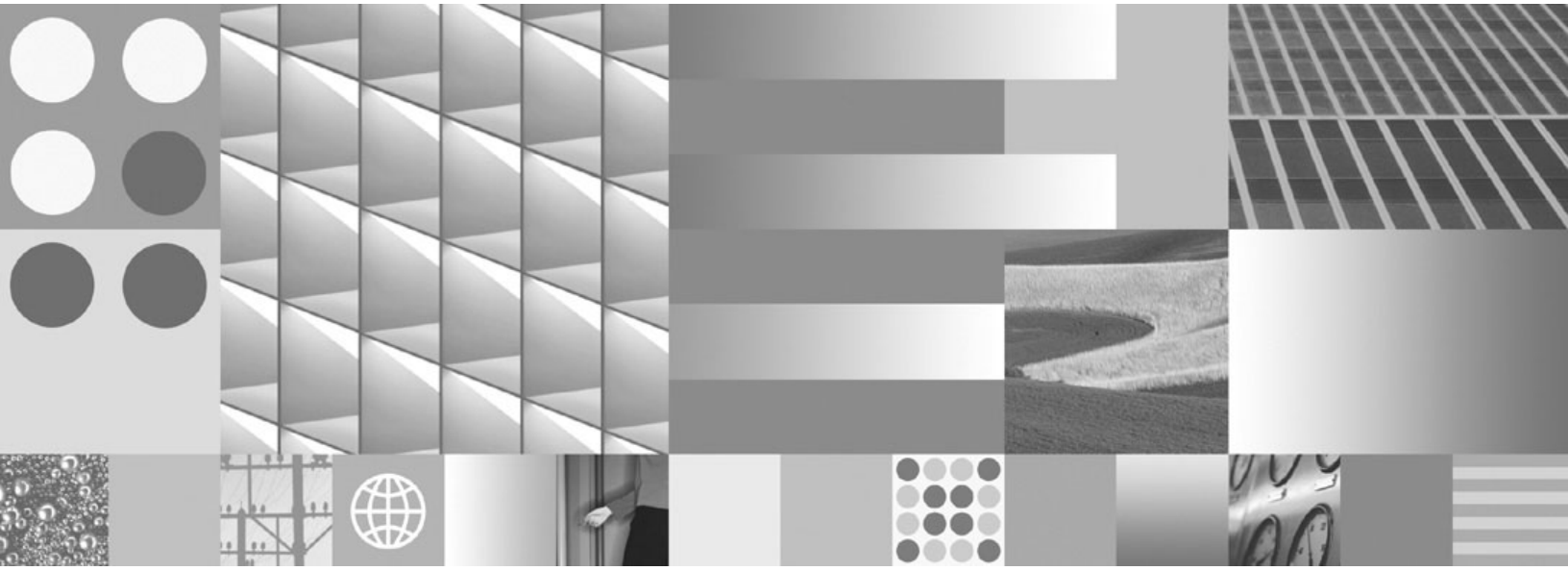
DB2 Version 9.5
for Linux, UNIX, and Windows



Developing Java Applications

SC23-5853-00

DB2 Version 9.5
for Linux, UNIX, and Windows



Developing Java Applications

SC23-5853-00

Note
Before using this information and the product it supports, read the general information under Appendix B, "Notices," on page 417.

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Contents

About this book

This book describes DB2® for Linux®, UNIX®, and Windows® support for Java™. This support lets you access relational databases from Java application programs.

Who should use this book

This book is for the following users:

- DB2 for Linux, UNIX, and Windows application developers who are familiar with Structured Query Language (SQL) and who know the Java programming language.
- DB2 for Linux, UNIX, and Windows system programmers who are installing JDBC and SQLJ support.

Chapter 1. Java application development for DB2

The DB2 database system provides driver support for client applications and applets that are written in Java using JDBC, and for embedded SQL for Java (SQLJ).

JDBC is an application programming interface (API) that Java applications use to access relational databases. DB2 support for JDBC lets you write Java applications that access local DB2 data or remote relational data on a server that supports DRDA®.

SQLJ provides support for embedded static SQL in Java applications. SQLJ was initially developed by IBM®, Oracle, and Tandem to complement the dynamic SQL JDBC model with a static SQL model.

In general, Java applications use JDBC for dynamic SQL and SQLJ for static SQL. However, because SQLJ can inter-operate with JDBC, an application program can use JDBC and SQLJ within the same unit of work.

Supported drivers for JDBC and SQLJ

The DB2 product includes support for two types of JDBC driver architecture.

According to the JDBC specification, there are four types of JDBC driver architectures:

Type 1
Drivers that implement the JDBC API as a mapping to another data access API, such as Open Database Connectivity (ODBC). Drivers of this type are generally dependent on a native library, which limits their portability. The DB2 database system does not support a type 1 driver.

Type 2
Drivers that are written partly in the Java programming language and partly in native code. The drivers use a native client library specific to the data source to which they connect. Because of the native code, their portability is limited.

Type 3
Drivers that use a pure Java client and communicate with a database using a database-independent protocol. The database then communicates the client's requests to the data source. The DB2 database system does not support a type 3 driver.

Type 4
Drivers that are pure Java and implement the network protocol for a specific data source. The client connects directly to the data source.

DB2 Database for Linux, UNIX, and Windows supports the following drivers:

Driver name	Packaged as	Driver type
DB2 JDBC Type 2 Driver for Linux, UNIX and Windows	db2java.zip	Type 2

Driver name	Packaged as	Driver type
IBM Data Server Driver for JDBC and SQLJ	• db2jcc.jar and sqlj.zip for JDBC 3.0 support • db2jcc4.jar and sqlj.zip for JDBC 4.0 support	Type 2 and Type 4

IBM Data Server Driver for JDBC and SQLJ (type 2 and type 4)

The IBM Data Server Driver for JDBC and SQLJ is a single driver that includes JDBC type 2 and JDBC type 4 behavior. When an application loads the IBM Data Server Driver for JDBC and SQLJ, a single driver instance is loaded for type 2 and type 4 implementations. The application can make type 2 and type 4 connections using this single driver instance. The type 2 and type 4 connections can be made concurrently. IBM Data Server Driver for JDBC and SQLJ type 2 driver behavior is referred to as *IBM Data Server Driver for JDBC and SQLJ type 2 connectivity.* IBM Data Server Driver for JDBC and SQLJ type 4 driver behavior is referred to as *IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.*

Two versions of the IBM Data Server Driver for JDBC and SQLJ are available. IBM Data Server Driver for JDBC and SQLJ Version 3.5 is JDBC 3.0-compliant. IBM Data Server Driver for JDBC and SQLJ Version 4.0 is JDBC 3.0-compliant and supports some JDBC 4.0 functions.

The IBM Data Server Driver for JDBC and SQLJ supports these JDBC and SQLJ functions:

- All of the methods that are described in the JDBC 3.0 specifications. See ″Driver support for JDBC APIs″.
- Some methods that are described in the JDBC 4.0 specifications, if you install IBM Data Server Driver for JDBC and SQLJ Version 4.0.
- SQLJ application programming interfaces, as defined by the SQLJ standards, for simplified data access from Java applications.
- Connections that are enabled for connection pooling. WebSphere® Application Server or another application server does the connection pooling.
- Java user-defined functions and stored procedures (IBM Data Server Driver for JDBC and SQLJ type 2 connectivity only).

  The IBM Data Server Driver for JDBC and SQLJ is the default driver for Java routines.
- Support for distributed transaction management. This support implements the Java 2 Platform, Enterprise Edition (J2EE) Java Transaction Service (JTS) and Java Transaction API (JTA) specifications, which conform to the X/Open standard for distributed transactions (*Distributed Transaction Processing: The XA Specification*, available from http://www.opengroup.org).

DB2 JDBC Type 2 Driver for Linux, UNIX and Windows (DB2 JDBC type 2 driver) (deprecated)

The DB2 JDBC type 2 driver lets Java applications make calls to DB2 through JDBC. Calls to the DB2 JDBC type 2 driver are translated to Java native methods. The DB2 JDBC Type 2 Driver uses the DB2 CLI interface to communicate with DB2 databases. The Java applications that use this driver must run on a DB2 client, through which JDBC requests flow to the DB2 database. DB2 Connect™ must be installed before the DB2 JDBC application driver can be used to access DB2 for i5/OS® data sources or data sources in the DB2 for z/OS environments.

The DB2 JDBC type 2 driver supports these JDBC and SQLJ functions:
- Most of the methods that are described in the JDBC 1.2 specification, and some of the methods that are described in the JDBC 2.0 specification.
- SQLJ statements that perform equivalent operations to all JDBC methods
- Connection pooling
- Distributed transactions
- Java user-defined functions and stored procedures

The DB2 JDBC Type 2 Driver for Linux, UNIX and Windows will not be supported in future releases. You should therefore consider moving to the IBM Data Server Driver for JDBC and SQLJ.

JDBC driver and DB2 database compatibility

You can use IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to connect to a DB2 database at a different release level.

The IBM Data Server Driver for JDBC and SQLJ is always downward compatible with DB2 databases at the previous release level. For example, IBM Data Server Driver for JDBC and SQLJ type 4 connectivity from the IBM Data Server Driver for JDBC and SQLJ Version 3.50, which is shipped with DB2 Database for Linux, UNIX, and Windows Version 9.5, to a DB2 Version 8 database is supported.

The IBM Data Server Driver for JDBC and SQLJ is upward compatible with the next version of a DB2 database if the applications under which the driver runs use no new features. For example, IBM Data Server Driver for JDBC and SQLJ type 4 connectivity from the IBM Data Server Driver for JDBC and SQLJ Version 2.9.31, which is shipped with DB2 Database for Linux, UNIX, and Windows Version 8 Fix Pack 12, to a DB2 Version 9.5 database is supported, if the applications under which the driver runs contain no DB2 Version 9.5 features.

Chapter 2. Installing the IBM Data Server Driver for JDBC and SQLJ

After you install the IBM Data Server Driver for JDBC and SQLJ, you can prepare and run JDBC or SQLJ applications.

Before you install the IBM Data Server Driver for JDBC and SQLJ, you need the following software.

- An SDK for Java, 1.4.2 or later.

  For all DB2 products except the IBM Data Server Runtime Client, the DB2 Database for Linux, UNIX, and Windows installation process automatically installs the SDK for Java, Version 5.

  If you want to use JDBC 4.0 functions, you need to install an SDK for Java, 6 or later.

  If you plan to run JDBC or SQLJ applications on your system, but not to prepare them, you need a Java run-time environment only.
- JVM native threads support

  Any JVMs that run Java applications that access DB2 databases must include native threads support. You can specify native threads as the default thread support for some JVMs by setting the THREADS_FLAG environment variable to "native". Refer to the documentation for your Java environment for instructions on making native threads the default on your system.
- Unicode support for System i servers

  If any SQLJ or JDBC programs will use IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to connect to a DB2 for i5/OS server, the OS/400® operating system must support the Unicode UTF-8 encoding scheme. The following table lists the OS/400 PTFs that you need for Unicode UTF-8 support:

Table 1. OS/400 PTFs for Unicode UTF-8 support

OS/400 version	PTF numbers
V5R3 or later	None (support is included)
V5R2	SI06541, SI06796, SI07557, SI07564, SI07565, SI07566, and SI07567
V5R1	SI06308, SI06300, SI06301, SI06302, SI06305, SI06307, and SI05872

- Java support for HP-UX clients and servers

  HP-UX servers: The IBM Data Server Driver for JDBC and SQLJ does not support databases that are in the HP-UX default character set, Roman8. Therefore, when you create a database on an HP-UX server that you plan to access with the IBM Data Server Driver for JDBC and SQLJ, you need to create the database with a different character set.

  HP-UX clients and servers: The Java environment on an HP-UX system requires special setup to run stored procedures under the IBM Data Server Driver for JDBC and SQLJ.

  See "Special setup for running Java routines in the HP-UX environment" on page 20 for details.

Follow these steps to install the IBM Data Server Driver for JDBC and SQLJ.

1. During the DB2 Database for Linux, UNIX, and Windows installation process, select `Java support` on UNIX or Linux, or `JDBC support` on Windows. These selections are defaults. If you have already installed DB2 Database for Linux, UNIX, and Windows without JDBC support, you can run the installation process in `Custom` mode to add JDBC support.

   Selection of `Java support` or `JDBC support` causes the installation process to perform the following actions:

   - Installs the IBM Data Server Driver for JDBC and SQLJ class files.

     The files are placed in the sqllib\java directory for Windows systems, or the sqllib/java directory for UNIX or Linux systems.

     The files names are:

     db2jcc.jar or db2jcc4.jar
     Include db2jcc.jar in the CLASSPATH if you plan to use the version of the IBM Data Server Driver for JDBC and SQLJ that includes only **JDBC 3.0 and earlier functions.**

     Include db2jcc4.jar in the CLASSPATH if you plan to use the version of the IBM Data Server Driver for JDBC and SQLJ that includes **JDBC 4.0 and later functions, as well as JDBC 3.0 and earlier functions.**

     sqlj.zip
     sqlj.zip is for preparing and executing SQLJ programs.
   - Modifies the CLASSPATH to include the IBM Data Server Driver for JDBC and SQLJ class files.

     Important: This step is performed automatically only for the db2jcc.jar file. If you are using the db2jcc4.jar file, you must modify the CLASSPATH manually. Change db2jcc.jar to db2jcc4.jar in the CLASSPATH.

     Important: Include db2jcc.jar or db2jcc4.jar in the CLASSPATH. Do not include both files.
   - Installs IBM Data Server Driver for JDBC and SQLJ license files, and modifies the CLASSPATH to include them.

     The files are placed in the sqllib\java directory for Windows systems, or the sqllib/java directory for UNIX or Linux systems. The file names are:

Table 2. IBM Data Server Driver for JDBC and SQLJ license files

License file	Server to which license file permits a connection	Product that includes license file
db2jcc_license_cisuz.jar	DB2 for z/OS® DB2 for i5/OS	All DB2 Connect products

     License files are not required for connections to DB2 Database for Linux, UNIX, and Windows, Cloudscape, or IBM Informix® Dynamic Server (IDS) databases from the IBM Data Server Driver for JDBC and SQLJ Version 3.50 or later.
   - Installs IBM Data Server Driver for JDBC and SQLJ native libraries for support of IBM Data Server Driver for JDBC and SQLJ type 2 connectivity.

     The files are placed in the sqllib\bin directory for Windows systems, or the sqllib/lib directory for UNIX or Linux systems.

     The file names are:

libdb2jcct2.so
For AIX®, HP-UX on IPF, Linux, and Solaris

libdb2jcct2.sl
For HP-UX on PA-RISC

db2jcct2.dll
For Windows

2. Customize the driver-wide configuration properties, if any of the defaults are inappropriate. See "Customization of IBM Data Server Driver for JDBC and SQLJ configuration properties" on page 15 for details.
3. Configure TCP/IP.

   Servers must be configured for TCP/IP communication in the following cases:

   - JDBC or SQLJ applications that use IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.
   - JDBC or SQLJ applications that use IBM Data Server Driver for JDBC and SQLJ type 2 connectivity, and specify *server* and *port* in the connection URL.

   Ensure that the TCP/IP listener is running. To activate the TCP/IP listener:

   a. Set the environment variable DB2COMM to TCPIP:

      ```
      db2set DB2COMM=TCPIP
      ```

   b. Update the database manager configuration file with the TCP/IP service name as specified in the services file:

      ```
      db2 update dbm cfg using SVCENAME TCP/IP-service-name
      ```

      The port number used for applets and SQLJ programs needs to be the same as the TCP/IP SVCENAME number used in the database manager configuration file.

   c. Execute the db2stop and db2start commands for the service name setting to take effect.
4. On DB2 Database for Linux, UNIX, and Windows servers on which you plan to run Java stored procedures or user-defined functions, ensure that the DB2_USE_DB2JCCT2_JROUTINE environment variable is not set, or is set to its default value of `YES`, `yes`, `ON`, `on`, `TRUE`, `true`, or 1 on those database servers. This setting indicates that Java stored procedures run under the IBM Data Server Driver for JDBC and SQLJ.

   If you need to run stored procedures under the DB2 JDBC Type 2 Driver for Linux, UNIX and Windows, set the DB2_USE_DB2JCCT2_JROUTINE environment variable to `OFF`.
5. On DB2 Database for Linux, UNIX, and Windows servers on which you plan to run Java stored procedures or user-defined functions, update the database manager configuration to include the path where the SDK for Java is located.

   You can do this by entering commands similar to these on the server command line:

   - *For database systems on UNIX or Linux:*

     ```
     db2 update dbm cfg using JDK_PATH /home/db2inst/jdk15
     ```

     /home/db2inst/jdk15 is the path where the SDK for Java is installed.
   - *For database systems on Windows:*

     ```
     db2 update dbm cfg using JDK_PATH c:\Program Files\jdk15
     ```

     c:\Program Files\jdk15 is the path where the SDK for Java is installed.

To verify the correct value for the JDK_PATH field in the DB2 database manager configuration, enter the following command on the database server:

```
db2 get dbm cfg
```

You might want to redirect the output to a file for easier viewing. The JDK_PATH field appears near the beginning of the output.

6. If you plan to call SQL procedures that are on DB2 Database for Linux, UNIX, and Windows servers from Java programs, and the date and time format that is associated with the territory code of the database servers is **not** the USA format, take the following actions:
   a. Set the DB2_SQLROUTINE_PREPOPTS registry variable on the database servers to indicate that the default datetime format is ISO:

      ```
      db2set DB2_SQLROUTINE_PREPOPTS="DATETIME ISO"
      ```

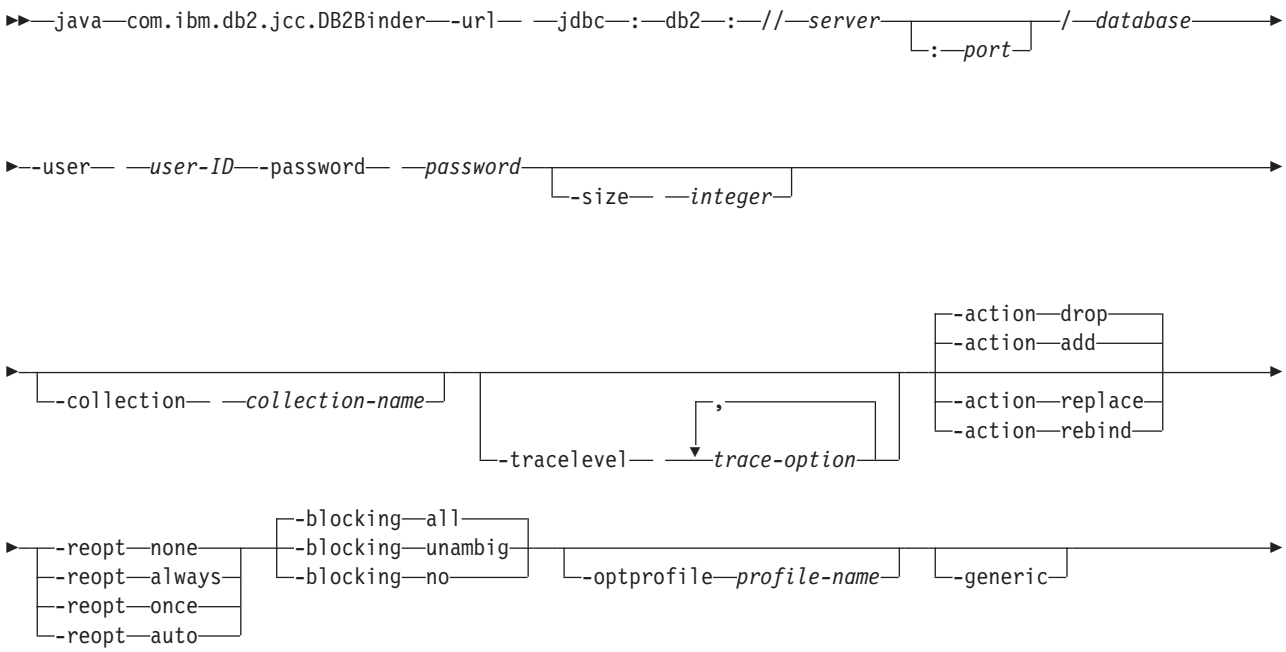
   b. Redefine any existing SQL procedures that you plan to call from Java programs.

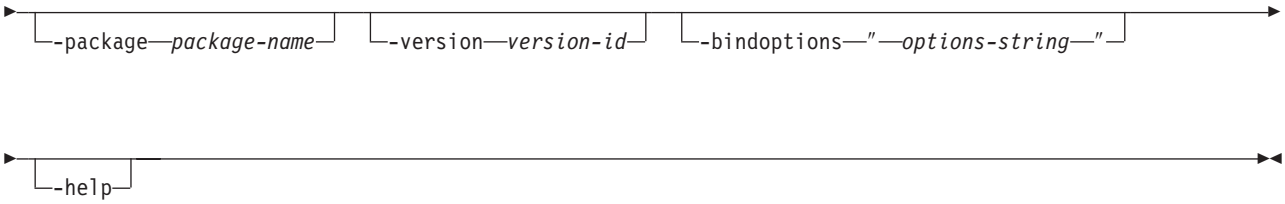
   These steps are necessary to ensure that the calling application receives date and time values correctly.
7. If you plan to access DB2 for z/OS database servers with your Java applications, follow the instructions in "Special setup for accessing DB2 for z/OS servers from Java programs" on page 16.

DB2Binder utility

The DB2Binder utility binds the DB2 packages that are used at the database server by the IBM Data Server Driver for JDBC and SQLJ, and grants EXECUTE authority on the packages to PUBLIC. Optionally, the DB2Binder utility can rebind DB2 packages that are not part of the IBM Data Server Driver for JDBC and SQLJ.

DB2Binder syntax





DB2Binder option descriptions

-url

Specifies the data source at which the IBM Data Server Driver for JDBC and SQLJ packages are to be bound. The variable parts of the `-url` value are:

server
The domain name or IP address of the operating system on which the database server resides.

port
The TCP/IP server port number that is assigned to the database server. The default is 446.

database
A name for the database server for which the profile is to be customized.

If the connection is to a DB2 for z/OS server, *database* is the DB2 location name that is defined during installation. All characters in this value must be uppercase characters. You can determine the location name by executing the following SQL statement on the server:

```
SELECT CURRENT SERVER FROM SYSIBM.SYSDUMMY1;
```

If the connection is to a DB2 Database for Linux, UNIX, and Windows server, *database* is the database name that is defined during installation.

If the connection is to an IBM Cloudscape server, the *database* is the fully-qualified name of the file that contains the database. This name must be enclosed in double quotation marks (″). For example:

```
"c:/databases/testdb"
```

-url

Specifies the data source at which the IBM Data Server Driver for JDBC and SQLJ packages are to be bound. The variable parts of the `-url` value are:

server
The domain name or IP address of the operating system on which the database server resides.

port
The TCP/IP server port number that is assigned to the database server. The default is 446.

database
The location name for the database server, as defined in the SYSIBM.LOCATIONS catalog table.

-user

Specifes the user ID under which the packages are to be bound. This user must have BIND authority on the packages.

-action
Specifies whether the IBM Data Server Driver for JDBC and SQLJ packages can be replaced.

add Indicates that a package can be created only if it does not already exist. Add is the default.

replace
Indicates that a package can be created even if a package with the same name already exists. The new package replaces the old package.

rebind
Indicates that the existing package should be rebound. This option does not apply to IBM Data Server Driver for JDBC and SQLJ packages. If -action rebind is specified, -generic must also be specified.

drop Indicates that some or all IBM Data Server Driver for JDBC and SQLJ packages should be dropped. The number of packages depends on the -size parameter.

-action drop applies only if the target database server is DB2 for z/OS.

-size
Controls the number of Statement, PreparedStatement, or CallableStatement objects that can be open concurrently, or the number of IBM Data Server Driver for JDBC and SQLJ packages that are dropped. The meaning of the -size parameter depends on the -action parameter:

- If the value of -action is add or replace, the value of -size is an integer that is used to calculate the number of DB2 packages that the IBM Data Server Driver for JDBC and SQLJ binds. If the value of -size is *integer*, the total number of packages is:

  ```
  number-of-isolation-levels*
  number-of-holdability-values*
  integer+
  number-of-packages-for-static-SQL
  = 4*2*integer+1
  ```

  The default -size value for -action add or -action replace is 3.

  In most cases, the default of 3 is adequate. If your applications throw SQLExceptions with -805 SQLCODEs, check that the applications close all unused resources. If they do, increase the -size value.

  If the value of -action is replace, and the value of -size results in fewer packages than already exist, no packages are dropped.
- If the value of -action is drop, the value of -size is the number of packages that are dropped. If -size is not specified, all IBM Data Server Driver for JDBC and SQLJ packages are dropped.
- If the value of -action is rebind, -size is ignored.

-collection
Specifies the collection ID for IBM Data Server Driver for JDBC and SQLJ or user packages. The default is NULLID. DB2Binder translates this value to uppercase.

You can create multiple instances of the IBM Data Server Driver for JDBC and SQLJ packages on a single database server by running `com.ibm.db2.jcc.DB2Binder` multiple times, and specifying a different value for -collection each time. At run time, you select a copy of the IBM Data Server Driver for JDBC and SQLJ by setting the `currentPackageSet` property to a value that matches a -collection value.

-tracelevel
Specifies what to trace while DB2Binder runs.

-reopt
Specifies whether DB2 for z/OS database servers determine access paths at run time. This option is valid only for connections to DB2 for z/OS database servers. This option is not sent to the database server if it is not specified. In that case, the database server determines the reoptimization behavior.

none Specifies that access paths are not determined at run time.

always
Specifies that access paths are determined each time a statement is run.

once Specifies that DB2 determines and caches the access path for a dynamic statement only once at run time. DB2 uses this access path until the prepared statement is invalidated, or until the statement is removed from the dynamic statement cache and needs to be prepared again.

auto Specifies that access paths are automatically determined by the database server.

-blocking
Specifies the type of row blocking for cursors.

ALL For cursors that are specified with the FOR READ ONLY clause or are not specified as FOR UPDATE, blocking occurs.

UNAMBIG
For cursors that are specified with the FOR READ ONLY clause, blocking occurs.

Cursors that are not declared with the FOR READ ONLY or FOR UPDATE clause which are not *ambiguous* and are *read-only* will be blocked. *Ambiguous* cursors will not be blocked

NO Blocking does not occur for any cursor.

For the definition of a read-only cursor and an ambiguous cursor, refer to ″DECLARE CURSOR″.

-optprofile
Specifies an optimization profile that is used for optimization of data change statements in the packages. This profile is an XML file that must exist on the target server. If -optprofile is not specified, and the CURRENT OPTIMIZATION PROFILE special register is set, the value of CURRENT OPTIMIZATION PROFILE is used. If -optprofile is not specified, and CURRENT OPTIMIZATION PROFILE is not set, no optimization profile is used.

-optprofile is valid only for connections to DB2 Database for Linux, UNIX, and Windows database servers.

-generic
Specifies that DB2Binder rebinds a user package instead of the IBM Data Server Driver for JDBC and SQLJ packages. If -generic is specified, -action rebind and -package must also be specified.

-package
Specifies the name of the package that is to be rebound. This option applies only to user packages. If -package is specified, -action rebind and -generic must also be specified.

-version
Specifies the version ID of the package that is to be rebound. If -version is specified, -action rebind, -package, and -generic must also be specified.

-bindoptions
Specifies a string that is delimited with quotation marks. The contents of that string are one or more parameter and value pairs that represent options for rebinding a user package.

Possible parameters and values are:

bindObjectExistenceRequired
Specifies whether the database server issues an error and does not rebind the package, if all objects or needed privileges do not exist at rebind time. Possible values are:

true This option corresponds to the SQLERROR(NOPACKAGE) bind option.

false This option corresponds to the SQLERROR(CONTINUE) bind option.

degreeIOParallelism
Specifies whether to attempt to run static queries using parallel processing to maximize performance. Possible values are:

1 No parallel processing.

This option corresponds to the DEGREE(1) bind option.

-1 Allow parallel processing.

This option corresponds to the DEGREE(ANY) bind option.

packageAuthorizationRules
Determines the values that apply at run time for the following dynamic SQL attributes:

- The authorization ID that is used to check authorization
- The qualifier that is used for unqualified objects
- The source for application programming options that the database server uses to parse and semantically verify dynamic SQL statements
- Whether dynamic SQL statements can include GRANT, REVOKE, ALTER, CREATE, DROP, and RENAME statements

Possible values are:

0 Use run behavior. This is the default.

This option corresponds to the DYNAMICRULES(RUN) bind option.

1 Use bind behavior.

This option corresponds to the DYNAMICRULES(BIND) bind option.

2 When the package is run as or runs under a stored procedure or user-defined function package, the database server processes dynamic SQL statements using invoke behavior. Otherwise, the database server processes dynamic SQL statements using run behavior.

This option corresponds to the DYNAMICRULES(INVOKERUN) bind option.

3 When the package is run as or runs under a stored procedure or user-defined function package, the database server processes dynamic SQL statements using invoke behavior. Otherwise, the database server processes dynamic SQL statements using bind behavior.

This option corresponds to the DYNAMICRULES(INVOKEBIND) bind option.

4 When the package is run as or runs under a stored procedure or user-defined function package, the database server processes dynamic SQL statements using define behavior. Otherwise, the database server processes dynamic SQL statements using run behavior.

This option corresponds to the DYNAMICRULES(DEFINERUN) bind option.

5 When the package is run as or runs under a stored procedure or user-defined function package, the database server processes dynamic SQL statements using define behavior. Otherwise, the database server processes dynamic SQL statements using bind behavior.

This option corresponds to the DYNAMICRULES(DEFINEBIND) bind option.

packageOwnerIdentifier
Specifies the authorization ID of the owner of the package.

This option corresponds to the OWNER bind option.

isolationLevel
Specifies how far to isolate an application from the effects of other running applications. Possible values are:

1 Uncommitted read

This option corresponds to the ISOLATION(UR) bind option.

2 Cursor stability

This option corresponds to the ISOLATION(CS) bind option.

3 Read stability

This option corresponds to the ISOLATION(RS) bind option.

4 Repeatable read

This option corresponds to the ISOLATION(RR) bind option.

releasePackageResourcesAtCommit
Specifies when to release resources that a program uses at each commit point. Possible values are:

true This option corresponds to the RELEASE(COMMIT) bind option.

false This option corresponds to the RELEASE(DEALLOCATE) bind option.

If -bindoptions is specified, -generic must also be specified.

DB2Binder return codes

DB2Binder returns one of the following return codes:

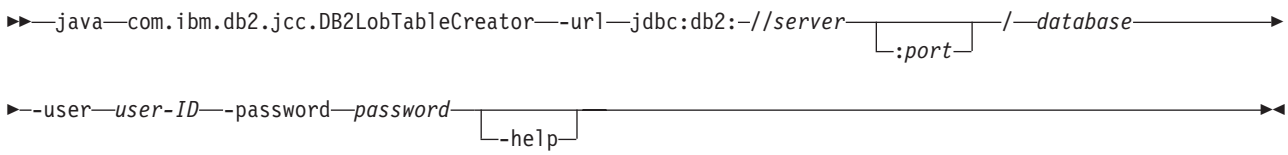
Table 3. DB2Binder return codes

Return code	Meaning
0	Successful execution.
-100	No bind options were specified.
-101	-url value was not specified.
-102	-user value was not specified.
-103	-password value was not specified.
-104	-action value was not specified.
-105	-blocking value was not specified.
-106	-collection value was not specified.
-107	-dbprotocol value was not specified.
-108	-keepdynamic value was not specified.
-109	-owner value was not specified.
-110	-reopt value was not specified.
-111	-size value was not specified.
-112	-tracelevel value was not specified.
-113	-optprofile value was not specified.
-200	No valid bind options were specified.
-201	-url value is invalid.
-204	-action value is invalid.
-205	-blocking value is invalid.
-206	-collection value is invalid.
-207	-dbprotocol value is invalid.
-208	-keepdynamic value is invalid.
-210	-reopt value is invalid.
-211	-size value is invalid.
-212	-tracelevel value is invalid.
-307	-dbprotocol value is not supported by the target database server.
-308	-keepdynamic value is not supported by the target database server.
-310	-reopt value is not supported by the target database server.
-313	-optprofile value is not supported by the target database server.
-401	The `Binder` class was not found.
-402	Connection to the database server failed.
-403	DatabaseMetaData retrieval for the database server failed.
-501	No more packages are available in the cluster.
-502	An existing package is not valid.
-503	The bind process returned an error.
-999	An error occurred during processing of an undocumented bind option.

DB2LobTableCreator utility

The DB2LobTableCreator utility creates tables on a DB2 for z/OS database server. Those tables are required by JDBC or SQLJ applications that use LOB locators to access data in DBCLOB or CLOB columns.

DB2LobTableCreator syntax



DB2LobTableCreator option descriptions

-url
Specifies the data source at which DB2LobTableCreator is to run. The variable parts of the `-url` value are:

jdbc:db2:
Indicates that the connection is to a server in the DB2 family.

server
The domain name or IP address of the database server.

port
The TCP/IP server port number that is assigned to the database server. This is an integer between 0 and 65535. The default is 446.

database
A name for the database server.

database is the DB2 location name that is defined during installation. All characters in this value must be uppercase characters. You can determine the location name by executing the following SQL statement on the server:

```
SELECT CURRENT SERVER FROM SYSIBM.SYSDUMMY1;
```

-user
Specifes the user ID under which DB2LobTableCreator is to run. This user must have authority to create tables in the DSNATPDB database.

-password
Specifes the password for the user ID.

-help
Specifies that the DB2LobTableCreator utility describes each of the options that it supports. If any other options are specified with -help, they are ignored.

Customization of IBM Data Server Driver for JDBC and SQLJ configuration properties

The IBM Data Server Driver for JDBC and SQLJ configuration properties let you set property values that have driver-wide scope. Those settings apply across applications and DataSource instances. You can change the settings without having to change application source code or DataSource characteristics.

Each IBM Data Server Driver for JDBC and SQLJ configuration property setting is of this form:

property=value

property can have one or more of the following forms:
- db2.jcc.override.*property-name*
- db2.jcc.*property-name*
- db2.jcc.default.*property-name*

If the configuration property begins with db2.jcc.override, the configuration property is applicable to all connections and overrides any Connection or DataSource property with the same *property-name*. If the configuration property begins with db2.jcc or db2.jcc.default, the configuration property value is a default. Connection or DataSource property settings override that value.

You can set configuration properties in the following ways:

- Set the configuration properties as Java system properties. Those settings override any other settings.

  For stand-alone Java applications, you can set the configuration properties as Java system properties by specifying -D*property=value* for each configuration property when you execute the java command.
- Set the configuration properties in a resource whose name you specify in the db2.jcc.propertiesFile Java system property. For example, you can specify an absolute path name for the db2.jcc.propertiesFile value.

  For stand-alone Java applications, you can set the configuration properties by specifying the -Ddb2.jcc.propertiesFile=*path* option when you execute the java command.
- Set the configuration properties in a resource named DB2JccConfiguration.properties. A standard Java resource search is used to find DB2JccConfiguration.properties. The IBM Data Server Driver for JDBC and SQLJ searches for this resource only if you have not set the db2.jcc.propertiesFile Java system property.

  DB2JccConfiguration.properties can be a stand-alone file, or it can be included in a JAR file.

  If the DB2JccConfiguration.properties file is in the ISO 8859-1 (Latin-1) encoding scheme, or is in the Latin-1 encoding scheme with some Unicode-encoded (*udddd*) characters, you do not need to do character conversion before the IBM Data Server Driver for JDBC and SQLJ can use the file. If the DB2JccConfiguration.properties file is in some other encoding scheme, you need to use the Java native2ascii converter to convert the contents to Latin-1 or Unicode-encoded characters.

  If DB2JccConfiguration.properties is a stand-alone file, the path for DB2JccConfiguration.properties must be in the CLASSPATH concatenation.

  If DB2JccConfiguration.properties is in a JAR file, the JAR file must be in the CLASSPATH concatenation.

Special setup for accessing DB2 for z/OS servers from Java programs

If you plan to write JDBC or SQLJ applications that access DB2 for z/OS database servers, your IBM Data Server Driver for JDBC and SQLJ installation process requires additional steps.

Follow these steps to allow connectivity to DB2 for z/OS servers:

1. If you plan to connect to any DB2 for z/OS Version 7 or Version 8 database servers, install these PTFs on those database servers.

Table 4. PTFs for DB2 for z/OS stored procedures

DB2 for z/OS	PTF or APAR numbers
Version 7	UQ72083, UQ93889, UK21848
Version 8	UQ93890, UK21849
Version 9	PK44166

2. Run the com.ibm.db2.jcc.DB2Binder utility to bind the DB2 packages that are used at the server by the IBM Data Server Driver for JDBC and SQLJ. See "DB2Binder utility" on page 8 for details.
3. On DB2 for z/OS database servers, customize and run job DSNTIJMS.

   DSNTIJMS is located in data set *prefix*.SDSNSAMP. It performs the following functions:

   - Creates the following stored procedures to support DatabaseMetaData methods, tracing, and error message formatting.
     - SQLCOLPRIVILEGES
     - SQLCOLUMNS
     - SQLFOREIGNKEYS
     - SQLFUNCTIONS
     - SQLFUNCTIONCOLUMNS
     - SQLGETTYPEINFO
     - SQLPRIMARYKEYS
     - SQLPROCEDURECOLS
     - SQLPROCEDURES
     - SQLSPECIALCOLUMNS
     - SQLSTATISTICS
     - SQLTABLEPRIVILEGES
     - SQLTABLES
     - SQLUDTS
     - SQLCAMESSAGE
   - Creates the following tables to support efficient storing of data in CLOB or DBCLOB columns and the use of LOB locators for CLOB or DBCLOB retrieval:
     - SYSIBM.SYSDUMMYU
     - SYSIBM.SYSDUMMYA
     - SYSIBM.SYSDUMMYE

     An alternative way to create those tables is to run the com.ibm.db2.jcc.DB2LobTableCreator utility on the client, against each of the DB2 for z/OS servers. See "DB2LobTableCreator utility" on page 15 for details.
4. Enable Unicode support for OS/390® and z/OS servers.

   If any SQLJ or JDBC programs will use IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to connect to a DB2 for z/OS Version 7 server, the OS/390 or z/OS operating system must support the Unicode UTF-8 encoding scheme. This support requires OS/390 Version 2 Release 9 with APAR OW44581, or a later release of OS/390 or z/OS, plus the OS/390 R8/R9/R10 Support for Unicode. Information APARs II13048 and II13049 contain additional information.
5. If you plan to use IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to implement distributed transactions against DB2 for z/OS Version 7 servers, run the DB2T4XAIndoubtUtil utility once for each of those

DB2 for z/OS Version 7 servers. See "DB2T4XAIndoubtUtil for distributed transactions with DB2 UDB for OS/390 and z/OS Version 7 servers" for details.

DB2T4XAIndoubtUtil for distributed transactions with DB2 UDB for OS/390 and z/OS Version 7 servers

If you plan to implement distributed transactions using IBM Data Server Driver for JDBC and SQLJ type 4 connectivity that include DB2 UDB for OS/390 and z/OS Version 7 servers, you need to run the DB2T4XAIndoubtUtil utility against those servers.

DB2T4XAIndoubtUtil allows Version 7 servers, which do not have built-in support for distributed transactions that implement the XA specification, to emulate that support.

DB2T4XAIndoubtUtil performs one or both of the following tasks:

- Creates a table named SYSIBM.INDOUBT and an associated index
- Binds DB2 packages named T4XAIN01, T4XAIN02, T4XAIN03, and T4XAIN04

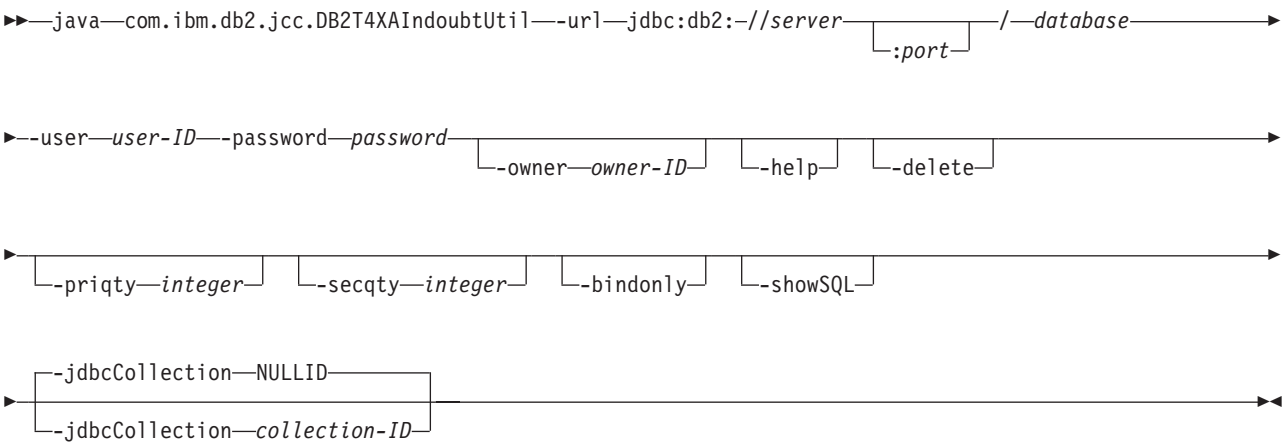
You should create and drop packages T4XAIN01, T4XAIN02, T4XAIN03, and T4XAIN04 only by running DB2T4XAIndoubtUtil. You can create and drop SYSTEM.INDOUBT and its index manually, but it is recommended that you use the utility. See DB2T4XAIndoubtUtil usage notes for instructions on how to create those objects manually.

DB2T4XAIndoubtUtil authorization

To run the DB2T4XAIndoubtUtil utility to create SYSTEM.INDOUBT and bind packages T4XAIN01, T4XAIN02, T4XAIN03, and T4XAIN04, you need SYSADM authority.

To run the DB2T4XAIndoubtUtil only to bind packages T4XAIN01, T4XAIN02, T4XAIN03, and T4XAIN04, you need BIND authority on the packages.

DB2T4XAIndoubtUtil syntax



DB2T4XAIndoubtUtil parameter descriptions

-url
Specifies the data source at which DB2T4XAIndoubtUtil is to run. The variable parts of the `-url` value are:

jdbc:db2:
Indicates that the connection is to a server in the DB2 family.

server
The domain name or IP address of the database server.

port
The TCP/IP server port number that is assigned to the database server. This is an integer between 0 and 65535. The default is 446.

database
A name for the database server.

database is the DB2 location name that is defined during installation. All characters in this value must be uppercase characters. You can determine the location name by executing the following SQL statement on the server:

```
SELECT CURRENT SERVER FROM SYSIBM.SYSDUMMY1;
```

-user
Specifes the user ID under which DB2T4XAIndoubtUtil is to run. This user must have SYSADM authority or must be a member of a RACF® group that corresponds to a secondary authorization ID with SYSADM authority.

-password
Specifes the password for the user ID.

-owner
Specifies a secondary authorization ID that has SYSADM authority. Use the -owner parameter if the -user parameter value does not have SYSADM authority. The -user parameter value must be a member of a RACF group whose name is *owner-ID*.

When the -owner parameter is specified, DB2T4XAIndoubtUtil uses *owner-ID* as:

- The authorization ID for creating the SYSIBM.INDOUBT table.
- The authorization ID of the owner of the T4XAIN01, T4XAIN02, T4XAIN03, and T4XAIN04 packages. SQL statements in those packages are executed using the authority of *owner-ID*.

-help
Specifies that the DB2T4XAIndoubtUtil utility describes each of the options that it supports. If any other options are specified with -help, they are ignored.

-delete
Specifies that the DB2T4XAIndoubtUtil utility deletes the objects that were created when DB2T4XAIndoubtUtil was run previously.

-priqty
Specifies the primary space allocation, in kilobytes, for the table space that contains the SYSIBM.INDOUBT table. The default value for -priqty is 1000.

Important: The -priqty value divided by the page size for the table space in which SYSIBM.INDOUBT resides must be greater than the maximum number of indoubt transactions that are allowed at a given time. For example, for a 4 KB page size, the default -priqty value of 1000 allows about 250 concurrent indoubt transactions.

-secqty
Specifies the secondary space allocation, in kilobytes, for the table space that contains the SYSIBM.INDOUBT table. The default value for -secqty is 0.

Recommendation: Always use the default value of 0 for the -secqty value, and specify a -priqty value that is large enough to accommodate the maximum number of concurrent indoubt transactions.

-bindonly
Specifies that the DB2T4XAIndoubtUtil utility binds the T4XAIN01, T4XAIN02, T4XAIN03, and T4XAIN04 packages and grants permission to PUBLIC to execute the packages, but does not create the SYSIBM.INDOUBT table.

-showSQL
Specifies that the DB2T4XAIndoubtUtil utility displays the SQL statements that it executes.

-jdbcCollection *collection-name* | **NULLID**
Specifies the value of the -collection parameter that was used when the IBM Data Server Driver for JDBC and SQLJ packages were bound with the DB2Binder utility. The -jdbcCollection parameter *must* be specified if the explicitly or implicitly specified value of the -collection parameter was *not* NULLID.

The default is -jdbcCollection NULLID.

DB2T4XAIndoubtUtil usage notes

To create the SYSTEM.INDOUBT table and its index manually, use these SQL statements:

```
CREATE TABLESPACE INDBTTS
 USING STOGROUP
 LOCKSIZE ROW
 BUFFERPOOL BP0
 SEGSIZE 32
 CCSID EBCDIC;

CREATE TABLE SYSIBM.INDOUBT(indbtXid VARCHAR(140) FOR BIT DATA NOT NULL,
                            uowId VARCHAR(25) FOR BIT DATA NOT NULL,
                            pSyncLog VARCHAR(150) FOR BIT DATA,
                            cSyncLog VARCHAR(150) FOR BIT DATA)
 IN INDBTTS;

CREATE UNIQUE INDEX INDBTIDX ON SYSIBM.INDOUBT(indbtXid, uowId);
```

DB2T4XAIndoubtUtil example

Run the DB2T4XAIndoubtUtil to allow a DB2 for OS/390 and z/OS Version 7 subsystem that has IP address mvs1, port number 446, and DB2 location name SJCEC1 to participate in XA distributed transactions.

```
java com.ibm.db2.jcc.DB2T4XAIndoubtUtil -url jdbc:db2://mvs1:446/SJCEC1 \
  -user SYSADM -password mypass
```

Special setup for running Java routines in the HP-UX environment

For the HP-UX operating system on PA-RISC processors, you have extra prerequisites for running Java stored procedures and user-defined functions.

In addition to the prerequisites in "Installing the IBM Data Server Driver for JDBC and SQLJ", you need to perform the following prerequisite steps:

1. Enable the db2hpjv tool by issuing the following commands on the command line:

   ```
   db2hpjv -e
   db2stop
   db2start
   ```

   If you need to disable db2hpjv, issue these commands:

   ```
   db2hpjv -d
   db2stop
   db2start
   ```

   If you need to disable db2hpjv, issue these commands: Java **must** be installed on the operating system before you issue `db2hpjv -e`. DB2 Database for Linux, UNIX, and Windows cannot run on HP-UX if Java routine support is enabled, but Java is not on the operating system.
2. Give the HP-UX run-time linker access to Java shared libraries.

   To run Java stored procedures or user-defined functions, the HP-UX run-time linker must be able to access certain Java shared libraries, and the DB2 system must be able to load these libraries and the JVM. Because the program that does this loading runs with setuid privileges, it looks for the dependent libraries **only** in `/usr/lib/pa20_64`. To create access to the Java shared libraries, choose one of the following methods:

   - Create symbolic links to the Java shared libraries. To do that, log in as root, and issue the following commands to create symbolic links to the Java shared libraries:

     ```
     ln -s /opt/java1.4/jre/lib/PA_RISC2.0W/*.sl /usr/lib/pa20_64
     ln -s /opt/java1.4/jre/lib/PA_RISC2.0W/hotspot/*.sl /usr/lib/pa20_64
     ```

     These commands create symbolic links to the following libraries:

     ```
     /opt/java1.4/jre/lib/PA_RISC2.0W/libnet.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libzip.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/librmi.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libnio.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libverify.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libmlib_image.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libhprof.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libjaas_unix.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libawt.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libcmm.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libdcpr.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libdt_socket.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libfontmanager.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libioser12.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libmawt.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libjsound.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libjava.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libjawt.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libjcov.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libjcpm.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libjdwp.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/libjpeg.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/hotspot/libjsig.sl
     /opt/java1.4/jre/lib/PA_RISC2.0W/hotspot/libjvm.sl
     ```

   - Add the /opt/java1.4/jre/lib/PA_RISC2.0W and opt/java1.4/jre/lib/PA_RISC2.0W/hotspot directories to the /etc/dld.sl.conf file, **and** to the SHLIB_PATH environment.
3. Give the HP-UX run-time linker access to Java shared libraries.

   If the DB2 server cannot find the shared Java libraries when it executes a Java routine, it generates a -4300 error.

Chapter 3. JDBC application programming

Writing a JDBC application has much in common with writing an SQL application in any other language.

In general, you need to do the following things:
- Access the Java packages that contain JDBC methods.
- Declare variables for sending data to or retrieving data from DB2 tables.
- Connect to a data source.
- Execute SQL statements.
- Handle SQL errors and warnings.
- Disconnect from the data source.

Although the tasks that you need to perform are similar to those in other languages, the way that you execute those tasks is somewhat different.

Example of a simple JDBC application

A simple JDBC application demonstrates the basic elements that JDBC applications need to include.

Figure 1. Simple JDBC application

```
import java.sql.*;                                                    1

public class EzJava
{
  public static void main(String[] args)
  {
    String urlPrefix = "jdbc:db2:";
    String url;
    String empNo;                                                     2
    Connection con;
    Statement stmt;
    ResultSet rs;

    System.out.println ("**** Enter class EzJava");

    // Check the that first argument has the correct form for the portion
    // of the URL that follows jdbc:db2:,
    // as described
    // in the Connecting to a data source using the DriverManager
    // interface with the IBM Data Server Driver for JDBC and SQLJ topic.
    // For example, for IBM Data Server Driver for
    // JDBC and SQLJ type 2 connectivity,
    // args[0] might be MVS1DB2M. For
    // type 4 connectivity, args[0] might
    // be //stlmvs1:10110/MVS1DB2M.

    if (args.length==0)
    {
      System.err.println ("Invalid value. First argument appended to "+
       "jdbc:db2: must specify a valid URL.");
      System.exit(1);
    }
    url = urlPrefix + args[0];
```

```
    try
    {
      // Load the driver
      Class.forName("com.ibm.db2.jcc.DB2Driver");                          3a
      System.out.println("**** Loaded the JDBC driver");

      // Create the connection using the IBM Data Server Driver for JDBC and SQLJ
      con = DriverManager.getConnection (url);                             3b
      // Commit changes manually
      con.setAutoCommit(false);
      System.out.println("**** Created a JDBC connection to the data source");

      // Create the Statement
      stmt = con.createStatement();                                        4a
      System.out.println("**** Created JDBC Statement object");

      // Execute a query and generate a ResultSet instance
      rs = stmt.executeQuery("SELECT EMPNO FROM EMPLOYEE");                4b
      System.out.println("**** Created JDBC ResultSet object");

      // Print all of the employee numbers to standard output device
      while (rs.next()) {
        empNo = rs.getString(1);
        System.out.println("Employee number = " + empNo);
      }
      System.out.println("**** Fetched all rows from JDBC ResultSet");
      // Close the ResultSet
      rs.close();
      System.out.println("**** Closed JDBC ResultSet");

      // Close the Statement
      stmt.close();
      System.out.println("**** Closed JDBC Statement");

      // Connection must be on a unit-of-work boundary to allow close
      con.commit();
      System.out.println ( "**** Transaction committed" );

      // Close the connection
      con.close();                                                         6
      System.out.println("**** Disconnected from data source");

      System.out.println("**** JDBC Exit from class EzJava - no errors");

    }

    catch (ClassNotFoundException e)
    {
      System.err.println("Could not load JDBC driver");
      System.out.println("Exception: " + e);
      e.printStackTrace();
    }

    catch(SQLException ex)                                                 5
    {
      System.err.println("SQLException information");
      while(ex!=null) {
        System.err.println ("Error msg: " + ex.getMessage());
        System.err.println ("SQLSTATE: " + ex.getSQLState());
        System.err.println ("Error code: " + ex.getErrorCode());
        ex.printStackTrace();
        ex = ex.getNextException(); // For drivers that support chained exceptions
      }
    }
  }  // End main
}    // End EzJava
```

Notes to Figure 1 on page 23:

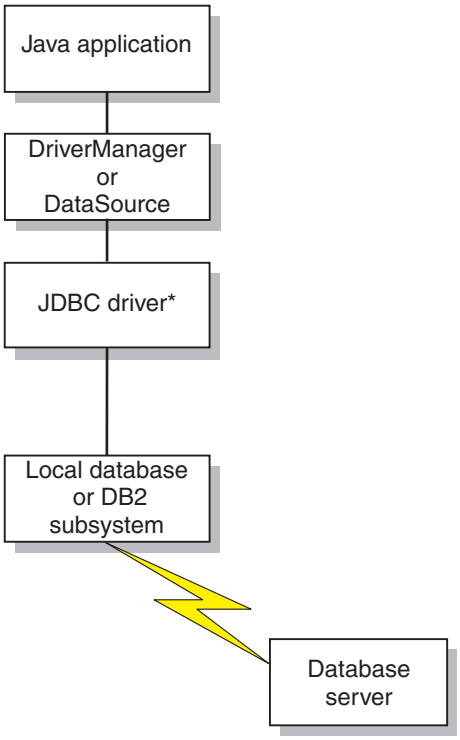
Note	Description
1	This statement imports the java.sql package, which contains the JDBC core API. For information on other Java packages that you might need to access, see ″Java packages for JDBC support″.
2	`String` variable empNo performs the function of a host variable. That is, it is used to hold data retrieved from an SQL query. See ″Variables in JDBC applications″ for more information.
3a and 3b	These two sets of statements demonstrate how to connect to a data source using one of two available interfaces. See ″How JDBC applications connect to a data source″ for more details. Step 3a (loading the JDBC driver) is not necessary if you use JDBC 4.0.
4a and 4b	These two sets of statements demonstrate how to perform a SELECT in JDBC. For information on how to perform other SQL operations, see ″JDBC interfaces for executing SQL″.
5	This `try/catch` block demonstrates the use of the SQLException class for SQL error handling. For more information on handling SQL errors, see ″Handling an SQLException under the IBM Data Server Driver for JDBC and SQLJ″. For information on handling SQL warnings, see ″Handling an SQLWarning under the IBM Data Server Driver for JDBC and SQLJ″.
6	This statement disconnects the application from the data source. See ″Disconnecting from data sources in JDBC applications″.

How JDBC applications connect to a data source

Before you can execute SQL statements in any SQL program, you must be connected to a data source.

The IBM Data Server Driver for JDBC and SQLJ supports type 2 and type 4 connectivity. Connections to DB2 databases can use type 2 or type 4 connectivity. Connections to IBM Informix Dynamic Server (IDS) databases can use type 4 connectivity.

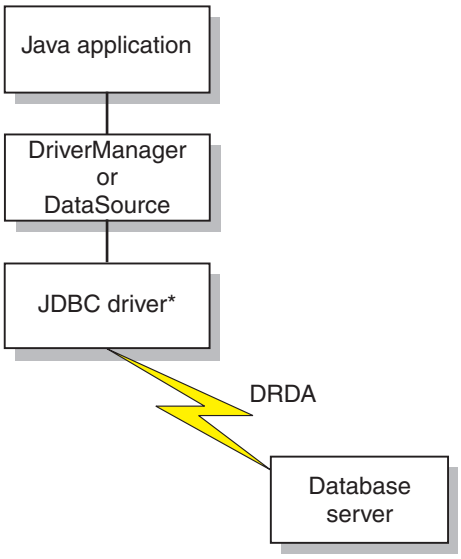
The following figure shows how a Java application connects to a data source using IBM Data Server Driver for JDBC and SQLJ type 2 connectivity.



*Java byte code executed under JVM,
and native code

Figure 2. Java application flow for IBM Data Server Driver for JDBC and SQLJ type 2 connectivity

The following figure shows how a Java application connects to a data source using IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.



*Java byte code executed under JVM

Figure 3. Java application flow for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity

How DB2 applications connect to a data source using the DriverManager interface with the DB2 JDBC Type 2 Driver

A JDBC application can establish a connection to a data source using the JDBC DriverManager interface, which is part of the java.sql package.

The Java application first loads the JDBC driver by invoking the Class.forName method. After the application loads the driver, it connects to a data source by invoking the DriverManager.getConnection method.

For the DB2 JDBC Type 2 Driver for Linux, UNIX and Windows (DB2 JDBC Type 2 Driver), you load the driver by invoking the Class.forName method with the following argument:

```
COM.ibm.db2.jdbc.app.DB2Driver
```

The following code demonstrates loading the DB2 JDBC Type 2 Driver:

```
try {
  // Load the DB2 JDBC Type 2 Driver with DriverManager
  Class.forName("COM.ibm.db2.jdbc.app.DB2Driver");
} catch (ClassNotFoundException e) {
    e.printStackTrace();
}
```

The `catch` block is used to print an error if the driver is not found.

After you load the driver, you connect to the data source by invoking the DriverManager.getConnection method. You can use one of the following forms of getConnection:

```
getConnection(String url);
getConnection(String url, user, password);
getConnection(String url, java.util.Properties info);
```

The *url* argument represents a data source.

For the DB2 JDBC Type 2 Driver, specify a URL of the following form:

Syntax for a URL for the DB2 JDBC Type 2 Driver:

The parts of the URL have the following meanings:

jdbc:db2:
jdbc:db2: indicates that the connection is to a DB2 data source.

database
A database alias. The alias refers to the DB2 database catalog entry on the DB2 client.

The *info* argument is an object of type java.util.Properties that contains a set of driver properties for the connection. Specifying the *info* argument is an alternative to specifying *property=value* strings in the URL.

Specifying a user ID and password for a connection: There are several ways to specify a user ID and password for a connection:

- Use the form of the getConnection method that specifies *user* and *password*.

- Use the form of the getConnection method that specifies *info*, after setting the user and password properties in a java.util.Properties object.

Example: Setting the user ID and password in user and password parameters:

```
String url = "jdbc:db2:toronto";
                                        // Set URL for data source
String user = "db2adm";
String password = "db2adm";
Connection con = DriverManager.getConnection(url, user, password);
                                        // Create connection
```

Example: Setting the user ID and password in a java.util.Properties object:

```
Properties properties = new Properties(); // Create Properties object
properties.put("user", "db2adm");         // Set user ID for connection
properties.put("password", "db2adm");     // Set password for connection
String url = "jdbc:db2:toronto";
                                        // Set URL for data source
Connection con = DriverManager.getConnection(url, properties);
                                        // Create connection
```

Connecting to a data source using the DriverManager interface with the IBM Data Server Driver for JDBC and SQLJ

A JDBC application can establish a connection to a data source using the JDBC DriverManager interface, which is part of the java.sql package.

The steps for establishing a connection are:

1. Load the JDBC driver by invoking the Class.forName method.

   If you are using JDBC 4.0, you do not need to explicitly load the JDBC driver.

   For the IBM Data Server Driver for JDBC and SQLJ, you load the driver by invoking the Class.forName method with the following argument:

   ```
   com.ibm.db2.jcc.DB2Driver
   ```

   For compatibility with previous JDBC drivers, you can use the following argument instead:

   ```
   COM.ibm.db2os390.sqlj.jdbc.DB2SQLJDriver
   ```

   The following code demonstrates loading the IBM Data Server Driver for JDBC and SQLJ:

   ```
   try {
     // Load the IBM Data Server Driver for JDBC and SQLJ with DriverManager
     Class.forName("com.ibm.db2.jcc.DB2Driver");
   } catch (ClassNotFoundException e) {
       e.printStackTrace();
   }
   ```

   The `catch` block is used to print an error if the driver is not found.

2. Connect to a data source by invoking the DriverManager.getConnection method.

   You can use one of the following forms of getConnection:

   ```
   getConnection(String url);
   getConnection(String url, user, password);
   getConnection(String url, java.util.Properties info);
   ```

   For IBM Data Server Driver for JDBC and SQLJ type 4 connectivity, the getConnection method must specify a user ID and password, through parameters or through property values.

The *url* argument represents a data source, and indicates what type of JDBC connectivity you are using.

The *info* argument is an object of type java.util.Properties that contains a set of driver properties for the connection. Specifying the *info* argument is an alternative to specifying *property=value;* strings in the URL. See ″Properties for the IBM Data Server Driver for JDBC and SQLJ″ for the properties that you can specify.

There are several ways to specify a user ID and password for a connection:

- Use the form of the getConnection method that specifies *url* with `property=value`; clauses, and include the user and password properties in the URL.
- Use the form of the getConnection method that specifies *user* and *password*.
- Use the form of the getConnection method that specifies *info*, after setting the user and password properties in a java.util.Properties object.

Example: Establishing a connection and setting the user ID and password in a URL:

```
String url = "jdbc:db2://myhost:5021/mydb:" +
  "user=dbadm;password=dbadm;";

                                          // Set URL for data source
Connection con = DriverManager.getConnection(url);
                                          // Create connection
```

Example: Establishing a connection and setting the user ID and password in user and password parameters:

```
String url = "jdbc:db2://myhost:5021/mydb";
                                          // Set URL for data source
String user = "dbadm";
String password = "dbadm";
Connection con = DriverManager.getConnection(url, user, password);
                                          // Create connection
```

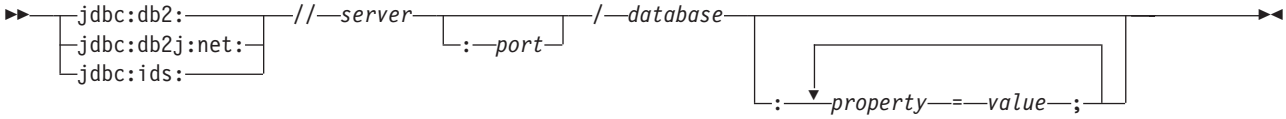
Example: Establishing a connection and setting the user ID and password in a java.util.Properties object:

```
Properties properties = new Properties(); // Create Properties object
properties.put("user", "dbadm");         // Set user ID for connection
properties.put("password", "dbadm");     // Set password for connection
String url = "jdbc:db2://myhost:5021/mydb";
                                          // Set URL for data source
Connection con = DriverManager.getConnection(url, properties);
                                          // Create connection
```

URL format for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity

If you are using type 4 connectivity in your JDBC application, and you are making a connection using the DriverManager interface, you need to specify a URL in the DriverManager.getConnection call that indicates type 4 connectivity.

IBM Data Server Driver for JDBC and SQLJ type 4 connectivity URL syntax



IBM Data Server Driver for JDBC and SQLJ type 4 connectivity URL option descriptions

The parts of the URL have the following meanings:

jdbc:db2: or jdbc:db2j:net:
The meanings of the initial portion of the URL are:

jdbc:db2:
Indicates that the connection is to a DB2 for z/OS, DB2 Database for Linux, UNIX, and Windows.

jdbc:db2: can also be used for a connection to an IBM Informix Dynamic Server (IDS) database, for application portability.

jdbc:db2j:net:
Indicates that the connection is to a remote IBM Cloudscape™ server.

jdbc:ids:
Indicates that the connection is to an IDS data source.
jdbc:informix-sqli: also indicates that the connection is to an IDS data source, but jdbc:ids: should be used.

server
The domain name or IP address of the data source.

port
The TCP/IP server port number that is assigned to the data source. This is an integer between 0 and 65535. The default is 446.

database
A name for the data source.

- If the connection is to a DB2 for z/OS server, *database* is the DB2 location name that is defined during installation. All characters in the DB2 location name must be uppercase characters. The IBM Data Server Driver for JDBC and SQLJ does not convert lowercase characters in the database value to uppercase for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

  You can determine the location name by executing the following SQL statement on the server:

  ```
  SELECT CURRENT SERVER FROM SYSIBM.SYSDUMMY1;
  ```

- If the connection is to a DB2 for z/OS server, all characters in *database* must be uppercase characters.
- If the connection is to a DB2 Database for Linux, UNIX, and Windows server, *database* is the database name that is defined during installation.
- If the connection is to an IDS server, *database* is the database name. The name is case-insensitive. The server converts the name to lowercase.
- If the connection is to an IBM Cloudscape server, the *database* is the fully-qualified name of the file that contains the database. This name must be enclosed in double quotation marks (″). For example:

  ```
  "c:/databases/testdb"
  ```

property=value;
A property and its value for the JDBC connection. You can specify one or more property and value pairs. Each property and value pair, including the last one, must end with a semicolon (;). Do not include spaces or other whitespace characters anywhere within the list of property and value strings.

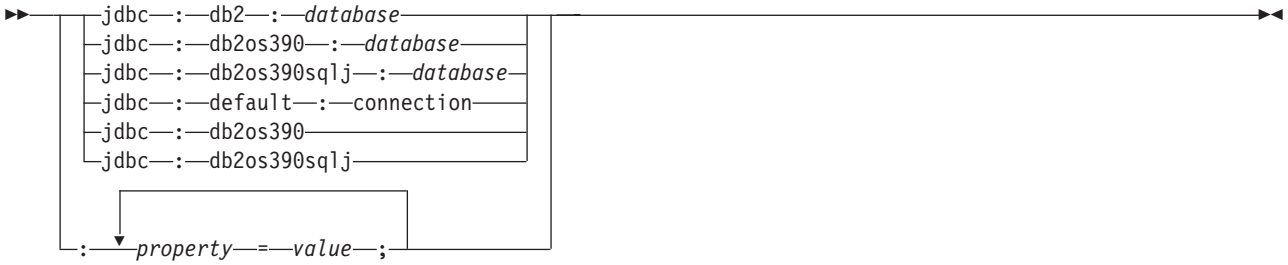
Some properties with an int data type have predefined constant field values. You must resolve constant field values to their integer values before you can use those values in the *url* parameter. For example, you cannot use com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL in a *url* parameter. However, you can build a URL string that includes com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL, and assign the URL string to a String variable. Then you can use the String variable in the *url* parameter:

```
String url =
 "jdbc:db2://sysmvs1.stl.ibm.com:5021" +
 "user=dbadm;password=dbadm;" +
 "traceLevel=" +
 (com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL) + ";";
 Connection con =
   java.sql.DriverManager.getConnection(url);
```

URL format for IBM Data Server Driver for JDBC and SQLJ type 2 connectivity

If you are using type 2 connectivity in your JDBC application, and you are making a connection using the DriverManager interface, you need to specify a URL in the DriverManager.getConnection call indicates type 2 connectivity.

IBM Data Server Driver for JDBC and SQLJ type 2 connectivity URL syntax



IBM Data Server Driver for JDBC and SQLJ type 2 connectivity URL options descriptions

The parts of the URL have the following meanings:

jdbc:db2: or jdbc:db2j:net:
The meanings of the initial portion of the URL are:

jdbc:db2:
Indicates that the connection is to a DB2 for z/OS or DB2 Database for Linux, UNIX, and Windows server.

jdbc:default:connection
Indicates that the URL is for a connection to the local subsystem through a DB2 thread that is controlled by CICS®, IMS™, or the Java stored procedure environment.

jdbc:db2j:net:
Indicates that the connection is to a remote IBM Cloudscape server.

database
A name for the database server.

- *database* is the database name that is defined during installation, if the value of the serverName connection property is null. If the value of serverName property is not null, *database* is a database alias.

- If the connection is to a DB2 for z/OS server or a DB2 for i5/OS server, all characters in *database* must be uppercase characters.

property=value;
A property and its value for the JDBC connection. You can specify one or more property and value pairs. Each property and value pair, including the last one, must end with a semicolon (;). Do not include spaces or other whitespace characters anywhere within the list of property and value strings.

Some properties with an int data type have predefined constant field values. You must resolve constant field values to their integer values before you can use those values in the *url* parameter. For example, you cannot use com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL in a *url* parameter. However, you can build a URL string that includes com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL, and assign the URL string to a String variable. Then you can use the String variable in the *url* parameter:

```
String url =
 "jdbc:db2://sysmvs1.stl.ibm.com:5021" +
 "user=dbadm;password=dbadm;" +
 "traceLevel=" +
 (com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL) + ";";
 Connection con =
   java.sql.DriverManager.getConnection(url);
```

Connecting to a data source using the DataSource interface

If your applications need to be portable among data sources, you should use the DataSource interface.

Using DriverManager to connect to a data source reduces portability because the application must identify a specific JDBC driver class name and driver URL. The driver class name and driver URL are specific to a JDBC vendor, driver implementation, and data source.

When you connect to a data source using the DataSource interface, you use a DataSource object.

The simplest way to use a DataSource object is to create and use the object in the same application, as you do with the DriverManager interface. However, this method does not provide portability.

The best way to use a DataSource object is for your system administrator to create and manage it separately, using WebSphere Application Server or some other tool. The program that creates and manages a DataSource object also uses the Java Naming and Directory Interface (JNDI) to assign a logical name to the DataSource object. The JDBC application that uses the DataSource object can then refer to the object by its logical name, and does not need any information about the underlying data source. In addition, your system administrator can modify the data source attributes, and you do not need to change your application program.

To learn more about using WebSphere to deploy DataSource objects, go to this URL on the Web:

`http://www.ibm.com/software/webservers/appserv/`

To learn about deploying DataSource objects yourself, see ″Creating and deploying DataSource objects″.

You can use the DataSource interface and the DriverManager interface in the same application, but for maximum portability, it is recommended that you use only the DataSource interface to obtain connections.

To obtain a connection using a DataSource object that the system administrator has already created and assigned a logical name to, follow these steps:

1. From your system administrator, obtain the logical name of the data source to which you need to connect.
2. Create a Context object to use in the next step. The Context interface is part of the Java Naming and Directory Interface (JNDI), not JDBC.
3. In your application program, use JNDI to get the DataSource object that is associated with the logical data source name.
4. Use the DataSource.getConnection method to obtain the connection.

   You can use one of the following forms of the getConnection method:

   ```
   getConnection();
   getConnection(String user, String password);
   ```

   Use the second form if you need to specify a user ID and password for the connection that are different from the ones that were specified when the DataSource was deployed.

Example of obtaining a connection using a DataSource object that was created by the system administrator: In this example, the logical name of the data source that you need to connect to is `jdbc/sampledb`. The numbers to the right of selected statements correspond to the previously-described steps.

```
import java.sql.*;
import javax.naming.*;
import javax.sql.*;
...
Context ctx=new InitialContext();                          2
DataSource ds=(DataSource)ctx.lookup("jdbc/sampledb");     3
Connection con=ds.getConnection();                         4
```

Figure 4. Obtaining a connection using a DataSource object

Example of creating and using a DataSource object in the same application:

Figure 5. Creating and using a DataSource object in the same application

```
import java.sql.*;        // JDBC base
import javax.sql.*;       // Addtional methods for JDBC
import com.ibm.db2.jcc.*; // IBM Data Server Driver for JDBC and SQLJ   1
                          // interfaces
DB2SimpleDataSource dbds=new DB2SimpleDataSource();              2
dbds.setDatabaseName("dbloc1");                                  3
                          // Assign the location name
dbds.setDescription("Our Sample Database");
                          // Description for documentation
dbds.setUser("john");
                          // Assign the user ID
dbds.setPassword("dbadm");
                          // Assign the password
Connection con=dbds.getConnection();                             4
                          // Create a Connection object
```

Note	Description
1	Import the package that contains the implementation of the DataSource interface.

Note	Description
2	Creates a DB2SimpleDataSource object. DB2SimpleDataSource is one of the IBM Data Server Driver for JDBC and SQLJ implementations of the DataSource interface. See ″Creating and deploying DataSource objects″ for information on DB2's DataSource implementations.
3	The setDatabaseName, setDescription, setUser, and setPassword methods assign attributes to the DB2SimpleDataSource object. See ″Properties for the IBM Data Server Driver for JDBC and SQLJ″ for information about the attributes that you can set for a DB2SimpleDataSource object under the IBM Data Server Driver for JDBC and SQLJ.
4	Establishes a connection to the data source that DB2SimpleDataSource object dbds represents.

How to determine which type of IBM Data Server Driver for JDBC and SQLJ connectivity to use

The IBM Data Server Driver for JDBC and SQLJ supports two types of connectivity: type 2 connectivity and type 4 connectivity.

For the DriverManager interface, you specify the type of connectivity through the URL in the DriverManager.getConnection method. For the DataSource interface, you specify the type of connectivity through the `driverType` property.

The following table summarizes the differences between type 2 connectivity and type 4 connectivity:

Table 5. Comparison of IBM Data Server Driver for JDBC and SQLJ type 2 connectivity and IBM Data Server Driver for JDBC and SQLJ type 4 connectivity

Function	IBM Data Server Driver for JDBC and SQLJ type 2 connectivity support	IBM Data Server Driver for JDBC and SQLJ type 4 connectivity support
SYSPLEX workload balancing and Connection Concentrator	Supported through DB2 Connect	Supported directly by the driver for a connection within a single JVM Supported through DB2 Connect across JVMs
Communication protocols	TCP/IP	TCP/IP
Performance	Better for accessing a local DB2 server	Better for accessing a remote DB2 server
Installation	Requires installation of native libraries in addition to Java classes	Requires installation of Java classes only
Stored procedures	Can be used to call or execute stored procedures	Can be used only to call stored procedures
Distributed transaction processing (XA)	Supported	Supported
J2EE 1.4 compliance	Compliant	Compliant

The following points can help you determine which type of connectivity to use.

Use IBM Data Server Driver for JDBC and SQLJ type 2 connectivity under these circumstances:

- Your JDBC or SQLJ application runs locally most of the time.
  Local applications have better performance with type 2 connectivity.

- You are *running* a Java stored procedure.

  A stored procedure environment consists of two parts: a client program, from which you call a stored procedure, and a server program, which is the stored procedure. You can call a stored procedure in a JDBC or SQLJ program that uses type 2 or type 4 connectivity, but you must run a Java stored procedure using type 2 connectivity.

Use IBM Data Server Driver for JDBC and SQLJ type 4 connectivity under these circumstances:

- Your JDBC or SQLJ application runs remotely most of the time.

  Remote applications have better performance with type 4 connectivity.
- You are using IBM Data Server Driver for JDBC and SQLJ connection concentrator and Sysplex workload balancing support.

JDBC connection objects

When you connect to a data source by either connection method, you create a Connection object, which represents the connection to the data source.

You use this Connection object to do the following things:

- Create Statement, PreparedStatement, and CallableStatement objects for executing SQL statements. These are discussed in ″Executing SQL statements in JDBC applications″.
- Gather information about the data source to which you are connected. This process is discussed in ″Learning about a data source using DatabaseMetaData methods″.
- Commit or roll back transactions. You can commit transactions manually or automatically. These operations are discussed in ″Commit or roll back a JDBC transaction″.
- Close the connection to the data source. This operation is discussed in ″Disconnecting from data sources in JDBC applications″.

Creating and deploying DataSource objects

JDBC versions starting with version 2.0 provide the DataSource interface for connecting to a data source. Using the DataSource interface is the preferred way to connect to a data source.

Using the DataSource interface involves two parts:

- Creating and deploying DataSource objects. This is usually done by a system administrator, using a tool such as WebSphere Application Server.
- Using the DataSource objects to create a connection. This is done in the application program.

This topic contains information that you need if you create and deploy the DataSource objects yourself.

The IBM Data Server Driver for JDBC and SQLJ provides the following DataSource implementations:

- com.ibm.db2.jcc.DB2SimpleDataSource, which does not support connection pooling. You can use this implementation with IBM Data Server Driver for JDBC and SQLJ type 2 connectivity or IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

- com.ibm.db2.jcc.DB2ConnectionPoolDataSource, which supports connection pooling. You can use this implementation with IBM Data Server Driver for JDBC and SQLJ type 2 connectivity or IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.
- com.ibm.db2.jcc.DB2XADataSource, which supports connection pooling and distributed transactions. The connection pooling is provided by WebSphere Application Server or another application server. You can use this implementation only with IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

The DB2 JDBC Type 2 Driver provides the following DataSource implementations:

- COM.ibm.db2.jdbc.DB2DataSource, which is enabled for connection pooling. With this implementation, connection pooling is handled internally and is transparent to the application.
- COM.ibm.db2.jdbc.DB2XADataSource, which does not have built-in support for distributed transactions and connection pooling. With this implementation, you must manage the distributed transactions and connection pooling yourself, either by writing your own code or by using a tool such as WebSphere Application Server.

When you create and deploy a DataSource object, you need to perform these tasks:

1. Create an instance of the appropriate DataSource implementation.
2. Set the properties of the DataSource object.
3. Register the object with the Java Naming and Directory Interface (JNDI) naming service.

The following example shows how to perform these tasks.

```
import java.sql.*;        // JDBC base
import javax.naming.*;    // JNDI Naming Services
import javax.sql.*;       // Additional methods for JDBC
import com.ibm.db2.jcc.*; // IBM Data Server Driver for
                          // JDBC and SQLJ
                          // implementation of JDBC
                          // standard extension APIs

DB2SimpleDataSource dbds = new com.ibm.db2.jcc.DB2SimpleDataSource();   1

dbds.setDatabaseName("db2loc1");                                        2
dbds.setDescription("Our Sample Database");
dbds.setUser("john");
dbds.setPassword("mypw");
...
Context ctx=new InitialContext();                                       3
Ctx.bind("jdbc/sampledb",dbds);                                         4
```

Figure 6. Example of creating and deploying a DataSource object

Note	Description
1	Creates an instance of the DB2SimpleDataSource class.
2	This statement and the next three statements set values for properties of this DB2SimpleDataSource object.
3	Creates a context for use by JNDI.
4	Associates DBSimple2DataSource object dbds with the logical name jdbc/sampledb. An application that uses this object can refer to it by the name jdbc/sampledb.

Java packages for JDBC support

Before you can invoke JDBC methods, you need to be able to access all or parts of various Java packages that contain those methods.

You can do that either by importing the packages or specific classes, or by using the fully-qualified class names. You might need the following packages or classes for your JDBC program:

java.sql
Contains the core JDBC API.

javax.naming
Contains classes and interfaces for Java Naming and Directory Interface (JNDI), which is often used for implementing a DataSource.

javax.sql
Contains methods for producing server-side applications using Java

javax.transaction
Contains JDBC support for distributed transactions for the DB2 JDBC Type 2 Driver for Linux, UNIX and Windows (DB2 JDBC Type 2 Driver).

com.ibm.db2.jcc
Contains the implementation of JDBC for the IBM Data Server Driver for JDBC and SQLJ.

COM.ibm.db2.jdbc
Contains the implementation of the JDBC for the DB2 JDBC Type 2 Driver.

Learning about a data source using DatabaseMetaData methods

The DatabaseMetaData interface contains methods that retrieve information about a data source. These methods are useful when you write generic applications that can access various data sources.

In generic applications that can access various data sources, you need to test whether a data source can handle various database operations before you execute them. For example, you need to determine whether the driver at a data source is at the JDBC 3.0 level before you invoke JDBC 3.0 methods against that driver.

DatabaseMetaData methods provide the following types of information:
- Features that the data source supports, such as the ANSI SQL level
- Specific information about the JDBC driver, such as the driver level
- Limits, such as the maximum number of columns that an index can have
- Whether the data source supports data definition statements (CREATE, ALTER, DROP, GRANT, REVOKE)
- Lists of objects at the data source, such as tables, indexes, or procedures
- Whether the data source supports various JDBC functions, such as batch updates or scrollable ResultSets
- A list of scalar functions that the driver supports

To invoke DatabaseMetaData methods, you need to perform these basic steps:

1. Create a DatabaseMetaData object by invoking the getMetaData method on the connection.
2. Invoke DatabaseMetaData methods to get information about the data source.
3. If the method returns a ResultSet:

a. In a loop, position the cursor using the next method, and retrieve data from each column of the current row of the ResultSet object using getXXX methods.
b. Invoke the close method to close the ResultSet object.

Example: The following code demonstrates how to use DatabaseMetaData methods to determine the driver version, to get a list of the stored procedures that are available at the data source, and to get a list of datetime functions that the driver supports. The numbers to the right of selected statements correspond to the previously-described steps.

Figure 7. Using DatabaseMetaData methods to get information about a data source

```
Connection con;
DatabaseMetaData dbmtadta;
ResultSet rs;
int mtadtaint;
String procSchema;
String procName;
String dtfnList;
...
dbmtadta = con.getMetaData();     // Create the DatabaseMetaData object  1
mtadtaint = dmtadta.getDriverVersion();                                  2
                                  // Check the driver version
System.out.println("Driver version: " + mtadtaint);
rs = dbmtadta.getProcedures(null, null, "%");
                                  // Get information for all procedures
while (rs.next()) {               // Position the cursor                 3a
 procSchema = rs.getString("PROCEDURE_SCHEM");
                                  // Get procedure schema
 procName = rs.getString("PROCEDURE_NAME");
                                  // Get procedure name
 System.out.println(procSchema + "." + procName);
                                  // Print the qualified procedure name
}
dtfnList = dbmtadta.getTimeDateFunctions();
                                  // Get list of supported datetime functions
System.out.println("Supported datetime functions:");
System.out.println(dtfnList);     // Print the list of datetime functions
rs.close();                       // Close the ResultSet                 3b
```

Variables in JDBC applications

As in any other Java application, when you write JDBC applications, you declare variables. In Java applications, those variables are known as Java identifiers.

Some of those identifiers have the same function as host variables in other languages: they hold data that you pass to or retrieve from database tables. Identifier `empNo` in the following code holds data that you retrieve from the EMPNO table column, which has the CHAR data type.

```
String empNo;
// Execute a query and generate a ResultSet instance
rs = stmt.executeQuery("SELECT EMPNO FROM EMPLOYEE");
while (rs.next()) {
 String empNo = rs.getString(1);
 System.out.println("Employee number = " + empNo);
}
```

Your choice of Java data types can affect performance because DB2 picks better access paths when the data types of your Java variables map closely to the DB2 data types.

JDBC interfaces for executing SQL

You execute SQL statements in a traditional SQL program to insert, update, delete, or merge data in tables, retrieve data from the tables, or call stored procedures. To perform the same functions in a JDBC program, you invoke methods.

Those methods are defined in the following interfaces:

- The Statement interface supports all SQL statement execution. The following interfaces inherit methods from the Statement interface:
  - The PreparedStatement interface supports any SQL statement containing input parameter markers. Parameter markers represent input variables. The PreparedStatement interface can also be used for SQL statements with no parameter markers.

    With the IBM Data Server Driver for JDBC and SQLJ, the PreparedStatement interface can be used to call stored procedures that have input parameters and no output parameters, and that return no result sets. However, the preferred interface is CallableStatement.
  - The CallableStatement interface supports the invocation of a stored procedure.

    The CallableStatement interface can be used to call stored procedures with input parameters, output parameters, or input and output parameters, or no parameters. With the IBM Data Server Driver for JDBC and SQLJ, you can also use the Statement interface to call stored procedures, but those stored procedures must have no parameters.
- The ResultSet interface provides access to the results that a query generates. The ResultSet interface has the same purpose as the cursor that is used in SQL applications in other languages.

Creating and modifying database objects using the Statement.executeUpdate method

The Statement.executeUpdate is one of the JDBC methods that you can use to update tables and call stored procedures.

You can use the Statement.executeUpdate method to do the following things:

- Execute data definition statements, such as CREATE, ALTER, DROP, GRANT, REVOKE
- Execute INSERT, UPDATE, DELETE, and MERGE statements that do not contain parameter markers
- With the IBM Data Server Driver for JDBC and SQLJ, execute the CALL statement to call stored procedures that have no parameters and that return no result sets.

To execute these SQL statements, you need to perform these steps:

1. Invoke the Connection.createStatement method to create a Statement object.
2. Invoke the Statement.executeUpdate method to perform the SQL operation.
3. Invoke the Statement.close method to close the Statement object.

Suppose that you want to execute this SQL statement:

```
UPDATE EMPLOYEE SET PHONENO='4657' WHERE EMPNO='000010'
```

The following code creates Statement object `stmt`, executes the UPDATE statement, and returns the number of rows that were updated in `numUpd`. The numbers to the right of selected statements correspond to the previously-described steps.

```
Connection con;
Statement stmt;
int numUpd;
...
stmt = con.createStatement();               // Create a Statement object  1
numUpd = stmt.executeUpdate(
  "UPDATE EMPLOYEE SET PHONENO='4657' WHERE EMPNO='000010'");              2
                                            // Perform the update
stmt.close();                               // Close Statement object     3
```

Figure 8. Using Statement.executeUpdate

Updating data in tables using the PreparedStatement.executeUpdate method

The Statement.executeUpdate method works if you update DB2 tables with constant values. However, updates often need to involve passing values in variables to DB2 tables. To do that, you use the PreparedStatement.executeUpdate method.

With the IBM Data Server Driver for JDBC and SQLJ, you can also use PreparedStatement.executeUpdate to call stored procedures that have input parameters and no output parameters, and that return no result sets.

DB2 for z/OS does not support dynamic execution of the CALL statement. For calls to stored procedures that are on DB2 for z/OS data sources, the parameters can be parameter markers or literals, but not expressions. The following types of literals are supported:

- Integer
- Double
- Decimal
- Character
- Hexadecimal
- Graphic

For calls to stored procedures that are on IBM Informix Dynamic Server data sources, the PreparedStatement object can be a CALL statement or an EXECUTE PROCEDURE statement.

When you execute an SQL statement many times, you can get better performance by creating the SQL statement as a PreparedStatement.

For example, the following UPDATE statement lets you update the employee table for only one phone number and one employee number:

```
UPDATE EMPLOYEE SET PHONENO='4657' WHERE EMPNO='000010'
```

Suppose that you want to generalize the operation to update the employee table for any set of phone numbers and employee numbers. You need to replace the constant phone number and employee number with variables:

```
UPDATE EMPLOYEE SET PHONENO=? WHERE EMPNO=?
```

Variables of this form are called parameter markers. To execute an SQL statement with parameter markers, you need to perform these steps:

1. Invoke the Connection.prepareStatement method to create a PreparedStatement object.
2. Invoke the PreparedStatement.setXXX methods to pass values to the variables.
3. Invoke the PreparedStatement.executeUpdate method to update the table with the variable values.
4. Invoke the PreparedStatement.close method to close the PreparedStatement object when you have finished using that object.

The following code performs the previous steps to update the phone number to '4657' for the employee with employee number '000010'. The numbers to the right of selected statements correspond to the previously-described steps.

```
Connection con;
PreparedStatement pstmt;
int numUpd;
...
pstmt = con.prepareStatement(
  "UPDATE EMPLOYEE SET PHONENO=? WHERE EMPNO=?");
                                // Create a PreparedStatement object       1
pstmt.setString(1,"4657");      // Assign first value to first parameter   2
pstmt.setString(2,"000010");    // Assign first value to second parameter
numUpd = pstmt.executeUpdate(); // Perform first update                    3
pstmt.setString(1,"4658");      // Assign second value to first parameter
pstmt.setString(2,"000020");    // Assign second value to second parameter
numUpd = pstmt.executeUpdate(); // Perform second update
pstmt.close();                  // Close the PreparedStatement object      4
```

Figure 9. Using PreparedStatement.executeUpdate for an SQL statement with parameter markers

You can also use the PreparedStatement.executeUpdate method for statements that have no parameter markers. The steps for executing a PreparedStatement object with no parameter markers are similar to executing a PreparedStatement object with parameter markers, except you skip step 2. The following example demonstrates these steps.

```
Connection con;
PreparedStatement pstmt;
int numUpd;
...
pstmt = con.prepareStatement(
  "UPDATE EMPLOYEE SET PHONENO='4657' WHERE EMPNO='000010'");
                                // Create a PreparedStatement object  1
numUpd = pstmt.executeUpdate(); // Perform the update                  3
pstmt.close();                  // Close the PreparedStatement object 4
```

Figure 10. Using PreparedStatement.executeUpdate for an SQL statement without parameter markers

JDBC executeUpdate methods against a DB2 for z/OS server

The JDBC standard states that the executeUpdate method returns a row count or 0. However, if the executeUpdate method is executed against a DB2 for z/OS server, it can return a value of -1.

For executeUpdate statements against a DB2 for z/OS server, the value that is returned depends on the type of SQL statement that is being executed:

- For an SQL statement that can have an update count, such as an INSERT, UPDATE, or DELETE statement, the returned value is the number of affected rows. It can be:

  - A positive number, if a positive number of rows are affected by the operation, and the operation is not a mass delete on a segmented table space.
  - 0, if no rows are affected by the operation.
  - -1, if the operation is a mass delete on a segmented table space.
- For an SQL CALL statement, a value of -1 is returned, because the data source cannot determine the number of affected rows. Calls to getUpdateCount or getMoreResults for a CALL statement also return -1.
- For any other SQL statement, a value of -1 is returned.

Making batch updates in JDBC applications

With batch updates, instead of updating rows of a table one at a time, you can direct JDBC to execute a group of updates at the same time. Statements that can be included in the same batch of updates are known as *batchable* statements.

If a statement has input parameters or host expressions, you can include that statement only in a batch that has other instances of the same statement. This type of batch is known as a *homogeneous batch*. If a statement has no input parameters, you can include that statement in a batch only if the other statements in the batch have no input parameters or host expressions. This type of batch is known as a *heterogeneous batch*. Two statements that can be included in the same batch are known as *batch compatible*.

Use the following Statement methods for creating, executing, and removing a batch of SQL updates:
- addBatch
- executeBatch
- clearBatch

Use the following PreparedStatement and CallableStatement method for creating a batch of parameters so that a single statement can be executed multiple times in a batch, with a different set of parameters for each execution.
- addBatch

Restrictions on executing statements in a batch:
- If you try to execute a SELECT statement in a batch, a BatchUpdateException is thrown.
- A CallableStatement object that you execute in a batch can contain output parameters. However, you cannot retrieve the values of the output parameters. If you try to do so, a BatchUpdateException is thrown.
- You cannot retrieve ResultSet objects from a CallableStatement object that you execute in a batch. A BatchUpdateException is not thrown, but the getResultSet method invocation returns a null value.

To make batch updates using several statements with no input parameters, follow these basic steps:
1. For each SQL statement that you want to execute in the batch, invoke the addBatch method.
2. Invoke the executeBatch method to execute the batch of statements.
3. Check for errors. If no errors occurred:
   a. Get the number of rows that were affect by each SQL statement from the array that the executeBatch invocation returns. This number does not include rows that were affected by triggers or by referential integrity enforcement.

b. If AutoCommit is disabled for the Connection object, invoke the commit method to commit the changes.

   If AutoCommit is enabled for the Connection object, the IBM Data Server Driver for JDBC and SQLJ adds a commit method at the end of the batch.

To make batch updates using a single statement with several sets of input parameters, follow these basic steps:

1. Invoke the createStatement method to create a Statement object.
2. For each set of input parameter values:
   a. Execute setXXX methods to assign values to the input parameters.
   b. Invoke the addBatch method to add the set of input parameters to the batch.
3. Invoke the executeBatch method to execute the statements with all sets of parameters.
4. Check for errors. If no errors occurred:
   a. Get the number of rows that were updated by each execution of the SQL statement from the array that the executeBatch invocation returns.
   b. If AutoCommit is disabled for the Connection object, invoke the commit method to commit the changes.

      If AutoCommit is enabled for the Connection object, the IBM Data Server Driver for JDBC and SQLJ adds a commit method at the end of the batch.

In the following code fragment, two sets of parameters are batched. An UPDATE statement that takes two input parameters is then executed twice, once with each set of parameters. The numbers to the right of selected statements correspond to the previously-described steps.

```
try {
...
  PreparedStatement prepStmt = con.prepareStatement(
    "UPDATE DEPT SET MGRNO=? WHERE DEPTNO=?");          1
  prepStmt.setString(1,mgrnum1);                        2a
  prepStmt.setString(2,deptnum1);
  prepStmt.addBatch();                                  2b

  prepStmt.setString(1,mgrnum2);
  prepStmt.setString(2,deptnum2);
  prepStmt.addBatch();
  int [] numUpdates=prepStmt.executeBatch();            3
  for (int i=0; i < numUpdates.length; i++) {           4a
    if (numUpdates[i] == SUCCESS_NO_INFO)
      System.out.println("Execution " + i +
        ": unknown number of rows updated");
    else
      System.out.println("Execution " + i +
        "successful: " numUpdates[i] + " rows updated");
  }
  con.commit();                                         4b
} catch(BatchUpdateException b) {
  // process BatchUpdateException
}
```

Figure 11. Performing a batch update

Learning about parameters in a PreparedStatement using ParameterMetaData methods

The IBM Data Server Driver for JDBC and SQLJ includes support for the ParameterMetaData interface. The ParameterMetaData interface contains methods that retrieve information about the parameter markers in a PreparedStatement object.

ParameterMetaData methods provide the following types of information:

- The data types of parameters, including the precision and scale of decimal parameters.
- The parameters' database-specific type names. For parameters that correspond to table columns that are defined with distinct types, these names are the distinct type names.
- Whether parameters are nullable.
- Whether parameters are input or output parameters.
- Whether the values of a numeric parameter can be signed.
- The fully-qualified Java class name that PreparedStatement.setObject uses when it sets a parameter value.

To invoke ParameterMetaData methods, you need to perform these basic steps:

1. Invoke the Connection.prepareStatement method to create a PreparedStatement object.
2. Invoke the PreparedStatement.getParameterMetaData method to retrieve a ParameterMetaData object.
3. Invoke ParameterMetaData.getParameterCount to determine the number of parameters in the PreparedStatement.
4. Invoke ParameterMetaData methods on individual parameters.

The following code demonstrates how to use ParameterMetaData methods to determine the number and data types of parameters in an SQL UPDATE statement. The numbers to the right of selected statements correspond to the previously-described steps.

```
Connection con;
ParameterMetaData pmtadta;
int mtadtacnt;
String sqlType;
...
pstmt = con.prepareStatement(
  "UPDATE EMPLOYEE SET PHONENO=? WHERE EMPNO=?");
                                  // Create a PreparedStatement object  1
pmtadta = pstmt.getParameterMetaData();                                 2
                                  // Create a ParameterMetaData object
mtadtacnt = pmtadta.getParameterCount();                                3
                                  // Determine the number of parameters
System.out.println("Number of statement parameters: " + mtadtacnt);
for (int i = 1; i <= mtadtacnt; i++) {
  sqlType = pmtadta.getParameterTypeName(i);                            4
                                  // Get SQL type for each parameter
 System.out.println("SQL type of parameter " + i " is " + sqlType);
}
...
pstmt.close();                       // Close the PreparedStatement
```

Figure 12. Using ParameterMetaData methods to get information about a PreparedStatement

Data retrieval in JDBC applications

In JDBC applications, you retrieve data using ResultSet objects. A ResultSet represents the result set of a query.

Retrieving data from tables using the Statement.executeQuery method

To retrieve data from a table using a SELECT statement with no parameter markers, you can use the Statement.executeQuery method.

This method returns a result table in a ResultSet object. After you obtain the result table, you need to use ResultSet methods to move through the result table and obtain the individual column values from each row.

With the IBM Data Server Driver for JDBC and SQLJ, you can also use the Statement.executeQuery method to retrieve a result set from a stored procedure call, if that stored procedure returns only one result set. If the stored procedure returns multiple result sets, you need to use the Statement.execute method.

This topic discusses the simplest kind of ResultSet, which is a read-only ResultSet in which you can only move forward, one row at a time. The IBM Data Server Driver for JDBC and SQLJ also supports updatable and scrollable ResultSets.

To retrieve rows from a table using a SELECT statement with no parameter markers, you need to perform these steps:

1. Invoke the Connection.createStatement method to create a Statement object.
2. Invoke the Statement.executeQuery method to obtain the result table from the SELECT statement in a ResultSet object.
3. In a loop, position the cursor using the next method, and retrieve data from each column of the current row of the ResultSet object using getXXX methods. `XXX` represents a data type.
4. Invoke the ResultSet.close method to close the ResultSet object.
5. Invoke the Statement.close method to close the Statement object when you have finished using that object.

The following code demonstrates how to retrieve all rows from the employee table. The numbers to the right of selected statements correspond to the previously-described steps.

```
String empNo;
Connection con;
Statement stmt;
ResultSet rs;
...
stmt = con.createStatement();     // Create a Statement object          1
rs = stmt.executeQuery("SELECT EMPNO FROM EMPLOYEE");                   2
                                  // Get the result table from the query
while (rs.next()) {               // Position the cursor               3
 empNo = rs.getString(1);             // Retrieve only the first column value
 System.out.println("Employee number = " + empNo);
                                  // Print the column value
}
rs.close();                       // Close the ResultSet               4
stmt.close();                     // Close the Statement               5
```

Figure 13. Using Statement.executeQuery

Retrieving data from tables using the PreparedStatement.executeQuery method

To retrieve data from a table using a SELECT statement with parameter markers, you use the PreparedStatement.executeQuery method.

This method returns a result table in a ResultSet object. After you obtain the result table, you need to use ResultSet methods to move through the result table and obtain the individual column values from each row.

With the IBM Data Server Driver for JDBC and SQLJ, you can also use the PreparedStatement.executeQuery method to retrieve a result set from a stored procedure call, if that stored procedure returns only one result set and has only input parameters. If the stored procedure returns multiple result sets, you need to use the Statement.execute method. See ″Retrieve multiple result sets from a stored procedure in a JDBC application″ for more information.

You can also use the PreparedStatement.executeQuery method for statements that have no parameter markers. When you execute a query many times, you can get better performance by creating the SQL statement as a PreparedStatement.

To retrieve rows from a table using a SELECT statement with parameter markers, you need to perform these steps:

1. Invoke the Connection.prepareStatement method to create a PreparedStatement object.
2. Invoke PreparedStatement.setXXX methods to pass values to the input parameters.
3. Invoke the PreparedStatement.executeQuery method to obtain the result table from the SELECT statement in a ResultSet object.
4. In a loop, position the cursor using the ResultSet.next method, and retrieve data from each column of the current row of the ResultSet object using getXXX methods.
5. Invoke the ResultSet.close method to close the ResultSet object.
6. Invoke the PreparedStatement.close method to close the PreparedStatement object when you have finished using that object.

The following code demonstrates how to retrieve rows from the employee table for a specific employee. The numbers to the right of selected statements correspond to the previously-described steps.

```
String empnum, phonenum;
Connection con;
PreparedStatement pstmt;
ResultSet rs;
...
pstmt = con.prepareStatement(
  "SELECT EMPNO, PHONENO FROM EMPLOYEE WHERE EMPNO=?");
                                  // Create a PreparedStatement object   1
pstmt.setString(1,"000010");      // Assign value to input parameter     2

rs = pstmt.executeQuery();        // Get the result table from the query 3
while (rs.next()) {               // Position the cursor                 4
 empnum = rs.getString(1);        // Retrieve the first column value
 phonenum = rs.getString(2);      // Retrieve the first column value
 System.out.println("Employee number = " + empnum +
   "Phone number = " + phonenum);
                                  // Print the column values
}
rs.close();                       // Close the ResultSet                 5
pstmt.close();                    // Close the PreparedStatement         6
```

Figure 14. Example of using PreparedStatement.executeQuery

Making batch queries in JDBC applications

The IBM Data Server Driver for JDBC and SQLJ provides a IBM Data Server Driver for JDBC and SQLJ-only DB2PreparedStatement interface that lets you perform batch queries on a homogeneous batch.

To make batch queries using a single statement with several sets of input parameters, follow these basic steps:

1. Invoke the prepareStatement method to create a PreparedStatement object for the SQL statement with input parameters.
2. For each set of input parameter values:
   a. Execute PreparedStatement.setXXX methods to assign values to the input parameters.
   b. Invoke the PreparedStatement.addBatch method to add the set of input parameters to the batch.
3. Cast the PreparedStatement object to a DB2PreparedStatement object.
4. Invoke the DB2PreparedStatement.executeBatch method to execute the statement with all sets of parameters.
5. Check for errors.

Example: In the following code fragment, two sets of parameters are batched. A SELECT statement that takes one input parameter is then executed twice, once with each parameter value. The numbers to the right of selected statements correspond to the previously described steps.

```
try {
...
  PreparedStatement prepStmt = con.prepareStatement(
    "SELECT EMPNO FROM EMPLOYEE WHERE EMPNO=?");        1
  prepStmt.setString(1,empnum1);                        2a
  prepStmt.addBatch();                                  2b

  prepStmt.setString(1,empnum2);
  prepStmt.addBatch();
  ((com.ibm.db2.jcc.DB2PreparedStatement)prepStmt).executeDB2QueryBatch();
```

```
} catch(BatchUpdateException b) {                    3,4
  // process BatchUpdateException                    5
}
```

Learning about a ResultSet using ResultSetMetaData methods

You cannot assume that you know the number of columns and data types of the columns in a table or result set. This is true especially when you are retrieving data from a remote data source.

When you write programs that retrieve unknown ResultSets, you need to use ResultSetMetaData methods to determine the characteristics of the ResultSets before you can retrieve data from them.

ResultSetMetaData methods provide the following types of information:

- The number of columns in a ResultSet
- The qualifier for the underlying table of the ResultSet
- Information about a column, such as the data type, length, precision, scale, and nullability
- Whether a column is read-only

After you invoke the executeQuery method to generate a ResultSet for a query on a table, follow these basic steps to determine the contents of the ResultSet:

1. Invoke the getMetaData method on the ResultSet object to create a ResultSetMetaData object.
2. Invoke the getColumnCount method to determine how many columns are in the ResultSet.
3. For each column in the ResultSet, execute ResultSetMetaData methods to determine column characteristics.

   The results of ResultSetMetaData.getColumnName call reflects the column name information that is stored in the DB2 catalog for that data source.

The following code demonstrates how to determine the data types of all the columns in the employee table. The numbers to the right of selected statements correspond to the previously-described steps.

```
String s;
Connection con;
Statement stmt;
ResultSet rs;
ResultSetMetaData rsmtadta;
int colCount
int mtadtaint;
int i;
String colName;
String colType;
...
stmt = con.createStatement();     // Create a Statement object
rs = stmt.executeQuery("SELECT * FROM EMPLOYEE");
                                  // Get the ResultSet from the query
rsmtadta = rs.getMetaData();      // Create a ResultSetMetaData object  1
colCount = rsmtadta.getColumnCount();                                  2
                                  // Find number of columns in EMP
for (i=1; i<= colCount; i++) {                                         3
 colName = rsmtadta.getColumnName();    // Get column name
 colType = rsmtadta.getColumnTypeName();
                                        // Get column data type
 System.out.println("Column = " + colName +
  " is data type " + colType);
                                        // Print the column value
}
```

Figure 15. Using ResultSetMetaData methods to get information about a ResultSet

Characteristics of a JDBC ResultSet under the IBM Data Server Driver for JDBC and SQLJ

The IBM Data Server Driver for JDBC and SQLJ provides support for scrollable, updatable, and holdable cursors.

In addition to moving forward, one row at a time, through a ResultSet, you might want to do the following things:

- Move backward or go directly to a specific row
- Update, delete, or insert rows in a ResultSet
- Leave the ResultSet open after a COMMIT

The following terms describe characteristics of a ResultSet:

scrollability
Whether the cursor for the ResultSet can move forward only, or forward one or more rows, backward one or more rows, or to a specific row.

If a cursor for a ResultSet is scrollable, it also has a sensitivity attribute, which describes whether the cursor is sensitive to changes to the underlying table.

updatability
Whether the cursor can be used to update or delete rows. This characteristic does not apply to a ResultSet that is returned from a stored procedure, because a stored procedure ResultSet cannot be updated.

For IBM Informix Dynamic Server data sources, cursors cannot be updatable.

holdability
Whether the cursor stays open after a COMMIT.

You set the updatability, scrollability, and holdability characteristics of a ResultSet through parameters in the Connection.prepareStatement or

Connection.createStatement methods. The ResultSet settings map to attributes of a cursor in the database. The following table lists the JDBC scrollability, updatability, and holdability settings, and the corresponding cursor attributes.

Table 6. JDBC ResultSet characteristics and SQL cursor attributes

JDBC setting	DB2 cursor setting	IBM Informix Dynamic Server cursor setting
CONCUR_READ_ONLY	FOR READ ONLY	FOR READ ONLY
CONCUR_UPDATABLE	FOR UPDATE	FOR UPDATE
HOLD_CURSORS_OVER_COMMIT	WITH HOLD	WITH HOLD
TYPE_FORWARD_ONLY	SCROLL not specified	SCROLL not specified
TYPE_SCROLL_INSENSITIVE	INSENSITIVE SCROLL	SCROLL
TYPE_SCROLL_SENSITIVE	SENSITIVE STATIC, SENSITIVE DYNAMIC, or ASENSITIVE, depending on the cursorSensitvity Connection and DataSource property	Not supported

If a JDBC ResultSet is static, the size of the result table and the order of the rows in the result table do not change after the cursor is opened. This means that if you insert rows into the underlying table, the result table for a static ResultSet does not change. If you delete a row of a result table, a delete hole occurs. You cannot update or delete a delete hole.

Specifying updatability, scrollability, and holdability for ResultSets in JDBC applications:

You use special parameters in the Connection.prepareStatement or Connection.createStatement methods to specify the updatability, scrollability, and holdability of a ResultSet.

By default, ResultSet objects not scrollable and not updatable. The default holdability depends on the data source, and can be determined from the DatabaseMetaData.getResultSetHoldability method. To change the scrollability, updatability, and holdability attributes for a ResultSet, follow these steps:

1. If the SELECT statement that defines the ResultSet has no input parameters, invoke the createStatement method to create a Statement object. Otherwise, invoke the prepareStatement method to create a PreparedStatement object. You need to specify forms of the createStatement or prepareStatement methods that include the *resultSetType*, *resultSetConcurrency*, or *resultSetHoldability* parameters.

   The form of the createStatement method that supports scrollability and updatability is:

   ```
   createStatement(int resultSetType, int resultSetConcurrency);
   ```

   The form of the createStatement method that supports scrollability, updatability, and holdability is:

   ```
   createStatement(int resultSetType, int resultSetConcurrency,
    int resultSetHoldability);
   ```

   The form of the prepareStatement method that supports scrollability and updatability is:

   ```
   prepareStatement(String sql, int resultSetType,
    int resultSetConcurrency);
   ```

The form of the prepareStatement method that supports scrollability, updatability, and holdability is:

```
prepareStatement(String sql, int resultSetType,
 int resultSetConcurrency, int resultSetHoldability);
```

The following table contains a list of valid values for *resultSetType* and *resultSetConcurrency*.

Table 7. Valid combinations of resultSetType and resultSetConcurrency for scrollable ResultSets

resultSetType **value**	*resultSetConcurrency* **value**
TYPE_FORWARD_ONLY	CONCUR_READ_ONLY
TYPE_FORWARD_ONLY	CONCUR_UPDATABLE
TYPE_SCROLL_INSENSITIVE	CONCUR_READ_ONLY
TYPE_SCROLL_SENSITIVE	CONCUR_READ_ONLY
TYPE_SCROLL_SENSITIVE	CONCUR_UPDATABLE

resultSetHoldability has two possible values: HOLD_CURSORS_OVER_COMMIT and CLOSE_CURSORS_AT_COMMIT. Either of these values can be specified with any valid combination of *resultSetConcurrency* and *resultSetHoldability*. The value that you set overrides the default holdability for the connection.

Restriction: If the ResultSet is scrollable, and the ResultSet is used to select columns from a table on a DB2 Database for Linux, UNIX, and Windows server, the SELECT list of the SELECT statement that defines the ResultSet cannot include columns with the following data types:

- BLOB
- CLOB
- XML
- A distinct type that is based on any of the previous data types in this list

2. If the SELECT statement has input parameters, invoke setXXX methods to pass values to the input parameters.
3. Invoke the executeQuery method to obtain the result table from the SELECT statement in a ResultSet object.
4. For each row that you want to access:
   a. Position the cursor using one of the methods that are listed in the following table.

Table 8. ResultSet methods for positioning a scrollable cursor

Method	**Positions the cursor**
first	On the first row of the ResultSet
last	On the last row of the ResultSet
next[1]	On the next row of the ResultSet
previous[2]	On the previous row of the ResultSet
absolute(int *n*)[3]	If $n>0$, on row n of the ResultSet. If $n<0$, and m is the number of rows in the ResultSet, on row $m+n+1$ of the ResultSet.
relative(int *n*)[4,5]	If $n>0$, on the row that is n rows after the current row. If $n<0$, on the row that is n rows before the current row. If $n=0$, on the current row.
afterLast	After the last row in the ResultSet
beforeFirst	Before the first row in the ResultSet

Table 8. ResultSet methods for positioning a scrollable cursor (continued)

Method	Positions the cursor

Notes:

1. If the cursor is before the first row of the ResultSet, this method positions the cursor on the first row.
2. If the cursor is after the last row of the ResultSet, this method positions the cursor on the last row.
3. If the absolute value of *n* is greater than the number of rows in the result set, this method positions the cursor after the last row if *n* is positive, or before the first row if *n* is negative.
4. The cursor must be on a valid row of the ResultSet before you can use this method. If the cursor is before the first row or after the last row, the method throws an SQLException.
5. Suppose that *m* is the number of rows in the ResultSet and *x* is the current row number in the ResultSet. If $n>0$ and $x+n>m$, the driver positions the cursor after the last row. If $n<0$ and $x+n<1$, the driver positions the cursor before the first row.

b. If you need to know the current cursor position, use the getRow, isFirst, isLast, `isBeforeFirst`, or isAfterLast method to obtain this information.

c. If you specified a *resultSetType* value of `TYPE_SCROLL_SENSITIVE` in step 1 on page 50, and you need to see the latest values of the current row, invoke the refreshRow method.

   Recommendation: Because refreshing the rows of a ResultSet can have a detrimental effect on the performance of your applications, you should invoke refreshRow *only* when you need to see the latest data.

d. Perform one or more of the following operations:

   - To retrieve data from each column of the current row of the ResultSet object, use getXXX methods.
   - To update the current row from the underlying table, use updateXXX methods to assign column values to the current row of the ResultSet. Then use updateRow to update the corresponding row of the underlying table. If you decide that you do not want to update the underlying table, invoke the cancelRowUpdates method instead of the updateRow method.

     The *resultSetConcurrency* value for the ResultSet must be `CONCUR_UPDATABLE` for you to use these methods.
   - To delete the current row from the underlying table, use the deleteRow method. Invoking deleteRow causes the driver to replace the current row of the ResultSet with a hole.

     The *resultSetConcurrency* value for the ResultSet must be `CONCUR_UPDATABLE` for you to use this method.

5. Invoke the close method to close the ResultSet object.
6. Invoke the close method to close the Statement or PreparedStatement object.

The following code demonstrates how to retrieve all rows from the employee table in reverse order, and update the phone number for employee number ″000010″. The numbers to the right of selected statements correspond to the previously-described steps.

```
String s;
Connection con;
Statement stmt;
ResultSet rs;
...
stmt = con.createStatement(ResultSet.TYPE_SCROLL_SENSITIVE,
                           ResultSet.CONCUR_UPDATABLE);                1
                                        // Create a Statement object
                                        // for a scrollable, updatable
                                        // ResultSet
rs = stmt.executeQuery("SELECT EMPNO FROM EMPLOYEE FOR UPDATE OF PHONENO");
                                       // Create the ResultSet         3
rs.afterLast();                        // Position the cursor at the end of
                                       // the ResultSet                4a
while (rs.previous()) {                // Position the cursor backward
 s = rs.getString("EMPNO");            // Retrieve the employee number 4d
                                       // (column 1 in the result
                                       // table)
 System.out.println("Employee number = " + s);
                                       // Print the column value
 if (s.compareTo("000010") == 0) {     // Look for employee 000010
  rs.updateString("PHONENO","4657");   // Update their phone number
  rs.updateRow();                      // Update the row
 }
}
rs.close();                            // Close the ResultSet          5
stmt.close();                          // Close the Statement          6
```

Figure 16. Using a scrollable cursor

Testing whether the current row of a ResultSet is a delete or update hole in a JDBC application:

If a ResultSet has the TYPE_SCROLL_SENSITIVE attribute, and the underlying cursor is SENSITIVE STATIC, you need to test for delete or update holes before you attempt to retrieve rows of the ResultSet.

After a SENSITIVE STATIC ResultSet is opened, it does not change size. This means that deleted rows are replaced by placeholders, which are also called *holes*. If updated rows no longer fit the criteria for the ResultSet, those rows also become holes. You cannot retrieve rows that are holes.

To test whether the current row in a ResultSet is a delete hole or update hole, follow these steps:

1. Call the DatabaseMetaData.deletesAreDetected or DatabaseMetaData.updatesAreDetected method with the TYPE_SCROLL_SENSITIVE argument to determine whether the data source creates holes for a TYPE_SCROLL_SENSITIVE ResultSet.
2. If DatabaseMetaData.deletesAreDetected or DatabaseMetaData.updatesAreDetected returns `true`, which means that the data source can create holes, call the ResultSet.rowDeleted or ResultSet.rowUpdated method to determine whether the current row is a delete or update hole. If the method returns `true`, the current row is a hole.

The following code tests whether the current row is a delete hole.

```
Statement stmt = con.createStatement(ResultSet.TYPE_SCROLL_SENSITIVE,
  ResultSet.CONCUR_UPDATABLE);
                                       // Create a Statement object
                                       // for a scrollable, updatable
                                       // ResultSet
ResultSet rs =
```

```
  stmt.executeQuery("SELECT EMPNO FROM EMPLOYEE FOR UPDATE OF PHONENO");
                                        // Create the ResultSet
DatabaseMetaData dbmd = con.getMetaData();
                                        // Create the DatabaseMetaData object
boolean dbSeesDeletes =
  dbmd.deletesAreDetected(ResultSet.TYPESCROLL_SENSITIVE);
                                        // Can the database see delete holes?
rs.afterLast();                         // Position the cursor at the end of
                                        // the ResultSet
while (rs.previous()) {                 // Position the cursor backward
 if (dbSeesDeletes) {                   // If delete holes can be detected
   if (!(rs.rowDeleted()))              // If this row is not a delete hole
   {
     s = rs.getString("EMPNO");         // Retrieve the employee number
     System.out.println("Employee number = " + s);
                                        // Print the column value
   }
  }
}
rs.close();                             // Close the ResultSet
stmt.close();                           // Close the Statement
```

Inserting a row into a ResultSet in a JDBC application:

If a ResultSet has a *resultSetConcurrency* attribute of CONCUR_UPDATABLE, you can insert rows into the ResultSet.

To insert a row into a ResultSet, follow these steps:

1. Perform the following steps for each row that you want to insert.
   a. Call the ResultSet.moveToInsertRow method to create the row that you want to insert. The row is created in a buffer outside the ResultSet.

      If an insert buffer already exists, all old values are cleared from the buffer.
   b. Call ResultSet.updateXXX methods to assign values to the row that you want to insert.

      You need to assign a value to at least one column in the ResultSet. If you do not do so, an SQLException is thrown when the row is inserted into the ResultSet.

      If you do not assign a value to a column of the ResultSet, when the underlying table is updated, the data source inserts the default value for the associated table column.

      If you assign a null value to a column that is defined as NOT NULL, the JDBC driver throws and SQLException.
   c. Call ResultSet.insertRow to insert the row into the ResultSet.

      After you call ResultSet.insertRow, all values are always cleared from the insert buffer, even if ResultSet.insertRow fails.
2. Reposition the cursor within the ResultSet.

   To move the cursor from the insert row to the ResultSet, you can invoke any of the methods that position the cursor at a specific row, such as ResultSet.first, ResultSet.absolute, or ResultSet.relative. Alternatively, you can call ResultSet.moveToCurrentRow to move the cursor to the row in the ResultSet that was the current row before the insert operation occurred.

   After you call ResultSet.moveToCurrentRow, all values are cleared from the insert buffer.

Example: The following code illustrates inserting a row into a ResultSet that consists of all rows in the sample DEPARTMENT table. After the row is inserted,

the code places the cursor where it was located in the ResultSet before the insert operation. The numbers to the right of selected statements correspond to the previously-described steps.

```
stmt = con.createStatement(ResultSet.TYPE_SCROLL_SENSITIVE,
              ResultSet.CONCUR_UPDATABLE);
ResultSet rs = stmt.executeQuery("SELECT * FROM DEPARTMENT");
rs.moveToInsertRow();                                          1a
rs.updateString("DEPT_NO", "M13");                             1b
rs.updateString("DEPTNAME", "TECHNICAL SUPPORT");
rs.updateString("MGRNO", "000010");
rs.updateString("ADMRDEPT", "A00");
rs.insertRow();                                                1c
rs.moveToCurrentRow();                                         2
```

Testing whether the current row was inserted into a ResultSet in a JDBC application:

If a ResultSet is dynamic, you can insert rows into it. After you insert rows into a ResultSet you might need to know which rows were inserted.

To test whether the current row in a ResultSet was inserted, follow these steps:

1. Call the DatabaseMetaData.ownInsertsAreVisible and DatabaseMetaData.othersInsertsAreVisible methods to determine whether inserts can be visible to the given type of ResultSet.
2. If inserts can be visible to the ResultSet, call the DatabaseMetaData.insertsAreDetected method to determine whether the given type of ResultSet can detect inserts.
3. If the ResultSet can detect inserts, call the ResultSet.rowInserted method to determine whether the current row is was inserted.

Multi-row SQL operations with the IBM Data Server Driver for JDBC and SQLJ

IBM Data Server Driver for JDBC and SQLJ supports multi-row INSERT, UPDATE, and FETCH for connections to data sources that support these operations.

Multi-row INSERT

When you execute multiple INSERT statements in a batch, and the data source supports multi-row INSERT, the IBM Data Server Driver for JDBC and SQLJ uses multi-row INSERT to insert the rows. Multi-row INSERT can provide better performance than individual INSERT statements.

You cannot execute a multi-row insert operation by including a multi-row INSERT statement in your JDBC application.

Multi-row FETCH

When you use a scrollable cursor to perform a FETCH in a JDBC application, and the useRowsetCursor property value is set to `true` or not set, the IBM Data Server Driver for JDBC and SQLJ uses multi-row FETCH to retrieve the rows, if the data source supports multi-row FETCH. Multi-row FETCH can provide better performance than individual FETCH statements.

Multi-row positioned UPDATE or DELETE

The IBM Data Server Driver for JDBC and SQLJ supports a technique for performing positioned update or delete operations that follows the JDBC 1

standard. That technique involves using the ResultSet.getCursorName method to obtain the name of the cursor for the ResultSet, and defining a positioned UPDATE or positioned DELETE statement of the following form:

```
UPDATE table SET col1=value1,...coln=valueN WHERE CURRENT OF cursorname
DELETE FROM table WHERE CURRENT OF cursorname
```

If you use the JDBC 1 technique to update or delete data on a data source that supports multi-row FETCH, the positioned UPDATE or DELETE statement might update or delete multiple rows, when you expect it to update or delete a single row. To avoid unexpected updates or deletes, you can take one of the following actions:

- Use an updatable ResultSet to retrieve and update one row at a time.
- Use the FOR ROW *n* OF ROWSET clause in your UPDATE or DELETE statements, to specify a specific row to modify or delete.

Calling stored procedures in JDBC applications

To call stored procedures, you invoke methods in the CallableStatement class.

The basic steps for calling a stored procedures are:

1. Invoke the Connection.prepareCall method with the CALL statement as its argument to create a CallableStatement object.

   Restriction: The parameter types that are permitted depend on whether the data source supports dynamic execution of the CALL statement. DB2 for z/OS does not support dynamic execution of the CALL statement. For a call to a stored procedure that is on a DB2 for z/OS database server, the parameters can be parameter markers or literals, but not expressions. The following table lists the types of literals that are supported, and the JDBC types to which they map.

Table 9. Supported literal types in parameters in DB2 for z/OS stored procedure calls

Literal parameter type	JDBC type	Examples
Integer	java.sql.Types.INTEGER	-122, 40022, +27
Floating-point decimal	java.sql.Types.DOUBLE	23E12, 40022E-4, +2723E+15, 1E+23, 0E0
Fixed-point decimal	java.sql.Types.DECIMAL	-23.12, 40022.4295, 0.0, +2723.23, 10000000000
Character	java.sql.Types.VARCHAR	'Grantham Lutz', 'O''Conner', 'ABcde?z?'
Hexadecimal	java.sql.Types.VARBINARY	X'C1C30427', X'00CF18E0'
Unicode string	java.sql.Types.VARCHAR	UX'0041', UX'0054006500730074'

2. Invoke the CallableStatement.setXXX methods to pass values to the input parameters (parameters that are defined as IN in the CREATE PROCEDURE statement).

   Restriction: If the data source does not support dynamic execution of the CALL statement, you must specify the data types for CALL statement input parameters **exactly** as they are specified in the stored procedure definition.
3. Invoke the CallableStatement.registerOutParameter method to indicate which parameters are output-only parameters (parameters that are defined as OUT in the CREATE PROCEDURE statement) or input and output parameters (parameters that are defined as INOUT in the CREATE PROCEDURE statement).

Restriction: If the data source does not support dynamic execution of the CALL statement, you must specify the data types for CALL statement output-only or input and output parameters **exactly** as they are specified in the stored procedure definition.

4. Invoke one of the following methods to call the stored procedure:

   CallableStatement.executeUpdate
   Invoke this method if the stored procedure does not return result sets.

   CallableStatement.executeQuery
   Invoke this method if the stored procedure returns one result set.

   CallableStatement.execute
   Invoke this method if the stored procedure returns multiple result sets, or an unknown number of result sets.

   Restriction: IBM Informix Dynamic Server (IDS) data sources do not support multiple result sets.

5. If the stored procedure returns multiple result sets, retrieve the result sets.

   Restriction: IDS data sources do not support multiple result sets.

6. Invoke the CallableStatement.getXXX methods to retrieve values from the OUT parameters or INOUT parameters.
7. Invoke the CallableStatement.close method to close the CallableStatement object when you have finished using that object.

Example: The following code illustrates calling a stored procedure that has one input parameter, four output parameters, and no returned ResultSets. The numbers to the right of selected statements correspond to the previously-described steps.

```
int ifcaret;
int ifcareas;
int xsbytes;
String errbuff;
Connection con;
CallableStatement cstmt;
ResultSet rs;
...
cstmt = con.prepareCall("CALL DSN8.DSN8ED2(?,?,?,?,?)");              1
                                  // Create a CallableStatement object
cstmt.setString (1, "DISPLAY THREAD(*)");                             2
                                  // Set input parameter (DB2 command)
cstmt.registerOutParameter (2, Types.INTEGER);                        3
                                  // Register output parameters
cstmt.registerOutParameter (3, Types.INTEGER);
cstmt.registerOutParameter (4, Types.INTEGER);
cstmt.registerOutParameter (5, Types.VARCHAR);
cstmt.executeUpdate();            // Call the stored procedure        4
ifcaret = cstmt.getInt(2);        // Get the output parameter values  6
ifcareas = cstmt.getInt(3);
xsbytes = cstmt.getInt(4);
errbuff = cstmt.getString(5);
cstmt.close();                                                        7
```

Retrieving multiple result sets from a stored procedure in a JDBC application

If you call a stored procedure that returns result sets, you need to include code to retrieve the result sets.

The steps that you take depend on whether you know how many result sets are returned, and whether you know the contents of those result sets.

Retrieving a known number of result sets from a stored procedure in a JDBC application:

Retrieving a known number of result sets from a stored procedure is a simpler procedure than retrieving an unknown number of result sets.

To retrieve result sets when you know the number of result sets and their contents, follow these steps:

1. Invoke the Statement.execute method, the PreparedStatement.execute method, or the CallableStatement.execute method to call the stored procedure.

   Use PreparedStatement.execute if the stored procedure has input parameters.
2. Invoke the getResultSet method to obtain the first result set, which is in a ResultSet object.
3. In a loop, position the cursor using the next method, and retrieve data from each column of the current row of the ResultSet object using getXXX methods.
4. If there are *n* result sets, repeat the following steps *n*-1 times:
   a. Invoke the getMoreResults method to close the current result set and point to the next result set.
   b. Invoke the getResultSet method to obtain the next result set, which is in a ResultSet object.
   c. In a loop, position the cursor using the next method, and retrieve data from each column of the current row of the ResultSet object using getXXX methods.

Example: The following code illustrates retrieving two result sets. The first result set contains an INTEGER column, and the second result set contains a CHAR column. The numbers to the right of selected statements correspond to the previously described steps.

```
CallableStatement cstmt;
ResultSet rs;
int i;
String s;
...
cstmt.execute();                          // Call the stored procedure      1
rs = cstmt.getResultSet();                // Get the first result set       2
while (rs.next()) {                       // Position the cursor            3
 i = rs.getInt(1);                        // Retrieve current result set value
 System.out.println("Value from first result set = " + i);
                                          // Print the value
}
cstmt.getMoreResults();                   // Point to the second result set 4a
                                          // and close the first result set
rs = cstmt.getResultSet();                // Get the second result set      4b
while (rs.next()) {                       // Position the cursor            4c
 s = rs.getString(1);                     // Retrieve current result set value
 System.out.println("Value from second result set = " + s);
                                          // Print the value
}
rs.close();                               // Close the result set
cstmt.close();                            // Close the statement
```

Retrieving an unknown number of result sets from a stored procedure in a JDBC application:

Retrieving an unknown number of result sets from a stored procedure is a more complicated procedure than retrieving a known number of result sets.

To retrieve result sets when you do not know the number of result sets or their contents, you need to retrieve ResultSets, until no more ResultSets are returned. For each ResultSet, use ResultSetMetaData methods to determine its contents.

After you call a stored procedure, follow these basic steps to retrieve the contents of an unknown number of result sets.

1. Check the value that was returned from the execute statement that called the stored procedure.

   If the returned value is `true`, there is at least one result set, so you need to go to the next step.
2. Repeat the following steps in a loop:
   a. Invoke the getResultSet method to obtain a result set, which is in a ResultSet object. Invoking this method closes the previous result set.
   b. Use ResultSetMetaData methods to determine the contents of the ResultSet, and retrieve data from the ResultSet.
   c. Invoke the getMoreResults method to determine whether there is another result set. If getMoreResults returns `true`, go to step 1 to get the next result set.

Example: The following code illustrates retrieving result sets when you do not know the number of result sets or their contents. The numbers to the right of selected statements correspond to the previously described steps.

```
CallableStatement cstmt;
ResultSet rs;
...
boolean resultsAvailable = cstmt.execute(); // Call the stored procedure
while (resultsAvailable) {                  // Test for result sets       1
 ResultSet rs = cstmt.getResultSet();       // Get a result set           2a
 ...                                          // Process the ResultSet
                                            // as you would process
                                            // a ResultSet from a table
 resultsAvailable = cstmt.getMoreResults(); // Check for next result set  2c
                                            // (Also closes the
                                            // previous result set)
}
```

Keeping result sets open when retrieving multiple result sets from a stored procedure in a JDBC application:

The getMoreResults method has a form that lets you leave the current ResultSet open when you open the next ResultSet.

To specify whether result sets stay open, follow this process:

When you call getMoreResults to check for the next ResultSet, use this form:

```
CallableStatement.getMoreResults(int current);
```

- To keep the current ResultSet open when you check for the next ResultSet, specify a value of `Statement.KEEP_CURRENT_RESULT` for *current*.
- To close the current ResultSet when you check for the next ResultSet, specify a value of `Statement.CLOSE_CURRENT_RESULT` for *current*.
- To close **all** ResultSet objects, specify a value of `Statement.CLOSE_ALL_RESULTS` for *current*.

Example: The following code keeps all ResultSets open until the final ResultSet has been retrieved, and then closes all ResultSets.

```
CallableStatement cstmt;
...
boolean resultsAvailable = cstmt.execute(); // Call the stored procedure
if (resultsAvailable==true) {               // Test for result set
 ResultSet rs1 = cstmt.getResultSet();      // Get a result set
 ...                                          // Process ResultSet
 resultsAvailable = cstmt.getMoreResults(Statement.KEEP_CURRENT_RESULT);
                                            // Check for next result set
                                            // but do not close
                                            // previous result set
 if (resultsAvailable==true) {              // Test for another result set
  ResultSet rs2 = cstmt.getResultSet();     // Get next result set
  ...                                         // Process either ResultSet
 }
}
resultsAvailable = cstmt.getMoreResults(Statement.CLOSE_ALL_RESULTS);
                                            // Close the result sets
```

LOBs in JDBC applications with the IBM Data Server Driver for JDBC and SQLJ

The IBM Data Server Driver for JDBC and SQLJ supports methods for updating and retrieving data from BLOB, CLOB, and DBCLOB columns in a table, and for calling stored procedures or user-defined functions with BLOB or CLOB parameters.

Progressive streaming with the IBM Data Server Driver for JDBC and SQLJ

If the data source supports progressive streaming, the IBM Data Server Driver for JDBC and SQLJ can use progressive streaming to retrieve data in LOB or XML columns.

DB2 for z/OS Version 9.1 and later supports progressive streaming for LOBs and XML objects. DB2 Database for Linux, UNIX, and Windows Version 9.5 and later supports progressive streaming for LOBs.

With progressive streaming, the data source dynamically determines the most efficient mode in which to return LOB or XML data, based on the size of the LOBs or XML objects.

For IBM Data Server Driver for JDBC and SQLJ Version 3.50 and later, progressive streaming behavior is the default for LOB retrieval, for connections to DB2 Database for Linux, UNIX, and Windows Version 9.5 and later.

Progressive streaming is supported in the IBM Data Server Driver for JDBC and SQLJ Version 3.1 and later, but for IBM Data Server Driver for JDBC and SQLJ Version 3.2 and later, progressive streaming behavior is the default for LOB and XML retrieval, for connections to DB2 for z/OS Version 9.1 and later.

If the IBM Data Server Driver for JDBC and SQLJ `progressiveStreaming` property is `DB2BaseDataSource.YES`, your application uses progressive streaming behavior.

When progressive streaming is enabled, you can control when the JDBC driver materializes LOBs with the `streamBufferSize` property. If a LOB or XML object is less than or equal to the `streamBufferSize` value, the object is materialized.

Important: With progressive streaming, when you retrieve a LOB or XML value from a ResultSet into an application variable, you can manipulate the contents of that application variable until you move the cursor or close the cursor on the

ResultSet. After that, the contents of the application variable are no longer available to you. If you perform any actions on the LOB in the application variable, you receive an SQLException. For example, suppose that progressive streaming is enabled, and you execute statements like this:

```
...
ResultSet rs = stmt.executeQuery("SELECT CLOBCOL FROM MY_TABLE");
rs.next();                          // Retrieve the first row of the ResultSet
Clob clobFromRow1  = rs.getClob(1); // Put the CLOB from the first column of
                                    // the first row in an application variable
String substr1Clob = clobFromRow1.getSubString(1,50);
                                    // Retrieve the first 50 bytes of the CLOB
rs.next();                          // Move the cursor to the next row.
                                    // clobFromRow1 is no longer available.
// String substr2Clob = clobFromRow1.getSubString(51,100);
                                    // This statement would yield an SQLException
Clob clobFromRow2  = rs.getClob(1); // Put the CLOB from the first column of
                                    // the second row in an application variable
rs.close();                         // Close the ResultSet.
                                    // clobFromRow2 is also no longer available.
```

After you execute rs.next() to position the cursor at the second row of the ResultSet, the CLOB value in clobFromRow1 is no longer available to you. Similarly, after you execute rs.close() to close the ResultSet, the values in clobFromRow1 and clobFromRow2 are no longer available.

If you disable progressive streaming, the way in which the IBM Data Server Driver for JDBC and SQLJ handles LOBs depends on the value of the `fullyMaterializeLobData` property.

Use of progressive streaming is the preferred method of LOB or XML data retrieval.

LOB locators with the IBM Data Server Driver for JDBC and SQLJ

The IBM Data Server Driver for JDBC and SQLJ can use LOB locators to retrieve data in LOB columns. You should use LOB locators only if the data source does not support progressive streaming.

To cause JDBC to use LOB locators to retrieve data from LOB columns, you need to set the `fullyMaterializeLobData` property to `false` and set the `progressiveStreaming` property to NO (`DB2BaseDataSource.NO` in an application program).

The effect of fullyMaterializeLobData depends on whether the data source supports progressive locators:

- If the data source does not support progressive locators:

  If the value of fullyMaterializeLobData is `true`, LOB data is fully materialized within the JDBC driver when a row is fetched. If the value is `false`, LOB data is streamed. The driver uses locators internally to retrieve LOB data in chunks on an as-needed basis It is highly recommended that you set this value to `false` when you retrieve LOBs that contain large amounts of data. The default is `true`.
- If the data source supports progressive streaming:

  The JDBC driver ignores the value of fullyMaterializeLobData if the progressiveStreaming property is set to YES (`DB2BaseDataSource.YES` in an application program) or is not set.

`fullyMaterializeLobData` has no effect on stored procedure parameters.

As in any other language, a LOB locator in a Java application is associated with only one data source. You cannot use a single LOB locator to move data between two different data sources. To move LOB data between two data sources, you need to materialize the LOB data when you retrieve it from a table in the first data source and then insert that data into the table in the second data source.

LOB operations with the IBM Data Server Driver for JDBC and SQLJ

The IBM Data Server Driver for JDBC and SQLJ supports methods for updating and retrieving data from BLOB, CLOB, and DBCLOB columns in a table, and for calling stored procedures or user-defined functions with BLOB or CLOB parameters.

Among the operations that you can perform on LOB data under the IBM Data Server Driver for JDBC and SQLJ are:

- Specify a BLOB or column as an argument of the following ResultSet methods to retrieve data from a BLOB or CLOB column:

  For BLOB columns:
  - getBinaryStream
  - getBytes

  For CLOB columns:
  - getAsciiStream
  - getCharacterStream
  - getString
- Call the following ResultSet methods to update a BLOB or CLOB column in an updatable ResultSet:

  For BLOB columns:
  - updateBinaryStream
  - updateBlob

  For CLOB columns:
  - updateAsciiStream
  - updateCharacterStream
  - updateClob

  If you specify -1 for the *length* parameter in any of the previously listed methods, the IBM Data Server Driver for JDBC and SQLJ reads the input data until it is exhausted.
- Use the following PreparedStatement methods to set the values for parameters that correspond to BLOB or CLOB columns:

  For BLOB columns:
  - setBytes
  - setBinaryStream
  - setObject, where the *Object* parameter value is an InputStream.

  For CLOB columns:
  - setString
  - setAsciiStream
  - setCharacterStream
  - setObject, where the *Object* parameter value is a Reader

  If you specify -1 for *length*, the IBM Data Server Driver for JDBC and SQLJ reads the input data until it is exhausted.
- Retrieve the value of a JDBC `CLOB` parameter using the CallableStatement.getString method.

Restriction: With IBM Data Server Driver for JDBC and SQLJ type 2 connectivity, you cannot call a stored procedure that has DBCLOB OUT or INOUT parameters.

If you are using the IBM Data Server Driver for JDBC and SQLJ Version 4.0 or later, you can perform the following additional operations:

- Use ResultSet.updateXXX or PreparedStatement.setXXX methods to update a BLOB or CLOB with a *length* value of up to 2GB for a BLOB or CLOB. For example, these methods are defined for BLOBs:

  ```
  ResultSet.updateBlob(int columnIndex, InputStream x, long length)
  ResultSet.updateBlob(String columnLabel, InputStream x, long length)
  ResultSet.updateBinaryStream(int columnIndex, InputStream x, long length)
  ResultSet.updateBinaryStream(String columnLabel, InputStream x, long length)
  PreparedStatement.setBlob(int columnIndex, InputStream x, long length)
  PreparedStatement.setBlob(String columnLabel, InputStream x, long length)
  PreparedStatement.setBinaryStream(int columnIndex, InputStream x, long length)
  PreparedStatement.setBinaryStream(String columnLabel, InputStream x, long length)
  ```

- Use ResultSet.updateXXX or PreparedStatement.setXXX methods without the *length* parameter when you update a BLOB or CLOB, to cause the IBM Data Server Driver for JDBC and SQLJ to read the input data until it is exhausted. For example:

  ```
  ResultSet.updateBlob(int columnIndex, InputStream x)
  ResultSet.updateBlob(String columnLabel, InputStream x)
  ResultSet.updateBinaryStream(int columnIndex, InputStream x)
  ResultSet.updateBinaryStream(String columnLabel, InputStream x)
  PreparedStatement.setBlob(int columnIndex, InputStream x)
  PreparedStatement.setBlob(String columnLabel, InputStream x)
  PreparedStatement.setBinaryStream(int columnIndex, InputStream x)
  PreparedStatement.setBinaryStream(String columnLabel, InputStream x)
  ```

- Create a Blob or Clob object that contains no data, using the Connection.createBlob or Connection.createClob method.
- Materialize a Blob or Clob object on the client, when progressive streaming or locators are in use, using the Blob.getBinaryStream or `Clob.getCharacterStream` method.
- Free the resources that a Blob or Clob object holds, using the Blob.free or Clob.free method.

Java data types for retrieving or updating LOB column data in JDBC applications

When the JDBC driver cannot immediately determine the data type of a parameter that is used with a LOB column, you need to choose a parameter data type that is compatible with the LOB data type.

When the deferPrepares property is set to true, and the IBM Data Server Driver for JDBC and SQLJ processes a PreparedStatement.setXXX call, the driver might need to do extra processing to determine data types. This extra processing can impact performance.

Input parameters for BLOB columns

For input parameters for BLOB columns, or input/output parameters that are used for input to BLOB columns, you can use one of the following techniques:

- Use a java.sql.Blob input variable, which is an exact match for a BLOB column:

  ```
  cstmt.setBlob(parmIndex, blobData);
  ```

- Use a CallableStatement.setObject call that specifies that the target data type is BLOB:

```
byte[] byteData = {(byte)0x1a, (byte)0x2b, (byte)0x3c};
cstmt.setObject(parmInd, byteData, java.sql.Types.BLOB);
```

- Use an input parameter of type of java.io.ByteArrayInputStream with a CallableStatement.setBinaryStream call. A java.io.ByteArrayInputStream object is compatible with a BLOB data type. For this call, you need to specify the exact length of the input data:

```
java.io.ByteArrayInputStream byteStream =
  new java.io.ByteArrayInputStream(byteData);
int numBytes = byteData.length;
cstmt.setBinaryStream(parmIndex, byteStream, numBytes);
```

Output parameters for BLOB columns

For output parameters for BLOB columns, or input/output parameters that are used for output from BLOB columns, you can use the following technique:

- Use the CallableStatement.registerOutParameter call to specify that an output parameter is of type BLOB. Then you can retrieve the parameter value into any variable that has a data type that is compatible with a BLOB data type. For example, the following code lets you retrieve a BLOB value into a byte[] variable:

```
cstmt.registerOutParameter(parmIndex, java.sql.Types.BLOB);
cstmt.execute();
byte[] byteData = cstmt.getBytes(parmIndex);
```

Input parameters for CLOB columns

For input parameters for CLOB columns, or input/output parameters that are used for input to CLOB columns, you can use one of the following techniques:

- Use a java.sql.Clob input variable, which is an exact match for a CLOB column:

```
cstmt.setClob(parmIndex, clobData);
```

- Use a CallableStatement.setObject call that specifies that the target data type is CLOB:

```
String charData = "CharacterString";
cstmt.setObject(parmInd, charData, java.sql.Types.CLOB);
```

- Use one of the following types of stream input parameters:
  - A java.io.StringReader input parameter with a cstmt.setCharacterStream call:

    ```
    java.io.StringReader reader = new java.io.StringReader(charData);
    cstmt.setCharacterStream(parmIndex, reader, charData.length);
    ```

  - A java.io.ByteArrayInputStream parameter with a cstmt.setAsciiStream call, for ASCII data:

    ```
    byte[] charDataBytes = charData.getBytes("US-ASCII");
    java.io.ByteArrayInputStream byteStream =
      new java.io.ByteArrayInputStream (charDataBytes);
    cstmt.setAsciiStream(parmIndex, byteStream, charDataBytes.length);
    ```

    For these calls, you need to specify the exact length of the input data.

- Use a String input parameter with a cstmt.setString call:

```
cstmt.setString(charData);
```

  If the length of the data is greater than 32KB, and the JDBC driver has no DESCRIBE information about the parameter data type, the JDBC driver assigns the CLOB data type to the input data.

- Use a String input parameter with a cstmt.setObject call, and specify the target data type as VARCHAR or LONGVARCHAR:

```
cstmt.setObject(parmIndex, charData, java.sql.Types.VARCHAR);
```

If the length of the data is greater than 32KB, and the JDBC driver has no DESCRIBE information about the parameter data type, the JDBC driver assigns the CLOB data type to the input data.

Output parameters for CLOB columns

For output parameters for CLOB columns, or input/output parameters that are used for output from CLOB columns, you can use one of the following techniques:

- Use the CallableStatement.registerOutParameter call to specify that an output parameter is of type CLOB. Then you can retrieve the parameter value into any variable that has a data type that is compatible with a CLOB data type. For example, the following code lets you retrieve a CLOB value into a String variable:

  ```
  cstmt.registerOutParameter(parmIndex, java.sql.Types.CLOB);
  cstmt.execute();
  String charData = cstmt.getString(parmIndex);
  ```

- Use the CallableStatement.registerOutParameter call to specify that an output parameter is of type VARCHAR or LONGVARCHAR:

  ```
  cstmt.registerOutParameter(parmIndex, java.sql.Types.VARCHAR);
  cstmt.execute();
  String charData = cstmt.getString(parmIndex);
  ```

  This technique should be used only if you know that the length of the retrieved data is less than or equal to 32KB. Otherwise, the data is truncated.

ROWIDs in JDBC with the IBM Data Server Driver for JDBC and SQLJ

DB2 for z/OS, DB2 for i5/OS, and IBM Informix Dynamic Server (IDS) support the ROWID data type for a column in a database table. A ROWID is a value that uniquely identifies a row in a table.

You can use the following ResultSet methods to retrieve data from a ROWID column:
- getRowId (JDBC 4.0 and later)
- getBytes
- getObject

You can use the following ResultSet method to update a ROWID column of an updatable ResultSet:
- updateRowId (JDBC 4.0 and later)

  updateRowId is valid only if the target database system supports updating of ROWID columns.

If you are using JDBC 3.0, for getObject, the IBM Data Server Driver for JDBC and SQLJ returns an instance of the IBM Data Server Driver for JDBC and SQLJ-only class com.ibm.db2.jcc.DB2RowID.

If you are using JDBC 4.0, for getObject, the IBM Data Server Driver for JDBC and SQLJ returns an instance of the class java.sql.RowId.

You can use the following PreparedStatement methods to set a value for a parameter that is associated with a ROWID column:
- setRowId (JDBC 4.0 and later)
- setBytes
- setObject

If you are using JDBC 3.0, for setObject, use the IBM Data Server Driver for JDBC and SQLJ-only type `com.ibm.db2.jcc.Types.ROWID` or an instance of the `com.ibm.db2.jcc.DB2RowID` class as the target type for the parameter.

If you are using JDBC 4.0, for setObject, use the type `java.sql.Types.RowId` or an instance of the `java.sql.ROWID` class as the target type for the parameter.

You can use the following CallableStatement methods to retrieve a ROWID column as an output parameter from a stored procedure call:
- getRowId (JDBC 4.0 and later)
- getObject

To call a stored procedure that is defined with a ROWID output parameter, register that parameter to be of the `java.sql.Types.ROWID` type.

ROWID values are valid for different periods of time, depending on the data source on which those ROWID values are defined. Use the DatabaseMetaData.getRowIdLifetime method to determine the time period for which a ROWID value is valid. The values that are returned for the data sources are listed in the following table.

Table 10. DatabaseMetaData.getRowIdLifetime values for supported data sources

Database server	DatabaseMetaData.getRowIdLifetime
DB2 for z/OS	ROWID_VALID_TRANSACTION
DB2 Database for Linux, UNIX, and Windows	ROWID_UNSUPPORTED
DB2 for i5/OS	ROWID_VALID_FOREVER
IDS	ROWID_VALID_FOREVER

Example: Using PreparedStatement.setRowId with a java.sql.RowId target type: Suppose that rwid is a RowId object. To set parameter 1, use this form of the setRowId method:

```
ps.setRowId(1, rid);
```

Example: Using PreparedStatement.setObject with a com.ibm.db2.jcc.DB2RowID target type: Suppose that rwid is an instance of com.ibm.db2.jcc.DB2RowID. To set parameter 1, use this form of the setObject method:

```
ps.setObject (1, rwid);
```

Example: Using ResultSet.getRowId to retrieve a ROWID value from a data source: To retrieve a ROWID value from the first column of a result set into RowId object rwid, use this form of the ResultSet.getRowId method:

```
java.sql.RowId rwid = rs.getRowId(1);
```

Example: Using CallableStatement.registerOutParameter with a java.sql.Types.ROWID parameter type: To register parameter 1 of a CALL statement as a `java.sql.Types.ROWID` data type, use this form of the registerOutParameter method:

```
cs.registerOutParameter(1, java.sql.Types.ROWID)
```

Distinct types in JDBC applications

A distinct type is a user-defined data type that is internally represented as a built-in SQL data type. You create a distinct type by executing the SQL statement CREATE DISTINCT TYPE.

In a JDBC program, you can create a distinct type using the executeUpdate method to execute the CREATE DISTINCT TYPE statement. You can also use executeUpdate to create a table that includes a column of that type. When you retrieve data from a column of that type, or update a column of that type, you use Java identifiers with data types that correspond to the built-in types on which the distinct types are based.

The following example creates a distinct type that is based on an INTEGER type, creates a table with a column of that type, inserts a row into the table, and retrieves the row from the table:

```
Connection con;
Statement stmt;
ResultSet rs;
String empNumVar;
int shoeSizeVar;
...
stmt = con.createStatement();               // Create a Statement object
stmt.executeUpdate(
  "CREATE DISTINCT TYPE SHOESIZE AS INTEGER");
                                            // Create distinct type
stmt.executeUpdate(
  "CREATE TABLE EMP_SHOE (EMPNO CHAR(6), EMP_SHOE_SIZE SHOESIZE)");
                                            // Create table with distinct type
stmt.executeUpdate("INSERT INTO EMP_SHOE " +
  "VALUES ('000010', 6)");                  // Insert a row
rs=stmt.executeQuery("SELECT EMPNO, EMP_SHOE_SIZE FROM EMP_SHOE);
                                            // Create ResultSet for query
while (rs.next()) {
  empNumVar = rs.getString(1);              // Get employee number
  shoeSizeVar = rs.getInt(2);               // Get shoe size (use int
                                            // because underlying type
                                            // of SHOESIZE is INTEGER)
  System.out.println("Employee number = " + empNumVar +
    " Shoe size = " + shoeSizeVar);
}
rs.close();                                 // Close ResultSet
stmt.close();                               // Close Statement
```

Figure 17. Creating and using a distinct type

Invocation of stored procedures with ARRAY parameters in JDBC applications

JDBC applications that run under the IBM Data Server Driver for JDBC and SQLJ can call stored procedures that have ARRAY parameters.

You can use the CallableStatement.setArray method or the CallableStatement.setObject method to assign a java.sql.Array object to an ARRAY stored procedure parameter.

You can register an output ARRAY parameter for a stored procedure call by specifying java.sql.Types.ARRAY as the parameter type in a CallableStatement.registerOutParameter call.

There are two ways to retrieve data from an ARRAY output parameter:

- Use the CallableStatement.getArray method to retrieve the data into a java.sql.Array object, and use the java.sql.Array.getArray method to retrieve the contents of the java.sql.Array object into a Java array.
- Use the CallableStatement.getArray method to retrieve the data into a java.sql.Array object. Use the java.sql.Array.getResultSet() method to retrieve the

data into a ResultSet object. Use ResultSet methods to retrieve elements of the array. Each row of the ResultSet contains two columns:

- An index into the array, which starts at 1
- The array element

Example: Suppose that input and output parameters IN_PHONE and OUT_PHONE in stored procedure GET_EMP_DATA are arrays that are defined like this:

```
CREATE TYPE PHONENUMBERS AS VARCHAR(10) ARRAY[5]
```

Call GET_EMP_DATA with the two parameters.

```
Connection con;
CallableStatement cstmt;
ResultSet rs;
java.sql.Array inPhoneData;
...
stmt = con.prepareCall("CALL GET_EMP_DATA(?,?)");
                                  // Create a CallableStatement object
cstmt.setObject (1, inPhoneData); // Set input parameter
cstmt.registerOutParameter (2, java.sql.Types.ARRAY);
                                  // Register out parameters
cstmt.executeUpdate();            // Call the stored procedure
Array outPhoneData = cstmt.getArray(2);
                                  // Get the output parameter array
System.out.println("Parameter values from GET_EMP_DATA call: ");
String [] outPhoneNums = (String [])outPhoneData.getArray();
                          // Retrieve output data from the JDBC Array object
                          // into a Java String array
for(int i=0; i<outPhoneNums.length; i++) {
  System.out.print(outPhoneNums[i]);
  System.out.println();
}
```

Savepoints in JDBC applications

An SQL savepoint represents the state of data and schemas at a particular point in time within a unit of work. There are SQL statements to set a savepoint, release a savepoint, and restore data and schemas to the state that the savepoint represents.

The IBM Data Server Driver for JDBC and SQLJ supports the following methods for using savepoints:

Connection.setSavepoint() or Connection.setSavepoint(String *name*)
Sets a savepoint. These methods return a Savepoint object that is used in later releaseSavepoint or rollback operations.

When you execute either of these methods, DB2 executes the form of the SAVEPOINT statement that includes ON ROLLBACK RETAIN® CURSORS.

Connection.releaseSavepoint(Savepoint *savepoint*)
Releases the specified savepoint, and all subsequently established savepoints.

Connection.rollback(Savepoint *savepoint*)
Rolls back work to the specified savepoint.

DatabaseMetaData.supportsSavepoints()
Indicates whether a data source supports savepoints.

The following example demonstrates how to set a savepoint, roll back to the savepoint, and release the savepoint.

```
Connection con;
Statement stmt;
ResultSet rs;
String empNumVar;
int shoeSizeVar;
...
con.setAutoCommit(false);                    // set autocommit OFF
stmt = con.createStatement();                // Create a Statement object
...                                            // Perform some SQL
con.commit();                                // Commit the transaction
stmt.executeUpdate("INSERT INTO EMP_SHOE " +
  "VALUES ('000010', 6)");                   // Insert a row
Savepoint savept = con.setSavepoint();       // Create a savepoint
...
stmt.executeUpdate("INSERT INTO EMP_SHOE " +
  "VALUES ('000020', 10)");                  // Insert another row
conn.rollback(savept);                       // Roll back work to the point
                                             //  after the first insert
...
con.releaseSavepoint(savept);                // Release the savepoint
stmt.close();                                // Close the Statement
```

Figure 18. Setting, rolling back to, and releasing a savepoint in a JDBC application

Retrieving automatically generated keys in JDBC applications

With the IBM Data Server Driver for JDBC and SQLJ, you can retrieve automatically generated keys (also called auto-generated keys) from a table using JDBC 3.0 methods.

An identity column is a table column that provides a way for the data source to automatically generate a numeric value for each row. You define an identity column in a CREATE TABLE or ALTER TABLE statement by specifying the AS IDENTITY clause when you define a column that has an exact numeric type with a scale of 0 (SMALLINT, INTEGER, BIGINT, DECIMAL with a scale of zero, or a distinct type based on one of these types).

To enable retrieval of automatically generated keys from a table, you need to indicate when you insert rows that you will want to retrieve automatically generated key values. You do that by setting a flag in a Connection.prepareStatement, Statement.executeUpdate, or Statement.execute method call. The statement that is executed must be an INSERT statement or an INSERT within SELECT statement. Otherwise, the JDBC driver ignores the parameter that sets the flag.

Restriction: You cannot prepare an SQL statement for retrieval of automatically generated keys and use the PreparedStatement object for batch updates. The IBM Data Server Driver for JDBC and SQLJ Version 3.50 or later throws an SQLException when you call the addBatch or executeBatch method on a PreparedStatement object that is prepared to return automatically generated keys.

To retrieve automatically generated keys from a table using JDBC 3.0 methods, you need to perform these steps:

1. Use one of the following methods to indicate that you want to return automatically generated keys:
   - If you plan to use the PreparedStatement.executeUpdate method to insert rows, invoke one of these forms of the Connection.prepareStatement method to create a PreparedStatement object:

The following form is valid for a table on any data source that supports identity columns. *sql-statement* must be a single-row INSERT statement.

```
Connection.prepareStatement(sql-statement,
  Statement.RETURN_GENERATED_KEYS);
```

The following forms are valid only if the data source supports identity columns and the INSERT within SELECT statement. *sql-statement* can be a single-row INSERT statement or a multiple-row INSERT statement. With the first form, you specify the names of the columns for which you want automatically generated keys. With the second form, you specify the positions in the table of the columns for which you want automatically generated keys.

```
Connection.prepareStatement(sql-statement, String [] columnNames);
Connection.prepareStatement(sql-statement, int [] columnIndexes);
```

- If you use the Statement.executeUpdate method to insert rows, invoke one of these forms of the Statement.executeUpdate method:

  The following form is valid for a table on any data source that supports identity columns. *sql-statement* must be a single-row INSERT statement.

  ```
  Statement.executeUpdate(sql-statement, Statement.RETURN_GENERATED_KEYS);
  ```

  The following forms are valid only if the data source supports identity columns and the INSERT within SELECT statement. *sql-statement* can be a single-row INSERT statement or a multiple-row INSERT statement. With the first form, you specify the names of the columns for which you want automatically generated keys. With the second form, you specify the positions in the table of the columns for which you want automatically generated keys.

  ```
  Statement.executeUpdate(sql-statement, String [] columnNames);
  Statement.executeUpdate(sql-statement, int [] columnIndexes);
  ```

2. Invoke the PreparedStatement.getGeneratedKeys method or the Statement.getGeneratedKeys method to retrieve a ResultSet object that contains the automatically generated key values.

   The data type of the automatically generated keys in the ResultSet is DECIMAL, regardless of the data type of the corresponding column.

The following code creates a table with an identity column, inserts a row into the table, and retrieves the automatically generated key value for the identity column. The numbers to the right of selected statements correspond to the previously described steps.

Figure 19. Example of retrieving automatically generated keys

```
import java.sql.*;
import java.math.*;
import com.ibm.db2.jcc.*;

Connection con;
Statement stmt;
ResultSet rs;
java.math.BigDecimal iDColVar;
...
stmt = con.createStatement();         // Create a Statement object

stmt.executeUpdate(
  "CREATE TABLE EMP_PHONE (EMPNO CHAR(6), PHONENO CHAR(4), " +
    "IDENTCOL INTEGER GENERATED ALWAYS AS IDENTITY)");
                                      // Create table with identity column
stmt.executeUpdate("INSERT INTO EMP_PHONE (EMPNO, PHONENO) " +          1
  "VALUES ('000010', '5555')",        // Insert a row
```

```
  Statement.RETURN_GENERATED_KEYS);   // Indicate you want automatically
                                      // generated keys
rs = stmt.getGeneratedKeys();         // Retrieve the automatically       2
                                      // generated key value in a ResultSet.
                                      // Only one row is returned.
                                      // Create ResultSet for query
while (rs.next()) {
  java.math.BigDecimal idColVar = rs.getBigDecimal(1);
                                      // Get automatically generated key
                                      // value
  System.out.println("automatically generated key value = " + idColVar);
}
rs.close();                           // Close ResultSet
stmt.close();                         // Close Statement
```

The following code creates a table with an identity column, inserts two rows into the table using a multiple-row INSERT statement, and retrieves the automatically generated key values for the identity column. The numbers to the right of selected statements correspond to the previously-described steps.

Figure 20. Example of retrieving automatically generated keys after a multiple-row INSERT

```
import java.sql.*;
import java.math.*;
import com.ibm.db2.jcc.*;

Connection con;
Statement stmt;
ResultSet rs;
...
stmt = con.createStatement();

stmt.executeUpdate(
  "CREATE TABLE EMP_PHONE (EMPNO CHAR(6), PHONENO CHAR(4), " +
  "IDENTCOL INTEGER GENERATED ALWAYS AS IDENTITY)");
                                      // Create table with identity column
String[] id_col = {"IDENTCOL"};
int updateCount =                                                       1
  stmt.executeUpdate("INSERT INTO EMP_PHONE (EMPNO, PHONENO)" +
  "VALUES ('000010', '5555'), ('000020', '5556')", id_col);
                                      // Insert two rows
                                      // Indicate you want automatically
                                      // generated keys
rs = stmt.getGeneratedKeys();         // Retrieve the automatically       2
                                      // generated key values in a ResultSet.
                                      // Two rows are returned.
                                      // Create ResultSet for query
while (rs.next()) {
 int idColVar = rs.getInt(1);
                                      // Get automatically generated key
                                      // values
 System.out.println("automatically generated key value = " + idColVar);
}
stmt.close();
con.close();
```

Providing extended client information to the data source with IBM Data Server Driver for JDBC and SQLJ-only methods

A set of IBM Data Server Driver for JDBC and SQLJ-only methods provide extra information about the client to the server. This information can be used for accounting, workload management, or debugging.

Extended client information is sent to the database server when the application performs an action that accesses the server, such as executing SQL.

In the IBM Data Server Driver for JDBC and SQLJ Version 4.0, the IBM Data Server Driver for JDBC and SQLJ-only methods are deprecated. You should use java.sql.Connection.setClientInfo instead.

The IBM Data Server Driver for JDBC and SQLJ-only methods are listed in the following table.

Table 11. Methods that provide client information to theDB2 server

Method	Information provided
setDB2ClientAccountingInformation	Accounting information
setDB2ClientApplicationInformation	Name of the application that is working with a connection
setDB2ClientDebugInfo	The CLIENT DEBUGINFO connection attribute for the Unified debugger
setDB2ClientProgramId	A caller-specified string that helps the caller identify which program is associated with a particular SQL statement
setDB2ClientUser	User name for a connection
setDB2ClientWorkstation	Client workstation name for a connection

To set the extended client information, follow these steps:

1. Create a Connection.
2. Cast the java.sql.Connection object to a com.ibm.db2.jcc.DB2Connection.
3. Call any of the methods shown in Table 11.
4. Execute an SQL statement to cause the information to be sent to theDB2 server.

The following code performs the previous steps to pass a user name and a workstation name to theDB2 server. The numbers to the right of selected statements correspond to the previously-described steps.

```
public class ClientInfoTest {
  public static void main(String[] args) {
    String url = "jdbc:db2://sysmvs1.stl.ibm.com:5021/san_jose";
    try {
      Class.forName("com.ibm.db2.jcc.DB2Driver");
      String user = "db2adm";
      String password = "db2adm";
      Connection conn = DriverManager.getConnection(url,        1
        user, password);
      if (conn instanceof DB2Connection) {
        DB2Connection db2conn = (DB2Connection) conn;           2
        db2conn.setDB2ClientUser("Michael L Thompson");         3
        db2conn.setDB2ClientWorkstation("sjwkstn1");
        // Execute SQL to force extended client information to be sent
        // to the server
        conn.prepareStatement("SELECT * FROM SYSIBM.SYSDUMMY1"
          + "WHERE 0 = 1").executeQuery();                      4
      }
    } catch (Throwable e) {
        e.printStackTrace();
      }
  }
}
```

Figure 21. Example of passing extended client information to aDB2 server

Providing extended client information to the data source with client info properties

The IBM Data Server Driver for JDBC and SQLJ Version 4.0 supports JDBC 4.0 client info properties, which you can use to provide extra information about the client to the server. This information can be used for accounting, workload management, or debugging.

Extended client information is sent to the database server when the application performs an action that accesses the server, such as executing SQL.

The application can also use the Connection.getClientInfo method to retrieve client information from the database server, or execute the DatabaseMetaData.getClientInfoProperties method to determine which client information the driver supports.

The JDBC 4.0 client info properties should be used instead IBM Data Server Driver for JDBC and SQLJ-only methods, which are deprecated.

To set client info properties, follow these steps:

1. Create a Connection.
2. Call the java.sql.setClientInfo method to set any of the client info properties that the database server supports.
3. Execute an SQL statement to cause the information to be sent to the database server.

The following code performs the previous steps to pass a user name and a workstation name to theDB2 server. The numbers to the right of selected statements correspond to the previously-described steps.

```
public class ClientInfoTest {
  public static void main(String[] args) {
   String url = "jdbc:db2://sysmvs1.stl.ibm.com:5021/san_jose";
    try {
      Class.forName("com.ibm.db2.jcc.DB2Driver");
      String user = "db2adm";
      String password = "db2adm";
      Connection conn = DriverManager.getConnection(url,       1
        user, password);
      conn.setClientInfo("ClientUser", "Michael L Thompson"); 2
      conn.setClientInfo("ClientWorkstation, "sjwkstn1");
      // Execute SQL to force extended client information to be sent
      // to the server
      conn.prepareStatement("SELECT * FROM SYSIBM.SYSDUMMY1"
         + "WHERE 0 = 1").executeQuery();                      3
    } catch (Throwable e) {
      e.printStackTrace();
    }
  }
}
```

Figure 22. Example of passing extended client information to aDB2 server

Client info properties support by the IBM Data Server Driver for JDBC and SQLJ

JDBC 4.0 includes client info properties, which contain information about a connection to a data source. The DatabaseMetaData.getClientInfoProperties method returns a list of client info properties that the IBM Data Server Driver for JDBC and SQLJ supports.

When you call DatabaseMetaData.getClientInfoProperties, a result set is returned that contains the following columns:

- NAME
- MAX_LEN
- DEFAULT_VALUE
- DESCRIPTION

The following table lists the client info property values that the IBM Data Server Driver for JDBC and SQLJ returns for DB2 Database for Linux, UNIX, and Windows

Table 12. Client info property values for DB2 Database for Linux, UNIX, and Windows

NAME	MAX_LEN	DEFAULT_VALUE	DESCRIPTION
ApplicationName	255	Empty string	The name of the application that is currently using the connection.
ClientAccountingInformation	255	Empty string	The value of the accounting string from the client information that is specified for the connection.
ClientHostname	255	The value that is set by DB2Connection.setDB2ClientWorkstation. If the value is not set, the default is the host name of the local host.	The host name of the computer on which the application that is using the connection is running.
ClientUser	255	Empty string	The name of the user on whose behalf the application that is using the connection is running.

The following table lists the client info property values that the IBM Data Server Driver for JDBC and SQLJ returns for DB2 for z/OS

Table 13. Client info property values for DB2 for z/OS

NAME	MAX_LEN	DEFAULT_VALUE for type 4 connectivity	DEFAULT_VALUE for type 2 connectivity	DESCRIPTION
ApplicationName	32	clientProgramName property value, if set. ″db2jcc_application″ otherwise.	Empty string	The name of the application that is currently using the connection.
ClientAccountingInformation	200	A string that is the concatenation of the following values: • ″JCC*nnnnn*″, where *nnnnn* is the driver level, such as 04000. • The value that is set by DB2Connection.setDB2ClientWorkstation. If the value is not set, the default is the host name of the local host. • applicationName property value, if set. 20 blanks otherwise. • clientUser property value, if set. Eight blanks otherwise.	Empty string	The value of the accounting string from the client information that is specified for the connection.
ClientHostname	18	The value that is set by DB2Connection.setDB2ClientWorkstation. If the value is not set, the default is the host name of the local host.	Empty string	The host name of the computer on which the application that is using the connection is running.
ClientUser	16	The value that is set by DB2Connection.setDB2ClientUser. If the value is not set, the default is the current user ID that is used to connect to the database.	Empty string	The name of the user on whose behalf the application that is using the connection is running.

Optimistic locking in JDBC applications

You can write JDBC applications to take advantage of optimistic locking on a data source.

Optimistic locking is a technique that applications can use to release locks between SELECT and UPDATE or DELETE operations. If the selected rows change before that application updates or deletes them, the UPDATE or DELETE operation fails. Optimistic locking minimizes the time during which a given resource is unavailable for use by other transactions.

In general, an application performs these steps to use optimistic locking:

1. Select rows from a table.
2. Release locks on the table.
3. Update the selected rows, if they have not changed.

To check whether the row has changed, the application queries the row change token. The row change token is not always a completely accurate indicator of whether the row has changed. If you create a table with a row change timestamp column, the row change token is completely accurate. If you create the table without a row change timestamp column, or alter a table to add a row change

timestamp column, the row change token might not accurately reflect updates to a row. This means that the row change token might indicate that a row has changed, even though it has not. This condition is called a *false negative* condition.

When you write a JDBC application to perform optimistic locking you follow similar steps:

1. Prepare and execute a query.

   Indicate whether you want optimistic locking information, and whether that information can include false negatives.
2. Determine whether the ResultSet has optimistic locking information, and whether that information can produce false negatives.

   Based on the type of optimistic locking information, you can decide whether to continue with optimistic locking.
3. Release locks on the table.
4. Update the selected rows, if the row change token indicates that they have not changed.

The following code demonstrates how a JDBC application can perform optimistic locking. The numbers in the example correspond to the previously listed steps.

```
com.ibm.db2.jcc.DB2Statement s1 =
  (com.ibm.db2.jcc.DB2Statement)conn.createStatement();
ResultSet rs =
 ((com.ibm.db2.jcc.DB2Statement)s1).executeDB2OptimisticLockingQuery
 ("SELECT EMPNO, SALARY, FROM EMP WHERE EMP.LASTNAME = 'HAAS'",
  com.ibm.db2.jcc.DB2Statement.RETURN_OPTLOCK_COLUMN_NO_FALSE_NEGATIVES); 1
                                  // Indicate that you plan to do
                                  // optimistic locking, and that you
                                  // want optimistic locking information
                                  // that does not generate
                                  // false negatives
ResultSetMetaData rsmd = rs.getMetaData();
int optColumns =                                                          2
  ((com.ibm.db2.jcc.DB2ResultSetMetaData)rsmd).getDB2OptimisticLockingColumns();
                                  // Retrieve the optimistic locking
                                  // information.
boolean optColumnsReturned = false;

if (optColumns == 0);             // If optimistic locking information is not
                                  // returned, do not attempt to do
                                  // optimistic locking.
else if (optColumns == 1);        // A value of 1 is never returned if
                                  // RETURN_OPTLOCK_COLUMN_NO_FALSE_NEGATIVES
                                  // is specified, because 1 indicates
                                  // that there could be false negatives.
else if (optColumns == 2)         // If optimistic locking information is
   optColumnsReturned = true;     // returned, and false negatives will not
                                  // occur, try optimistic locking.

rs.next();                        // Retrieve the contents of the ResultSet
int emp_id = rs.getInt(1);
double salary = rs.getDouble(2);

long rowChangeToken = 0;
Object rid = null;
int type = -1;

if (optColumnsReturned) {
  rowChangeToken =                // Get the row change token.
    ((com.ibm.db2.jcc.DB2ResultSet)rs).getDB2RowChangeToken();
  rid = ((com.ibm.db2.jcc.DB2ResultSet)rs).getDB2RID();
                                  // Get the RID, which uniquely identifies
                                  // the row.
  int type = ((com.ibm.db2.jcc.DB2ResultSet)rs).getDB2RIDType ();
                                  // Get the data type of the RID.
}
// ************************************************
// Release the locks or disconnect from the database.
// Perform some work on the retrieved data.
// Reconnect to the data source.
```

```
// ************************************************
...
PreparedStatement s2 =
  conn.prepareStatement ("UPDATE EMP SET SALARY = ? " +
  "WHERE EMPNO = ? AND ROW CHANGE TOKEN FOR EMP = ? and " +
  "RID_BIT(EMP) = ?");
                                  // Statement for updating the
                                  // previously selected rows that
                                  // have not changed.
s2.setDouble(1, salary+10000);
s2.setInt(2, emp_id);
                                  // Set the new row values.
s2.setLong(3, rowChangeToken);
                                  // Set the row change token of the
                                  // previously retrieved row.
if (type == java.sql.Types.BIGINT)
  s2.setLong (4, ((Long)rid).longValue());
else if (type == java.sql.Types.VARBINARY)
  s2.setBytes (4, (byte[])rid);
                                  // Set the RID of the previously
                                  // retrieved row.
                                  // Use the correct setXXX method
                                  // for the data type of the RID.
int updateCount = s2.executeUpdate();                                    3
                                  // Perform the update.
if (updateCount == 1);            // Update is successful.
else                              // Update failed.
...
```

XML data in JDBC applications

In JDBC applications, you can store data in XML columns and retrieve data from XML columns.

In database tables, the XML built-in data type is used to store XML data in a column as a structured set of nodes in a tree format.

In applications, XML data is in the serialized string format.

In JDBC applications, you can:

- Store an entire XML document in an XML column using setXXX methods.
- Retrieve an entire XML document from an XML column using getXXX methods.
- Retrieve a sequence from a document in an XML column by using the SQL XMLQUERY function to retrieve the sequence into a serialized sequence in the database, and then using getXXX methods to retrieve the data into an application variable.
- Retrieve a sequence from a document in an XML column by using an XQuery expression, prepended with the string 'XQUERY', to retrieve the elements of the sequence into a result table in the database, in which each row of the result table represents an item in the sequence. Then use getXXX methods to retrieve the data into application variables.
- Retrieve a sequence from a document in an XML column as a user-defined table by using the SQL XMLTABLE function to define the result table and retrieve it. Then use getXXX methods to retrieve the data from the result table into application variables.

JDBC 4.0 `java.sql.SQLXML` objects can be used to retrieve and update data in XML columns. Invocations of metadata methods, such as ResultSetMetaData.getColumnTypeName return the integer value `java.sql.Types.SQLXML` for an XML column type.

XML column updates in JDBC applications

When you update or insert data into XML columns of a database table, the input data in your JDBC applications must be in the serialized string format.

The following table lists the methods and corresponding input data types that you can use to put data in XML columns.

Table 14. Methods and data types for updating XML columns

Method	Input data type
PreparedStatement.setAsciiStream	InputStream
PreparedStatement.setBinaryStream	InputStream
PreparedStatement.setBlob	Blob
PreparedStatement.setBytes	byte[]
PreparedStatement.setCharacterStream	Reader
PreparedStatement.setClob	Clob
PreparedStatement.setObject	byte[], Blob, Clob, SQLXML, DB2Xml (deprecated), InputStream, Reader, String
PreparedStatement.setString	String

The encoding of XML data can be derived from the data itself, which is known as *internally encoded* data, or from external sources, which is known as *externally encoded* data. XML data that is sent to the database server as binary data is treated as internally encoded data. XML data that is sent to the data source as character data is treated as externally encoded data.

External encoding for Java applications is always Unicode encoding.

Externally encoded data can have internal encoding. That is, the data might be sent to the data source as character data, but the data contains encoding information. The data source handles incompatibilities between internal and external encoding as follows:

- If the data source is DB2 Database for Linux, UNIX, and Windows, the database source generates an error if the external and internal encoding are incompatible, unless the external and internal encoding are Unicode. If the external and internal encoding are Unicode, the database source ignores the internal encoding.
- If the database source is DB2 for z/OS, the database source ignores the internal encoding.

Data in XML columns is stored in UTF-8 encoding. The database source handles conversion of the data from its internal or external encoding to UTF-8.

Example: The following example demonstrates inserting data from an SQLXML object into an XML column. The data is String data, so the database source treats the data as externally encoded.

```
public void insertSQLXML()
{
 Connection con = DriverManager.getConnection(url);
  SQLXML info = con.createSQLXML;
                             // Create an SQLXML object
  PreparedStatement insertStmt = null;
  String infoData =
    "<customerinfo xmlns=""http://posample.org"" " +
```

```
    "Cid=""1000"" xmlns=""http://posample.org"">...</customerinfo>";
  cid.setString(cidData);
                            // Populate the SQLXML object
  int cid = 1000;
  try {
    sqls = "INSERT INTO CUSTOMER (CID, INFO) VALUES (?, ?)";
    insertStmt = con.prepareStatement(sqls);
    insertStmt.setInt(1, cid);
    insertStmt.setSQLXML(2, info);
                            // Assign the SQLXML object value
               // to an input parameter
    if (insertStmt.executeUpdate() != 1) {
      System.out.println("insertSQLXML: No record inserted.");
    }
  }
  catch (IOException ioe) {
   ioe.printStackTrace();
  }
  catch (SQLException sqle) {
    System.out.println("insertSQLXML: SQL Exception: " +
      sqle.getMessage());
    System.out.println("insertSQLXML: SQL State: " +
      sqle.getSQLState());
    System.out.println("insertSQLXML: SQL Error Code: " +
      sqle.getErrorCode());

  }
}
```

Example: The following example demonstrates inserting data from a file into an XML column. The data is inserted as binary data, so the database server honors the internal encoding.

```
public void insertBinStream()
{
  PreparedStatement insertStmt = null;
  String sqls = null;
  int cid = 0;
  ResultSet rs=null;
  Statement stmt=null;
  try {
    sqls = "INSERT INTO CUSTOMER (CID, INFO) VALUES (?, ?)";
    insertStmt = conn.prepareStatement(sqls);
    insertStmt.setInt(1, cid);
    File file = new File(fn);
    insertStmt.setBinaryStream(2,
      new FileInputStream(file), (int)file.length());
    if (insertStmt.executeUpdate() != 1) {
      System.out.println("insertBinStream: No record inserted.");
    }
  }
  catch (IOException ioe) {
   ioe.printStackTrace();
  }
  catch (SQLException sqle) {
    System.out.println("insertBinStream: SQL Exception: " +
      sqle.getMessage());
    System.out.println("insertBinStream: SQL State: " +
      sqle.getSQLState());
    System.out.println("insertBinStream: SQL Error Code: " +
      sqle.getErrorCode());

  }
}
```

XML data retrieval in JDBC applications

The In JDBC applications, you use ResultSet.getXXX or ResultSet.getObject methods to retrieve data from XML columns.

When you retrieve data from XML columns of a DB2 table, the output data is in the serialized string format. This is true whether you retrieve the entire contents of an XML column or a sequence from the column.

You can use one of the following techniques to retrieve XML data:

- Use the ResultSet.getSQLXML method to retrieve the data. Then use a SQLXML.getXXX method to retrieve the data into a compatible output data type.

  SQLXML.getXXX methods add XML declarations with encoding specifications to the output data.
- Use a ResultSet.getXXX method other than ResultSet.getObject to retrieve the data into a compatible data type.
- Use the ResultSet.getObject method to retrieve the data, and then cast it to the DB2Xml type and assign it to a DB2Xml object. Then use a DB2Xml.getDB2XXX or DB2Xml.getDB2XmlXXX method to retrieve the data into a compatible output data type.

  DB2Xml.getDB2XmlXXX methods add XML declarations with encoding specifications to the output data. DB2Xml.getDB2XXX methods do not add XML declarations with encoding specifications to the output data.

  This technique uses the deprecated DB2Xml objects. Use of the previously described technique is preferable.

The following table lists the ResultSet methods and corresponding output data types for retrieving XML data.

Table 15. ResultSet methods and data types for retrieving XML data

Method	Output data type
ResultSet.getAsciiStream	InputStream
ResultSet.getBinaryStream	InputStream
ResultSet.getBytes	byte[]
ResultSet.getCharacterStream	Reader
ResultSet.getObject	DB2Xml
ResultSet.getSQLXML	SQLXML
ResultSet.getString	String

The following table lists the methods that you can call to retrieve data from a java.sql.SQLXML or a com.ibm.db2.jcc.DB2Xml object, and the corresponding output data types and type of encoding in the XML declarations.

Table 16. SQLXML and DB2Xml methods, data types, and added encoding specifications

Method	Output data type	Type of XML internal encoding declaration added
SQLXML.getBinaryStream	InputStream	None
SQLXML.getCharacterStream	Reader	None
SQLXML.getSource	Source	None
SQLXML.getString	String	None

Table 16. SQLXML and DB2Xml methods, data types, and added encoding specifications (continued)

Method	Output data type	Type of XML internal encoding declaration added
DB2Xml.getDB2AsciiStream	InputStream	None
DB2Xml.getDB2BinaryStream	InputStream	None
DB2Xml.getDB2Bytes	byte[]	None
DB2Xml.getDB2CharacterStream	Reader	None
DB2Xml.getDB2String	String	None
DB2Xml.getDB2XmlAsciiStream	InputStream	US-ASCII
DB2Xml.getDB2XmlBinaryStream	InputStream	Specified by getDB2XmlBinaryStream *targetEncoding* parameter
DB2Xml.getDB2XmlBytes	byte[]	Specified by DB2Xml.getDB2XmlBytes *targetEncoding* parameter
DB2Xml.getDB2XmlCharacterStream	Reader	ISO-10646-UCS-2
DB2Xml.getDB2XmlString	String	ISO-10646-UCS-2

If the application executes the XMLSERIALIZE function on the data that is to be returned, after execution of the function, the data has the data type that is specified in the XMLSERIALIZE function, not the XML data type. Therefore, the driver handles the data as the specified type and ignores any internal encoding declarations.

Example: The following example demonstrates retrieving data from an XML column into an SQLXML object, and then using the SQLXML.getString method to retrieve the data into a string.

```
public void fetchToSQLXML()
  {
    System.out.println(">> fetchToSQLXML: Get XML data as an SQLXML object " +
    "using getSQLXML");
    PreparedStatement selectStmt = null;
    String sqls = null, stringDoc = null;
    ResultSet rs = null;

    try{
      sqls = "SELECT info FROM customer WHERE cid = " + cid;
      selectStmt = conn.prepareStatement(sqls);
      rs = selectStmt.executeQuery();

      // Get metadata
      // Column type for XML column is the integer java.sql.Types.OTHER
      ResultSetMetaData meta = rs.getMetaData();
      String colType = meta.getColumnType(1);
      System.out.println("fetchToSQLXML: Column type = " + colType);
      while (rs.next()) {
        // Retrieve the XML data with getSQLXML.
        // Then write it to a string with
        // explicit internal ISO-10646-UCS-2 encoding.
        java.sql.SQLXML xml = rs.getSQLXML(1);
        System.out.println (xml.getString());
      }
      rs.close();
    }
    catch (SQLException sqle) {
      System.out.println("fetchToSQLXML: SQL Exception: " +
        sqle.getMessage());
      System.out.println("fetchToSQLXML: SQL State: " +
        sqle.getSQLState());
```

```
      System.out.println("fetchToSQLXML: SQL Error Code: " +
        sqle.getErrorCode());
    }
  }
```

Example: The following example demonstrates retrieving data from an XML column into a String variable.

```
public void fetchToString()
  {
    System.out.println(">> fetchToString: Get XML data " +
    "using getString");
    PreparedStatement selectStmt = null;
    String sqls = null, stringDoc = null;
    ResultSet rs = null;

    try{
      sqls = "SELECT info FROM customer WHERE cid = " + cid;
      selectStmt = conn.prepareStatement(sqls);
      rs = selectStmt.executeQuery();

      // Get metadata
      // Column type for XML column is the integer java.sql.Types.OTHER
      ResultSetMetaData meta = rs.getMetaData();
      String colType = meta.getColumnType(1);
      System.out.println("fetchToString: Column type = " + colType);

      while (rs.next()) {
        stringDoc = rs.getString(1);
        System.out.println("Document contents:");
        System.out.println(stringDoc);
 }
    catch (SQLException sqle) {
      System.out.println("fetchToString: SQL Exception: " +
        sqle.getMessage());
      System.out.println("fetchToString: SQL State: " +
        sqle.getSQLState());
      System.out.println("fetchToString: SQL Error Code: " +
        sqle.getErrorCode());
    }
  }
```

Example: The following example demonstrates retrieving data from an XML column into a DB2Xml object, and then using the DB2Xml.getDB2XmlString method to retrieve the data into a string with an added XML declaration with an ISO-10646-UCS-2 encoding specification.

```
public void fetchToDB2Xml()
  {
    System.out.println(">> fetchToDB2Xml: Get XML data as a DB2XML object " +
    "using getObject");
    PreparedStatement selectStmt = null;
    String sqls = null, stringDoc = null;
    ResultSet rs = null;

    try{
      sqls = "SELECT info FROM customer WHERE cid = " + cid;
      selectStmt = conn.prepareStatement(sqls);
      rs = selectStmt.executeQuery();

      // Get metadata
      // Column type for XML column is the integer java.sql.Types.OTHER
      ResultSetMetaData meta = rs.getMetaData();
      String colType = meta.getColumnType(1);
      System.out.println("fetchToDB2Xml: Column type = " + colType);
      while (rs.next()) {
        // Retrieve the XML data with getObject, and cast the object
```

```
        // as a DB2Xml object. Then write it to a string with
        // explicit internal ISO-10646-UCS-2 encoding.
        com.ibm.db2.jcc.DB2Xml xml =
          (com.ibm.db2.jcc.DB2Xml) rs.getObject(1);
        System.out.println (xml.getDB2XmlString());
      }
      rs.close();
    }
    catch (SQLException sqle) {
      System.out.println("fetchToDB2Xml: SQL Exception: " +
        sqle.getMessage());
      System.out.println("fetchToDB2Xml: SQL State: " +
        sqle.getSQLState());
      System.out.println("fetchToDB2Xml: SQL Error Code: " +
        sqle.getErrorCode());
    }
  }
```

Invocation of routines with XML parameters in Java applications

SQL or external stored procedures and external user-defined functions can include XML parameters.

For SQL procedures, those parameters in the stored procedure definition have the XML type. For external stored procedures and user-defined functions, XML parameters in the routine definition have the XML AS CLOB type. When you call a stored procedure or user-defined function that has XML parameters, you need to use a compatible data type in the invoking statement.

To call a routine with XML input parameters from a JDBC program, use parameters of the java.sql.SQLXML or com.ibm.db2.jcc.DB2Xml type. To register XML output parameters, register the parameters as the java.sql.Types.SQLXML or com.ibm.db2.jcc.DB2Types.XML type. (The com.ibm.db2.jcc.DB2Xml and com.ibm.db2.jcc.DB2Types.XML types are deprecated.)

Example: JDBC program that calls a stored procedure that takes three XML parameters: an IN parameter, an OUT parameter, and an INOUT parameter. This example requires JDBC 4.0.

```
java.sql.SQLXML in_xml = xmlvar;
java.sql.SQLXML out_xml = null;
java.sql.SQLXML inout_xml = xmlvar;
                                  // Declare an input, output, and
                                  // input/output XML parameter
Connection con;
CallableStatement cstmt;
ResultSet rs;
...
stmt = con.prepareCall("CALL SP_xml(?,?,?)");
                                  // Create a CallableStatement object
cstmt.setObject (1, in_xml);      // Set input parameter
cstmt.registerOutParameter (2, java.sql.Types.SQLXML);
                                  // Register out and input parameters
cstmt.registerOutParameter (3, java.sql.Types.SQLXML);
cstmt.executeUpdate();            // Call the stored procedure
System.out.println("Parameter values from SP_xml call: ");
System.out.println("Output parameter value ");
printString(out_xml.getString());
                          // Use the SQLXML.getString
                          // method getBytes to convert the
                          // value to a string for printing
System.out.println("Input/output parameter value ");
printString(inout_xml.getString());
```

To call a routine with XML parameters from an SQLJ program, use parameters of the `com.ibm.db2.jcc.DB2Xml` type.

Example: SQLJ program that calls a stored procedure that takes three XML parameters: an IN parameter, an OUT parameter, and an INOUT parameter. This example requires JDBC 4.0.

```
java.sql.SQLXML in_xml = xmlvar;
java.sql.SQLXML out_xml = null;
java.sql.SQLXML inout_xml = xmlvar;
                                  // Declare an input, output, and
                                  // input/output XML parameter
...
#sql [myConnCtx] {CALL SP_xml(:IN in_xml,
                              :OUT out_xml,
                              :INOUT inout_xml)};
                                  // Call the stored procedure
System.out.println("Parameter values from SP_xml call: ");
System.out.println("Output parameter value ");
printString(out_xml.getString());
                            // Use the SQLXML.getString method to
                            // convert the value to a string for printing
System.out.println("Input/output parameter value ");
printString(inout_xml.getString());
```

Java support for XML schema registration and removal

The IBM Data Server Driver for JDBC and SQLJ provides methods that let you write Java application programs to register and remove XML schemas and their components.

Those methods are equivalent to the SYSPROC.XSR_REGISTER, SYSPROC.XSR_ADDSCHEMADOC, SYSPROC.XSR_COMPLETE, SYSPROC.XSR_REMOVE, and SYSPROC.XSR_UPDATE stored procedures that DB2 provides. The JDBC methods are:

DB2Connection.registerDB2XMLSchema
Registers an XML schema in DB2, using one or more XML schema documents. There are two forms of this method: one form for XML schema documents that are input from an InputStream objects, and one form for XML schema documents that are in a `String`.

DB2Connection.deregisterDB2XMLObject
Removes an XML schema definition from DB2.

DB2Connection.updateDB2XmlSchema
Replaces the XML schema documents in a registered XML schema with the XML schema documents from another registered XML schema. Optionally drops the XML schema whose contents are copied.

Before you can invoke these methods, the underlying stored procedures must be installed on the DB2 database server.

Example: Registration of an XML schema: The following example demonstrates the use of registerDB2XmlSchema to register an XML schema in DB2 using a single XML schema document (customer.xsd) that is read from an input stream. The SQL schema name for the registered schema is SYSXSR. The *xmlSchemaLocations* value is null, so DB2 will not find this XML schema on an invocation of DSN_XMLVALIDATE that supplies a non-null XML schema location value. No additional properties are registered.

Figure 23. Example of registration of an XML schema with DB2 using an XML document from an input stream

```
public static void registerSchema(
  Connection con,
  String schemaName)
  throws SQLException {
  // Define the registerDB2XmlSchema parameters
  String[] xmlSchemaNameQualifiers = new String[1];
  String[] xmlSchemaNames = new String[1];
  String[] xmlSchemaLocations = new String[1];
  InputStream[] xmlSchemaDocuments = new InputStream[1];
  int[] xmlSchemaDocumentsLengths = new int[1];
  java.io.InputStream[] xmlSchemaDocumentsProperties = new InputStream[1];
  int[] xmlSchemaDocumentsPropertiesLengths = new int[1];
  InputStream xmlSchemaProperties;
  int xmlSchemaPropertiesLength;
  //Set the parameter values
  xmlSchemaLocations[0] = "";
  FileInputStream fi = null;
  xmlSchemaNameQualifiers[0] = "SYSXSR";
  xmlSchemaNames[0] = schemaName;
  try {
    fi = new FileInputStream("customer.xsd");
    xmlSchemaDocuments[0] = new BufferedInputStream(fi);
  } catch (FileNotFoundException e) {
         e.printStackTrace();
  }
  try {
     xmlSchemaDocumentsLengths[0] = (int) fi.getChannel().size();
     System.out.println(xmlSchemaDocumentsLengths[0]);
  } catch (IOException e1) {
         e1.printStackTrace();
  }
  xmlSchemaDocumentsProperties[0] = null;
  xmlSchemaDocumentsPropertiesLengths[0] = 0;
  xmlSchemaProperties = null;
  xmlSchemaPropertiesLength = 0;
  DB2Connection ds = (DB2Connection) con;
  // Invoke registerDB2XmlSchema
  ds.registerDB2XmlSchema(
    xmlSchemaNameQualifiers,
    xmlSchemaNames,
    xmlSchemaLocations,
    xmlSchemaDocuments,
    xmlSchemaDocumentsLengths,
    xmlSchemaDocumentsProperties,
    xmlSchemaDocumentsPropertiesLengths,
    xmlSchemaProperties,
    xmlSchemaPropertiesLength,
    false);
}
```

Example: Removal of an XML schema: The following example demonstrates the use of deregisterDB2XmlObject to remove an XML schema from DB2. The SQL schema name for the registered schema is SYSXSR.

Figure 24. Example of removal of an XML schema from DB2

```
public static void deregisterSchema(
  Connection con,
  String schemaName)
  throws SQLException {
  // Define and assign values to the deregisterDB2XmlObject parameters
  String xmlSchemaNameQualifier = "SYSXSR";
```

```
  String xmlSchemaName = schemaName;
  DB2Connection ds = (DB2Connection) con;
  // Invoke deregisterDB2XmlObject
  ds.deregisterDB2XmlObject(
    xmlSchemaNameQualifier,
    xmlSchemaName);
}
```

Example: Update of an XML schema: The following example demonstrates the use of updateDB2XmlSchema to update the contents of an XML schema with the contents of another XML schema. The schema that is copied is kept in the repository. The SQL schema name for both registered schemas is SYSXSR.

Figure 25. Example of updating an XML schema

```
public static void updateSchema(
  Connection con,
  String schemaNameTarget,
  String schemaNameSource)
  throws SQLException {
  // Define and assign values to the updateDB2XmlSchema parameters
  String xmlSchemaNameQualifierTarget = "SYSXSR";
  String xmlSchemaNameQualifierSource = "SYSXSR";
  String xmlSchemaNameTarget = schemaNameTarget;
  String xmlSchemaNameSource = schemaNameSource;
  boolean dropSourceSchema = false;
  DB2Connection ds = (DB2Connection) con;
  // Invoke updateDB2XmlSchema
  ds.updateDB2XmlSchema(
    xmlSchemaNameQualifierTarget,
    xmlSchemaNameTarget,
  xmlSchemaNameQualifierSource,
  xmlSchemaNameSource,
    dropSourceSchema);
}
```

Transaction control in JDBC applications

In JDBC applications, as in other types of SQL applications, transaction control involves explicitly or implicitly committing and rolling back transactions, and setting the isolation level for transactions.

IBM Data Server Driver for JDBC and SQLJ isolation levels

The IBM Data Server Driver for JDBC and SQLJ supports a number of isolation levels, which correspond to database server isolation levels.

JDBC isolation levels can be set for a unit of work within a JDBC program, using the Connection.setTransactionIsolation method. The default isolation level can be set with the defaultIsolationLevel property.

The following table shows the values of *level* that you can specify in the Connection.setTransactionIsolation method and their database server equivalents.

Table 17. Equivalent JDBC and DB2 isolation levels

JDBC value	DB2 isolation level
TRANSACTION_SERIALIZABLE	Repeatable read
TRANSACTION_REPEATABLE_READ	Read stability
TRANSACTION_READ_COMMITTED	Cursor stability

Table 17. Equivalent JDBC and DB2 isolation levels (continued)

JDBC value	DB2 isolation level
TRANSACTION_READ_UNCOMMITTED	Uncommitted read

Committing or rolling back JDBC transactions

In JDBC, to commit or roll back transactions explicitly, use the commit or rollback methods.

For example:

```
 Connection con;
 ...
con.commit();
```

If autocommit mode is on, the database manager performs a commit operation after every SQL statement completes. To set autocommit mode on, invoke the Connection.setAutoCommit(true) method. To set autocommit mode off, invoke the Connection.setAutoCommit(false) method. To determine whether autocommit mode is on, invoke the Connection.getAutoCommit method.

Connections that participate in distributed transactions cannot invoke the setAutoCommit(true) method.

When you change the autocommit state, the database manager executes a commit operation, if the application is not already on a transaction boundary.

While a connection is participating in a distributed transaction, the associated application cannot issue the commit or rollback methods.

Default JDBC autocommit modes

The default autocommit mode depends on the data source to which the JDBC application connects.

Autocommit default for DB2 data sources

For connections to DB2 data sources, the default autocommit mode is `true`.

Autocommit default for IDS data sources

For connections to IDS data sources, the default autocommit mode depends on the type of data source. The following table shows the defaults.

Table 18. Default autocommit modes for IDS data sources

Type of data source	Default autocommit mode for local transactions	Default autocommit mode for global transactions
ANSI-compliant database	true	false
Non-ANSI-compliant database without logging	false	not applicable
Non-ANSI-compliant database with logging	true	false

Exceptions and warnings under the IBM Data Server Driver for JDBC and SQLJ

In JDBC applications, SQL errors throw exceptions, which you handle using `try/catch` blocks. SQL warnings do not throw exceptions, so you need to invoke methods to check whether warnings occurred after you execute SQL statements.

The IBM Data Server Driver for JDBC and SQLJ provides the following classes and interfaces, which provide information about errors and warnings.

SQLException

The SQLException class for handling errors. All JDBC methods throw an instance of SQLException when an error occurs during their execution. According to the JDBC specification, an SQLException object contains the following information:

- An `int` value that contains an error code. SQLException.getErrorCode retrieves this value.
- A String object that contains the SQLSTATE, or null. SQLException.getSQLState retrieves this value.
- A String object that contains a description of the error, or null. SQLException.getMessage retrieves this value.
- A pointer to the next SQLException, or null. SQLException.getNextException retrieves this value.

When a JDBC method throws a single SQLException, that SQLException might be caused by an underlying Java exception that occurred when the IBM Data Server Driver for JDBC and SQLJ processed the method. In this case, the SQLException wraps the underlying exception, and you can use the SQLException.getCause method to retrieve information about the error.

DB2Diagnosable

The IBM Data Server Driver for JDBC and SQLJ-only interface com.ibm.db2.jcc.DB2Diagnosable extends the SQLException class. The DB2Diagnosable interface gives you more information about errors that occur when the data source is accessed. If the JDBC driver detects an error, DB2Diagnosable gives you the same information as the standard SQLException class. However, if the database server detects the error, DB2Diagnosable adds the following methods, which give you additional information about the error:

getSqlca
Returns an DB2Sqlca object with the following information:
- An SQL error code
- The SQLERRMC values
- The SQLERRP value
- The SQLERRD values
- The SQLWARN values
- The SQLSTATE

getThrowable
Returns a java.lang.Throwable object that caused the SQLException, or null, if no such object exists.

printTrace
Prints diagnostic information.

SQLException subclasses

If you are using JDBC 4.0 or later, you can obtain more specific information than an SQLException provides by catching the following exception classes:

- SQLNonTransientException

  An SQLNonTransientException is thrown when an SQL operation that failed previously cannot succeed when the operation is retried, unless some corrective action is taken. The SQLNonTransientException class has these subclasses:
  - SQLFeatureNotSupportedException
  - SQLNonTransientConnectionException
  - SQLDataException
  - SQLIntegrityConstraintViolationException
  - SQLInvalidAuthorizationSpecException
  - SQLSyntaxException
- SQLTransientException

  An SQLTransientException is thrown when an SQL operation that failed previously might succeed when the operation is retried, without intervention from the application. A connection is still valid after an SQLTransientException is thrown. The SQLTransientException class has these subclasses:
  - SQLTransientConnectionException
  - SQLTransientRollbackException
  - SQLTimeoutException
- SQLRecoverableException

  An SQLRecoverableException is thrown when an operation that failed previously might succeed if the application performs some recovery steps, and retries the transaction. A connection is no longer valid after an SQLRecoverableException is thrown.
- SQLClientInfoException

  A SQLClientInfoException is thrown by the Connection.setClientInfo method when one or more client properties cannot be set. The SQLClientInfoException indicates which properties cannot be set.

BatchUpdateException

A BatchUpdateException object contains the following items about an error that occurs during execution of a batch of SQL statements:

- A String object that contains a description of the error, or `null`.
- A String object that contains the SQLSTATE for the failing SQL statement, or `null`
- An integer value that contains the error code, or zero
- An integer array of update counts for SQL statements in the batch, or `null`
- A pointer to an SQLException object, or `null`

One BatchUpdateException is thrown for the entire batch. At least one SQLException object is chained to the BatchUpdateException object. The SQLException objects are chained in the same order as the corresponding statements were added to the batch. To help you match SQLException objects to statements in the batch, the error description field for each SQLException object begins with this string:

```
Error for batch element #n:
```

n is the number of the statement in the batch.

SQL warnings during batch execution do not throw BatchUpdateExceptions. To obtain information about warnings, use the Statement.getWarnings method on the object on which you ran the executeBatch method. You can then retrieve an error description, SQLSTATE, and error code for each SQLWarning object.

SQLWarning

The IBM Data Server Driver for JDBC and SQLJ accumulates warnings when SQL statements return positive SQLCODEs, and when SQL statements return 0 SQLCODEs with non-zero SQLSTATEs.

Calling getWarnings retrieves an SQLWarning object.

Important: When a call to Statement.executeUpdate or PreparedStatement.executeUpdate affects no rows, the IBM Data Server Driver for JDBC and SQLJ generates an SQLWarning with error code +100.

When a call to ResultSet.next returns no rows, the IBM Data Server Driver for JDBC and SQLJ does not generate an SQLWarning.

A generic SQLWarning object contains the following information:
- A String object that contains a description of the warning, or null
- A String object that contains the SQLSTATE, or null
- An `int` value that contains an error code
- A pointer to the next SQLWarning, or null

Under the IBM Data Server Driver for JDBC and SQLJ, like an SQLException object, an SQLWarning object can also contain DB2-specific information. The DB2-specific information for an SQLWarning object is the same as the DB2-specific information for an SQLException object.

Handling an SQLException under the IBM Data Server Driver for JDBC and SQLJ

As in all Java programs, error handling for JDBC applications is done using `try/catch` blocks. Methods throw exceptions when an error occurs, and the code in the `catch` block handles those exceptions.

The basic steps for handling an SQLException in a JDBC program that runs under the IBM Data Server Driver for JDBC and SQLJ are:

1. Give the program access to the com.ibm.db2.jcc.DB2Diagnosable interface and the com.ibm.db2.jcc.DB2Sqlca class. You can fully qualify all references to them, or you can import them:
   ```
   import com.ibm.db2.jcc.DB2Diagnosable;
   import com.ibm.db2.jcc.DB2Sqlca;
   ```
2. Optional: During a connection to a DB2 for z/OS or IBM Informix Dynamic Server (IDS) data source, set the setRetrieveMessagesFromServerOnGetMessage property to `true` if you want full message text from an SQLException.getMessage call.
3. Put code that can generate an SQLException in a `try` block.
4. In the `catch` block, perform the following steps in a loop:
   a. Test whether you have retrieved the last SQLException. If not, continue to the next step.

b. Optional: For an SQL statement that executes on an IDS data source, execute the com.ibm.db2.jcc.DB2Statement.getIDSSQLStatementOffSet method to determine which columns have syntax errors.

   DB2Statement.getIDSSQLStatementOffSet returns the offset into the SQL statement of the first syntax error.

c. Check whether any IBM Data Server Driver for JDBC and SQLJ-only information exists by testing whether the SQLException is an instance of DB2Diagnosable. If so:

   1) Cast the object to a DB2Diagnosable object.
   2) Optional: Invoke the DB2Diagnosable.printTrace method to write all SQLException information to a java.io.PrintWriter object.
   3) Invoke the DB2Diagnosable.getThrowable method to determine whether an underlying java.lang.Throwable caused the SQLException.
   4) Invoke the DB2Diagnosable.getSqlca method to retrieve the DB2Sqlca object.
   5) Invoke the DB2Sqlca.getSqlCode method to retrieve an SQL error code value.
   6) Invoke the DB2Sqlca.getSqlErrmc method to retrieve a string that contains all SQLERRMC values, or invoke the DB2Sqlca.getSqlErrmcTokens method to retrieve the SQLERRMC values in an array.
   7) Invoke the DB2Sqlca.getSqlErrp method to retrieve the SQLERRP value.
   8) Invoke the DB2Sqlca.getSqlErrd method to retrieve the SQLERRD values in an array.
   9) Invoke the DB2Sqlca.getSqlWarn method to retrieve the SQLWARN values in an array.
   10) Invoke the DB2Sqlca.getSqlState method to retrieve the SQLSTATE value.
   11) Invoke the DB2Sqlca.getMessage method to retrieve error message text from the data source.

d. Invoke the SQLException.getNextException method to retrieve the next SQLException.

The following code demonstrates how to obtain IBM Data Server Driver for JDBC and SQLJ-specific information from an SQLException that is provided with the IBM Data Server Driver for JDBC and SQLJ. The numbers to the right of selected statements correspond to the previously-described steps.

Figure 26. Processing an SQLException under the IBM Data Server Driver for JDBC and SQLJ

```
import java.sql.*;                      // Import JDBC API package
import com.ibm.db2.jcc.DB2Diagnosable;  // Import packages for DB2      1
import com.ibm.db2.jcc.DB2Sqlca;        // SQLException support
java.io.PrintWriter printWriter;        // For dumping all SQLException
                                        // information
String url = "jdbc:db2://myhost:9999/myDB:" +                         2
  "retrieveMessagesFromServerOnGetMessage=true;";
                                  // Set properties to retrieve full message
                                  // text
String user = "db2adm";
String password = "db2adm";
java.sql.Connection con =
```

```
  java.sql.DriverManager.getConnection (url, user, password)
                                  // Connect to a DB2 for z/OS data source


...
try {                                                                    3
  // Code that could generate SQLExceptions
 ...
} catch(SQLException sqle) {
    while(sqle != null) {             // Check whether there are more    4a
                                      // SQLExceptions to process
 //=====> Optional IBM Data Server Driver for JDBC and SQLJ-only
 // error processing
      if (sqle instanceof DB2Diagnosable) {                              4c
      // Check if IBM Data Server Driver for JDBC and SQLJ-only
      // information exists
          com.ibm.db2.jcc.DB2Diagnosable diagnosable =
            (com.ibm.db2.jcc.DB2Diagnosable)sqle;                        4c1
          diagnosable.printTrace (printWriter, "");                      4c2
          java.lang.Throwable throwable =
            diagnosable.getThrowable();                                  4c3
          if (throwable != null) {
            // Extract java.lang.Throwable information
            // such as message or stack trace.
            ...
          }
          DB2Sqlca sqlca = diagnosable.getSqlca();                       4c4
                                      // Get DB2Sqlca object
          if (sqlca != null) {        // Check that DB2Sqlca is not null
            int sqlCode = sqlca.getSqlCode(); // Get the SQL error code  4c5
            String sqlErrmc = sqlca.getSqlErrmc();                       4c6
                                      // Get the entire SQLERRMC
            String[] sqlErrmcTokens = sqlca.getSqlErrmcTokens();
                                      // You can also retrieve the
                                      // individual SQLERRMC tokens
            String sqlErrp = sqlca.getSqlErrp();                         4c7
                                      // Get the SQLERRP
            int[] sqlErrd = sqlca.getSqlErrd();                          4c8
                                      // Get SQLERRD fields
            char[] sqlWarn = sqlca.getSqlWarn();                         4c9
                                      // Get SQLWARN fields
            String sqlState = sqlca.getSqlState();                       4c10
                                      // Get SQLSTATE
            String errMessage = sqlca.getMessage();                      4c11
                                      // Get error message

            System.err.println ("Server error message: " + errMessage);

            System.err.println ("--------------- SQLCA ---------------");
            System.err.println ("Error code: " + sqlCode);
            System.err.println ("SQLERRMC: " + sqlErrmc);
            If (sqlErrmcTokens != null) {
              for (int i=0; i< sqlErrmcTokens.length; i++) {
                System.err.println ("  token " + i + ": " + sqlErrmcTokens[i]);
              }
            }
            System.err.println ( "SQLERRP: " + sqlErrp );
            System.err.println (
              "SQLERRD(1): " + sqlErrd[0] + "\n" +
              "SQLERRD(2): " + sqlErrd[1] + "\n" +
              "SQLERRD(3): " + sqlErrd[2] + "\n" +
              "SQLERRD(4): " + sqlErrd[3] + "\n" +
              "SQLERRD(5): " + sqlErrd[4] + "\n" +
              "SQLERRD(6): " + sqlErrd[5] );
            System.err.println (
              "SQLWARN1: " + sqlWarn[0] + "\n" +
              "SQLWARN2: " + sqlWarn[1] + "\n" +
```

```
                "SQLWARN3: " + sqlWarn[2] + "\n" +
                "SQLWARN4: " + sqlWarn[3] + "\n" +
                "SQLWARN5: " + sqlWarn[4] + "\n" +
                "SQLWARN6: " + sqlWarn[5] + "\n" +
                "SQLWARN7: " + sqlWarn[6] + "\n" +
                "SQLWARN8: " + sqlWarn[7] + "\n" +
                "SQLWARN9: " + sqlWarn[8] + "\n" +
                "SQLWARNA: " + sqlWarn[9] );
              System.err.println ("SQLSTATE: " + sqlState);
                                                 // portion of SQLException
            }
          sqle=sqle.getNextException();     // Retrieve next SQLException      4d
        }
    }
```

Handling an SQLWarning under the IBM Data Server Driver for JDBC and SQLJ

Unlike SQL errors, SQL warnings do not cause JDBC methods to throw exceptions. Instead, the Connection, Statement, PreparedStatement, `CallableStatement`, and ResultSet classes contain getWarnings methods, which you need to invoke after you execute SQL statements to determine whether any SQL warnings were generated.

The basic steps for retrieving SQL warning information are:

1. Optional: During connection to the database server, set properties that affect SQLWarning objects.

   If you want full message text from a DB2 for z/OS or IBM Informix Dynamic Server (IDS) data source when you execute SQLWarning.getMessage calls, set the setRetrieveMessagesFromServerOnGetMessage property to `true`.
2. Immediately after invoking a method that connects to a database server or executes an SQL statement, invoke the getWarnings method to retrieve an SQLWarning object.
3. Perform the following steps in a loop:
   a. Test whether the SQLWarning object is null. If not, continue to the next step.
   b. Invoke the SQLWarning.getMessage method to retrieve the warning description.
   c. Invoke the SQLWarning.getSQLState method to retrieve the SQLSTATE value.
   d. Invoke the SQLWarning.getErrorCode method to retrieve the error code value.
   e. If you want DB2-specific warning information, perform the same steps that you perform to get DB2-specific information for an SQLException.
   f. Invoke the SQLWarning.getNextWarning method to retrieve the next SQLWarning.

The following code illustrates how to obtain generic SQLWarning information. The numbers to the right of selected statements correspond to the previously-described steps.

```
String url = "jdbc:db2://myhost:9999/myDB:" +                          1
  "retrieveMessagesFromServerOnGetMessage=true;";
                                  // Set properties to retrieve full message
                                  // text
String user = "db2adm";
String password = "db2adm";
java.sql.Connection con =
  java.sql.DriverManager.getConnection (url, user, password)
                                  // Connect to a DB2 for z/OS data source
Statement stmt;
ResultSet rs;
SQLWarning sqlwarn;
...
stmt = con.createStatement();     // Create a Statement object
rs = stmt.executeQuery("SELECT * FROM EMPLOYEE");
                                  // Get the result table from the query
sqlwarn = stmt.getWarnings();     // Get any warnings generated           2
while (sqlwarn != null) {         // While there are warnings, get and    3a
                                  // print warning information
  System.out.println ("Warning description: " + sqlwarn.getMessage());   3b
  System.out.println ("SQLSTATE: " + sqlwarn.getSQLState());             3c
  System.out.println ("Error code: " + sqlwarn.getErrorCode());         3d
  sqlwarn=sqlwarn.getNextWarning();     // Get next SQLWarning           3f
}
```

Figure 27. Example of processing an SQLWarning

Retrieving information from a BatchUpdateException

When an error occurs during execution of a statement in a batch, processing continues. However, executeBatch throws a BatchUpdateException.

To retrieve information from the BatchUpdateException, follow these steps:

1. Use the BatchUpdateException.getUpdateCounts method to determine the number of rows that each SQL statement in the batch updated before the exception was thrown.

   getUpdateCount returns an array with an element for each statement in the batch. An element has one of the following values:

   n The number of rows that the statement updated.

   Statement.SUCCESS_NO_INFO
   This value is returned if the number of updated rows cannot be determined.

   Statement.EXECUTE_FAILED
   This value is returned if the statement did not execute successfully.
2. Use SQLException methods getMessage, getSQLState, and getErrorCode to retrieve the description of the error, the SQLSTATE, and the error code for the first error.
3. Use the BatchUpdateException.getNextException method to get a chained SQLException.
4. In a loop, execute the getMessage, getSQLState, getErrorCode, and getNextException method calls to obtain information about an SQLException and get the next SQLException.

The following code fragment demonstrates how to obtain the fields of a BatchUpdateException and the chained SQLException objects. The numbers to the

right of selected statements correspond to the previously-described steps.

```
try {
  // Batch updates
} catch(BatchUpdateException buex) {
    System.err.println("Contents of BatchUpdateException:");
    System.err.println(" Update counts: ");
    int [] updateCounts = buex.getUpdateCounts();             1
    for (int i = 0; i < updateCounts.length; i++) {
      System.err.println("  Statement " + i + ":" + updateCounts[i]);
    }
    System.err.println(" Message: " + buex.getMessage());     2
    System.err.println(" SQLSTATE: " + buex.getSQLState());
    System.err.println(" Error code: " + buex.getErrorCode());
    SQLException ex = buex.getNextException();                3
    while (ex != null) {                                      4
      System.err.println("SQL exception:");
      System.err.println(" Message: " + ex.getMessage());
      System.err.println(" SQLSTATE: " + ex.getSQLState());
      System.err.println(" Error code: " + ex.getErrorCode());
      ex = ex.getNextException();
    }
}
```

Figure 28. Retrieving a BatchUpdateException fields

Handling an SQLException under the DB2 JDBC Type 2 Driver

As in all Java programs, error handling under the DB2 JDBC Type 2 Driver is done using `try/catch` blocks. Methods throw exceptions when an error occurs, and the code in the `catch` block handles those exceptions.

JDBC provides the SQLException class for handling errors. All JDBC methods throw an instance of SQLException when an error occurs during their execution. According to the JDBC specification, an SQLException object contains the following information:

- A `String` object that contains a description of the error, or null
- A `String` object that contains the SQLSTATE, or null
- An `int` value that contains an error code
- A pointer to the next SQLException, or null

The basic steps for handling an SQLException in a JDBC program that runs under the DB2 JDBC Type 2 Driver for Linux, UNIX and Windows (DB2 JDBC Type 2 Driver) are:

1. Put code that can generate an SQLException in a `try` block.
2. In the `catch` block, perform the following steps in a loop:
   a. Test whether you have retrieved the last SQLException. If not, continue to the next step.
   b. Retrieve error information from the SQLException.
   c. Invoke the SQLException.getNextException method to retrieve the next SQLException.

The following code illustrates a `catch` block that uses the DB2 version of SQLException that is provided with the DB2 JDBC Type 2 Driver. The numbers to the right of selected statements correspond to the previously-described steps.

```
import java.sql.*;                    // Import JDBC API package
...
try {
  // Code that could generate SQLExceptions                          1
 ...
} catch(SQLException sqle) {
    while(sqle != null) {             // Check whether there are more   2a
      System.out.println("Message:  " + sqle.getMessage());            2b
      System.out.println("SQLSTATE: " + sqle.getSQLState());
      System.out.println("SQL error code: " + sqle.getErrorCode());
      sqle=sqle.getNextException();     // Retrieve next SQLException   2c
    }
}
```

Figure 29. Processing an SQLException under the IBM Data Server Driver for JDBC and SQLJ

Handling an SQLWarning under the DB2 JDBC Type 2 Driver

Unlike SQL errors, SQL warnings do not cause JDBC methods to throw exceptions. Instead, the Connection, Statement, PreparedStatement, `CallableStatement`, and ResultSet classes contain getWarnings methods, which you need to invoke after you execute SQL statements to determine whether any SQL warnings were generated.

Calling getWarnings retrieves an SQLWarning object.

The DB2 JDBC Type 2 Driver for Linux, UNIX and Windows (DB2 JDBC Type 2 Driver) generates generic SQLWarning objects. A generic SQLWarning object contains the following information:

- A `String` object that contains a description of the warning, or null
- A `String` object that contains the SQLSTATE, or null
- An `int` value that contains an error code
- A pointer to the next SQLWarning, or null

The basic steps for retrieving SQL warning information are:

1. Immediately after invoking a method that executes an SQL statement, invoke the getWarnings method to retrieve an SQLWarning object.
2. Perform the following steps in a loop:
   a. Test whether the SQLWarning object is null. If not, continue to the next step.
   b. Invoke the SQLWarning.getMessage method to retrieve the warning description.
   c. Invoke the SQLWarning.getSQLState method to retrieve the SQLSTATE value.
   d. Invoke the SQLWarning.getErrorCode method to retrieve the error code value.
   e. Invoke the SQLWarning.getNextWarning method to retrieve the next SQLWarning.

The following code illustrates how to obtain generic SQLWarning information. The numbers to the right of selected statements correspond to the previously-described steps.

```
Connection con;
Statement stmt;
ResultSet rs;
SQLWarning sqlwarn;
...
stmt = con.createStatement();     // Create a Statement object
rs = stmt.executeQuery("SELECT * FROM EMPLOYEE");
                                  // Get the result table from the query
sqlwarn = stmt.getWarnings();     // Get any warnings generated          1
while (sqlwarn != null) {         // While there are warnings, get and   2a
                                  // print warning information
  System.out.println ("Warning description: " + sqlwarn.getMessage());   2b
  System.out.println ("SQLSTATE: " + sqlwarn.getSQLState());             2c
  System.out.println ("Error code: " + sqlwarn.getErrorCode());         2d
  sqlwarn=sqlwarn.getNextWarning();     // Get next SQLWarning           2e
}
```

Figure 30. Processing an SQLWarning

IBM Data Server Driver for JDBC and SQLJ client reroute support

The DB2 automatic client reroute feature allows client applications to recover from a loss of communication with the server so that they can continue to work with minimal interruption. JDBC and SQLJ client applications can take advantage of that support.

Whenever a server crashes, each client that is connected to that server receives a communication error, which terminates the connection and results in an application error. When availability is important, you should have a redundant setup or failover support. Failover is the ability of a server to take over operations when another server fails. In either case, the IBM Data Server Driver for JDBC and SQLJ client attempts to reestablish the connection to the original server or to a new server. When the connection is reestablished, the application receives an SQLException that informs it of the transaction failure, but the application can continue with the next transaction.

IBM Data Server Driver for JDBC and SQLJ client reroute support is available for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to DB2 Database for Linux, UNIX, and Windows or DB2 for z/OS servers. It works for connections that are obtained using the javax.sql.DataSource, javax.sql.ConnectionPoolDataSource, `javax.sql.XADataSource`, or java.sql.DriverManager interface.

To set primary and alternate servers for client reroute when you use the DataSource or `ConnectionPoolDataSource` interface, you set the clientRerouteServerListJNDIName property.

To set primary and alternate servers for client reroute when you use the DriverManager interface, you set the clientRerouteAlternateServerName and clientRerouteAlternatePortNumber properties.

If you do not set JDBC driver properties for primary and alternate servers, client reroute can occur if primary and alternate server addresses are set in DNS entries. The IBM Data Server Driver for JDBC and SQLJ looks for primary and alternate server information in DNS entries if primary and alternate server information is not in JDBC driver memory and JDNI is not used.

Restriction: Client reroute support for connections that are made with the DriverManager interface has the following restrictions:

- Alternate server information is shared between DriverManager connections only if you create the connections with the same URL and properties.
- You cannot set the clientRerouteServerListJNDIName property or the clientRerouteServerListJNDIContext properties for a DriverManager connection.
- Client reroute is not enabled for default connections (jdbc:default:connection).

Configuration of DB2 for z/OS servers for client reroute

If Sysplex routing is disabled on a DB2 for z/OS server, and a data sharing group is set up for member-specific access, you can use IBM Data Server Driver for JDBC and SQLJ client reroute support.

If Sysplex routing is enabled for a DB2 data sharing group, work is distributed among all members of a data sharing group by the DB2 for z/OS server and Workload Manager for z/OS (WLM). If one of the members of a DB2 data sharing group fails, work is automatically transferred to other members. In this case, IBM Data Server Driver for JDBC and SQLJ client reroute support is not needed.

Setting up member-specific access includes setting up a location alias that represents one or more members of the data sharing group. Before a JDBC or SQLJ client application can use the client reroute facility, a location alias needs to exist that represents at least two members of the data sharing group. The client application connects to those members using the location alias, instead of using the location name to connect to the entire group. If one member fails, connections are attempted to other members of the data sharing group, based on their priority (WLM server weight information).

IBM Data Server Driver for JDBC and SQLJ client reroute support works only for member-specific access. It does not work for group access. Therefore, only a member dynamic virtual IP address (DVIPA) should be defined. A group DVIPA should not be defined.

To set up the data sharing group so that JDBC and SQLJ client applications can take advantage of client reroute support, the database administrator needs to perform these steps:

1. Specify the DRDA port number on which all members listen for incoming SQL requests.
2. Specify a unique resynchronization port number for each member.
3. Designate subsets of members to which DRDA requesters can connect.
4. Specify a generic LU name for the data sharing group, if RACF PassTickets are used.

See the topic ″Configuring data sharing groups as TCP/IP servers″ in the Information Management Software for z/OS Solutions Information Center at http://publib.boulder.ibm.com/infocenter/imzic for details.

IBM Data Server Driver for JDBC and SQLJ client reroute operation on the client

IBM Data Server Driver for JDBC and SQLJ client reroute support works for connections that are obtained using the javax.sql.DataSource, javax.sql.ConnectionPoolDataSource, javax.sql.XADataSource, or java.sql.DriverManager interface.

Client reroute on the client operates in the following way:

1. Before the first connection to the data source, the IBM Data Server Driver for JDBC and SQLJ obtains primary and alternate server information.
   a. If the clientRerouteAlternateServerName and clientRerouteAlternatePortNumber DataSource properties are set, the IBM Data Server Driver for JDBC and SQLJ loads those values into memory as the alternate server values, along with the primary server values serverName and portNumber.
   b. If the clientRerouteAlternateServerName and clientRerouteAlternatePortNumber DataSource properties are not set, and a JNDI store is configured by setting the property clientRerouteServerListJNDIName on the DB2BaseDataSource, the IBM Data Server Driver for JDBC and SQLJ loads the primary and alternate server information from the JNDI store into memory.
   c. If no DataSource properties are set for the alternate servers, and JNDI is not configured, the IBM Data Server Driver for JDBC and SQLJ checks DNS tables for primary and alternate server information. If DNS information exists, the IBM Data Server Driver for JDBC and SQLJ loads those values into memory.
   d. If no primary or alternate server information is available, a connection cannot be established, and the IBM Data Server Driver for JDBC and SQLJ throws an exception.
2. The IBM Data Server Driver for JDBC and SQLJ connects to the data source using the primary server name and port number.
3. If the connection to the primary server fails:
   a. The IBM Data Server Driver for JDBC and SQLJ attempts to reconnect to the primary server.
   b. If reconnection to the primary server fails, the IBM Data Server Driver for JDBC and SQLJ attempts to connect to the alternate servers.

   Reconnection to the primary server is called *failback*. Connection to an alternate server is called *failover*.

   The IBM Data Server Driver for JDBC and SQLJ uses the maxRetriesForClientReroute and retryIntervalForClientReroute properties to determine how many times to retry the connection and how long to wait between retries. An attempt to connect to the primary server and alternate servers counts as one retry.
4. If failover is successful during the initial connection, the driver generates an SQLWarning. If a successful failover occurs after the initial connection, the driver throws an SQLException to the application with error code -4498, to indicate to the application that the connection to the alternate server was automatically reestablished and the transaction was implicitly rolled back. The application can then retry its transaction without doing an explicit rollback first.

   After a successful connection to alternate servers, the Connection or DataSource has the original properties, except for the server name and port number. In addition, any data source special registers that were modified during the original connection are reestablished in the failover connection.

   You can determine whether alternate server information was used in establishing a connection by calling the DB2Connection.alternateWasUsedOnConnect method. If the data source returns primary and alternate server information that is different from the in-memory list, the in-memory primary and alternate server information is updated. The value that DB2Connection.alternateWasUsedOnConnect returns depends on the

latest alternate information that is in memory, and not on the initial configuration of the DB2BaseDataSource.

IBM Data Server Driver for JDBC and SQLJ client reroute support with JNDI

If you make connections with the javax.sql.DataSource, javax.sql.ConnectionPoolDataSource, or javax.sql.XADataSource interface, you indicate to the IBM Data Server Driver for JDBC and SQLJ that JNDI is configured for client reroute by setting the clientRerouteServerListJNDIName property.

You can also specify the clientRerouteServerListJNDIContext property, which provides the JNDI context that is used for binding and lookup of a DB2ClientRerouteServerList instance.

For client reroute with JNDI, the in-memory primary and alternate server information is an instance of the DB2ClientRerouteServerList class, which implements the javax.naming.Referenceable interface.

DB2ClientRerouteServerList is a serializable Java bean with the following properties:

Property name	Data type
com.ibm.db2.jcc.DB2ClientRerouteServerList.alternateServerName	String[]
com.ibm.db2.jcc.DB2ClientRerouteServerList.alternatePortNumber	int[]
com.ibm.db2.jcc.DB2ClientRerouteServerList.primaryServerName	String[]
com.ibm.db2.jcc.DB2ClientRerouteServerList.primaryPortNumber	int[]

getXXX and setXXX methods are defined for each property.

When a DataSource is configured to use JNDI for storing client reroute alternate information, the standard server and port properties of the DataSource are not used for a getConnection request. Instead, the primary server address is obtained from the transient clientRerouteServerList information. If the JNDI store is not available due to a JNDI bind or lookup failure, the IBM Data Server Driver for JDBC and SQLJ attempts to make a connection using the standard server and port properties of the DataSource. Warnings are accumulated to indicate that a JNDI bind or lookup failure occurred.

After a failover:

- The IBM Data Server Driver for JDBC and SQLJ attempts to propagate the updated server information to the JNDI store.
- primaryServerName and primaryPortNumber values that are specified in DB2ClientRerouteServerList are used for the connection. If primaryServerName is not specified, the serverName value for the DataSource instance is used.

To set up storage to make DB2ClientRerouteServerList persistent, follow these steps:

1. Create an instance of DB2ClientRerouteServerList, and bind that instance to the JNDI registry.

   Example:

   ```
   // Create a starting context for naming operations
   InitialContext registry = new InitialContext();
   // Create a DB2ClientRerouteServerList object
   ```

```
DB2ClientRerouteServerList address = new DB2ClientRerouteServerList();

// Set the port number and server name for the primary server
address.setPrimaryPortNumber(50000);
address.setPrimaryServerName("mvs1.sj.ibm.com");

// Set the  port number and server name for the alternate server
int[] port = {50002};
String[] server = {"mvs3.sj.ibm.com"};
address.setAlternatePortNumber(port);
address.setAlternateServerName(server);

registry.rebind("serverList", address);
```

2. Assign the JNDI name of the DB2ClientRerouteServerList object to the clientRerouteServerListJNDIName property.

   Example:

   ```
   datasource.setClientRerouteServerListJNDIName("serverList");
   ```

Disconnecting from data sources in JDBC applications

When you have finished with a connection to a data source, it is *essential* that you close the connection to the data source. Doing this releases the Connection object's database and JDBC resources immediately.

To close the connection to the data source, use the close method. For example:

```
 Connection con;
 ...
con.close();
```

For a connection to a DB2 data source, if autocommit mode is not on, the connection needs to be on a unit-of-work boundary before you close the connection.

For a connection to an IBM Informix Dynamic Server database, if the database supports logging, and autocommit mode is not on, the connection needs to be on a unit-of-work boundary before you close the connection.

Chapter 4. SQLJ application programming

Writing a SQLJ application has much in common with writing an SQL application in any other language.

In general, you need to do the following things:
- Import the Java packages that contain SQLJ and JDBC methods.
- Declare variables for sending data to or retrieving data from DB2 tables.
- Connect to a data source.
- Execute SQL statements.
- Handle SQL errors and warnings.
- Disconnect from the data source.

Although the tasks that you need to perform are similar to those in other languages, the way that you execute those tasks, and the order in which you execute those tasks, is somewhat different.

Example of a simple SQLJ application

A simple SQLJ application demonstrates the basic elements that JDBC applications need to include.

Figure 31. Simple SQLJ application

```
import sqlj.runtime.*;                                          1
import java.sql.*;

#sql context EzSqljCtx;                                         3a
#sql iterator EzSqljNameIter (String LASTNAME);                 4a

public class EzSqlj {
  public static void main(String args[])
    throws SQLException
  {
    EzSqljCtx ctx = null;
    String URLprefix = "jdbc:db2:";
    String url;
    url = new String(URLprefix + args[0]);
                                          // Location name is an input parameter
    String hvmgr="000010";                                      2
    String hvdeptno="A00";
    try {                                                       3b
      Class.forName("com.ibm.db2.jcc.DB2Driver");
    } catch (Exception e)
    {
       throw new SQLException("Error in EzSqlj: Could not load the driver");
    }
    try
    {
       System.out.println("About to connect using url: " + url);
       Connection con0 = DriverManager.getConnection(url);      3c
                                          // Create a JDBC Connection
       con0.setAutoCommit(false);         // set autocommit OFF
       ctx = new EzSqljCtx(con0);                               3d

       try
       {
```

```
        EzSqljNameIter iter;
        int count=0;

        #sql [ctx] iter =
          {SELECT LASTNAME FROM EMPLOYEE};                          4b
                                          // Create result table of the SELECT
        while (iter.next()) {                                       4c
           System.out.println(iter.LASTNAME());
                                          // Retrieve rows from result table
           count++;
        }
        System.out.println("Retrieved " + count + " rows of data");
      }
      catch( SQLException e )                                       5
      {
         System.out.println ("**** SELECT SQLException...");
         while(e!=null) {
           System.out.println ("Error msg: " + e.getMessage());
           System.out.println ("SQLSTATE: " + e.getSQLState());
           System.out.println ("Error code: " + e.getErrorCode());
           e = e.getNextException(); // Check for chained exceptions
         }
      }
      catch( Exception e )
      {
         System.out.println("**** NON-SQL exception   = " + e);
         e.printStackTrace();
      }
      try
      {
        #sql [ctx]                                                  4d
          {UPDATE DEPARTMENT SET MGRNO=:hvmgr
             WHERE DEPTNO=:hvdeptno};   // Update data for one department
                                                                    6
        #sql [ctx] {COMMIT};            // Commit the update
      }
      catch( SQLException e )
      {
         System.out.println ("**** UPDATE SQLException...");
         System.out.println ("Error msg: " + e.getMessage() + ". SQLSTATE=" +
           e.getSQLState() + " Error code=" + e.getErrorCode());
         e.printStackTrace();
      }
      catch( Exception e )
      {
         System.out.println("**** NON-SQL exception   = " + e);
         e.printStackTrace();
      }
      iter.close();                      // Close the iterator
      ctx.close();                                                  7
    }
    catch(SQLException e)
    {
       System.out.println ("**** SQLException ...");
       System.out.println ("Error msg: " + e.getMessage() + ". SQLSTATE=" +
         e.getSQLState() + " Error code=" + e.getErrorCode());
       e.printStackTrace();
    }
    catch(Exception e)
    {
      System.out.println ("**** NON-SQL exception = " + e);
      e.printStackTrace();
    }

  }
```

Notes® to Figure 31 on page 103:

Note	Description
1	These statements import the java.sql package, which contains the JDBC core API, and the sqlj.runtime package, which contains the SQLJ API. For information on other packages or classes that you might need to access, see "Java packages for SQLJ support".
2	`String` variables hvmgr and hvdeptno are *host identifiers*, which are equivalent to DB2 host variables. See "Variables in SQLJ applications" for more information.
3a, 3b, 3c, and 3d	These statements demonstrate how to connect to a data source using one of the three available techniques. See "Connecting to a data source using SQLJ" for more details. Step 3b (loading the JDBC driver) is not necessary if you use JDBC 4.0.
4a , 4b, 4c, and 4d	These statements demonstrate how to execute SQL statements in SQLJ. Statement 4a demonstrates the SQLJ equivalent of declaring an SQL cursor. Statements 4b and 4c show one way of doing the SQLJ equivalent of executing SQL FETCHes. Statement 4d shows how to do the SQLJ equivalent of performing an SQL UPDATE. For more information, see "SQL statements in an SQLJ application".
5	This `try/catch` block demonstrates the use of the SQLException class for SQL error handling. For more information on handling SQL errors, see "Handling SQL errors in an SQLJ application". For more information on handling SQL warnings, see "Handling SQL warnings in an SQLJ application".
6	This is an example of a comment. For rules on including comments in SQLJ programs, see "Comments in an SQLJ application".
7	This statement closes the connection to the data source. See "Closing the connection to the data source in an SQLJ application".

Connecting to a data source using SQLJ

In an SQLJ application, as in any other DB2 application, you must be connected to a data source before you can execute SQL statements.

You can use one six techniques to connect to a data source in an SQLJ program. Two use the JDBC DriverManager interface, two use the JDBC DataSource interface, one uses a previously created connection, and one uses the default connection.

SQLJ connection technique 1: JDBC DriverManager interface

SQLJ connection technique 1 uses the JDBC DriverManager interface as the underlying means for creating the connection.

To use SQLJ connection technique 1, follow these steps:

1. Execute an SQLJ *connection declaration clause*.

   Doing this generates a *connection context class*. The simplest form of the connection declaration clause is:

   ```
   #sql context context-class-name;
   ```

   The name of the generated connection context class is *context-class-name*.
2. Load a JDBC driver by invoking the Class.forName method.
   - For the IBM Data Server Driver for JDBC and SQLJ, invoke Class.forName this way:

     ```
     Class.forName("com.ibm.db2.jcc.DB2Driver");
     ```

This step is unnecessary if you use the JDBC 4.0 driver.

- For the DB2 JDBC Type 2 Driver, invoke Class.forName this way:

```
Class.forName("COM.ibm.db2.jdbc.app.DB2Driver");
```

3. Invoke the constructor for the connection context class that you created in step 1 on page 105.

   Doing this creates a connection context object that you specify in each SQL statement that you execute at the associated data source. The constructor invocation statement needs to be in one of the following forms:

```
connection-context-class connection-context-object=
  new connection-context-class(String url, boolean autocommit);

connection-context-class connection-context-object=
  new connection-context-class(String url, String user,
    String password, boolean autocommit);
connection-context-class connection-context-object=
  new connection-context-class(String url, Properties info,
    boolean autocommit);
```

   The meanings of the parameters are:

   url A string that specifies the location name that is associated with the data source. That argument has one of the forms that are specified in ″Connect to a data source using the DriverManager interface with the IBM Data Server Driver for JDBC and SQLJ″. The form depends on which JDBC driver you are using.

   user **and** *password*
   Specify a user ID and password for connection to the data source, if the data source to which you are connecting requires them.

   info
   Specifies an object of type java.util.Properties that contains a set of driver properties for the connection. For the DB2 JDBC Type 2 Driver for Linux, UNIX and Windows (DB2 JDBC Type 2 Driver), you should specify only the `user` and `password` properties. For the IBM Data Server Driver for JDBC and SQLJ, you can specify any of the properties listed in ″Properties for the IBM Data Server Driver for JDBC and SQLJ″.

   autocommit
   Specifies whether you want the database manager to issue a COMMIT after every statement. Possible values are `true` or `false`. If you specify `false`, you need to do explicit commit operations.

The following code uses connection technique 1 to create a connection to location NEWYORK. The connection requires a user ID and password, and does not require autocommit. The numbers to the right of selected statements correspond to the previously-described steps.

```
#sql context Ctx;            // Create connection context class Ctx        1
String userid="dbadm";       // Declare variables for user ID and password
String password="dbadm";
String empname;              // Declare a host variable
...
try {                        // Load the JDBC driver
  Class.forName("com.ibm.db2.jcc.DB2Driver");                              2
}
catch (ClassNotFoundException e) {
   e.printStackTrace();
}
Ctx myConnCtx=                                                             3
  new Ctx("jdbc:db2://sysmvs1.stl.ibm.com:5021/NEWYORK",
  userid,password,false);    // Create connection context object myConnCtx
                             // for the connection to NEWYORK
#sql [myConnCtx] {SELECT LASTNAME INTO :empname FROM EMPLOYEE
   WHERE EMPNO='000010'};
                             // Use myConnCtx for executing an SQL statement
```

Figure 32. Using connection technique 1 to connect to a data source

SQLJ connection technique 2: JDBC DriverManager interface

SQLJ connection technique 2 uses the JDBC DriverManager interface as the underlying means for creating the connection.

To use SQLJ connection technique 2, follow these steps:

1. Execute an SQLJ *connection declaration clause*.

   Doing this generates a *connection context class*. The simplest form of the connection declaration clause is:

   ```
   #sql context context-class-name;
   ```

   The name of the generated connection context class is *context-class-name*.
2. Load a JDBC driver by invoking the Class.forName method.
   - For the IBM Data Server Driver for JDBC and SQLJ, invoke Class.forName this way:

     ```
     Class.forName("com.ibm.db2.jcc.DB2Driver");
     ```

     This step is unnecessary if you use the JDBC 4.0 driver.
   - For the DB2 JDBC Type 2 Driver, invoke Class.forName this way:

     ```
     Class.forName("COM.ibm.db2.jdbc.app.DB2Driver");
     ```
3. Invoke the JDBC DriverManager.getConnection method.

   Doing this creates a JDBC connection object for the connection to the data source. You can use any of the forms of getConnection that are specified in ″Connect to a data source using the DriverManager interface with the IBM Data Server Driver for JDBC and SQLJ″.

   The meanings of the *url*, *user*, and *password* parameters are:

   url A string that specifies the location name that is associated with the data source. That argument has one of the forms that are specified in ″Connect to a data source using the DriverManager interface with the IBM Data Server Driver for JDBC and SQLJ″. The form depends on which JDBC driver you are using.

   user **and** *password*
   Specify a user ID and password for connection to the data source, if the data source to which you are connecting requires them.

4. Invoke the constructor for the connection context class that you created in step 1 on page 107

   Doing this creates a connection context object that you specify in each SQL statement that you execute at the associated data source. The constructor invocation statement needs to be in the following form:

   ```
   connection-context-class connection-context-object=
     new connection-context-class(Connection JDBC-connection-object);
   ```

   The *JDBC-connection-object* parameter is the Connection object that you created in step 3 on page 107.

The following code uses connection technique 2 to create a connection to location NEWYORK. The connection requires a user ID and password, and does not require autocommit. The numbers to the right of selected statements correspond to the previously-described steps.

```
#sql context Ctx;           // Create connection context class Ctx        1
String userid="dbadm";      // Declare variables for user ID and password
String password="dbadm";
String empname;             // Declare a host variable
...
try {                       // Load the JDBC driver
  Class.forName("com.ibm.db2.jcc.DB2Driver");                            2
}
catch (ClassNotFoundException e) {
   e.printStackTrace();
}
Connection jdbccon=                                                      3
  DriverManager.getConnection("jdbc:db2://sysmvs1.stl.ibm.com:5021/NEWYORK",
    userid,password);
                            // Create JDBC connection object jdbccon
jdbccon.setAutoCommit(false); // Do not autocommit
Ctx myConnCtx=new Ctx(jdbccon);                                          4
                            // Create connection context object myConnCtx
                            // for the connection to NEWYORK
#sql [myConnCtx] {SELECT LASTNAME INTO :empname FROM EMPLOYEE
   WHERE EMPNO='000010'};
                            // Use myConnCtx for executing an SQL statement
```

Figure 33. Using connection technique 2 to connect to a data source

SQLJ connection technique 3: JDBC DataSource interface

SQLJ connection technique 3 uses the JDBC DataSource as the underlying means for creating the connection.

To use SQLJ connection technique 3, follow these steps:

1. Execute an SQLJ *connection declaration clause*.

   Doing this generates a *connection context class*. The simplest form of the connection declaration clause is:

   ```
   #sql context context-class-name;
   ```

   The name of the generated connection context class is *context-class-name*.

2. If your system administrator created a DataSource object in a different program, follow these steps. Otherwise, create a DataSource object and assign properties to it.
   a. Obtain the logical name of the data source to which you need to connect.
   b. Create a context to use in the next step.

c. In your application program, use the Java Naming and Directory Interface (JNDI) to get the DataSource object that is associated with the logical data source name.

3. Invoke the JDBC DataSource.getConnection method.

   Doing this creates a JDBC connection object for the connection to the data source. You can use one of the following forms of getConnection:

   ```
   getConnection();
   getConnection(user, password);
   ```

   The meanings of the *user* and *password* parameters are:

   user **and** *password*
   Specify a user ID and password for connection to the data source, if the data source to which you are connecting requires them.

4. If the default autocommit mode is not appropriate, invoke the JDBC Connection.setAutoCommit method.

   Doing this indicates whether you want the database manager to issue a COMMIT after every statement. The form of this method is:

   ```
   setAutoCommit(boolean autocommit);
   ```

5. Invoke the constructor for the connection context class that you created in step 1 on page 108.

   Doing this creates a connection context object that you specify in each SQL statement that you execute at the associated data source. The constructor invocation statement needs to be in the following form:

   ```
   connection-context-class connection-context-object=
     new connection-context-class(Connection JDBC-connection-object);
   ```

   The *JDBC-connection-object* parameter is the Connection object that you created in step 3.

The following code uses connection technique 3 to create a connection to a location with logical name `jdbc/sampledb`. This example assumes that the system administrator created and deployed a DataSource object that is available through JNDI lookup. The numbers to the right of selected statements correspond to the previously-described steps.

```
import java.sql.*;
import javax.naming.*;
import javax.sql.*;
...
#sql context CtxSqlj;       // Create connection context class CtxSqlj   1
Context ctx=new InitialContext();                                         2b
DataSource ds=(DataSource)ctx.lookup("jdbc/sampledb");                    2c
Connection con=ds.getConnection();                                        3
String empname;             // Declare a host variable
...
con.setAutoCommit(false);   // Do not autocommit                          4
CtxSqlj myConnCtx=new CtxSqlj(con);                                       5
                            // Create connection context object myConnCtx
#sql [myConnCtx] {SELECT LASTNAME INTO :empname FROM EMPLOYEE
   WHERE EMPNO='000010'};
                            // Use myConnCtx for executing an SQL statement
```

Figure 34. Using connection technique 3 to connect to a data source

SQLJ connection technique 4: JDBC DataSource interface

SQLJ connection technique 4 uses the JDBC DataSource as the underlying means for creating the connection. This technique **requires** that the DataSource is registered with JNDI.

To use SQLJ connection technique 4, follow these steps:

1. From your system administrator, obtain the logical name of the data source to which you need to connect.
2. Execute an SQLJ connection declaration clause.

   For this type of connection, the connection declaration clause needs to be of this form:

   ```
   #sql public static context context-class-name
    with (dataSource="logical-name");
   ```

   The connection context must be declared as public and static. *logical-name* is the data source name that you obtained in step 1.
3. Invoke the constructor for the connection context class that you created in step 2.

   Doing this creates a connection context object that you specify in each SQL statement that you execute at the associated data source. The constructor invocation statement needs to be in one of the following forms:

   ```
   connection-context-class connection-context-object=
     new connection-context-class();

   connection-context-class connection-context-object=
     new connection-context-class (String user,
       String password);
   ```

   The meanings of the *user* and *password* parameters are:

   user **and** *password*
   : Specify a user ID and password for connection to the data source, if the data source to which you are connecting requires them.

The following code uses connection technique 4 to create a connection to a location with logical name `jdbc/sampledb`. The connection requires a user ID and password.

```
#sql public static context Ctx
  with (dataSource="jdbc/sampledb");                                    2
                                // Create connection context class Ctx
String userid="dbadm";          // Declare variables for user ID and password
String password="dbadm";

String empname;                 // Declare a host variable
...
Ctx myConnCtx=new Ctx(userid, password);                                3
                                // Create connection context object myConnCtx
                                // for the connection to jdbc/sampledb
#sql [myConnCtx] {SELECT LASTNAME INTO :empname FROM EMPLOYEE
   WHERE EMPNO='000010'};
                                // Use myConnCtx for executing an SQL statement
```

Figure 35. Using connection technique 4 to connect to a data source

SQLJ connection technique 5: Use a previously created connection

SQLJ connection technique 5 uses a previously created connection to connect to the data source.

In general, one program declares a connection context class, creates connection contexts, and passes them as parameters to other programs. A program that uses the connection context invokes a constructor with the passed connection context object as its argument.

Program CtxGen.sqlj declares connection context Ctx and creates instance oldCtx:

```
#sql context Ctx;
...
// Create connection context object oldCtx
```

Program test.sqlj receives oldCtx as a parameter and uses oldCtx as the argument of its connection context constructor:

```
void useContext(sqlj.runtime.ConnectionContext oldCtx)
                                    // oldCtx was created in CtxGen.sqlj
{
  Ctx myConnCtx=
    new Ctx(oldCtx);                // Create connection context object myConnCtx
                                    // from oldCtx
  #sql [myConnCtx] {SELECT LASTNAME INTO :empname FROM EMPLOYEE
     WHERE EMPNO='000010'};
                                    // Use myConnCtx for executing an SQL statement
...
}
```

SQLJ connection technique 6: Use the default connection

SQLJ connection technique 6 uses the default connection to connect to the data source. It should be used only in situations where the database thread is controlled by another resource manager, such as the Java stored procedure environment.

You use the default connection by specifying your SQL statements without a connection context object. When you use this technique, you do not need to load a JDBC driver unless you explicitly use JDBC interfaces in your program.

The default connection context can be:

- The connection context that is associated with the data source that is bound to the logical name jdbc/defaultDataSource
- An explicitly created connection context that has been set as the default connection context with the ConnectionContext.setDefaultContext method. This method of creating a default connection context is not recommended.

The following SQLJ execution clause does not have a connection context, so it uses the default connection context.

```
#sql {SELECT LASTNAME INTO :empname FROM EMPLOYEE
   WHERE EMPNO='000010'};  // Use default connection for
                           // executing an SQL statement
```

Java packages for SQLJ support

Before you can execute SQLJ statements or invoke JDBC methods in your SQLJ program, you need to be able to access all or parts of various Java packages that contain support for those statements.

You can do that either by importing the packages or specific classes, or by using fully-qualified class names. You might need the following packages or classes for your SQLJ program:

sqlj.runtime
Contains the SQLJ run-time API.

java.sql
Contains the core JDBC API.

com.ibm.db2.jcc
Contains the driver-specific implementation of JDBC and SQLJ.

javax.naming
Contains methods for performing Java Naming and Directory Interface (JNDI) lookup.

javax.sql
Contains methods for creating DataSource objects.

Variables in SQLJ applications

In DB2 programs in other languages, you use host variables to pass data between the application program and DB2. In SQLJ programs, In SQLJ programs, you can use host variables or *host expressions*.

A host expression begins with a colon (:). The colon is followed by an optional parameter mode identifier (IN, OUT, or INOUT), which is followed by a parenthesized expression clause.

Host variables and host expressions are case sensitive.

A complex expression is an array element or Java expression that evaluates to a single value. A complex expression in an SQLJ clause must be surrounded by parentheses.

The following examples demonstrate how to use host expressions.

Example: Declaring a Java identifier and using it in a SELECT statement:

In this example, the statement that begins with `#sql` has the same function as a SELECT statement in other languages. This statement assigns the last name of the employee with employee number 000010 to Java identifier `empname`.

```
String empname;
...
#sql [ctxt]
  {SELECT LASTNAME INTO :empname FROM EMPLOYEE WHERE EMPNO='000010'};
```

Example: Declaring a Java identifier and using it in a stored procedure call:

In this example, the statement that begins with `#sql` has the same function as an SQL CALL statement in other languages. This statement uses Java identifier `empno` as an input parameter to stored procedure `A`. The value `IN`, which precedes `empno`, specifies that `empno` is an input parameter. For a parameter in a CALL statement, `IN` is the default. The explicit or default qualifier that indicates how the parameter is used (IN, OUT, or INOUT) must match the corresponding value in the parameter definition that you specified in the CREATE PROCEDURE statement for the stored procedure.

```
String empno = "0000010";
...
#sql [ctxt] {CALL A (:IN empno)};
```

Example: Using a complex expression as a host identifier:

This example uses complex expression (((int)yearsEmployed++/5)*500) as a host expression.

```
#sql [ctxt] {UPDATE EMPLOYEE
        SET BONUS=:(((int)yearsEmployed++/5)*500) WHERE EMPNO=:empID};
```

SQLJ performs the following actions when it processes a complex host expression:

- Evaluates each of the host expressions in the statement, from left to right, before assigning their respective values to the database.
- Evaluates side effects, such as operations with postfix operators, according to normal Java rules. All host expressions are fully evaluated before any of their values are passed to DB2.
- Uses Java rules for rounding and truncation.

Therefore, if the value of yearsEmployed is 6 before the UPDATE statement is executed, the value that is assigned to column BONUS by the UPDATE statement is ((int)6/5)*500, or 500. After 500 is assigned to BONUS, the value of yearsEmployed is incremented.

Restrictions on variable names: Two strings have special meanings in SQLJ programs. Observe the following restrictions when you use these strings in your SQLJ programs:

- The string __sJT_ is a reserved prefix for variable names that are generated by SQLJ. Do not begin the following types of names with __sJT_:
  - Host expression names
  - Java variable names that are declared in blocks that include executable SQL statements
  - Names of parameters for methods that contain executable SQL statements
  - Names of fields in classes that contain executable SQL statements, or in classes with subclasses or enclosed classes that contain executable SQL statements
- The string _SJ is a reserved suffix for resource files and classes that are generated by SQLJ. Avoid using the string _SJ in class names and input source file names.

Comments in an SQLJ application

To document your SQLJ program, you need to include comments. To do that, use Java comments. Java comments are denoted by /* */ or //.

You can include Java comments outside SQLJ clauses, wherever the Java language permits them. Within an SQLJ clause, you can use Java comments in the following places:

- Within a host expression (/* */ or //).
- Within an SQL statement in an executable clause, if the data source supports a comment within the SQL statement (/* */ or --).

  /* and */ pairs in an SQL statement can be nested.

SQL statement execution in SQLJ applications

You execute SQL statements in a traditional SQL program to create tables, insert, update, delete, or merge data in tables, retrieve data from the tables, call stored procedures, or commit or roll back transactions. In an SQLJ program, you also execute these statements, within SQLJ *executable clauses*.

An executable clause can have one of the following general forms:

```
#sql [connection-context] {sql-statement};
#sql [connection-context,execution-context] {sql-statement};
#sql [execution-context] {sql-statement};
```

execution-context specification
In an executable clause, you should **always** specify an explicit connection context, with one exception: you do not specify an explicit connection context for a FETCH statement. You include an execution context only for specific cases. See ″Control the execution of SQL statements in SQLJ″ for information about when you need an execution context.

connection-context specification
In an executable clause, if you do not explicitly specify a connection context, the executable clause uses the default connection context.

Creating and modifying DB2 objects in an SQLJ application

Use SQLJ executable clauses to execute data definition statements (CREATE, ALTER, DROP, GRANT, REVOKE) or to execute INSERT, searched or positioned UPDATE, and searched or positioned DELETE statements.

The following executable statements demonstrate an INSERT, a searched UPDATE, and a searched DELETE:

```
#sql [myConnCtx] {INSERT INTO DEPARTMENT VALUES
  ("X00","Operations 2","000030","E01",NULL)};
#sql [myConnCtx] {UPDATE DEPARTMENT
  SET MGRNO="000090" WHERE MGRNO="000030"};
#sql [myConnCtx] {DELETE FROM DEPARTMENT
  WHERE DEPTNO="X00"};
```

Performing positioned UPDATE and DELETE operations in an SQLJ application

As in DB2 applications in other languages, performing positioned UPDATEs and DELETEs with SQLJ is an extension of retrieving rows from a result table.

The basic steps are:

1. Declare the iterator.

   The iterator can be positioned or named. For positioned UPDATE or DELETE operations, the iterator must be declared as updatable. To do this, the declaration must include the following clauses:

   implements sqlj.runtime.ForUpdate
   This clause causes the generated iterator class to include methods for using updatable iterators. This clause is required for programs with positioned UPDATE or DELETE operations.

   with (updateColumns=*″column-list″***)**
   This clause specifies a comma-separated list of the columns of the result table that the iterator will update. This clause is optional.

   You need to declare the iterator as `public`, so you need to follow the rules for declaring and using `public` iterators in the same file or different files.

   If you declare the iterator in a file by itself, any SQLJ source file that has addressability to the iterator and imports the generated class can retrieve data and execute positioned UPDATE or DELETE statements using the iterator. The authorization ID under which a positioned UPDATE or DELETE statement executes depends on whether the statement executes statically or dynamically. If the statement executes statically, the authorization ID is the owner of the plan or package that includes the statement. If the statement executes dynamically

the authorization ID is determined by the DYNAMICRULES behavior that is in effect. For the IBM Data Server Driver for JDBC and SQLJ, the behavior is always DYNAMICRULES BIND.

2. Disable autocommit mode for the connection.

   If autocommit mode is enabled, a COMMIT operation occurs every time the positioned UPDATE statement executes, which causes the iterator to be destroyed unless the iterator has the `with (holdability=true)` attribute. Therefore, you need to turn autocommit off to prevent COMMIT operations until you have finished using the iterator. If you want a COMMIT to occur after every update operation, an alternative way to keep the iterator from being destroyed after each COMMIT operation is to declare the iterator `with (holdability=true)`.

3. Create an instance of the iterator class.

   This is the same step as for a non-updatable iterator.

4. Assign the result table of a SELECT to an instance of the iterator.

   This is the same step as for a non-updatable iterator. The SELECT statement must not include a FOR UPDATE clause.

5. Retrieve and update rows.

   For a positioned iterator, do this by performing the following actions in a loop:

   a. Execute a FETCH statement in an executable clause to obtain the current row.
   b. Test whether the iterator is pointing to a row of the result table by invoking the PositionedIterator.endFetch method.
   c. If the iterator is pointing to a row of the result table, execute an SQL UPDATE... WHERE CURRENT OF *:iterator-object* statement in an executable clause to update the columns in the current row. Execute an SQL DELETE... WHERE CURRENT OF *:iterator-object* statement in an executable clause to delete the current row.

   For a named iterator, do this by performing the following actions in a loop:

   a. Invoke the next method to move the iterator forward.
   b. Test whether the iterator is pointing to a row of the result table by checking whether next returns `true`.
   c. Execute an SQL UPDATE... WHERE CURRENT OF *iterator-object* statement in an executable clause to update the columns in the current row. Execute an SQL DELETE... WHERE CURRENT OF *iterator-object* statement in an executable clause to delete the current row.

6. Close the iterator.

   Use the close method to do this.

The following code shows how to declare a positioned iterator and use it for positioned UPDATEs. The numbers to the right of selected statements correspond to the previously described steps.

First, in one file, declare positioned iterator `UpdByPos`, specifying that you want to use the iterator to update column `SALARY`:

```
import java.math.*;    // Import this class for BigDecimal data type
#sql public iterator UpdByPos implements sqlj.runtime.ForUpdate       1
  with(updateColumns="SALARY") (String, BigDecimal);
```

Figure 36. Example of declaring a positioned iterator for a positioned UPDATE

Then, in another file, use UpdByPos for a positioned UPDATE, as shown in the following code fragment:

```
import sqlj.runtime.*;       // Import files for SQLJ and JDBC APIs
import java.sql.*;
import java.math.*;          // Import this class for BigDecimal data type
import UpdByPos;             // Import the generated iterator class that
                             // was created by the iterator declaration clause
                             // for UpdByName in another file
#sql context HSCtx;          // Create a connnection context class HSCtx
public static void main (String args[])
{
  try {
    Class.forName("com.ibm.db2.jcc.DB2Driver");
  }
  catch (ClassNotFoundException e) {
    e.printStackTrace();
          }
  Connection HSjdbccon=
  DriverManager.getConnection("jdbc:db2:SANJOSE");
                     // Create a JDBC connection object
  HSjdbccon.setAutoCommit(false);
                     // Set autocommit off so automatic commits       2
                     // do not destroy the cursor between updates
  HSCtx myConnCtx=new HSCtx(HSjdbccon);
                     // Create a connection context object
  UpdByPos upditer;  // Declare iterator object of UpdByPos class     3
  String enum;       // Declares host variable to receive EMPNO
  BigDecimal sal;    // and SALARY column values
  #sql [myConnCtx]
    upditer = {SELECT EMPNO, SALARY FROM EMPLOYEE                     4
      WHERE WORKDEPT='D11'};
                     // Assign result table to iterator object
  #sql {FETCH :upditer INTO :enum,:sal};                              5a
                             // Move cursor to next row
  while (!upditer.endFetch())                                         5b
                             // Check if on a row
  {
    #sql [myConnCtx] {UPDATE EMPLOYEE SET SALARY=SALARY*1.05
      WHERE CURRENT OF :upditer};                                     5c
                             // Perform positioned update
    System.out.println("Updating row for " + enum);
    #sql {FETCH :upditer INTO :enum,:sal};
                             // Move cursor to next row
  }
  upditer.close();           // Close the iterator                   6
  #sql [myConnCtx] {COMMIT};
                             // Commit the changes
  myConnCtx.close();         // Close the connection context
}
```

Figure 37. Example of performing a positioned UPDATE with a positioned iterator

The following code shows how to declare a named iterator and use it for positioned UPDATEs. The numbers to the right of selected statements correspond to the previously described steps.

First, in one file, declare named iterator UpdByName, specifying that you want to use the iterator to update column SALARY:

```
import java.math.*;          // Import this class for BigDecimal data type
#sql public iterator UpdByName implements sqlj.runtime.ForUpdate     1
  with(updateColumns="SALARY") (String EmpNo, BigDecimal Salary);
```

Figure 38. Example of declaring a named iterator for a positioned UPDATE

Then, in another file, use UpdByName for a positioned UPDATE, as shown in the following code fragment:

```
import sqlj.runtime.*;       // Import files for SQLJ and JDBC APIs
import java.sql.*;
import java.math.*;          // Import this class for BigDecimal data type
import UpdByName;            // Import the generated iterator class that
                             // was created by the iterator declaration clause
                             // for UpdByName in another file
#sql context HSCtx;          // Create a connnection context class HSCtx
public static void main (String args[])
{
  try {
    Class.forName("com.ibm.db2.jcc.DB2Driver");
  }
  catch (ClassNotFoundException e) {
    e.printStackTrace();
          }
  Connection HSjdbccon=
  DriverManager.getConnection("jdbc:db2:SANJOSE");
                         // Create a JDBC connection object
  HSjdbccon.setAutoCommit(false);
                         // Set autocommit off so automatic commits  2
                         // do not destroy the cursor between updates
  HSCtx myConnCtx=new HSCtx(HSjdbccon);
                         // Create a connection context object
  UpdByName upditer;                                                  3
                         // Declare iterator object of UpdByName class
  String enum;               // Declare host variable to receive EmpNo
                             // column values
  #sql [myConnCtx]
    upditer = {SELECT EMPNO, SALARY FROM EMPLOYEE                     4
      WHERE WORKDEPT='D11'};
                             // Assign result table to iterator object
  while (upditer.next())                                              5a,5b
                             // Move cursor to next row and
                             // check ifon a row
  {
    enum = upditer.EmpNo();  // Get employee number from current row
    #sql [myConnCtx]
      {UPDATE EMPLOYEE SET SALARY=SALARY*1.05
        WHERE CURRENT OF :upditer};                                   5c
                             // Perform positioned update
    System.out.println("Updating row for " + enum);
  }
  upditer.close();           // Close the iterator                   6
  #sql [myConnCtx] {COMMIT};
                             // Commit the changes
  myConnCtx.close();         // Close the connection context
}
```

Figure 39. Example of performing a positioned UPDATE with a named iterator

Iterators as passed variables for positioned UPDATE or DELETE operations in an SQLJ application

SQLJ allows iterators to be passed between methods as variables.

An iterator that is used for a positioned UPDATE or DELETE statement can be identified only at runtime. The same SQLJ positioned UPDATE or DELETE

statement can be used with different iterators at runtime. If you specify a value of YES for -staticpositioned when you customize your SQLJ application as part of the program preparation process, the SQLJ customizer prepares positioned UPDATE or DELETE statements to execute statically. In this case, the customizer must determine which iterators belong with which positioned UPDATE or DELETE statements. The SQLJ customizer does this by matching iterator data types to data types in the UPDATE or DELETE statements. However, if there is not a unique mapping of tables in UPDATE or DELETE statements to iterator classes, the SQLJ customizer cannot determine exactly which iterators and UPDATE or DELETE statements go together. The SQLJ customizer must arbitrarily pair iterators with UPDATE or DELETE statements, which can sometimes result in SQL errors. The following code fragments illustrate this point.

```
#sql iterator GeneralIter implements sqlj.runtime.ForUpdate
  ( String );

  public static void main ( String args[] )
  {
...
    GeneralIter iter1 = null;
    #sql [ctxt] iter1 = { SELECT CHAR_COL1 FROM TABLE1 };

    GeneralIter iter2 = null;
    #sql [ctxt] iter2 = { SELECT CHAR_COL2 FROM TABLE2 };
...

    doUpdate ( iter1 );
  }

  public static void doUpdate ( GeneralIter iter )
  {
    #sql [ctxt] { UPDATE TABLE1 ... WHERE CURRENT OF :iter };
  }
```

Figure 40. Static positioned UPDATE that fails

In this example, only one iterator is defined. Two instances of that iterator are defined, and each is associated with a different SELECT statement that retrieves data from a different table. During customization and binding with -staticpositioned YES, SQLJ creates two DECLARE CURSOR statements, one for each SELECT statement, and attempts to bind an UPDATE statement for each cursor. However, the bind process fails with SQLCODE -509 when `UPDATE TABLE1 ... WHERE CURRENT OF :iter` is bound for the cursor for `SELECT CHAR_COL2 FROM TABLE2` because the table for the UPDATE does not match the table for the cursor.

You can avoid a bind time error for a program like the one in Figure 40 by specifying the bind option SQLERROR(CONTINUE). However, this technique has the drawback that it causes the DB2 database manager to build a package, regardless of the SQL errors that are in the program. A better technique is to write the program so that there is a one-to-one mapping between tables in positioned UPDATE or DELETE statements and iterator classes. Figure 41 on page 119 shows an example of how to do this.

```
#sql iterator Table2Iter(String);
#sql iterator Table1Iter(String);
  public static void main ( String args[] )
  {
...
    Table2Iter iter2 = null;
    #sql [ctxt] iter2 = { SELECT CHAR_COL2 FROM TABLE2 };

    Table1Iter iter1 = null;
    #sql [ctxt] iter1 = { SELECT CHAR_COL1 FROM TABLE1 };
...

    doUpdate(iter1);

  }

 public static void doUpdate ( Table1Iter iter )
  {
    ...
    #sql [ctxt] { UPDATE TABLE1 ... WHERE CURRENT OF :iter };
    ...
  }
 public static void doUpdate ( Table2Iter iter )
  {
    ...
    #sql [ctxt] { UPDATE TABLE2 ... WHERE CURRENT OF :iter };
    ...
  }
```

Figure 41. Static positioned UPDATE that succeeds

With this method of coding, each iterator class is associated with only one table. Therefore, the DB2 bind process can always associate the positioned UPDATE statement with a valid iterator.

Making batch updates in SQLJ applications

The IBM Data Server Driver for JDBC and SQLJ supports batch updates in SQLJ. With batch updates, instead of updating rows of a table one at a time, you can direct SQLJ to execute a group of updates at the same time.

You can include the following types of statements in a batch update:
- Searched INSERT, UPDATE, or DELETE statements
- CREATE, ALTER, DROP, GRANT, or REVOKE statements
- CALL statements with input parameters only

Unlike JDBC, SQLJ allows heterogeneous batches that contain statements with input parameters or host expressions. You can therefore combine any of the following items in an SQLJ batch:
- Instances of the same statement
- Different statements
- Statements with different numbers of input parameters or host expressions
- Statements with different data types for input parameters or host expressions
- Statements with no input parameters or host expressions

When an error occurs during execution of a statement in a batch, the remaining statements are executed, and a BatchUpdateException is thrown after all the statements in the batch have executed. See ″Retrieving information from a BatchUpdateException″ for information on how to process a BatchUpdateException.

To obtain information about warnings, use the Statement.getWarnings method on the object on which you ran the executeBatch method. You can then retrieve an error description, SQLSTATE, and error code for each SQLWarning object.

When a batch is executed implicitly because the program contains a statement that cannot be added to the batch, the batch is executed before the new statement is processed. If an error occurs during execution of the batch, the statement that caused the batch to execute does not execute.

The basic steps for creating, executing, and deleting a batch of statements are:

1. Disable `AutoCommit` for the connection.

   Do this so that you can control whether to commit changes to already-executed statements when an error occurs during batch execution.
2. Acquire an execution context.

   All statements that execute in a batch must use this execution context.
3. Invoke the ExecutionContext.setBatching(true) method to create a batch.

   Subsequent batchable statements that are associated with the execution context that you created in step 2 are added to the batch for later execution.

   If you want to batch sets of statements that are not batch compatible in parallel, you need to create an execution context for each set of batch compatible statements.
4. Include SQLJ executable clauses for SQL statements that you want to batch.

   These clauses must include the execution context that you created in step 2.

   If an SQLJ executable clause has input parameters or host expressions, you can include the statement in the batch multiple times with different values for the input parameters or host expressions.

   To determine whether a statement was added to an existing batch, was the first statement in a new batch, or was executed inside or outside a batch, invoke the ExecutionContext.getUpdateCount method. This method returns one of the following values:

   `ExecutionContext.ADD_BATCH_COUNT`
   : This is a constant that is returned if the statement was added to an existing batch.

   `ExecutionContext.NEW_BATCH_COUNT`
   : This is a constant that is returned if the statement was the first statement in a new batch.

   `ExecutionContext.EXEC_BATCH_COUNT`
   : This is a constant that is returned if the statement was part of a batch, and the batch was executed.

   Other integer
   : This value is the number of rows that were updated by the statement. This value is returned if the statement was executed rather than added to a batch.
5. Execute the batch explicitly or implicitly.
   - Invoke the ExecutionContext.executeBatch method to execute the batch explicitly.

     executeBatch returns an integer array that contains the number of rows that were updated by each statement in the batch. The order of the elements in the array corresponds to the order in which you added statements to the batch.

- Alternatively, a batch executes implicitly under the following circumstances:
  - You include a batchable statement in your program that is not compatible with statements that are already in the batch. In this case, SQLJ executes the statements that are already in the batch and creates a new batch that includes the incompatible statement. SQLJ also executes the statement that is not compatible with the statements in the batch.
  - You include a statement in your program that is not batchable. In this case, SQLJ executes the statements that are already in the batch. SQLJ also executes the statement that is not batchable.
  - After you invoke the `ExecutionContext.setBatchLimit(n)` method, you add a statement to the batch that brings the number of statements in the batch to *n* or greater. *n* can have one of the following values:

    `ExecutionContext.UNLIMITED_BATCH`
    This constant indicates that implicit execution occurs only when SQLJ encounters a statement that is batchable but incompatible, or not batchable. Setting this value is the same as not invoking setBatchLimit.

    `ExecutionContext.AUTO_BATCH`
    This constant indicates that implicit execution occurs when the number of statements in the batch reaches a number that is set by SQLJ.

    Positive integer
    When this number of statements have been added to the batch, SQLJ executes the batch implicitly. However, the batch might be executed before this many statements have been added if SQLJ encounters a statement that is batchable but incompatible, or not batchable.

  To determine the number of rows that were updated by a batch that was executed implicitly, invoke the ExecutionContext.getBatchUpdateCounts method. getBatchUpdateCounts returns an integer array that contains the number of rows that were updated by each statement in the batch. The order of the elements in the array corresponds to the order in which you added statements to the batch. Each array element can be one of the following values:

  -2 This value indicates that the SQL statement executed successfully, but the number of rows that were updated could not be determined.

  -3 This value indicates that the SQL statement failed.

  Other integer
  This value is the number of rows that were updated by the statement.

6. Optionally, when all statements have been added to the batch, disable batching.

   Do this by invoking the ExecutionContext.setBatching(false) method. When you disable batching, you can still execute the batch implicitly or explicitly, but no more statements are added to the batch. Disabling batching is useful when a batch already exists, and you want to execute a batch compatible statement, rather than adding it to the batch.

   If you want to clear a batch without executing it, invoke the ExecutionContext.cancel method.
7. If batch execution was implicit, perform a final, explicit executeBatch to ensure that all statements have been executed.

In the following code fragment, raises are given to all managers by performing UPDATEs in a batch. The numbers to the right of selected statements correspond

to the previously-described steps.

```
#sql iterator GetMgr(String);       // Declare positioned iterator
{
  GetMgr deptiter;                  // Declare object of GetMgr class
  String mgrnum = null;             // Declare host variable for manager number
  int raise = 400;                  // Declare raise amount
  int currentSalary;                // Declare current salary
  String url, username, password;   // Declare url, user ID, password
  ...
  TestContext c1 = new TestContext (url, username, password, false); 1
  ExecutionContext ec = new ExecutionContext();                      2
  ec.setBatching(true);                                              3

  #sql [c1] deptiter =
    {SELECT MGRNO FROM DEPARTMENT};
                                    // Assign the result table of the SELECT
                                    // to iterator object deptiter
  #sql {FETCH :deptiter INTO :mgrnum};
                                    // Retrieve the first manager number
  while (!deptiter.endFetch()) {    // Check whether the FETCH returned a row
    #sql [c1]
      {SELECT SALARY INTO :currentSalary FROM EMPLOYEE
        WHERE EMPNO=:mgrnum};
    #sql [c1, ec]                                                    4
      {UPDATE EMPLOYEE SET SALARY=:(currentSalary+raise)
        WHERE EMPNO=:mgrnum};
    #sql {FETCH :deptiter INTO :mgrnum };
                                    // Fetch the next row
  }
  ec.executeBatch();                                                 5
  ec.setBatching(false);                                             6
  #sql [c1] {COMMIT};
  deptiter.close();                 // Close the iterator
  ec.close();                       // Close the execution context
  c1.close();                       // Close the connection
}
```

Figure 42. Example of performing a batch update

Data retrieval in SQLJ applications

SQLJ applications use a *result set iterator* to retrieve result sets. Like a cursor, a result set iterator can be non-scrollable or scrollable.

Just as in DB2 applications in other languages, if you want to retrieve a single row from a table in an SQLJ application, you can write a SELECT INTO statement with a WHERE clause that defines a result table that contains only that row:

```
#sql [myConnCtx] {SELECT DEPTNO INTO :hvdeptno
  FROM DEPARTMENT WHERE DEPTNAME="OPERATIONS"};
```

However, most SELECT statements that you use create result tables that contain many rows. In DB2 applications in other languages, you use a cursor to select the individual rows from the result table. That cursor can be non-scrollable, which means that when you use it to fetch rows, you move the cursor serially, from the beginning of the result table to the end. Alternatively, the cursor can be scrollable, which means that when you use it to fetch rows, you can move the cursor forward, backward, or to any row in the result table.

This topic discusses how to use non-scrollable iterators. For information on using scrollable iterators, see ″Use scrollable iterators in an SQLJ application″.

A result set iterator is a Java object that you use to retrieve rows from a result table. Unlike a cursor, a result set iterator can be passed as a parameter to a method.

The basic steps in using a result set iterator are:
1. Declare the iterator, which results in an iterator class
2. Define an instance of the iterator class.
3. Assign the result table of a SELECT to an instance of the iterator.
4. Retrieve rows.
5. Close the iterator.

There are two types of iterators: *positioned iterators* and *named iterators*. Postitioned iterators extend the interface sqlj.runtime.PositionedIterator. Positioned iterators identify the columns of a result table by their position in the result table. Named iterators extend the interface sqlj.runtime.NamedIterator. Named iterators identify the columns of the result table by result table column names.

Using a named iterator in an SQLJ application

Use a named iterator to refer to each of the columns in a result table by name.

The steps in using a named iterator are:

1. Declare the iterator.

   You declare any result set iterator using an *iterator declaration clause*. This causes an iterator class to be created that has the same name as the iterator. For a named iterator, the iterator declaration clause specifies the following information:

   - The name of the iterator
   - A list of column names and Java data types
   - Information for a Java class declaration, such as whether the iterator is `public` or `static`
   - A set of attributes, such as whether the iterator is holdable, or whether its columns can be updated

   When you declare a named iterator for a query, you specify names for each of the iterator columns. Those names must match the names of columns in the result table for the query. An iterator column name and a result table column name that differ only in case are considered to be matching names. The named iterator class that results from the iterator declaration clause contains *accessor methods*. There is one accessor method for each column of the iterator. Each accessor method name is the same as the corresponding iterator column name. You use the accessor methods to retrieve data from columns of the result table.

   You need to specify Java data types in the iterators that closely match the corresponding DB2 column data types. See ″Java, JDBC, and SQL data types″ for a list of the best mappings between Java data types and DB2 data types.

   You can declare an iterator in a number of ways. However, because a Java class underlies each iterator, you need to ensure that when you declare an iterator, the underlying class obeys Java rules. For example, iterators that contain a *with-clause* must be declared as `public`. Therefore, if an iterator needs to be `public`, it can be declared only where a `public` class is allowed. The following list describes some alternative methods of declaring an iterator:

   - As `public`, in a source file by itself

This method lets you use the iterator declaration in other code modules, and provides an iterator that works for all SQLJ applications. In addition, there are no concerns about having other top-level classes or `public` classes in the same source file.

- As a top-level class in a source file that contains other top-level class definitions

  Java allows only one public, top-level class in a code module. Therefore, if you need to declare the iterator as public, such as when the iterator includes a with-clause, no other classes in the code module can be declared as public.

- As a nested static class within another class

  Using this alternative lets you combine the iterator declaration with other class declarations in the same source file, declare the iterator and other classes as public, and make the iterator class visible to other code modules or packages. However, when you reference the iterator from outside the nesting class, you must fully-qualify the iterator name with the name of the nesting class.

- As an inner class within another class

  When you declare an iterator in this way, you can instantiate it only within an instance of the nesting class. However, you can declare the iterator and other classes in the file as public.

  You cannot cast a JDBC ResultSet to an iterator if the iterator is declared as an inner class. This restriction does not apply to an iterator that is declared as a static nested class. See ″Use SQLJ and JDBC in the same application″ for more information on casting a ResultSet to a iterator.

2. Create an instance of the iterator class.

   You declare an object of the named iterator class to retrieve rows from a result table.

3. Assign the result table of a SELECT to an instance of the iterator.

   To assign the result table of a SELECT to an iterator, you use an SQLJ *assignment clause*. The format of the assignment clause for a named iterator is:

   ```
   #sql context-clause iterator-object={select-statement};
   ```

   See ″SQLJ assignment-clause″ and ″SQLJ context-clause″ for more information.

4. Retrieve rows.

   Do this by invoking accessor methods in a loop. Accessor methods have the same names as the corresponding columns in the iterator, and have no parameters. An accessor method returns the value from the corresponding column of the current row in the result table. Use the NamedIterator.next() method to move the cursor forward through the result table.

   To test whether you have retrieved all rows, check the value that is returned when you invoke the next method. next returns a `boolean` with a value of `false` if there is no next row.

5. Close the iterator.

   Use the NamedIterator.close method to do this.

The following code demonstrates how to declare and use a named iterator. The numbers to the right of selected statements correspond to the previously-described steps.

```
#sql  iterator ByName(String LastName, Date HireDate);                    1
                                // Declare named iterator ByName
{
  ByName nameiter;              // Declare object of ByName class          2
  #sql [ctxt]
 nameiter={SELECT LASTNAME, HIREDATE FROM EMPLOYEE};                       3
                                // Assign the result table of the SELECT
                                // to iterator object nameiter
  while (nameiter.next())       // Move the iterator through the result    4
                                // table and test whether all rows retrieved
  {
    System.out.println( nameiter.LastName() + " was hired on "
      + nameiter.HireDate());   // Use accessor methods LastName and
                                // HireDate to retrieve column values
  }
  nameiter.close();             // Close the iterator                      5
}
```

Figure 43. Example of using a named iterator

Using a positioned iterator in an SQLJ application

Use a positioned iterator to refer to columns in a result table by their position in the result set.

The steps in using a positioned iterator are:

1. Declare the iterator.

   You declare any result set iterator using an *iterator declaration clause*. This causes an iterator class to be created that has the same name and attributes as the iterator. For a positioned iterator, the iterator declaration clause specifies the following information:

   - The name of the iterator
   - A list of Java data types
   - Information for a Java class declaration, such as whether the iterator is `public` or `static`
   - A set of attributes, such as whether the iterator is holdable, or whether its columns can be updated

   The data type declarations represent columns in the result table and are referred to as columns of the result set iterator. The columns of the result set iterator correspond to the columns of the result table, in left-to-right order. For example, if an iterator declaration clause has two data type declarations, the first data type declaration corresponds to the first column in the result table, and the second data type declaration corresponds to the second column in the result table.

   You need to specify Java data types in the iterators that closely match the corresponding DB2 column data types. See ″Java, JDBC, and SQL data types″ for a list of the best mappings between Java data types and DB2 data types.

   You can declare an iterator in a number of ways. However, because a Java class underlies each iterator, you need to ensure that when you declare an iterator, the underlying class obeys Java rules. For example, iterators that contain a *with-clause* must be declared as `public`. Therefore, if an iterator needs to be `public`, it can be declared only where a `public` class is allowed. The following list describes some alternative methods of declaring an iterator:

   - As `public`, in a source file by itself

     This is the most versatile method of declaring an iterator. This method lets you use the iterator declaration in other code modules, and provides an

iterator that works for all SQLJ applications. In addition, there are no concerns about having other top-level classes or `public` classes in the same source file.

- As a top-level class in a source file that contains other top-level class definitions

  Java allows only one public, top-level class in a code module. Therefore, if you need to declare the iterator as public, such as when the iterator includes a with-clause, no other classes in the code module can be declared as public.

- As a nested static class within another class

  Using this alternative lets you combine the iterator declaration with other class declarations in the same source file, declare the iterator and other classes as public, and make the iterator class visible from other code modules or packages. However, when you reference the iterator from outside the nesting class, you must fully-qualify the iterator name with the name of the nesting class.

- As an inner class within another class

  When you declare an iterator in this way, you can instantiate it only within an instance of the nesting class. However, you can declare the iterator and other classes in the file as public.

  You cannot cast a JDBC ResultSet to an iterator if the iterator is declared as an inner class. This restriction does not apply to an iterator that is declared as a static nested class. See ″Use SQLJ and JDBC in the same application″ for more information on casting a ResultSet to a iterator.

2. Create an instance of the iterator class.

   You declare an object of the positioned iterator class to retrieve rows from a result table.

3. Assign the result table of a SELECT to an instance of the iterator.

   To assign the result table of a SELECT to an iterator, you use an SQLJ *assignment clause*. The format of the assignment clause for a positioned iterator is:

   ```
   #sql context-clause iterator-object={select-statement};
   ```

4. Retrieve rows.

   Do this by executing FETCH statements in executable clauses in a loop. The FETCH statements looks the same as a FETCH statements in other languages.

   To test whether you have retrieved all rows, invoke the PositionedIterator.endFetch method after each FETCH. endFetch returns a `boolean` with the value `true` if the FETCH failed because there are no rows to retrieve.

5. Close the iterator.

   Use the PositionedIterator.close method to do this.

The following code demonstrates how to declare and use a positioned iterator. The numbers to the right of selected statements correspond to the previously-described steps.

```
#sql iterator ByPos(String,Date); // Declare positioned iterator ByPos 1
{
  ByPos positer;                    // Declare object of ByPos class   2
  String name = null;               // Declare host variables
  Date hrdate;
  #sql [ctxt] positer =
    {SELECT LASTNAME, HIREDATE FROM EMPLOYEE};                          3
                                    // Assign the result table of the SELECT
                                    // to iterator object positer
  #sql {FETCH :positer INTO :name, :hrdate };                           4
                                    // Retrieve the first row
  while (!positer.endFetch())       // Check whether the FETCH returned a row
  { System.out.println(name + " was hired in " +
      hrdate);
    #sql {FETCH :positer INTO :name, :hrdate };
                                    // Fetch the next row
  }
  positer.close();                  // Close the iterator              5
}
```

Figure 44. Example of using a positioned iterator

Multiple open iterators for the same SQL statement in an SQLJ application

With the IBM Data Server Driver for JDBC and SQLJ, your application can have multiple concurrently open iterators for a single SQL statement in an SQLJ application. With this capability, you can perform one operation on a table using one iterator while you perform a different operation on the same table using another iterator.

When you use concurrently open iterators in an application, you should close iterators when you no longer need them to prevent excessive storage consumption in the Java heap.

The following examples demonstrate how to perform the same operations on a table without concurrently open iterators on a single SQL statement and with concurrently open iterators on a single SQL statement. These examples use the following iterator declaration:

```
import java.math.*;
#sql public iterator  MultiIter(String EmpNo, BigDecimal Salary);
```

Without the capability for multiple, concurrently open iterators for a single SQL statement, if you want to select employee and salary values for a specific employee number, you need to define a different SQL statement for each employee number, as shown in Figure 45 on page 128.

```
MultiIter iter1 = null;            // Iterator instance for retrieving
                                   // data for first employee
String EmpNo1 = "000100";          // Employee number for first employee
#sql [ctx] iter2 =
  {SELECT EMPNO, SALARY FROM EMPLOYEE WHERE EMPNO = :EmpNo1};
                                   // Assign result table to first iterator
MultiIter iter2 = null;            // Iterator instance for retrieving
                                   // data for second employee
String EmpNo2 = "000200";          // Employee number for second employee
#sql [ctx] iter2 =
  {SELECT EMPNO, SALARY FROM EMPLOYEE WHERE EMPNO = :EmpNo2};
                                   // Assign result table to second iterator
// Process with iter1
// Process with iter2
iter1.close();                     // Close the iterators
iter2.close();
```

Figure 45. Example of concurrent table operations using iterators with different SQL statements

Figure 46 demonstrates how you can perform the same operations when you have the capability for multiple, concurrently open iterators for a single SQL statement.

```
...
MultiIter iter1 = openIter("000100"); // Invoke openIter to assign the result table
                                      // (for employee 100) to the first iterator
MultiIter iter2 = openIter("000200"); // Invoke openIter to assign the result
                                      // table to the second iterator
                                      // iter1 stays open when iter2 is opened
// Process with iter1
// Process with iter2
...
iter1.close();                        // Close the iterators
iter2.close();
...
public MultiIter openIter(String EmpNo)
                                      // Method to assign a result table
                                      // to an iterator instance
{
  MultiIter iter;
  #sql [ctxt] iter =
    {SELECT EMPNO, SALARY FROM EMPLOYEE WHERE EMPNO = :EmpNo};
  return iter;                        // Method returns an iterator instance
}
```

Figure 46. Example of concurrent table operations using iterators with the same SQL statement

Multiple open instances of an iterator in an SQLJ application

Multiple instances of an iterator can be open concurrently in a single SQLJ application. One application for this ability is to open several instances of an iterator that uses host expressions. Each instance can use a different set of host expression values.

The following example shows an application with two concurrently open instances of an iterator.

```
...
ResultSet myFunc(String empid)  // Method to open an iterator and get a resultSet
{
  MyIter iter;
  #sql iter = {SELECT * FROM EMPLOYEE WHERE EMPNO = :empid};
  return iter.getResultSet();
}

// An application can call this method to get a resultSet for each
// employee ID. The application can process each resultSet separately.
...
ResultSet rs1 = myFunc("000100");  // Get employee record for employee ID 000100
...
ResultSet rs2 = myFunc("000200");  // Get employee record for employee ID 000200
```

Figure 47. Example of opening more than one instance of an iterator in a single application

As with any other iterator, you need to remember to close this iterator after the last time you use it to prevent excessive storage consumption.

Using scrollable iterators in an SQLJ application

In addition to moving forward, one row at a time, through a result table, you might want to move backward or go directly to a specific row. The IBM Data Server Driver for JDBC and SQLJ provides this capability.

An iterator in which you can move forward, backward, or to a specific row is called a *scrollable iterator*. A scrollable iterator in SQLJ is equivalent to the result table of a database cursor that is declared as SCROLL.

Like a scrollable cursor, a scrollable iterator can be *insensitive* or *sensitive*. A sensitive scrollable iterator can be *static* or *dynamic*. Insensitive means that changes to the underlying table after the iterator is opened are not visible to the iterator. Insensitive iterators are read-only. Sensitive means that changes that the iterator or other processes make to the underlying table are visible to the iterator. Asensitive means that if the cursor is a read-only cursor, it behaves as an insensitive cursor. If it is not a read-only cursor, it behaves as a sensitive cursor.

If a scrollable iterator is static, the size of the result table and the order of the rows in the result table do not change after the iterator is opened. This means that you cannot insert into result tables, and if you delete a row of a result table, a delete hole occurs. If you update a row of the result table so that the row no longer qualifies for the result table, an update hole occurs. Fetching from a hole results in an SQLException.

If a scrollable iterator is dynamic, the size of the result table and the order of the rows in the result table can change after the iterator is opened. Rows that are inserted or deleted with INSERT and DELETE statements that are executed by the same application process are immediately visible. Rows that are inserted or deleted with INSERT and DELETE statements that are executed by other application processes are visible after the changes are committed.

Important: DB2 Database for Linux, UNIX, and Windows servers do not support dynamic scrollable cursors. You can use dynamic scrollable iterators in your SQLJ applications only if those applications access data on DB2 for z/OS servers, at Version 9 or later.

To create and use a scrollable iterator, you need to follow these steps:

1. Specify an iterator declaration clause that includes the following clauses:

- `implements sqlj.runtime.Scrollable`

  This indicates that the iterator is scrollable.
- `with (sensitivity=INSENSITIVE|SENSITIVE|ASENSITIVE)` or `with (sensitivity=SENSITIVE, dynamic=true|false)`

  `sensitivity=INSENSITIVE|SENSITIVE|ASENSITIVE` indicates whether update or delete operations on the underlying table can be visible to the iterator. The default sensitivity is `INSENSITIVE`.

  `dynamic=true|false` indicates whether the size of the result table or the order of the rows in the result table can change after the iterator is opened. The default value of dynamic is `false`.

The iterator can be a named or positioned iterator. For example, the following iterator declaration clause declares a positioned, sensitive, dynamic, scrollable iterator:

```
#sql public iterator ByPos
  implements sqlj.runtime.Scrollable
  with (sensitivity=SENSITIVE, dynamic=true)  (String);
```

The following iterator declaration clause declares a named, insensitive, scrollable iterator:

```
#sql public iterator ByName
  implements sqlj.runtime.Scrollable
  with (sensitivity=INSENSITIVE) (String EmpNo);
```

Restriction: You cannot use a scrollable iterator to select columns with the following data types from a table on a DB2 Database for Linux, UNIX, and Windows server:
- LONG VARCHAR
- LONG VARGRAPHIC
- BLOB
- CLOB
- A distinct type that is based on any of the previous data types in this list
- A structured type

2. Create an iterator object, which is an instance of your iterator class.
3. If you want to give the SQLJ runtime environment a hint about the initial fetch direction, use the `setFetchDirection(int direction)` method. *direction* can be `FETCH_FORWARD` or `FETCH_REVERSE`. If you do not invoke setFetchDirection, the fetch direction is `FETCH_FORWARD`.
4. For each row that you want to access:

   For a named iterator, perform the following steps:

   a. Position the cursor using one of the methods listed in the following table.

Table 19. sqlj.runtime.Scrollable methods for positioning a scrollable cursor

Method	Positions the cursor
first	On the first row of the result table
last	On the last row of the result table
previous[1]	On the previous row of the result table
next	On the next row of the result table
`absolute(int n)`[2]	If $n>0$, on row n of the result table. If $n<0$, and m is the number of rows in the result table, on row $m+n+1$ of the result table.

Table 19. sqlj.runtime.Scrollable methods for positioning a scrollable cursor (continued)

Method	Positions the cursor
`relative(int n)`[3]	If $n>0$, on the row that is n rows after the current row. If $n<0$, on the row that is n rows before the current row. If $n=0$, on the current row.
afterLast	After the last row in the result table
beforeFirst	Before the first row in the result table

Notes:

1. If the cursor is after the last row of the result table, this method positions the cursor on the last row.
2. If the absolute value of n is greater than the number of rows in the result table, this method positions the cursor after the last row if n is positive, or before the first row if n is negative.
3. Suppose that m is the number of rows in the result table and x is the current row number in the result table. If $n>0$ and $x+n>m$, the iterator is positioned after the last row. If $n<0$ and $x+n<1$, the iterator is positioned before the first row.

b. If you need to know the current cursor position, use the getRow, isFirst, isLast, `isBeforeFirst`, or isAfterLast method to obtain this information.

   If you need to know the current fetch direction, invoke the getFetchDirection method.

c. Use accessor methods to retrieve the current row of the result table.

d. If update or delete operations by the iterator or by other means are visible in the result table, invoke the getWarnings method to check whether the current row is a hole.

For a positioned iterator, perform the following steps:

a. Use a FETCH statement with a fetch orientation clause to position the iterator and retrieve the current row of the result table. Table 20 lists the clauses that you can use to position the cursor.

Table 20. FETCH clauses for positioning a scrollable cursor

Method	Positions the cursor
FIRST	On the first row of the result table
LAST	On the last row of the result table
PRIOR[1]	On the previous row of the result table
NEXT	On the next row of the result table
ABSOLUTE(n)[2]	If $n>0$, on row n of the result table. If $n<0$, and m is the number of rows in the result table, on row $m+n+1$ of the result table.
RELATIVE(n)[3]	If $n>0$, on the row that is n rows after the current row. If $n<0$, on the row that is n rows before the current row. If $n=0$, on the current row.
AFTER[4]	After the last row in the result table
BEFORE[4]	Before the first row in the result table

Table 20. FETCH clauses for positioning a scrollable cursor (continued)

Method	Positions the cursor

Notes:

1. If the cursor is after the last row of the result table, this method positions the cursor on the last row.
2. If the absolute value of *n* is greater than the number of rows in the result table, this method positions the cursor after the last row if *n* is positive, or before the first row if *n* is negative.
3. Suppose that *m* is the number of rows in the result table and *x* is the current row number in the result table. If $n>0$ and $x+n>m$, the iterator is positioned after the last row. If $n<0$ and $x+n<1$, the iterator is positioned before the first row.
4. Values are not assigned to host expressions.

   b. If update or delete operations by the iterator or by other means are visible in the result table, invoke the getWarnings method to check whether the current row is a hole.

5. Invoke the close method to close the iterator.

The following code demonstrates how to use a named iterator to retrieve the employee number and last name from all rows from the employee table in reverse order. The numbers to the right of selected statements correspond to the previously-described steps.

```
#sql  iterator ScrollIter implements sqlj.runtime.Scrollable          1
  (String EmpNo, String LastName);
{
  ScrollIter scrliter;                                                2
  #sql [ctxt]
  scrliter={SELECT EMPNO, LASTNAME FROM EMPLOYEE};
  scrliter.afterLast();
  while (scrliter.previous())                                         4a
  {
    System.out.println(scrliter.EmpNo() + " "                         4c
      + scrliter.LastName());
  }
  scrliter.close();                                                   5
}
```

Figure 48. Example of using scrollable iterators

Calling stored procedures in an SQLJ application

To call a stored procedure, you use an executable clause that contains an SQL CALL statement.

You can execute the CALL statement with host identifier parameters. You can execute the CALL statement with literal parameters only if the DB2 server on which the CALL statement runs supports execution of the CALL statement dynamically.

The basic steps in calling a stored procedure are:

1. Assign values to input (IN or INOUT) parameters.
2. Call the stored procedure.
3. Process output (OUT or INOUT) parameters.
4. If the stored procedure returns multiple result sets, retrieve those result sets.

The following code illustrates calling a stored procedure that has three input parameters and three output parameters. The numbers to the right of selected statements correspond to the previously-described steps.

```
String FirstName="TOM";            // Input parameters                 1
String LastName="NARISINST";
String Address="IBM";
int CustNo;                        // Output parameters
String Mark;
String MarkErrorText;
...
#sql [myConnCtx] {CALL ADD_CUSTOMER(:IN FirstName,                      2
                            :IN LastName,
                            :IN Address,
                            :OUT CustNo,
                            :OUT Mark,
                            :OUT MarkErrorText)};
                                  // Call the stored procedure
System.out.println("Output parameters from ADD_CUSTOMER call: ");
System.out.println("Customer number for " + LastName + ": " + CustNo);  3
System.out.println(Mark);
If (MarkErrorText != null)
  System.out.println(" Error messages:" + MarkErrorText);
```

Figure 49. Example of calling a stored procedure in an SQLJ application

Retrieving multiple result sets from a stored procedure in an SQLJ application

Some stored procedures return one or more result sets to the calling program. The calling program needs to retrieve the contents of those result sets.

To retrieve the rows from those result sets, you execute these steps:

1. Acquire an execution context for retrieving the result set from the stored procedure.
2. Associate the execution context with the CALL statement for the stored procedure.

   Do not use this execution context for any other purpose until you have retrieved and processed the last result set.
3. For each result set:
   a. Use the ExecutionContext method getNextResultSet to retrieve the result set.
   b. If you do not know the contents of the result set, use ResultSetMetaData methods to retrieve this information.
   c. Use an SQLJ result set iterator or JDBC ResultSet to retrieve the rows from the result set.

Result sets are returned to the calling program in the same order that their cursors are opened in the stored procedure. When there are no more result sets to retrieve, getNextResultSet returns a null value.

getNextResultSet has two forms:

```
getNextResultSet();
getNextResultSet(int current);
```

When you invoke the first form of getNextResultSet, SQLJ closes the currently-open result set and advances to the next result set. When you invoke the second form of getNextResultSet, the value of *current* indicates what SQLJ does with the currently-open result set before it advances to the next result set:

java.sql.Statement.CLOSE_CURRENT_RESULT
Specifies that the current ResultSet object is closed when the next ResultSet object is returned.

java.sql.Statement.KEEP_CURRENT_RESULT
Specifies that the current ResultSet object stays open when the next ResultSet object is returned.

java.sql.Statement.CLOSE_ALL_RESULTS
Specifies that all open ResultSet objects are closed when the next ResultSet object is returned.

The following code calls a stored procedure that returns multiple result sets. For this example, it is assumed that the caller does not know the number of result sets to be returned or the contents of those result sets. It is also assumed that autoCommit is false. The numbers to the right of selected statements correspond to the previously-described steps.

```
ExecutionContext execCtx=myConnCtx.getExecutionContext();      1
#sql [myConnCtx, execCtx] {CALL MULTRSSP()};                   2
            // MULTRSSP returns multiple result sets
ResultSet rs;
while ((rs = execCtx.getNextResultSet()) != null)              3a
{
  ResultSetMetaData rsmeta=rs.getMetaData();                   3b
  int numcols=rsmeta.getColumnCount();
  while (rs.next())                                            3c
  {
    for (int i=1; i<=numcols; i++)
    {
      String colval=rs.getString(i);
      System.out.println("Column " + i + "value is " + colval);
    }
  }
}
```

Figure 50. Retrieving result sets from a stored procedure

LOBs in SQLJ applications with the IBM Data Server Driver for JDBC and SQLJ

With the IBM Data Server Driver for JDBC and SQLJ, you can retrieve LOB data into `Clob` or `Blob` host expressions or update CLOB, BLOB, or DBCLOB columns from `Clob` or `Blob` host expressions. You can also declare iterators with `Clob` or `Blob` data types to retrieve data from CLOB, BLOB, or DBCLOB columns.

Retrieving or updating LOB data: To retrieve data from a BLOB column, declare an iterator that includes a data type of `Blob` or `byte[]`. To retrieve data from a CLOB or DBCLOB column, declare an iterator in which the corresponding column has a `Clob` data type.

To update data in a BLOB column, use a host expression with data type `Blob`. To update data in a CLOB or DBCLOB column, use a host expression with data type `Clob`.

Progressive streaming or LOB locators: In SQLJ applications, you can use progressive streaming or LOB locators in the same way that you use them in JDBC applications.

Java data types for retrieving or updating LOB column data in SQLJ applications

When the deferPrepares property is set to true, and the IBM Data Server Driver for JDBC and SQLJ processes an uncustomized SQLJ statement that includes host expressions, the driver might need to do extra processing to determine data types. This extra processing can impact performance.

When the JDBC driver cannot immediately determine the data type of a parameter that is used with a LOB column, you need to choose a parameter data type that is compatible with the LOB data type.

Input parameters for BLOB columns

For input parameters for BLOB columns, you can use either of the following techniques:

- Use a java.sql.Blob input variable, which is an exact match for a BLOB column:

  ```
  java.sql.Blob blobData;
  #sql {CALL STORPROC(:IN blobData)};
  ```

  Before you can use a java.sql.Blob input variable, you need to create a java.sql.Blob object, and then populate that object.
- Use an input parameter of type of sqlj.runtime.BinaryStream. A sqlj.runtime.BinaryStream object is compatible with a BLOB data type. For this call, you need to specify the exact length of the input data:

  ```
  java.io.ByteArrayInputStream byteStream =
    new java.io.ByteArrayInputStream(byteData);
  int numBytes = byteData.length;
  sqlj.runtime.BinaryStream binStream =
    new sqlj.runtime.BinaryStream(byteStream, numBytes);
  #sql {CALL STORPROC(:IN binStream)};
  ```

  You cannot use this technique for input/output parameters.

Output parameters for BLOB columns

For output or input/output parameters for BLOB columns, you can use the following technique:

- Declare the output parameter or input/output variable with a java.sql.Blob data type:

  ```
  java.sql.Blob blobData = null;
  #sql CALL STORPROC (:OUT blobData)};
  ```

  ```
  java.sql.Blob blobData = null;
  #sql CALL STORPROC (:INOUT blobData)};
  ```

Input parameters for CLOB columns

For input parameters for CLOB columns, you can use one of the following techniques:

- Use a java.sql.Clob input variable, which is an exact match for a CLOB column:

  ```
  #sql CALL STORPROC(:IN clobData)};
  ```

  Before you can use a java.sql.Clob input variable, you need to create a java.sql.Clob object, and then populate that object.
- Use one of the following types of stream input parameters:
  - A sqlj.runtime.CharacterStream input parameter:

```
java.lang.String charData;
java.io.StringReader reader = new java.io.StringReader(charData);
sqlj.runtime.CharacterStream charStream =
  new sqlj.runtime.CharacterStream (reader, charData.length);
#sql {CALL STORPROC(:IN charStream)};
```

– A sqlj.runtime.UnicodeStream parameter, for Unicode UTF-16 data:

```
byte[] charDataBytes = charData.getBytes("UnicodeBigUnmarked");
java.io.ByteArrayInputStream byteStream =
  new java.io.ByteArrayInputStream(charDataBytes);
sqlj.runtime.UnicodeStream uniStream =
  new sqlj.runtime.UnicodeStream(byteStream, charDataBytes.length );
#sql {CALL STORPROC(:IN uniStream)};
```

– A sqlj.runtime.AsciiStream parameter, for ASCII data:

```
byte[] charDataBytes = charData.getBytes("US-ASCII");
java.io.ByteArrayInputStream byteStream =
  new java.io.ByteArrayInputStream (charDataBytes);
sqlj.runtime.AsciiStream asciiStream =
  new sqlj.runtime.AsciiStream (byteStream, charDataBytes.length);
#sql {CALL STORPROC(:IN asciiStream)};
```

For these calls, you need to specify the exact length of the input data. You cannot use this technique for input/output parameters.

- Use a java.lang.String input parameter:

```
java.lang.String charData;
#sql {CALL STORPROC(:IN charData)};
```

Output parameters for CLOB columns

For output or input/output parameters for CLOB columns, you can use one of the following techniques:

- Use a java.sql.Clob output variable, which is an exact match for a CLOB column:

```
java.sql.Clob clobData = null;
#sql CALL STORPROC(:OUT clobData)};
```

- Use a java.lang.String output variable:

```
java.lang.String charData = null;
#sql CALL STORPROC(:OUT charData)};
```

This technique should be used only if you know that the length of the retrieved data is less than or equal to 32KB. Otherwise, the data is truncated.

Output parameters for DBCLOB columns

DBCLOB output or input/output parameters for stored procedures are not supported.

SQLJ and JDBC in the same application

You can combine SQLJ clauses and JDBC calls in a single program.

To do this effectively, you need to be able to do the following things:

- Use a JDBC Connection to build an SQLJ ConnectionContext, or obtain a JDBC Connection from an SQLJ ConnectionContext.
- Use an SQLJ iterator to retrieve data from a JDBC ResultSet or generate a JDBC ResultSet from an SQLJ iterator.

Building an SQLJ ConnectionContext from a JDBC Connection: To do that:

1. Execute an SQLJ connection declaration clause to create a ConnectionContext class.
2. Load the driver or obtain a DataSource instance.
3. Invoke the JDBC DriverManager.getConnection or DataSource.getConnection method to obtain a JDBC Connection.
4. Invoke the ConnectionContext constructor with the Connection as its argument to create the ConnectionContext object.

Obtaining a JDBC Connection from an SQLJ ConnectionContext: To do this,

1. Execute an SQLJ connection declaration clause to create a ConnectionContext class.
2. Load the driver or obtain a DataSource instance.
3. Invoke the ConnectionContext constructor with the URL of the driver and any other necessary parameters as its arguments to create the ConnectionContext object.
4. Invoke the JDBC ConnectionContext.getConnection method to create the JDBC Connection object.

See "Connect to a data source using SQLJ" for more information on SQLJ connections.

Retrieving JDBC result sets using SQLJ iterators: Use the *iterator conversion statement* to manipulate a JDBC result set as an SQLJ iterator. The general form of an iterator conversion statement is:

```
#sql iterator={CAST :result-set};
```

Before you can successfully cast a result set to an iterator, the iterator must conform to the following rules:

- The iterator must be declared as public.
- If the iterator is a positioned iterator, the number of columns in the result set must match the number of columns in the iterator. In addition, the data type of each column in the result set must match the data type of the corresponding column in the iterator.
- If the iterator is a named iterator, the name of each accessor method must match the name of a column in the result set. In addition, the data type of the object that an accessor method returns must match the data type of the corresponding column in the result set.

The code in Figure 51 on page 138 builds and executes a query using a JDBC call, executes an iterator conversion statement to convert the JDBC result set to an SQLJ iterator, and retrieves rows from the result table using the iterator.

```
#sql public iterator ByName(String LastName, Date HireDate);      1
public void HireDates(ConnectionContext connCtx, String whereClause)
{

  ByName nameiter;           // Declare object of ByName class
  Connection conn=connCtx.getConnection();
                             // Create JDBC connection
  Statement stmt = conn.createStatement();                         2
  String query = "SELECT LASTNAME, HIREDATE FROM EMPLOYEE";
  query+=whereClause;   // Build the query
  ResultSet rs = stmt.executeQuery(query);                         3
  #sql [connCtx] nameiter = {CAST :rs};                            4
  while (nameiter.next())
  {
    System.out.println( nameiter.LastName() + " was hired on "
      + nameiter.HireDate());

  }
  nameiter.close();                                                5
  stmt.close();
}
```

Figure 51. Converting a JDBC result set to an SQLJ iterator

Notes to Figure 51:

Note	Description
1	This SQLJ clause creates the named iterator class ByName, which has accessor methods LastName() and HireDate() that return the data from result table columns LASTNAME and HIREDATE.
2	This statement and the following two statements build and prepare a query for dynamic execution using JDBC.
3	This JDBC statement executes the SELECT statement and assigns the result table to result set rs.
4	This iterator conversion clause converts the JDBC ResultSet rs to SQLJ iterator nameiter, and the following statements use nameiter to retrieve values from the result table.
5	The nameiter.close() method closes the SQLJ iterator and JDBC ResultSet rs.

Generating JDBC ResultSets from SQLJ iterators: Use the getResultSet method to generate a JDBC ResultSet from an SQLJ iterator. Every SQLJ iterator has a getResultSet method. After you convert an iterator to a result set, you need to fetch rows using only the result set.

The code in Figure 52 on page 139 generates a positioned iterator for a query, converts the iterator to a result set, and uses JDBC methods to fetch rows from the table.

```
#sql iterator EmpIter(String, java.sql.Date);
{
...
  EmpIter iter=null;
  #sql [connCtx] iter=
    {SELECT LASTNAME, HIREDATE FROM EMPLOYEE};                    1
  ResultSet rs=iter.getResultSet();                               2
  while (rs.next())                                               3
  { System.out.println(rs.getString(1) + " was hired in " +
      rs.getDate(2));
  }
  rs.close();                                                     4
}
```

Figure 52. Converting an SQLJ iterator to a JDBC ResultSet

Notes to Figure 52:

Note	Description
1	This SQLJ clause executes the SELECT statement, constructs an iterator object that contains the result table for the SELECT statement, and assigns the iterator object to variable iter.
2	The getResultSet() method converts iterator iter to ResultSet rs.
3	The JDBC getString() and getDate() methods retrieve values from the ResultSet. The next() method moves the cursor to the next row in the ResultSet.
4	The rs.close() method closes the SQLJ iterator as well as the ResultSet.

Rules and restrictions for using JDBC ResultSets in SQLJ applications: When you write SQLJ applications that include JDBC result sets, observe the following rules and restrictions:

- You cannot cast a ResultSet to an SQLJ iterator if the ResultSet and the iterator have different holdability attributes.

  A JDBC ResultSet or an SQLJ iterator can remain open after a COMMIT operation. For a JDBC ResultSet, this characteristic is controlled by the IBM Data Server Driver for JDBC and SQLJ property `resultSetHoldability`. For an SQLJ iterator, this characteristic is controlled by the `with holdability` parameter of the iterator declaration. Casting a ResultSet that has holdability to an SQLJ iterator that does not, or casting a ResultSet that does not have holdability to an SQLJ iterator that does, is not supported.
- Close a generated ResultSet object or the underlying iterator at the end of the program.

  Closing the iterator object from which a ResultSet object is generated also closes the ResultSet object. Closing the generated ResultSet object also closes the iterator object. In general, it is best to close the object that is used last.
- For the IBM Data Server Driver for JDBC and SQLJ, which supports scrollable iterators and scrollable and updatable ResultSets, the following restrictions apply:
  - Scrollable iterators have the same restrictions as their underlying JDBC ResultSets.
  - You cannot cast a JDBC ResultSet that is not updatable to an SQLJ iterator that is updatable.

Controlling the execution of SQL statements in SQLJ

You can use selected methods of the SQLJ ExecutionContext class to control or monitor the execution of SQL statements.

To use ExecutionContext methods, follow these steps:

1. Acquire the default execution context from the connection context.

   There are two ways to acquire an execution context:

   - Acquire the default execution context from the connection context. For example:

     ```
     ExecutionContext execCtx = connCtx.getExecutionContext();
     ```

   - Create a new execution context by invoking the constructor for ExecutionContext. For example:

     ```
     ExecutionContext execCtx=new ExecutionContext();
     ```

2. Associate the execution context with an SQL statement.

   To do that, specify an execution context after the connection context in the execution clause that contains the SQL statement.

3. Invoke ExecutionContext methods.

   Some ExecutionContext methods are applicable before the associated SQL statement is executed, and some are applicable only after their associated SQL statement is executed.

   For example, you can use method getUpdateCount to count the number of rows that are deleted by a DELETE statement after you execute the DELETE statement.

The following code demonstrates how to acquire an execution context, and then use the getUpdateCount method on that execution context to determine the number of rows that were deleted by a DELETE statement. The numbers to the right of selected statements correspond to the previously-described steps.

```
ExecutionContext execCtx=new ExecutionContext();                          1
#sql [connCtx, execCtx] {DELETE FROM EMPLOYEE WHERE SALARY > 10000};      2
System.out.println("Deleted " + execCtx.getUpdateCount() + " rows");      3
```

ROWIDs in SQLJ with the IBM Data Server Driver for JDBC and SQLJ

DB2 for z/OS and DB2 for i5/OS support the ROWID data type for a column in a table. A ROWID is a value that uniquely identifies a row in a table.

If you use ROWIDs in SQLJ programs, you need to customize those programs.

JDBC 4.0 includes interface java.sql.RowId that you can use in iterators and in CALL statement parameters. If you do not have JDBC 4.0, you can use the IBM Data Server Driver for JDBC and SQLJ-only class com.ibm.db2.jcc.DB2RowID. For an iterator, you can also use the byte[] object type to retrieve ROWID values.

The following code shows an example of an iterator that is used to select values from a ROWID column:

```
#sql iterator PosIter(int,String,java.sql.RowId);
                                // Declare positioned iterator
                                // for retrieving ITEM_ID (INTEGER),
                                // ITEM_FORMAT (VARCHAR), and ITEM_ROWID (ROWID)
                                // values from table ROWIDTAB
{
  PosIter positrowid;           // Declare object of PosIter class
  java.sql.RowId rowid = null;
  int id = 0;
  String i_fmt = null;
                                // Declare host expressions
  #sql [ctxt] positrowid =
    {SELECT ITEM_ID, ITEM_FORMAT, ITEM_ROWID FROM ROWIDTAB
       WHERE ITEM_ID=3};
                                // Assign the result table of the SELECT
                                // to iterator object positrowid
  #sql {FETCH :positrowid INTO :id, :i_fmt, :rowid};
                                // Retrieve the first row
  while (!positrowid.endFetch())
                                // Check whether the FETCH returned a row
    {System.out.println("Item ID " + id + " Item format " +
       i_fmt + " Item ROWID ");
     printBytes(rowid.getBytes());
                           // Use the getBytes method to
                           // convert the value to bytes for printing
      #sql {FETCH :positrowid INTO :id, :i_fmt, :rowid};
                                // Retrieve the next row
    }
  positrowid.close();           // Close the iterator
}
```

Figure 53. Example of using an iterator to retrieve ROWID values

The following code shows an example of calling a stored procedure that takes three ROWID parameters: an IN parameter, an OUT parameter, and an INOUT parameter.

```
java.sql.RowId in_rowid = rowid;
java.sqlRowId out_rowid = null;
java.sql.RowId inout_rowid = rowid;
                                    // Declare an input, output, and
                                    // input/output ROWID parameter
...
#sql [myConnCtx] {CALL SP_ROWID(:IN in_rowid,
                              :OUT out_rowid,
                              :INOUT inout_rowid)};
                                    // Call the stored procedure
System.out.println("Parameter values from SP_ROWID call: ");
System.out.println("Output parameter value ");
printBytes(out_rowid.getBytes());
                           // Use the getBytes method to
                           // convert the value to bytes for printing
System.out.println("Input/output parameter value ");
printBytes(inout_rowid.getBytes());
```

Figure 54. Example of calling a stored procedure with a ROWID parameter

Distinct types in SQLJ applications

In an SQLJ program, you can create a distinct type using the CREATE DISTINCT TYPE statement in an executable clause.

You can also use CREATE TABLE in an executable clause to create a table that includes a column of that type. When you retrieve data from a column of that

type, or update a column of that type, you use Java identifiers with data types that correspond to the built-in types on which the distinct types are based.

The following example creates a distinct type that is based on an INTEGER type, creates a table with a column of that type, inserts a row into the table, and retrieves the row from the table:

```
String empNumVar;
int shoeSizeVar;
...
#sql [myConnCtx] {CREATE DISTINCT TYPE SHOESIZE AS INTEGER WITH COMPARISONS};
                                          // Create distinct type
#sql [myConnCtx] {COMMIT}; // Commit the create
#sql [myConnCtx] {CREATE TABLE EMP_SHOE
  (EMPNO CHAR(6), EMP_SHOE_SIZE SHOESIZE)};
                                          // Create table using distinct type
#sql [myConnCtx] {COMMIT}; // Commit the create
#sql [myConnCtx] {INSERT INTO EMP_SHOE
  VALUES('000010',6)};                    // Insert a row in the table
#sql [myConnCtx] {COMMIT}; // Commit the INSERT
#sql [myConnCtx] {SELECT EMPNO, EMP_SHOE_SIZE
  INTO :empNumVar, :shoeSizeVar
  FROM EMP_SHOE};                         // Retrieve the row
System.out.println("Employee number: " + empNumVar +
  " Shoe size: " + shoeSizeVar);
```

Figure 55. Defining and using a distinct type

Invocation of stored procedures with ARRAY parameters in SQLJ applications

SQLJ applications that run under the IBM Data Server Driver for JDBC and SQLJ can call stored procedures that have ARRAY parameters.

You can use java.sql.Array objects as IN, OUT, or INOUT parameters in a stored procedure.

Use the DB2Connection.createArrayOf method to assign values to an ARRAY input stored procedure parameter.

There are two ways to retrieve data from an ARRAY output stored procedure parameter:

- Use the java.sql.Array.getArray method to retrieve the contents of output parameter into a Java array.
- Use a java.sql.Array.getResultSet method to retrieve the output parameter data into a ResultSet object. Then use ResultSet methods to retrieve elements of the array. Each row of the ResultSet contains two columns:
  - An index into the array, which starts at 1
  - The array element

  You need to retrieve the array elements from the ResultSet using the getObject method.

Example: Suppose that input and output parameters IN_PHONE and OUT_PHONE in stored procedure GET_EMP_DATA are arrays that are defined like this:

```
CREATE TYPE PHONENUMBERS AS VARCHAR(10) ARRAY[5]
```

Call GET_EMP_DATA with the two parameters.

```
Connection con;
String type = "CHAR";
String [] contents = {"1234", "5678", "9101"};
...
com.ibm.db2.jcc.DB2Connection db2con = (com.ibm.db2.jcc.DB2Connection) con;
                                    // Cast the Connection as a DB2Connection
                                    // so you can use the
                                    // DB2Connection.createArrayOf method
java.sql.Array inPhoneData = db2con.createArrayOf(type, contents);
java.sql.Array outPhoneData;
try {
  #sql [db2con] {CALL GET_EMP_DATA(:IN inPhoneData, :OUT outPhoneData ) };
}
catch( SQLException e )
{
  throw e;
}
ResultSet rs = outPhoneData.getResultSet();
while (rs.next()) {
  String phoneNum = rs.getString(2); // Get phone number
  System.out.println("Phone number = " + phoneNum);
}
```

Savepoints in SQLJ applications

Under the IBM Data Server Driver for JDBC and SQLJ, you can include any form of the SQL SAVEPOINT statement in your SQLJ program.

An SQL savepoint represents the state of data and schemas at a particular point in time within a unit of work. SQL statements exist to set a savepoint, release a savepoint, and restore data and schemas to the state that the savepoint represents.

The following example demonstrates how to set a savepoint, roll back to the savepoint, and release the savepoint.

Figure 56. Setting, rolling back to, and releasing a savepoint in an SQLJ application

```
#sql context Ctx;             // Create connection context class Ctx
String empNumVar;
int shoeSizeVar;
...
try {                         // Load the JDBC driver
  Class.forName("com.ibm.db2.jcc.DB2Driver");
}
catch (ClassNotFoundException e) {
   e.printStackTrace();
}
Connection jdbccon=
  DriverManager.getConnection("jdbc:db2://sysmvs1.stl.ibm.com:5021/NEWYORK",
    userid,password);
                              // Create JDBC connection object jdbccon
jdbccon.setAutoCommit(false); // Do not autocommit
Ctx ctxt=new Ctx(jdbccon);
                              // Create connection context object myConnCtx
                              // for the connection to NEWYORK
...                             // Perform some SQL
#sql [ctxt] {COMMIT};         // Commit the transaction
                              // Commit the create
#sql [ctxt]
  {INSERT INTO EMP_SHOE VALUES ('000010', 6)};
                              // Insert a row
#sql [ctxt]
  {SAVEPOINT SVPT1 ON ROLLBACK RETAIN CURSORS};
                              // Create a savepoint
```

```
...
#sql [ctxt]
  {INSERT INTO EMP_SHOE VALUES ('000020', 10)};
                                // Insert another row
#sql [ctxt] {ROLLBACK TO SAVEPOINT SVPT1};
                                // Roll back work to the point
                                //  after the first insert
...
#sql [ctxt] {RELEASE SAVEPOINT SVPT1};
                                // Release the savepoint
ctx.close();                    // Close the connection context
```

XML data in SQLJ applications

In SQLJ applications, you can store data in XML columns and retrieve data from XML columns.

In DB2 tables, the XML built-in data type is used to store XML data in a column as a structured set of nodes in a tree format.

In applications, XML data is in the serialized string format.

In SQLJ applications, you can:

- Store an entire XML document in an XML column using INSERT or UPDATE statements.
- Retrieve an entire XML document from an XML column using single-row SELECT statements or iterators.
- Retrieve a sequence from a document in an XML column by using the SQL XMLQUERY function to retrieve the sequence in the database, and then using single-row SELECT statements or iterators to retrieve the serialized XML string data into an application variable.
- Retrieve a sequence from a document in an XML column by using an XQuery expression, prepended with the string 'XQUERY', to retrieve the elements of the sequence into a result table in the database, in which each row of the result table represents an item in the sequence. Then use using single-row SELECT statements or iterators to retrieve the data into application variables.
- Retrieve a sequence from a document in an XML column as a user-defined table by using the SQL XMLTABLE function to define the result table and retrieve it. Then use using single-row SELECT statements or iterators to retrieve the data from the result table into application variables.

JDBC 4.0 `java.sql.SQLXML` objects can be used to retrieve and update data in XML columns. Invocations of metadata methods, such as ResultSetMetaData.getColumnTypeName return the integer value `java.sql.Types.SQLXML` for an XML column type.

XML column updates in SQLJ applications

When you update or insert data into XML columns of a table in an SQLJ application, the input data must be in the serialized string format.

The host expression data types that you can use to update XML columns are:

- java.sql.SQLXML (requires an SDK for Java Version 6 or later, and the IBM Data Server Driver for JDBC and SQLJ Version 4.0 or later)
- com.ibm.db2.jcc.DB2Xml (deprecated)
- String
- byte

- Blob
- Clob
- sqlj.runtime.AsciiStream
- sqlj.runtime.BinaryStream
- sqlj.runtime.CharacterStream

For stream types, you need to use an sqlj.runtime.*type*Stream host expression, rather than a java.io.*type*InputStream host expression so that you can pass the length of the stream to the JDBC driver.

The encoding of XML data can be derived from the data itself, which is known as *internally encoded* data, or from external sources, which is known as *externally encoded* data. XML data that is sent to the database server as binary data is treated as internally encoded data. XML data that is sent to the data source as character data is treated as externally encoded data. The external encoding is the default encoding for the JVM.

External encoding for Java applications is always Unicode encoding.

Externally encoded data can have internal encoding. That is, the data might be sent to the data source as character data, but the data contains encoding information. The data source handles incompatibilities between internal and external encoding as follows:

- If the data source is DB2 Database for Linux, UNIX, and Windows, the data source generates an error if the external and internal encoding are incompatible, unless the external and internal encoding are Unicode. If the external and internal encoding are Unicode, the data source ignores the internal encoding.
- If the data source is DB2 for z/OS, the data source ignores internal encoding.

Data in XML columns is stored in UTF-8 encoding.

Example: Suppose that you use the following statement to insert data from String host expression xmlString into an XML column in a table. xmlString is a character type, so its external encoding is used, whether or not it has an internal encoding specification.

```
#sql [ctx] {INSERT INTO CUSTACC VALUES (1, :xmlString)};
```

Example: Suppose that you copy the data from xmlString into a byte array with CP500 encoding. The data contains an XML declaration with an encoding declaration for CP500. Then you insert the data from the byte[] host expression into an XML column in a table.

```
byte[] xmlBytes = xmlString.getBytes("CP500");
#sql[ctx] {INSERT INTO CUSTACC VALUES (4, :xmlBytes)};
```

A byte string is considered to be internally encoded data. The data is converted from its internal encoding scheme to UTF-8, if necessary, and stored in its hierarchical format on the data source.

Example: Suppose that you copy the data from xmlString into a byte array with US-ASCII encoding. Then you construct an sqlj.runtime.AsciiStream host expression, and insert data from the sqlj.runtime.AsciiStream host expression into an XML column in a table on a data source.

```
byte[] b = xmlString.getBytes("US-ASCII");
java.io.ByteArrayInputStream xmlAsciiInputStream =
  new java.io.ByteArrayInputStream(b);
```

```
sqlj.runtime.AsciiStream sqljXmlAsciiStream =
  new sqlj.runtime.AsciiStream(xmlAsciiInputStream,  b.length);
#sql[ctx] {INSERT INTO CUSTACC VALUES (4, :sqljXmlAsciiStream)};
```

sqljXmlAsciiStream is a stream type, so its internal encoding is used. The data is converted from its internal encoding to UTF-8 encoding and stored in its hierarchical form on the data source.

Example: sqlj.runtime.CharacterStream host expression: Suppose that you construct an sqlj.runtime.CharacterStream host expression, and insert data from the sqlj.runtime.CharacterStream host expression into an XML column in a table.

```
java.io.StringReader xmlReader =
  new java.io.StringReader(xmlString);
sqlj.runtime.CharacterStream sqljXmlCharacterStream =
  new sqlj.runtime.CharacterStream(xmlReader,  xmlString.length());
#sql [ctx] {INSERT INTO CUSTACC VALUES (4, :sqljXmlCharacterStream)};
```

sqljXmlCharacterStream is a character type, so its external encoding is used, whether or not it has an internal encoding specification.

Example: Suppose that you retrieve a document from an XML column into a java.sql.SQLXML host expression, and insert the data into an XML column in a table.

```
java.sql.ResultSet rs = s.executeQuery ("SELECT * FROM CUSTACC");
rs.next();
java.sql.SQLXML xmlObject = (java.sql.SQLXML)rs.getObject(2);
#sql [ctx] {INSERT INTO CUSTACC VALUES (6, :xmlObject)};
```

After you retrieve the data it is still in UTF-8 encoding, so when you insert the data into another XML column, no conversion occurs.

Example: Suppose that you retrieve a document from an XML column into a com.ibm.db2.jcc.DB2Xml host expression, and insert the data into an XML column in a table.

```
java.sql.ResultSet rs = s.executeQuery ("SELECT * FROM CUSTACC");
rs.next();
com.ibm.db2.jcc.DB2Xml xmlObject = (com.ibm.db2.jcc.DB2Xml)rs.getObject(2);
#sql [ctx] {INSERT INTO CUSTACC VALUES (6, :xmlObject)};
```

After you retrieve the data it is still in UTF-8 encoding, so when you insert the data into another XML column, no conversion occurs.

XML data retrieval in SQLJ applications

When you retrieve data from XML columns of a database table in an SQLJ application, the output data must be explicitly or implicitly serialized.

The host expression or iterator data types that you can use to retrieve data from XML columns are:

- java.sql.SQLXML (requires an SDK for Java Version 6 or later, and the IBM Data Server Driver for JDBC and SQLJ Version 4.0 or later)
- com.ibm.db2.jcc.DB2Xml (deprecated)
- String
- byte[]
- sqlj.runtime.AsciiStream
- sqlj.runtime.BinaryStream
- sqlj.runtime.CharacterStream

If the application does not call the XMLSERIALIZE function before data retrieval, the data is converted from UTF-8 to the external application encoding for the character data types, or the internal encoding for the binary data types. No XML declaration is added. If the host expression is an object of the java.sql.SQLXML or com.ibm.db2.jcc.DB2Xml type, you need to call an additional method to retrieve the data from this object. The method that you call determines the encoding of the output data and whether an XML declaration with an encoding specification is added.

The following table lists the methods that you can call to retrieve data from a java.sql.SQLXML or a com.ibm.db2.jcc.DB2Xml object, and the corresponding output data types and type of encoding in the XML declarations.

Table 21. SQLXML and DB2Xml methods, data types, and added encoding specifications

Method	Output data type	Type of XML internal encoding declaration added
SQLXML.getBinaryStream	InputStream	None
SQLXML.getCharacterStream	Reader	None
SQLXML.getSource	Source	None
SQLXML.getString	String	None
DB2Xml.getDB2AsciiStream	InputStream	None
DB2Xml.getDB2BinaryStream	InputStream	None
DB2Xml.getDB2Bytes	byte[]	None
DB2Xml.getDB2CharacterStream	Reader	None
DB2Xml.getDB2String	String	None
DB2Xml.getDB2XmlAsciiStream	InputStream	US-ASCII
DB2Xml.getDB2XmlBinaryStream	InputStream	Specified by getDB2XmlBinaryStream *targetEncoding* parameter
DB2Xml.getDB2XmlBytes	byte[]	Specified by DB2Xml.getDB2XmlBytes *targetEncoding* parameter
DB2Xml.getDB2XmlCharacterStream	Reader	ISO-10646-UCS-2
DB2Xml.getDB2XmlString	String	ISO-10646-UCS-2

If the application executes the XMLSERIALIZE function on the data that is to be returned, after execution of the function, the data has the data type that is specified in the XMLSERIALIZE function, not the XML data type. Therefore, the driver handles the data as the specified type and ignores any internal encoding declarations.

Example: Suppose that you retrieve data from an XML column into a String host expression.

```
#sql iterator  XmlStringIter (int, String);
#sql [ctx] siter = {SELECT C1, CADOC from CUSTACC};
#sql {FETCH :siter INTO :row, :outString};
```

The String type is a character type, so the data is converted from UTF-8 to the external encoding, which is the default JVM encoding, and returned without any XML declaration.

Example: Suppose that you retrieve data from an XML column into a byte[] host expression.

```
#sql iterator  XmlByteArrayIter (int, byte[]);
XmlByteArrayIter biter = null;
#sql [ctx] biter =  {SELECT c1, CADOC from CUSTACC};
#sql {FETCH :biter INTO :row, :outBytes};
```

The byte[] type is a binary type, so no data conversion from UTF-8 encoding occurs, and the data is returned without any XML declaration.

Example: Suppose that you retrieve a document from an XML column into a java.sql.SQLXML host expression, but you need the data in a binary stream.

```
#sql iterator  SqlXmlIter (int, java.sql.SQLXML);
SqlXmlIter SQLXMLiter = null;
java.sql.SQLXML outSqlXml = null;
#sql [ctx] SqlXmlIter = {SELECT c1, CADOC from CUSTACC};
#sql {FETCH :SqlXmlIter INTO :row, :outSqlXml};
java.io.InputStream XmlStream = outSqlXml.getBinaryStream();
```

The FETCH statement retrieves the data into the SQLXML object in UTF-8 encoding. The SQLXML.getBinaryStream stores the data in a binary stream.

Example: Suppose that you retrieve a document from an XML column into a com.ibm.db2.jcc.DB2Xml host expression, but you need the data in a byte string with an XML declaration that includes an internal encoding specification for UTF-8.

```
#sql iterator  DB2XmlIter (int, com.ibm.db2.jcc.DB2Xml);
DB2XmlIter db2xmliter = null;
com.ibm.db2.jcc.DB2Xml outDB2Xml = null;
#sql [ctx] db2xmliter = {SELECT c1, CADOC from CUSTACC};
#sql {FETCH :db2xmliter INTO :row, :outDB2Xml};
byte[] byteArray = outDB2XML.getDB2XmlBytes("UTF-8");
```

The FETCH statement retrieves the data into the DB2Xml object in UTF-8 encoding. The getDB2XmlBytes method with the UTF-8 argument adds an XML declaration with a UTF-8 encoding specification and stores the data in a byte array.

SQLJ utilization of SDK for Java Version 5 function

Your SQLJ applications can use a number of functions that were introduced with the SDK for Java Version 5.

Static import

The static import construct lets you access static members without qualifying those members with the name of the class to which they belong. For SQLJ applications, this means that you can use static members in host expressions without qualifying them.

Example: Suppose that you want to declare a host expression of this form:

```
double r = cos(PI * E);
```

cos, PI, and E are members of the java.lang.Math class. To declare r without explicitly qualifying cos, PI, and E, include the following static import statement in your program:

```
import static java.lang.Math.*;
```

Annotations

Java annotations are a means for adding metadata to Java programs that can also affect the way that those programs are treated by tools and libraries. Annotations are declared with annotation type declarations, which are similar to interface declarations. Java annotations can appear in the following types of classes or interfaces:

- Class declaration
- Interface declaration
- Nested class declaration
- Nested interface declaration

You cannot include Java annotations directly in SQLJ programs, but you can include annotations in Java source code, and then include that source code in your SQLJ programs.

Example: Suppose that you declare the following marker annotation in a program called MyAnnot.java:

```
public @interface MyAnot { }
```

You also declare the following marker annotation in a program called MyAnnot2.java:

```
public @interface MyAnot2 { }
```

You can then use those annotations in an SQLJ program:

```
// Class annotations
@MyAnot2 public @MyAnot class  TestAnnotation
{
  // Field annotation
  @MyAnot
  private static final int field1 = 0;
  // Constructor annotation
  @MyAnot2 public @MyAnot TestAnnotation  () { }
   // Method annotation
   @MyAnot
   public static void main (String a[])
   {
      TestAnnotation TestAnnotation_o = new TestAnnotation();
      TestAnnotation_o.runThis();
   }
  // Inner class annotation
  public static @MyAnot class TestAnotherInnerClass { }
  // Inner interface annotation
  public static @MyAnot interface TestAnotInnerInterface { }
}
```

Enumerated types

An enumerated type is a data type that consists of a set of ordered values. The SDK for Java version 5 introduces the `enum` type for enumerated types.

You cannot include Java `enum` types directly in SQLJ programs, but you can include enums the following places:

- In Java source files (.java files) that you include in an SQLJ program
- In SQLJ class declarations

Example: The TestEnum.sqlj class declaration includes an `enum` type:

```
public class TestEnum2
{
    public enum Color {
   RED,ORANGE,YELLOW,GREEN,BLUE,INDIGO,VIOLET}
  Color color = null;
  switch (color) {
 case RED:
    System.out.println("Red is at one end of the spectrum.");
    #sql[ctx] { INSERT INTO MYTABLE VALUES (:color) };
   break;
 case VIOLET:
    System.out.println("Violet is on the other end of the spectrum.");
   break;
 case ORANGE:
 case YELLOW:
 case GREEN:
  case BLUE:
  case INDIGO:
    System.out.println("Everything else is in the middle.");
   break;
}
```

Generics

You can use generics in your Java programs to assign a type to a Java collection. The SQLJ translator tolerates Java generic syntax. Examples of generics that you can use in SQLJ programs are:

- A List of List objects:

  ```
  List <List<String>> strList2 = new ArrayList<List<String>>();
  ```

- A HashMap in which the key/value pair has the String type:

  ```
  Map <String,String> map = new HashMap<String,String>();
  ```

- A method that takes a List with elements of any type:

  ```
  public void mthd(List <?> obj) {
  ...
  }
  ```

Although you can use generics in SQLJ host variables, the value of doing so is limited because the SQLJ translator cannot determine the types of those host variables.

Enhanced for loop

The enhanced `for` lets you specify that a set of operations is performed on each member of a collection or array. You can use the iterator in the enhanced `for` loop in host expressions.

Example: INSERT each of the items in array names into table TAB.

```
String[] names = {"ABC","DEF","GHI"};
for (String n : names)
{
  #sql {INSERT INTO TAB (VARCHARCOL) VALUES(:n) };
}
```

Varargs

Varargs make it easier to pass an arbitrary number of values to a method. A Vararg in the last argument position of a method declaration indicates that the last arguments are an array or a sequence of arguments. An SQLJ program can use the passed arguments in host expressions.

Example: Pass an arbitrary number of parameters of type Object, to a method that inserts each parameter value into table TAB.

```
public void runThis(Object...  objects) throws SQLException
{
  for (Object obj : objects)
  {
    #sql { INSERT INTO TAB (VARCHARCOL) VALUES(:obj) };
  }
}
```

Transaction control in SQLJ applications

In SQLJ applications, as in other types of SQL applications, transaction control involves explicitly or implicitly committing and rolling back transactions, and setting the isolation level for transactions.

Setting the isolation level for an SQLJ transaction

To set the isolation level for a unit of work within an SQLJ program, use the SET TRANSACTION ISOLATION LEVEL clause.

The following table shows the values that you can specify in the SET TRANSACTION ISOLATION LEVEL clause and their DB2 equivalents.

Table 22. Equivalent SQLJ and DB2 isolation levels

SET TRANSACTION value	DB2 isolation level
SERIALIZABLE	Repeatable read
REPEATABLE READ	Read stability
READ COMMITTED	Cursor stability
READ UNCOMMITTED	Uncommitted read

The isolation level affects the underlying JDBC connection as well as the SQLJ connection.

Committing or rolling back SQLJ transactions

If you disable autocommit for an SQLJ connection, you need to perform explicit commit or rollback operations.

You do this using execution clauses that contain the SQL COMMIT or ROLLBACK statements.

To commit a transaction in an SQLJ program, use a statement like this:

```
#sql [myConnCtx] {COMMIT};
```

To roll back a transaction in an SQLJ program, use a statement like this:

```
#sql [myConnCtx] {ROLLBACK};
```

Handling SQL errors and warnings in SQLJ applications

SQLJ clauses throw SQLExceptions when SQL errors occur, but not when most SQL warnings occur.

SQLJ generates an SQLException under the following circumstances:

- When any SQL statement returns a negative SQL error code

- When a SELECT INTO SQL statement returns a +100 SQL error code

You need to explicitly check for other SQL warnings.

- For SQL error handling, include try/catch blocks around SQLJ statements.
- For SQL warning handling, invoke the getWarnings method after every SQLJ statement.

Handling SQL errors in an SQLJ application

SQLJ clauses use the JDBC class java.sql.SQLException for error handling.

To handle SQL errors in SQLJ applications, following these steps:

1. Import the java.sql.SQLException class.
2. Use the Java error handling `try/catch` blocks to modify program flow when an SQL error occurs.
3. Obtain error information from the SQLException.

   You can use the getErrorCode method to retrieve SQL error codes and the getSQLState method to retrieve SQLSTATEs.

   If you are using the IBM Data Server Driver for JDBC and SQLJ, obtain additional information from the SQLException by casting it to a DB2Diagnosable object, in the same way that you obtain this information in a JDBC application.

   For the DB2 JDBC Type 2 Driver for Linux, UNIX and Windows (DB2 JDBC Type 2 Driver), use the standard SQLException to retrieve SQL error information.

The following code prints out the SQL error that occurred if a SELECT statement fails.

```
try {
  #sql [ctxt] {SELECT LASTNAME INTO :empname
    FROM EMPLOYEE WHERE EMPNO='000010'};
}
catch(SQLException e) {
  System.out.println("Error code returned: " + e.getErrorCode());
}
```

Handling SQL warnings in an SQLJ application

Other than a +100 SQL error code on a SELECT INTO statement,DB2 warnings do not throw SQLExceptions. To handleDB2 warnings, you need to give the program access to the java.sql.SQLWarning class.

If you want to retrieve DB2-specific information about a warning, you also need to give the program access to the com.ibm.db2.jcc.DB2Diagnosable interface and the com.ibm.db2.jcc.DB2Sqlca class. Then follow these steps:

1. Set up an execution context for that SQL clause. See ″Control the execution of SQL statements in SQLJ″ for information on how to set up an execution context.
2. To check for aDB2 warning, invoke the getWarnings method after you execute an SQLJ clause.

   getWarnings returns the first SQLWarning object that an SQL statement generates. Subsequent SQLWarning objects are chained to the first one.
3. To retrieve DB2-specific information from the SQLWarning object with the IBM Data Server Driver for JDBC and SQLJ, follow the instructions in ″Handle an SQLException under the IBM Data Server Driver for JDBC and SQLJ″.

The following example demonstrates how to retrieve an SQLWarning object for an SQL clause with execution context execCtx. The numbers to the right of selected statements correspond to the previously-described steps.

```
ExecutionContext execCtx=myConnCtx.getExecutionContext();    1
                                    // Get default execution context from
                                    // connection context
SQLWarning sqlWarn;
...
#sql [myConnCtx,execCtx] {SELECT LASTNAME INTO :empname
  FROM EMPLOYEE WHERE EMPNO='000010'};
if ((sqlWarn = execCtx.getWarnings()) != null)              2
System.out.println("SQLWarning " + sqlWarn);
```

Closing the connection to a data source in an SQLJ application

When you have finished with a connection to a data source, you need to close the connection to the data source. Doing so releases the connection context object's DB2 and SQLJ resources immediately.

To close the connection to the data source, use one of the ConnectionContext.close methods.

- If you execute ConnectionContext.close() or ConnectionContext.close(ConnectionContext.CLOSE_CONNECTION), the connection context, as well as the connection to the data source, are closed.
- If you execute ConnectionContext.close(ConnectionContext.KEEP_CONNECTION) the connection context is closed, but the connection to the data source is not.

The following code closes the connection context, but does not close the connection to the data source.

```
...
ctx = new EzSqljctx(con0);          // Create a connection context object
                                    // from JDBC connection con0
...                                   // Perform various SQL operations
 EzSqljctx.close(ConnectionContext.KEEP_CONNECTION);
                                    // Close the connection context but keep
                                    // the connection to the data source open
```

Chapter 5. Security under the IBM Data Server Driver for JDBC and SQLJ

When you use the IBM Data Server Driver for JDBC and SQLJ, you choose a security mechanism by specifying a value for the `securityMechanism` property.

You can set this property in one of the following ways:

- If you use the DriverManager interface, set `securityMechanism` in a java.util.Properties object before you invoke the form of the getConnection method that includes the java.util.Properties parameter.
- If you use the DataSource interface, and you are creating and deploying your own DataSource objects, invoke the DataSource.setSecurityMechanism method after you create a DataSource object.

You can determine the security mechanism that is in effect for a connection by calling the DB2Connection.getDB2SecurityMechanism method.

The following table lists the security mechanisms that the IBM Data Server Driver for JDBC and SQLJ supports, and the data sources that support those security mechanisms.

Table 23. Database server support for IBM Data Server Driver for JDBC and SQLJ security mechanisms

Security mechanism	Supported by		
	DB2 Database for Linux, UNIX, and Windows	DB2 for z/OS	IBM Informix Dynamic Server
User ID and password	Yes	Yes	Yes
User ID only	Yes	Yes	Yes
User ID and encrypted password	Yes	Yes	Yes
Encrypted user ID	Yes	Yes	No
Encrypted user ID and encrypted password	Yes	Yes	Yes
Encrypted user ID and encrypted security-sensitive data	No	Yes	No
Encrypted user ID, encrypted password, and encrypted security-sensitive data	Yes	Yes	No
Kerberos[1]	Yes	Yes	No
Plugin[1]	Yes	No	No

Note:

1. Available for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity only.

The following table lists the security mechanisms that the IBM Data Server Driver for JDBC and SQLJ supports, and the value that you need to specify for the `securityMechanism` property to specify each security mechanism.

The default security mechanism is CLEAR_TEXT_PASSWORD_SECURITY. If the server does not support CLEAR_TEXT_PASSWORD_SECURITY but supports ENCRYPTED_USER_AND_PASSWORD_SECURITY, the IBM Data Server Driver

for JDBC and SQLJ driver updates the security mechanism to ENCRYPTED_USER_AND_PASSWORD_SECURITY and attempts to connect to the server. Any other mismatch in security mechanism support between the requester and the server results in an error.

Table 24. Security mechanisms supported by the IBM Data Server Driver for JDBC and SQLJ

Security mechanism	**securityMechanism** property value
User ID and password	DB2BaseDataSource.CLEAR_TEXT_PASSWORD_SECURITY
User ID only	DB2BaseDataSource.USER_ONLY_SECURITY
User ID and encrypted password	DB2BaseDataSource.ENCRYPTED_PASSWORD_SECURITY
Encrypted user ID	DB2BaseDataSource.ENCRYPTED_USER_ONLY_SECURITY
Encrypted user ID and encrypted password	DB2BaseDataSource.ENCRYPTED_USER_AND_PASSWORD_SECURITY
Encrypted user ID and encrypted security-sensitive data	DB2BaseDataSource.ENCRYPTED_USER_AND_DATA_SECURITY
Encrypted user ID, encrypted password, and encrypted security-sensitive data	DB2BaseDataSource.ENCRYPTED_USER_PASSWORD_AND_DATA_SECURITY
Kerberos	DB2BaseDataSource.KERBEROS_SECURITY
Plugin	DB2BaseDataSource.PLUGIN_SECURITY

The following table shows possible DB2 Database for Linux, UNIX, and Windows server authentication types and the compatible IBM Data Server Driver for JDBC and SQLJ securityMechanism property values.

Table 25. Compatible DB2 Database for Linux, UNIX, and Windows server authentication types and IBM Data Server Driver for JDBC and SQLJ securityMechanism values

DB2 Database for Linux, UNIX, and Windows server authentication type	**securityMechanism setting**
CLIENT	USER_ONLY_SECURITY
SERVER	CLEAR_TEXT_PASSWORD_SECURITY
SERVER_ENCRYPT	CLEAR_TEXT_PASSWORD_SECURITY, ENCRYPTED_PASSWORD_SECURITY, or ENCRYPTED_USER_AND_PASSWORD_SECURITY
DATA_ENCRYPT	ENCRYPTED_USER_PASSWORD_AND_DATA_SECURITY
KERBEROS	KERBEROS_SECURITY or PLUGIN_SECURITY[2]
KRB_SERVER_ENCRYPT	KERBEROS_SECURITY , PLUGIN_SECURITY[1], ENCRYPTED_PASSWORD_SECURITY, or ENCRYPTED_USER_AND_PASSWORD_SECURITY
GSSPLUGIN	PLUGIN_SECURITY[1] or KERBEROS_SECURITY
GSS_SERVER_ENCRYPT[3]	CLEAR_TEXT_PASSWORD_SECURITY, ENCRYPTED_PASSWORD_SECURITY, ENCRYPTED_USER_AND_PASSWORD_SECURITY, PLUGIN_SECURITY, or KERBEROS_SECURITY

Notes:

1. For PLUGIN_SECURITY, the plugin must be a Kerberos plugin.
2. For PLUGIN_SECURITY, one of the plugins at the server identifies itself as supporting Kerberos.
3. GSS_SERVER_ENCRYPT is a combination of GSSPLUGIN and SERVER_ENCRYPT.

User ID and password security under the IBM Data Server Driver for JDBC and SQLJ

With the IBM Data Server Driver for JDBC and SQLJ, one of the available security methods is user ID and password security.

To specify user ID and password security for a JDBC connection, use one of the following techniques.

For the DriverManager interface: You can specify the user ID and password directly in the DriverManager.getConnection invocation. For example:

```
import java.sql.*;          // JDBC base
...
String id = "dbadm";        // Set user ID
String pw = "dbadm";        // Set password
String url = "jdbc:db2://mvs1.sj.ibm.com:5021/san_jose";
                            // Set URL for the data source

Connection con = DriverManager.getConnection(url, id, pw);
                            // Create connection
```

Another method is to set the user ID and password directly in the URL string. For example:

```
import java.sql.*;          // JDBC base
...
String url =
  "jdbc:db2://mvs1.sj.ibm.com:5021/san_jose:user=dbadm;password=dbadm;";

                            // Set URL for the data source
Connection con = DriverManager.getConnection(url);
                            // Create connection
```

Alternatively, you can set the user ID and password by setting the `user` and `password` properties in a Properties object, and then invoking the form of the getConnection method that includes the Properties object as a parameter. Optionally, you can set the `securityMechanism` property to indicate that you are using user ID and password security. For example:

```
import java.sql.*;                          // JDBC base
import com.ibm.db2.jcc.*;                   // IBM Data Server Driver for JDBC
                                            // and SQLJ implementation of JDBC
...
Properties properties = new java.util.Properties();
                                            // Create Properties object
properties.put("user", "dbadm");            // Set user ID for the connection
properties.put("password", "dbadm");        // Set password for the connection
properties.put("securityMechanism",
  new String("" + com.ibm.db2.jcc.DB2BaseDataSource.CLEAR_TEXT_PASSWORD_SECURITY +
  ""));
                                            // Set security mechanism to
                                            // user ID and password
String url = "jdbc:db2://mvs1.sj.ibm.com:5021/san_jose";
                                            // Set URL for the data source
Connection con = DriverManager.getConnection(url, properties);
                                            // Create connection
```

For the DataSource interface: you can specify the user ID and password directly in the DataSource.getConnection invocation. For example:

```
import java.sql.*;                          // JDBC base
import com.ibm.db2.jcc.*;                   // IBM Data Server Driver for JDBC
                                            // and SQLJ implementation of JDBC
```

```
...
Context ctx=new InitialContext();         // Create context for JNDI
DataSource ds=(DataSource)ctx.lookup("jdbc/sampledb");
                                          // Get DataSource object
String id = "dbadm";                      // Set user ID
String pw = "dbadm";                      // Set password
Connection con = ds.getConnection(id, pw);
                                          // Create connection
```

Alternatively, if you create and deploy the DataSource object, you can set the user ID and password by invoking the DataSource.setUser and DataSource.setPassword methods after you create the DataSource object. Optionally, you can invoke the DataSource.setSecurityMechanism method property to indicate that you are using user ID and password security. For example:

```
...
com.ibm.db2.jcc.DB2SimpleDataSource ds =       // Create DB2SimpleDataSource object
  new com.ibm.db2.jcc.DB2SimpleDataSource();
ds.setDriverType(4);                           // Set driver type
ds.setDatabaseName("san_jose");                // Set location
ds.setServerName("mvs1.sj.ibm.com");           // Set server name
ds.setPortNumber(5021);                        // Set port number
ds.setUser("dbadm");                           // Set user ID
ds.setPassword("dbadm");                       // Set password
ds.setSecurityMechanism(
  com.ibm.db2.jcc.DB2BaseDataSource.CLEAR_TEXT_PASSWORD_SECURITY);
                                               // Set security mechanism to
                                               // user ID and password
```

User ID-only security under the IBM Data Server Driver for JDBC and SQLJ

With the IBM Data Server Driver for JDBC and SQLJ, one of the available security methods is user-ID only security.

To specify user ID security for a JDBC connection, use one of the following techniques.

For the DriverManager interface: Set the user ID and security mechanism by setting the `user` and `securityMechanism` properties in a Properties object, and then invoking the form of the getConnection method that includes the Properties object as a parameter. For example:

```
import java.sql.*;                     // JDBC base
import com.ibm.db2.jcc.*;              // IBM Data Server Driver
                                       // for JDBC and SQLJ
                                       // implementation of JDBC
...
Properties properties = new Properties();
                                       // Create a Properties object
properties.put("user", "db2adm");      // Set user ID for the connection
properties.put("securityMechanism",
  new String("" + com.ibm.db2.jcc.DB2BaseDataSource.USER_ONLY_SECURITY + ""));
                                       // Set security mechanism to
                                       // user ID only
String url = "jdbc:db2://mvs1.sj.ibm.com:5021/san_jose";
                                       // Set URL for the data source
Connection con = DriverManager.getConnection(url, properties);
                                       // Create the connection
```

For the DataSource interface: If you create and deploy the DataSource object, you can set the user ID and security mechanism by invoking the DataSource.setUser and DataSource.setSecurityMechanism methods after you create the DataSource object. For example:

```
import java.sql.*;                      // JDBC base
import com.ibm.db2.jcc.*;               // IBM Data Server Driver
                                        // for JDBC and SQLJ
                                        // implementation of JDBC
...
com.ibm.db2.jcc.DB2SimpleDataSource db2ds =
  new com.ibm.db2.jcc.DB2SimpleDataSource();
                                        // Create DB2SimpleDataSource object
db2ds.setDriverType(4);                 // Set the driver type
db2ds.setDatabaseName("san_jose");      // Set the location
db2ds.setServerName("mvs1.sj.ibm.com");
                                        // Set the server name
db2ds.setPortNumber(5021);              // Set the port number
db2ds.setUser("db2adm");                // Set the user ID
db2ds.setSecurityMechanism(
  com.ibm.db2.jcc.DB2BaseDataSource.USER_ONLY_SECURITY);
                                        // Set security mechanism to
                                        // user ID only
```

Encrypted password security, encrypted user ID security, or encrypted user ID and encrypted password security under the IBM Data Server Driver for JDBC and SQLJ

IBM Data Server Driver for JDBC and SQLJ supports encrypted password security, encrypted user ID security, or encrypted user ID and encrypted password security for accessing data sources.

If you use encrypted password security, encrypted user ID security, or encrypted user ID and encrypted password security, the IBM Java Cryptography Extension (JCE) needs to be enabled on your client. The IBM JCE is part of the IBM SDK for Java, Version 1.4.2 or later.

You need the IBM JCE to use 256-bit encrypted client/server communication from the IBM Data Server Driver for JDBC and SQLJ driver to DB2 Database for Linux, UNIX, and Windows servers.

You can also use encrypted security-sensitive data in addition to encrypted user ID security or encrypted user ID and encrypted password security. You specify encryption of security-sensitive data through the `ENCRYPTED_USER_AND_DATA_SECURITY` or `ENCRYPTED_USER_PASSWORD_AND_DATA_SECURITY` `securityMechanism` value. `ENCRYPTED_USER_AND_DATA_SECURITY` is valid for connections to DB2 for z/OS servers only.

DB2 for z/OS or DB2 Database for Linux, UNIX, and Windows database servers encrypt the following data when you specify encryption of security-sensitive data:

- SQL statements that are being prepared, executed, or bound into a package
- Input and output parameter information
- Result sets
- LOB data
- XML data
- Results of describe operations

Before you can use encrypted security-sensitive data, the z/OS Integrated Cryptographic Services Facility needs to be installed and enabled on the z/OS operating system.

To specify encrypted user ID or encrypted password security for a JDBC connection, use one of the following techniques.

For the DriverManager interface: Set the user ID, password, and security mechanism by setting the `user`, `password`, and `securityMechanism` properties in a Properties object, and then invoking the form of the getConnection method that includes the Properties object as a parameter. For example, use code like this to set the user ID and encrypted password security mechanism:

```
import java.sql.*;                          // JDBC base
import com.ibm.db2.jcc.*;                   // IBM Data Server Driver for JDBC
                                            // and SQLJ implementation of JDBC
...
Properties properties = new Properties(); // Create a Properties object
properties.put("user", "dbadm");            // Set user ID for the connection
properties.put("password", "dbadm");        // Set password for the connection
properties.put("securityMechanism",
  new String("" + com.ibm.db2.jcc.DB2BaseDataSource.ENCRYPTED_PASSWORD_SECURITY +
  ""));
                                            // Set security mechanism to
                                            // user ID and encrypted password
String url = "jdbc:db2://mvs1.sj.ibm.com:5021/san_jose";
                                            // Set URL for the data source
Connection con = DriverManager.getConnection(url, properties);
                                            // Create the connection
```

For the DataSource interface: If you create and deploy the DataSource object, you can set the user ID, password, and security mechanism by invoking the DataSource.setUser, DataSource.setPassword, and DataSource.setSecurityMechanism methods after you create the DataSource object. For example, use code like this to set the encrypted user ID and encrypted password security mechanism:

```
import java.sql.*;                          // JDBC base
import com.ibm.db2.jcc.*;                   // IBM Data Server Driver for JDBC
                                            // and SQLJ implementation of JDBC
...
com.ibm.db2.jcc.DB2SimpleDataSource ds =
  new com.ibm.db2.jcc.DB2SimpleDataSource();
                                            // Create the DataSource object
ds.setDriverType(4);                        // Set the driver type
ds.setDatabaseName("san_jose");             // Set the location
ds.setServerName("mvs1.sj.ibm.com");
                                            // Set the server name
ds.setPortNumber(5021);                     // Set the port number
ds.setUser("db2adm");                       // Set the user ID
ds.setPassword("db2adm");                   // Set the password
ds.setSecurityMechanism(
  com.ibm.db2.jcc.DB2BaseDataSource.ENCRYPTED_PASSWORD_SECURITY);
                                            // Set security mechanism to
                                            // User ID and encrypted password
```

Kerberos security under the IBM Data Server Driver for JDBC and SQLJ

JDBC support for Kerberos security is available for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity only.

To enable JDBC support for Kerberos security, you also need to enable the following components of your software development kit (SDK) for Java:
- Java Cryptography Extension
- Java Generic Security Service (JGSS)
- Java Authentication and Authorization Service (JAAS)

See the documentation for your SDK for Java for information on how to enable these components.

There are three ways to specify Kerberos security for a connection:
- With a user ID and password
- Without a user ID or password
- With a delegated credential

Kerberos security with a user ID and password

For this case, Kerberos uses the specified user ID and password to obtain a ticket-granting ticket (TGT) that lets you authenticate to the database server.

You need to set the `user`, `password`, `kerberosServerPrincipal`, and `securityMechanism` properties. The `kerberosServerPrincipal` property specifies the principal name that the database server registers with a Kerberos Key Distribution Center (KDC).

For the DriverManager interface: Set the user ID, password, Kerberos server, and security mechanism by setting the `user`, `password`, `kerberosServerPrincipal`, and `securityMechanism` properties in a Properties object, and then invoking the form of the getConnection method that includes the Properties object as a parameter. For example, use code like this to set the Kerberos security mechanism with a user ID and password:

```
import java.sql.*;                          // JDBC base
import com.ibm.db2.jcc.*;                   // IBM Data Server Driver for JDBC
                                            // and SQLJ implementation of JDBC
...
Properties properties = new Properties(); // Create a Properties object
properties.put("user", "db2adm");         // Set user ID for the connection
properties.put("password", "db2adm");     // Set password for the connection
properties.put("kerberosServerPrincipal",
  "sample/srvlsj.ibm.com@SRVLSJ.SJ.IBM.COM");
                                            // Set the Kerberos server
properties.put("securityMechanism",
  new String("" +
  com.ibm.db2.jcc.DB2BaseDataSource.KERBEROS_SECURITY + ""));
                                            // Set security mechanism to
                                            // Kerberos
String url = "jdbc:db2://mvs1.sj.ibm.com:5021/san_jose";
                                            // Set URL for the data source
Connection con = DriverManager.getConnection(url, properties);
                                            // Create the connection
```

For the DataSource interface: If you create and deploy the DataSource object, set the Kerberos server and security mechanism by invoking the DataSource.setKerberosServerPrincipal and `DataSource.setSecurityMechanism` methods after you create the DataSource object. For example:

```
import java.sql.*;                          // JDBC base
import com.ibm.db2.jcc.*;                   // IBM Data Server Driver for JDBC
                                            // and SQLJ implementation of JDBC
...
com.ibm.db2.jcc.DB2SimpleDataSource db2ds =
```

```
  new com.ibm.db2.jcc.DB2SimpleDataSource();
                                        // Create the DataSource object
db2ds.setDriverType(4);                 // Set the driver type
db2ds.setDatabaseName("san_jose");      // Set the location
db2ds.setUser("db2adm");                // Set the user
db2ds.setPassword("db2adm");            // Set the password
db2ds.setServerName("mvs1.sj.ibm.com");
                                        // Set the server name
db2ds.setPortNumber(5021);              // Set the port number
db2ds.setKerberosServerPrincipal(
  "sample/srvlsj.ibm.com@SRVLSJ.SJ.IBM.COM");
                                        // Set the Kerberos server
db2ds.setSecurityMechanism(
  com.ibm.db2.jcc.DB2BaseDataSource.KERBEROS_SECURITY);
                                        // Set security mechanism to
                                        // Kerberos
```

Kerberos security with no user ID or password

For this case, the Kerberos default credentials cache must contain a ticket-granting ticket (TGT) that lets you authenticate to the database server.

You need to set the `kerberosServerPrincipal` and `securityMechanism` properties.

For the DriverManager interface: Set the Kerberos server and security mechanism by setting the `kerberosServerPrincipal` and `securityMechanism` properties in a Properties object, and then invoking the form of the getConnection method that includes the Properties object as a parameter. For example, use code like this to set the Kerberos security mechanism without a user ID and password:

```
import java.sql.*;                      // JDBC base
import com.ibm.db2.jcc.*;               // IBM Data Server Driver for JDBC
                                        // and SQLJ implementation of JDBC
...
Properties properties = new Properties(); // Create a Properties object
properties.put("kerberosServerPrincipal",
  "sample/srvlsj.ibm.com@SRVLSJ.SJ.IBM.COM");
                                        // Set the Kerberos server
properties.put("securityMechanism",
  new String("" +
  com.ibm.db2.jcc.DB2BaseDataSource.KERBEROS_SECURITY + ""));
                                        // Set security mechanism to
                                        // Kerberos
String url = "jdbc:db2://mvs1.sj.ibm.com:5021/san_jose";
                                        // Set URL for the data source
Connection con = DriverManager.getConnection(url, properties);
                                        // Create the connection
```

For the DataSource interface: If you create and deploy the DataSource object, set the Kerberos server and security mechanism by invoking the DataSource.setKerberosServerPrincipal and `DataSource.setSecurityMechanism` methods after you create the DataSource object. For example:

```
import java.sql.*;                      // JDBC base
import com.ibm.db2.jcc.*;               // IBM Data Server Driver for JDBC
                                        // and SQLJ implementation of JDBC
...
DB2SimpleDataSource db2ds =
  new com.ibm.db2.jcc.DB2SimpleDataSource();
                                        // Create the DataSource object
db2ds.setDriverType(4);                 // Set the driver type
db2ds.setDatabaseName("san_jose");      // Set the location
db2ds.setServerName("mvs1.sj.ibm.com");
                                        // Set the server name
db2ds.setPortNumber(5021);              // Set the port number
```

```
db2ds.setKerberosServerPrincipal(
  "sample/srvlsj.ibm.com@SRVLSJ.SJ.IBM.COM");
                                        // Set the Kerberos server
db2ds.setSecurityMechanism(
  com.ibm.db2.jcc.DB2BaseDataSource.KERBEROS_SECURITY);
                                        // Set security mechanism to
                                        // Kerberos
```

Kerberos security with a delegated credential from another principal

For this case, you authenticate to the database server using a delegated credential that another principal passes to you.

You need to set the `kerberosServerPrincipal`, `gssCredential`, and `securityMechanism` properties.

For the DriverManager interface: Set the Kerberos server, delegated credential, and security mechanism by setting the `kerberosServerPrincipal`, and `securityMechanism` properties in a Properties object. Then invoke the form of the getConnection method that includes the Properties object as a parameter. For example, use code like this to set the Kerberos security mechanism without a user ID and password:

```
import java.sql.*;                      // JDBC base
import com.ibm.db2.jcc.*;               // IBM Data Server Driver for JDBC
                                        // and SQLJ implementation of JDBC
...
Properties properties = new Properties(); // Create a Properties object
properties.put("kerberosServerPrincipal",
  "sample/srvlsj.ibm.com@SRVLSJ.SJ.IBM.COM");
                                        // Set the Kerberos server
properties.put("gssCredential",delegatedCredential);
                                        // Set the delegated credential
properties.put("securityMechanism",
  new String("" +
    com.ibm.db2.jcc.DB2BaseDataSource.KERBEROS_SECURITY + ""));
                                        // Set security mechanism to
                                        // Kerberos
String url = "jdbc:db2://mvs1.sj.ibm.com:5021/san_jose";
                                        // Set URL for the data source
Connection con = DriverManager.getConnection(url, properties);
                                        // Create the connection
```

For the DataSource interface: If you create and deploy the DataSource object, set the Kerberos server, delegated credential, and security mechanism by invoking the DataSource.setKerberosServerPrincipal, DataSource.setGssCredential, and DataSource.setSecurityMechanism methods after you create the DataSource object. For example:

```
DB2SimpleDataSource db2ds = new com.ibm.db2.jcc.DB2SimpleDataSource();
                                           // Create the DataSource object
db2ds.setDriverType(4);                    // Set the driver type
db2ds.setDatabaseName("san_jose");         // Set the location
db2ds.setServerName("mvs1.sj.ibm.com");  // Set the server name
db2ds.setPortNumber(5021);                 // Set the port number
db2ds.setKerberosServerPrincipal(
  "sample/srvlsj.ibm.com@SRVLSJ.SJ.IBM.COM");
                                           // Set the Kerberos server
db2ds.setGssCredential(delegatedCredential);
                                           // Set the delegated credential
db2ds.setSecurityMechanism(
```

```
com.ibm.db2.jcc.DB2BaseDataSource.KERBEROS_SECURITY);
                                          // Set security mechanism to
                                          // Kerberos
```

IBM Data Server Driver for JDBC and SQLJ security plugin support

You can create your own authentication mechanisms in the form of loadable libraries, or plugins, that DB2 Database for Linux, UNIX, and Windows loads to perform user authentication. To support development of security plugins in Java, the IBM Data Server Driver for JDBC and SQLJ provides security plugin support.

IBM Data Server Driver for JDBC and SQLJ security plugin support is available for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to DB2 Database for Linux, UNIX, and Windows servers only.

To use plugin security, you need a security plugin on the client and another plugin on the server.

The security plugins need to include the following things:

- A class that extends the com.ibm.db2.jcc.DB2JCCPlugin abstract class

  The com.ibm.db2.jcc.DB2JCCPlugin abstract class is provided with the IBM Data Server Driver for JDBC and SQLJ.
- Within the com.ibm.db2.jcc.DB2JCCPlugin class, a com.ibm.db2.jcc.DB2JCCPlugin.getTicket method

  This method retrieves a Kerberos ticket for a user and returns security context information in a byte array. The information in the byte array is used by the IBM Data Server Driver for JDBC and SQLJ to access the DB2 database server.
- Implementations of several methods that are defined in the org.ietf.jgss.GSSContext and `org.ietf.jgss.GSSCredential` interfaces

  These method implementations need to follow the Generic Security Service Application Program Interface, Version 2 (IETF RFC2743) and Generic Security Service API Version 2: Java-Bindings (IETF RFC2853) specifications. The plugin must implement and call the following methods:

  GSSContext.dispose
  Releases any system resources and cryptographic information that are stored in a context object, and invalidates the context.

  GSSContext.getCredDelegState
  Determines wheter credential delegation is enabled on a context.

  GSSContext.getMutualAuthState
  Determines whether mutual authentication is enabled on the context.

  GSSContext.initSecContext
  Starts the context creation phase, and processes any tokens that are generated by the peer's acceptSecContext method.

  GSSContext.requestCredDeleg
  Requests that the credentials of the initiator are delegated to the acceptor when a context is established.

  GSSContext.requestMutualAuth
  Requests mutual authentication when a context is established.

  GSSCredential.dispose
  Releases any sensitive information that the GSSCredential object contains.

Two Java plugin samples are provided in sqllib/samples/java/jdbc to help you write Java security plugins:

JCCSimpleGSSPlugin.java
An implementation of a GSS-API plugin for the server, which performs user ID and password checking. This sample is a Java version of the C language sample program gssapi_simple.c.

JCCKerberosPlugin.java
A Kerberos security plugin for the client. This sample is a Java version of the C language sample program IBMkrb5.c.

When an application program obtains a connection using JDBC plugin security, it needs to set the following Connection or DataSource properties:

Table 26. Connection or DataSource property settings for Java security plugin use

Property	Setting
com.ibm.db2.jcc.DB2BaseDataSource.user	The user ID under which the Connection is to be obtained
com.ibm.db2.jcc.DB2BaseDataSource.password	The password for the user ID
com.ibm.db2.jcc.DB2BaseDataSource.securityMechanism	com.ibm.db2.jcc.DB2BaseDataSource.PLUGIN_SECURITY
com.ibm.db2.jcc.DB2BaseDataSource.pluginName	The name of the plugin module for a server-side security plugin
com.ibm.db2.jcc.DB2BaseDataSource.plugin	The plugin object for a client-side security plugin

Example: The following code sets the properties for a connection that uses GSS-API plugin security. The connection uses the JCCSimpleGSSPlugin sample plugin on the client side, and the gssapi_simple sample plugin on the server side.

```
java.util.Properties properties = new java.util.Properties();
properties.put("user", "db2admin");
properties.put("password", "admindb2");
properties.put("pluginName", "gssapi_simple");
properties.put("securityMechanism",
  new String(""+com.ibm.db2.jcc.DB2BaseDataSource.PLUGIN_SECURITY+""));
com.ibm.db2.jcc.DB2JCCPlugin plugin =
  new com.ibm.db2.jcc.samples.plugins.JCCSimpleGSSplugin();
properties.put("plugin", plugin);
Connection con = java.sql.DriverManager.getConnection(url,
  properties);
```

IBM Data Server Driver for JDBC and SQLJ trusted context support

The IBM Data Server Driver for JDBC and SQLJ provides methods that allow you to establish and use trusted connections in Java programs.

Trusted connections are supported for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to DB2 Database for Linux, UNIX, and Windows and DB2 for z/OS, and IBM Data Server Driver for JDBC and SQLJ type 2 connectivity to DB2 for z/OS.

A three-tiered application model consists of a database server, a middleware server such as WebSphere Application Server, and end users. With this model, the middleware server is responsible for accessing the database server on behalf of end users. Trusted context support ensures that an end user's database identity and database privileges are used when the middleware server performs any database requests on behalf of that end user.

A trusted context is an object that the database administrator defines that contains a system authorization ID and a set of trust attributes. Currently, for DB2 database servers, a database connection is the only type of context that is supported. The trust attributes identify a set of characteristics of a connection that are required for the connection to be considered a trusted connection. The relationship between a database connection and a trusted context is established when the connection to the database server is first created, and that relationship remains for the life of the database connection.

After a trusted context is defined, and an initial trusted connection to the DB2 database server is made, the middleware server can use that database connection under a different user without reauthenticating the new user at the database server.

To avoid vulnerability to security breaches, an application server that uses these trusted methods should not use untrusted connection methods.

The DB2ConnectionPoolDataSource class provides several versions of the getDB2TrustedPooledConnection method, and the DB2XADataSource class provides several versions of the getDB2TrustedXAConnection method, which allow an application server to establish the initial trusted connection. You choose a method based on the types of connection properties that you pass and whether you use Kerberos security. When an application server calls one of these methods, the IBM Data Server Driver for JDBC and SQLJ returns an Object[] array with two elements:

- The first element contains a connection instance for the initial connection.
- The second element contains a unique cookie for the connection instance. The cookie is generated by the JDBC driver and is used for authentication during subsequent connection reuse.

The DB2PooledConnection class provides several versions of the getDB2Connection method, and the DB2Connection class provides several versions of the reuseDB2Connection method, which allow an application server to reuse an existing trusted connection on behalf of a new user. The application server uses the method to pass the following items to the new user:

- The cookie from the initial connection
- New connection properties for the reused connection

The JDBC driver checks that the supplied cookie matches the cookie of the underlying trusted physical connection, to ensure that the connection request originates from the application server that established the trusted physical connection. If the cookies match, the connection becomes available for immediate use by this new user, with the new properties.

Example: Obtain the initial trusted connection:

```
// Create a DB2ConnectionPoolDataSource instance
com.ibm.db2.jcc.DB2ConnectionPoolDataSource dataSource =
  new com.ibm.db2.jcc.DB2ConnectionPoolDataSource();
// Set properties for this instance
dataSource.setDatabaseName ("STLEC1");
dataSource.setServerName ("v7ec167.svl.ibm.com");
dataSource.setDriverType (4);
dataSource.setPortNumber(446);
java.util.Properties properties = new java.util.Properties();
// Set other properties using
// properties.put("property", "value");
// Supply the user ID and password for the connection
```

```
String user = "user";
String password = "password";
// Call getDB2TrustedPooledConnection to get the trusted connection
// instance and the cookie for the connection
Object[] objects = dataSource.getDB2TrustedPooledConnection(
                         user,password, properties);
```

Example: Reuse an existing trusted connection:

```
// The first item that was obtained from the previous getDB2TrustedPooledConnection
// call is a connection object. Cast it to a PooledConnection object.
javax.sql.PooledConnection pooledCon =
  (javax.sql.PooledConnection)objects[0];
properties = new java.util.Properties();
// Set new properties for the reused object using
// properties.put("property", "value");
// The second item that was obtained from the previous getDB2TrustedPooledConnection
// call is the cookie for the connection. Cast it as a byte array.
byte[] cookie = ((byte[])(objects[1]);
// Supply the user ID for the new connection.
String newuser = "newuser";
// Supply the name of a mapping service that maps a workstation user
// ID to a z/OS RACF ID
String userRegistry = "registry";
// Do not supply any security token data to be traced.
byte[] userSecTkn = null;
// Do not supply a previous user ID.
String originalUser = null;
// Call getDB2Connection to get the connection object for the new
// user.
java.sql.Connection con =
  ((com.ibm.db2.jcc.DB2PooledConnection)pooledCon).getDB2Connection(
     cookie,newuser,password,userRegistry,userSecTkn,originalUser,properties);
```

IBM Data Server Driver for JDBC and SQLJ support for SSL

The IBM Data Server Driver for JDBC and SQLJ provides support for the Security Socket Layer (SSL) through the Java Secure Socket Extension (JSSE).

You can use SSL support in your Java applications if you use IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to DB2 for z/OS Version 9.1 or later, or to DB2 Database for Linux, UNIX, and Windows Version 9.1, Fix Pack 2 or later.

In the IBM Data Server Driver for JDBC and SQLJ, you enable SSL support by setting the DB2BaseDataSource.sslConnection property to `true`. This causes the IBM Data Server Driver for JDBC and SQLJ to use an SSL socket to connect to DB2 database servers.

Before a client application can use SSL, the user of the client application needs to:

- Get a certificate from the security administrator of the host system, and use the Java keytool utility to import the certificate into a truststore.

  For example, supposed that a certificate has been retrieved from a DB2 database server and stored in a file named jcc.cacert. Issue the following keytool utility statement to read the certificate from file jcc.cacert, and store it in a truststore named cacerts.

  ```
  keytool -import -file jcc.cacert -keystore cacerts
  ```

- Set the following Java system properties:

  javax.net.ssl.trustStore
  Specifies the truststore.

javax.net.ssl.trustStorePassword
Specifies the truststore password.

The IBM Data Server Driver for JDBC and SQLJ can use the IBM FIPS-compliant provider for SSL, or the SunJSSE provider. To use the IBM Data Server Driver for JDBC and SQLJ in FIPS-compliant mode, use the FIPS-approved providers IBMJSSEFIPSProvider and IBMJCEFIPS, or enable FIPS mode in the IBMJSSE2 provider.

To use the IBMJSSEFIPSProvider and IBMJCEFIPS providers, in the `java.security` file, add the following lines:

```
security.provider.n=com.ibm.fips.jsse.IBMJSSEFIPSProvider
security.provider.n=com.ibm.crypto.fips.provider.IBMJCEFIPS

ssl.SocketFactory.provider=com.ibm.fips.jsse.JSSESocketFactory
ssl.ServerSocketFactory.provider= com.ibm.fips.jsse.JSSEServerSocketFactory
```

n is the preference order. The previously specified providers need to have a higher preference order (lower value *n*) than the non-FIPS providers in the `java.security` file.

To enable FIPS mode in the IBMJSSE2 provider, follow these steps:

1. Set the `IBMJSSE2` FIPS system property to enable FIPS mode:
   ```
   com.ibm.jsse2.JSSEFIPS=true
   ```
2. Set security properties to ensure that all JSSE code uses the IBMJSSE2 provider:
   ```
   ssl.SocketFactory.provider=com.ibm.jsse2.SSLSocketFactoryImpl
   ssl.SocketFactory.provider=com.ibm.jsse2.SSLServerSocketFactoryImpl
   ```
3. Add the IBMJCEFIPS cryptographic provider.
   To do that, add com.ibm.crypto.fips.provider.IBMJCEFIPS to the provider list before the IBMJCE provider. Do not remove the IBMJCE provider. The IBMJCE provider is required for keystore support.

No changes to applications are needed for the IBMJSSE2 provider to run in FIPS mode.

Restrictions:

- Non-FIPS-mode JSSE applications cannot run in a JVM that is in FIPS mode.
- When the IBMJSSE2 provider runs in FIPS mode, it cannot use hardware cryptography.

Security for preparing SQLJ applications with the IBM Data Server Driver for JDBC and SQLJ

Two ways to provide security during SQLJ application preparation are to allow users to customize applications only, and to limit access to a specific set of tables during customization.

Allowing users to customize only

You can use one of the following techniques to allow a set of users to customize SQLJ applications, but not to bind or run those applications:

- **Create a database system for customization only (recommended solution):** Follow these steps:

1. Create a new database manager instance. This is the customization-only system.
2. On the customization-only system, define all the tables and views that are accessed by the SQLJ applications. The table or view definitions must be the same as the definitions on the database manager instance where the application will be bound and will run (the bind-and-run system). Executing the DESCRIBE statement on the tables or views must give the same results on the customization-only system and the bind-and-run system.
3. On the customization-only system, grant the necessary table or view privileges to users who will customize SQLJ applications.
4. On the customization-only system, users run the sqlj command with the -compile=true option to create Java byte codes and serialized profiles for their programs. Then they run the db2sqljcustomize command with the -automaticbind NO option to create customized serialized profiles.
5. Copy the java byte code files and customized serialized profiles to the bind-and-run system.
6. A user with authority to bind packages on the bind-and-run system runs the db2sqljbind command on the customized serialized profiles that were copied from the customization-only system.

- **Use a stored procedure to do customization:** Write a Java stored procedure that customizes serialized profiles and binds packages for SQLJ applications on behalf of the end user. This Java stored procedure needs to use a JDBC driver package that was bound with one of the DYNAMICRULES options that causes dynamic SQL to be performed under a different user ID from the end user's authorization ID. For example, you might use the DYNAMICRULES option DEFINEBIND or DEFINERUN to execute dynamic SQL under the authorization ID of the creator of the Java stored procedure. You need to grant EXECUTE authority on the stored procedure to users who need to do SQLJ customization.

  The stored does the following things:

  1. Receives the compiled SQLJ program and serialized profiles in BLOB input parameters
  2. Copies the input parameters to its file system
  3. Runs db2sqljcustomize to customize the serialized profiles and bind the packages for the SQLJ program
  4. Returns the customized serialized profiles in output parameters
- **Use a stand-alone program to do customization:** This technique involves writing a program that performs the same steps as a Java stored procedure that customizes serialized profiles and binds packages for SQLJ applications on behalf of the end user. However, instead of running the program as a stored procedure, you run the program as a stand-alone program under a library server.

Restricting table access during customization

When you customize serialized profiles, you should do online checking, to give the application program information about the data types and lengths of table columns that the program accesses. By default, customization includes online checking.

Online checking requires that the user who customizes a serialized profile has authorization to execute PREPARE and DESCRIBE statements against SQL statements in the SQLJ program. That authorization includes the SELECT privilege on tables and views that are accessed by the SQL statements. If SQL statements contain unqualified table names, the qualifier that is used during online checking

is the value of the db2sqljcustomize -qualifier parameter. Therefore, for online checking of tables and views with unqualified names in an SQLJ application, you can grant the SELECT privilege only on tables and views with a qualifier that matches the value of the -qualifier parameter.

Chapter 6. Security under the DB2 JDBC Type 2 Driver

The DB2 JDBC Type 2 Driver for Linux, UNIX and Windows (DB2 JDBC Type 2 Driver) supports user ID and password security.

You must set the user ID and the password, or set neither. If you do not set a user ID and password, the driver uses the user ID and password of the user who is currently logged on to the operating system.

To specify user ID and password security for a JDBC connection, use one of the following techniques.

For the DriverManager interface: you can specify the user ID and password directly in the DriverManager.getConnection invocation. For example:

```
import java.sql.*;        // JDBC base
...
String id = "db2adm";      // Set user ID
Sring pw = "db2adm";       // Set password
String url = "jdbc:db2:toronto";
                           // Set URL for the data source
Connection con = DriverManager.getConnection(url, id, pw);
                           // Create connection
```

Alternatively, you can set the user ID and password by setting the `user` and `password` properties in a Properties object, and then invoking the form of the getConnection method that includes the Properties object as a parameter. For example:

```
import java.sql.*;                          // JDBC base
import COM.ibm.db2.jdbc.*;                  // DB2 JDBC Type 2 driver
                                            // implementation of JDBC
...
Properties properties = new java.util.Properties();
                                            // Create Properties object
properties.put("user", "db2adm");           // Set user ID for the connection
properties.put("password", "db2adm");       // Set password for the connection
String url = "jdbc:db2:toronto";
                                            // Set URL for the data source
Connection con = DriverManager.getConnection(url, properties);
                                            // Create connection
```

For the DataSource interface: you can specify the user ID and password directly in the DataSource.getConnection invocation. For example:

```
import java.sql.*;                          // JDBC base
import COM.ibm.db2.jdbc.*;                  // DB2 JDBC Type 2 driver
                                            // implementation of JDBC
...
Context ctx=new InitialContext();           // Create context for JNDI
DataSource ds=(DataSource)ctx.lookup("jdbc/sampledb");
                                            // Get DataSource object
String id = "db2adm";                       // Set user ID
Sring pw = "db2adm";                        // Set password
Connection con = ds.getConnection(id, pw);
                                            // Create connection
```

Alternatively, if you create and deploy the DataSource object, you can set the user ID and password by invoking the DataSource.setUser and DataSource.setPassword methods after you create the DataSource object. For example:

```
import java.sql.*;                          // JDBC base
import COM.ibm.db2.jdbc.*;                  // DB2 JDBC Type 2 driver
                                            // implementation of JDBC
...
DB2DataSource db2ds = new DB2DataSource();
                                              // Create DataSource object
db2ds.setDatabaseName("toronto");             // Set location
db2ds.setUser("db2adm");                      // Set user ID
db2ds.setPassword("db2adm");                  // Set password
```

Chapter 7. Building Java database applications

You can build JDBC and SQLJ database applications manually. Alternatively, you can use a Java makefile to build JDBC applications, and use the bldsqlj build file that is shipped with DB2 Database for Linux, UNIX, and Windows to build SQLJ applications.

Building JDBC applets

You can use a Java `makefile` or manually execute the javac command to build JDBC applications.

The following steps demonstrate how to build and run the `Applt.java` sample JDBC applet.

1. Compile `Applt.java` to produce the file `Applt.class` with this command:
   ```
   javac Applt.java
   ```
2. Ensure that your working directory is accessible by your web browser, or by your Java applet viewer, if you are using it. If your directory is not accessible, copy the following files into a directory that is accessible:
   - Applt.html
   - Applt.class
3. Copy `sqllib\java\db2jcc.jar` on Windows or `sqllib/java/db2jcc.jar` on UNIX, into the same directory as `Applt.class` and `Applt.html`.

   If you are using any JDBC 4.0 functions, copy db2jcc4.jar instead of db2jcc.jar.
4. If you are using the IBM Data Server Driver for JDBC and SQLJ, connect with that driver by modifying the `Applt.html` file according to the instructions in the file. For the TCP/IP port number, you should use the database port number 50000.
5. To run this applet, either ensure that a web server is installed and running on your DB2 machine (server or client), or you can use the applet viewer that comes with the SDK for Java by entering the following command in the working directory of your client machine:
   ```
   appletviewer Applt.html
   ```

Building JDBC applications

You can use a Java `makefile` or manually execute the javac command to build JDBC applications.

The following steps demonstrate how to build and run the `DbInfo` sample JDBC application.

1. Compile `DbInfo.java` to produce the file `DbInfo.class` with this command:
   ```
   javac DbInfo.java
   ```
2. If you are running a Java application on UNIX in a 64-bit DB2 instance but the software development kit for Java is 32-bit, you need to change the DB2 library path before running the application. For example, on AIX:
   - If using bash or Korn shell:
     ```
     export LIBPATH=$HOME/sqllib/lib32
     ```
   - If using C shell:
     ```
     setenv LIBPATH $HOME/sqllib/lib32
     ```

3. Run the Java interpreter on the application with this command:

   ```
   java DbInfo
   ```

Building JDBC routines

You can use a Java `makefile` or the javac command to build JDBC routines. After you build those routines, you need to catalog them.

The following steps demonstrate how to build and run these routines:

- The `SpServer` sample JDBC stored procedure
- The `UDFsrv` sample user-defined function, which has no SQL statements
- The `UDFsqlsv` sample user-defined function, which has SQL statements
- To build and run the SpServer.java stored procedure on the server, from the command line:
  1. Compile SpServer.java to produce the file SpServer.class with this command:

     ```
     javac SpServer.java
     ```

  2. Copy `SpServer.class` to the `sqllib\function` directory on Windows operating systems, or to the `sqllib/function` directory on UNIX.
  3. Catalog the routines by running the spcat script on the server. The spcat script connects to the sample database, uncatalogs the routines if they were previously cataloged by calling SpDrop.db2, then catalogs them by calling SpCreate.db2, and finally disconnects from the database. You can also run the SpDrop.db2 and SpCreate.db2 scripts individually.
  4. Stop and restart the database to allow the new class file to be recognized. If necessary, set the file mode for the class file to ″read″ so it is readable by the fenced user.
  5. Compile and run the `SpClient` client application to access the stored procedure class.
- To build and run the `UDFsrv.java` user-defined function program (user-defined function with no SQL statements) on the server, from the command line:
  1. Compile `UDFsrv.java` to produce the file UDFsrv.class with this command:

     ```
     javac UDFsrv.java
     ```

  2. Copy `UDFsrv.class` to the `sqllib\function` directory on Windows operating systems, or to the `sqllib/function` directory on UNIX.
  3. Compile and run a client program that calls UDFsrv.

     To access the `UDFsrv` library, you can use the UDFcli.java JDBC application, or the UDFcli.sqlj SQLJ client application. Both versions of the client program contain the CREATE FUNCTION SQL statement that you use to register the user-defined functions with the database, and also contain SQL statements that use the user-defined functions.
- To build and run the `UDFsqlsv.java` user-defined function program (user-defined function with SQL statements) on the server, from the command line:
  1. Compile `UDFsqlsv.java` to produce the file `UDFsqlsv.class` with this command:

     ```
     javac UDFsqlsv.java
     ```

  2. Copy `UDFsqlsv.class` to the `sqllib\function` directory on Windows operating systems, or to the `sqllib/function` directory on UNIX.
  3. Compile and run a client program that calls UDFsqlsv.

     To access the `UDFsqlsv` library, you can use the `UDFsqlcl.java` JDBC application. The client program contains the CREATE FUNCTION SQL

statement that you use to register the user-defined functions with the database, and also contains SQL statements that use the user-defined functions.

Building SQLJ applets

You can use a Java `makefile` or the `bldsqlj` build file to build SQLJ applets.

The following steps demonstrate how to build and run the `Applt` sample SQLJ applet. These steps use the build file, `bldsqlj` (UNIX), or `bldsqlj.bat` (Windows), which contains commands to build either an SQLJ applet or application.

The build file takes up to six parameters: $1, $2, $3, $4, $5, and $6 on UNIX, and %1, %2, %3, %4, %5, and %6 on Windows. The first parameter specifies the name of your program. The second parameter specifies the user ID for the database instance, the third parameter specifies the password. The fourth parameter specifies the server name. The fifth parameter specifies the port number. And the sixth parameter specifies the database name. For all but the first parameter, program name, default values can be used. See the build file for details about using default parameter values.

1. Build the applet with this command:
   ```
   bldsqlj Applt <userid> <password> <server_name> <port_number> <db_name>
   ```
2. Ensure that your working directory is accessible by your web browser, or by your Java applet viewer, if you are using it. If your directory is not accessible, copy the following files into a directory that is accessible:
   - Applt.html
   - Applt.class
   - Applt_Cursor1.class
   - Applt_Cursor2.class
   - Applt_SJProfileKeys.class
   - Applt_SJProfile0.ser
3. Copy `sqllib\java\db2jcc.jar` on Windows or `sqllib/java/db2jcc.jar` on UNIX, into the same directory as `Applt.class` and `Applt.html`.

   If you are using any JDBC 4.0 functions, copy db2jcc4.jar instead of db2jcc.jar.
4. If you are using the IBM Data Server Driver for JDBC and SQLJ, connect with that driver by modifying the `Applt.html` file according to the instructions in the file. For the TCP/IP port number, you should use the database port number 50000.
5. To run this applet, either ensure that a web server is installed and running on your DB2 machine (server or client), or you can use the applet viewer that comes with the SDK for Java by entering the following command in the working directory of your client machine:
   ```
   appletviewer Applt.html
   ```

Building SQLJ applications

You can use a Java `makefile` or the `bldsqlj` build file to build SQLJ applications.

The following steps demonstrate how to build and run the `TbMod` sample SQLJ application. These steps use the build file, `bldsqlj` (UNIX), or `bldsqlj.bat` (Windows), which contains commands to build either an SQLJ applet or application.

The build file takes up to six parameters: $1, $2, $3, $4, $5, and $6 on UNIX, and %1, %2, %3, %4, %5, and %6 on Windows. The first parameter specifies the name of your program. The second parameter specifies the user ID for the database instance, the third parameter specifies the password. The fourth parameter specifies the server name. The fifth parameter specifies the port number. And the sixth parameter specifies the database name. For all but the first parameter, program name, default values can be used. See the build file for details about using default parameter values.

1. Build the application with this command:
   ```
   bldsqlj TbMod <userid> <password> <server_name> <port_number> <db_name>
   ```
2. If you are running a Java application on UNIX in a 64-bit DB2 instance but the software development kit for Java is 32-bit, you need to change the DB2 library path before running the application. For example, on AIX:
   - If using bash or Korn shell:
     ```
     export LIBPATH=$HOME/sqllib/lib32
     ```
   - If using C shell:
     ```
     setenv LIBPATH $HOME/sqllib/lib32
     ```
3. Run the Java interpreter on the application with this command:
   ```
   java TbMod
   ```
4. And finally, this.

Here's an example... Insert tab A into slot B.

Now, you too can do this...

Java applet considerations

DB2 databases can be accessed by using Java applets.

Keep the following points in mind when using them:

- For a larger JDBC or SQLJ applet that consists of several Java classes, you might choose to package all its classes in a single JAR file. For an SQLJ applet, you would also have to package its serialized profiles along with its classes. If you choose to do this, add your JAR file into the `archive` parameter in the "applet" tag. For details, see the documentation for your software development kit for Java.

  For SQLJ applets, some browsers do not yet have support for loading a serialized object from a resource file associated with the applet. For example, you will get the following error message when trying to load the supplied sample applet `Applt` in those browsers:
  ```
  java.lang.ClassNotFoundException: Applt_SJProfile0
  ```

  As a workaround, there is a utility which converts a serialized profile into a profile stored in Java class format. The utility is a Java class called sqlj.runtime.profile.util.SerProfileToClass. It takes a serialized profile resource file as input and produces a Java class containing the profile as output. Your profile can be converted using one of the following commands:
  ```
  profconv Applt_SJProfile0.ser
  ```

  or
  ```
  java sqlj.runtime.profile.util.SerProfileToClass Applt_SJProfile0.ser
  ```

The class Applt_SJProfile0.class is created as a result. Replace all profiles in `.ser` format used by the applet with profiles in `.class` format, and the problem should go away.

- You can place the file `db2jcc.jar` into a directory that is shared by several applets that might be loaded from your Web site. `db2jcc.jar` is for applets using the IBM Data Server Driver for JDBC and SQLJ or for any SQLJ applet. This file is in the `sqllib\java` directory on Windows operating systems, and in the `sqllib/java` directory on UNIX. You might need to add a `codebase` parameter into the "applet" tag in the HTML file to identify the directory. For details, see the documentation for your software development kit for Java.

  If you are using any JDBC 4.0 functions, copy db2jcc4.jar instead of db2jcc.jar.
- The JDBC applet server (listener), `db2jd`, contains signal handling to make it more robust. As a result, you cannot use the CTRL-C key sequence to terminate `db2jd`. Therefore, the only way to terminate the listener is to kill the process by using `kill -9` (for UNIX) or the Task Manager (for Windows).

SQLJ application and applet options for UNIX

The `bldsqlj` build script builds SQLJ applications and applets on UNIX operating systems. `bldsqlj` specifies a set of SQLJ translator and customizer options.

Recommendation: Use the same SQLJ translator and customizer options that `bldsqlj` uses when you build your SQLJ applications and applets on UNIX platforms.

The options that `bldsqlj` includes are:

sqlj The SQLJ translator (also compiles the program).

"${progname}.sqlj"
The SQLJ source file. The `progname=${1%.sqlj}` command removes the extension if it was included in the input file name, so when the extension is added back again, it is not duplicated.

db2sqljcustomize
The SQLJ profile customizer.

-url Specifies a JDBC URL for establishing a database connection, such as `jdbc:db2://servername:50000/sample`.

-user Specifies a user ID.

-password
Specifies a password.

"${progname}_SJProfile0"
Specifies a serialized profile for the program.

SQLJ application and applet options for Windows

The `bldsqlj.bat` batch file builds SQLJ applications and applets on Windows operating systems. `bldsqlj.bat` specifies a set of SQLJ translator and customizer options.

Recommendation: Use the same SQLJ translator and customizer options that `bldsqlj.bat` uses when you build your SQLJ applications and applets on Windows operating systems.

The options that `bldsqlj.bat` includes are:

sqlj The SQLJ translator (also compiles the program).

%1.sqlj
The SQLJ source file.

db2sqljcustomize
The SQLJ profile customizer.

-url Specifies a JDBC URL for establishing a database connection, such as `jdbc:db2://servername:50000/sample`.

-user Specifies a user ID.

-password
Specifies a password.

%1_SJProfile0
Specifies a serialized profile for the program.

Building SQL routines

You can use a Java `makefile` or the `bldsqljs` build file to build SQLJ routines. After you build those routines, you need to catalog them.

The following steps demonstrate how to build and run the `SpServer` sample SQLJ stored procedure. These steps use the build file, `bldsqljs` (UNIX), or `bldsqljs.bat` (Windows), which contains commands to build either an SQLJ applet or application.

The build file takes up to six parameters: $1, $2, $3, $4, $5, and $6 on UNIX, and %1, %2, %3, %4, %5, and %6 on Windows. The first parameter specifies the name of your program. The second parameter specifies the user ID for the database instance, the third parameter specifies the password. The fourth parameter specifies the server name. The fifth parameter specifies the port number. And the sixth parameter specifies the database name. For all but the first parameter, program name, default values can be used. See the build file for details about using default parameter values.

1. Build the stored procedure application with this command:
   ```
   bldsqljs SpServer <userid> <password> <server_name> <port_number> <db_name>
   ```
2. Catalog the stored procedure with this command:
   ```
   spcat
   ```
   This script connects to the sample database, uncatalogs the routines if they were previously cataloged by calling SpDrop.db2, then catalogs them by calling SpCreate.db2, and finally disconnects from the database. You can also run the SpDrop.db2 and SpCreate.db2 scripts individually.
3. Stop and restart the database to allow the new class file to be recognized. If necessary, set the file mode for the class file to read, so it is readable by the fenced user.
4. Compile and run the `SpClient` client application to access the stored procedure class. You can build `SpClient` with the application build file, `bldsqlj` (UNIX) or `bldsqlj.bat` (Windows).

SQLJ routine options for UNIX

The `bldsqljs` build script builds SQLJ routines on UNIX operating systems. `bldsqljs` specifies a set of SQLJ translator and customizer options.

Recommendation: Use the same SQLJ translator and customizer options that `bldsqljs` uses when you build your SQLJ routines on UNIX platforms.

The options that `bldsqljs` includes are:

sqlj The SQLJ translator (also compiles the program).

"${progname}.sqlj"
The SQLJ source file. The `progname=${1%.sqlj}` command removes the extension if it was included in the input file name, so when the extension is added back again, it is not duplicated.

db2sqljcustomize
The SQLJ profile customizer.

-url Specifies a JDBC URL for establishing a database connection, such as `jdbc:db2://servername:50000/sample`.

-user Specifies a user ID.

-password
Specifies a password.

"${progname}_SJProfile0"
Specifies a serialized profile for the program.

SQLJ routine options for Windows

The `bldsqljs.bat` batch file builds SQLJ routines on Windows operating systems. `bldsqljs.bat` specifies a set of SQLJ translator and customizer options.

Recommendation: Use the same SQLJ translator and customizer options that `bldsqljs.bat` uses when you build your SQLJ routines on Windows operating systems.

The following SQLJ translator and customizer options are used in the `bldsqljs.bat` batch file on Windows operating systems. These are the options DB2 recommends that you use to build SQLJ routines (stored procedures and user-defined functions).

sqlj The SQLJ translator (also compiles the program).

%1.sqlj
The SQLJ source file.

db2sqljcustomize
The DB2 for Java profile customizer.

-url Specifies a JDBC URL for establishing a database connection, such as `jdbc:db2://servername:50000/sample`.

-user Specifies a user ID.

-password
Specifies a password.

%1_SJProfile0
Specifies a serialized profile for the program.

Chapter 8. Problem diagnosis with the IBM Data Server Driver for JDBC and SQLJ

To obtain data for diagnosing SQLJ or JDBC problems with the IBM Data Server Driver for JDBC and SQLJ, collect trace data and run utilities that format the trace data.

You should run the trace and diagnostic utilities only under the direction of IBM software support.

Collecting JDBC trace data

Use one of the following procedures to start the trace:

Procedure 1: For IBM Data Server Driver for JDBC and SQLJ type 4 connectivity or IBM Data Server Driver for JDBC and SQLJ type 2 connectivity for DB2 for Linux, UNIX and Windows , the recommended method is to start the trace by setting the db2.jcc.override.traceFile property or the db2.jcc.override.traceDirectory property in the IBM Data Server Driver for JDBC and SQLJ configuration properties file.

Procedure 2:

1. If you use the DataSource interface to connect to a data source, invoke the DB2BaseDataSource.setTraceLevel method to set the type of tracing that you need. The default trace level is `TRACE_ALL`. See ″Properties for the IBM Data Server Driver for JDBC and SQLJ″ for information on how to specify more than one type of tracing.
2. Invoke the DB2BaseDataSource.setJccLogWriter method to specify the trace destination and turn the trace on.

Procedure 3:

If you use the DataSource interface to connect to a data source, invoke the javax.sql.DataSource.setLogWriter method to turn the trace on. With this method, `TRACE_ALL` is the only available trace level.

If you use the DriverManager interface to connect to a data source, follow this procedure to start the trace.

1. Invoke the DriverManager.getConnection method with the `traceLevel` property set in the *info* parameter or *url* parameter for the type of tracing that you need. The default trace level is `TRACE_ALL`. See ″Properties for the IBM Data Server Driver for JDBC and SQLJ″ for information on how to specify more than one type of tracing.
2. Invoke the DriverManager.setLogWriter method to specify the trace destination and turn the trace on.

After a connection is established, you can turn the trace off or back on, change the trace destination, or change the trace level with the DB2Connection.setJccLogWriter method. To turn the trace off, set the logWriter value to `null`.

The logWriter property is an object of type java.io.PrintWriter. If your application cannot handle java.io.PrintWriter objects, you can use the `traceFile` property to specify the destination of the trace output. To use the `traceFile` property, set the

logWriter property to `null`, and set the `traceFile` property to the name of the file to which the driver writes the trace data. This file and the directory in which it resides must be writable. If the file already exists, the driver overwrites it.

Procedure 4: If you are using the DriverManager interface, specify the `traceFile` and `traceLevel` properties as part of the URL when you load the driver. For example:

```
String url = "jdbc:db2://sysmvs1.stl.ibm.com:5021/san_jose" +
 ":traceFile=/u/db2p/jcctrace;" +
 "traceLevel=" + com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DRDA_FLOWS + ";";
```

Procedure 5: Use DB2TraceManager methods. The DB2TraceManager class provides the ability to suspend and resume tracing of any type of log writer.

Example of starting a trace using configuration properties: For a complete example of using configuration parameters to collect trace data, see ″Example of using configuration properties to start a JDBC trace″.

Trace example program: For a complete example of a program for tracing under the IBM Data Server Driver for JDBC and SQLJ, see ″Example of a trace program under the IBM Data Server Driver for JDBC and SQLJ″.

Collecting SQLJ trace data during customization or bind

To collect trace data to diagnose problems during the SQLJ customization or bind process, specify the -tracelevel and -tracefile options when you run the db2sqljcustomize or db2sqljbind bind utility.

Formatting information about an SQLJ serialized profile

The `profp` utility formats information about each SQLJ clause in a serialized profile. The format of the `profp` utility is:

Run the `profp` utility on the serialized profile for the connection in which the error occurs. If an exception is thrown, a Java stack trace is generated. You can determine which serialized profile was in use when the exception was thrown from the stack trace.

Formatting information about an SQLJ customized serialized profile

The `db2sqljprint` utility formats information about each SQLJ clause in a serialized profile that is customized for the IBM Data Server Driver for JDBC and SQLJ.

Run the `db2sqljprint` utility on the customized serialized profile for the connection in which the error occurs.

Example of using configuration properties to start a JDBC trace

You can control tracing of JDBC applications without modifying those applications.

Suppose that you want to collect trace data for a program named Test.java, which uses IBM Data Server Driver for JDBC and SQLJ type 4 connectivity. Test.java does no tracing, and you do not want to modify the program, so you enable tracing using configuration properties. You want your trace output to have the following characteristics:

- Trace information for each connection on the same DataSource is written to a separate trace file. Output goes into a directory named /Trace.
- Each trace file name begins with jccTrace1.
- If trace files with the same names already exist, the trace data is appended to them.

Although Test1.java does not contain any code to do tracing, you want to set the configuration properties so that if the application is modified in the future to do tracing, the settings within the program will take precedence over the settings in the configuration properties. To do that, use the set of configuration properties that begin with db2.jcc, not db2.jcc.override.

The configuration property settings look like this:
- db2.jcc.traceDirectory=/Trace
- db2.jcc.traceFile=jccTrace1
- db2.jcc.traceFileAppend=true

You want the trace settings to apply only to your stand-alone program Test1.java, so you create a file with these settings, and then refer to the file when you invoke the Java program by specifying the -Ddb2.jcc.propertiesFile option. Suppose that the file that contains the settings is /Test/jcc.properties. To enable tracing when you run Test1.java, you issue a command like this:

```
java -Ddb2.jcc.propertiesFile=/Test/jcc.properties Test1
```

Suppose that Test1.java creates two connections for one DataSource. The program does not define a logWriter object, so the driver creates a global logWriter object for the trace output. When the program completes, the following files contain the trace data:
- /Trace/jccTrace1_global_0
- /Trace/jccTrace1_global_1

Example of a trace program under the IBM Data Server Driver for JDBC and SQLJ

You might want to write a single class that includes methods for tracing under the DriverManager interface, as well as the DataSource interface.

The following example shows such a class. The example uses IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

Figure 57. Example of tracing under the IBM Data Server Driver for JDBC and SQLJ

```
public class TraceExample
{

  public static void main(String[] args)
  {
    sampleConnectUsingSimpleDataSource();
    sampleConnectWithURLUsingDriverManager();
  }
```

```
private static void sampleConnectUsingSimpleDataSource()
{
  java.sql.Connection c = null;
  java.io.PrintWriter printWriter =
   new java.io.PrintWriter(System.out, true);
                                     // Prints to console, true means
                                     // auto-flush so you don't lose trace
  try {
    javax.sql.DataSource ds =
     new com.ibm.db2.jcc.DB2SimpleDataSource();
    ((com.ibm.db2.jcc.DB2BaseDataSource) ds).setServerName("sysmvs1.stl.ibm.com");
    ((com.ibm.db2.jcc.DB2BaseDataSource) ds).setPortNumber(5021);
    ((com.ibm.db2.jcc.DB2BaseDataSource) ds).setDatabaseName("san_jose");
    ((com.ibm.db2.jcc.DB2BaseDataSource) ds).setDriverType(4);

   ds.setLogWriter(printWriter);    // This turns on tracing

   // Refine the level of tracing detail
   ((com.ibm.db2.jcc.DB2BaseDataSource) ds).
    setTraceLevel(com.ibm.db2.jcc.DB2SimpleDataSource.TRACE_CONNECTS |
    com.ibm.db2.jcc.DB2SimpleDataSource.TRACE_DRDA_FLOWS);

   // This connection request is traced using trace level
   // TRACE_CONNECTS | TRACE_DRDA_FLOWS
   c = ds.getConnection("myname", "mypass");

   // Change the trace level to TRACE_ALL
   // for all subsequent requests on the connection
   ((com.ibm.db2.jcc.DB2Connection) c).setJccLogWriter(printWriter,
    com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL);
   // The following INSERT is traced using trace level TRACE_ALL
   java.sql.Statement s1 = c.createStatement();
   s1.executeUpdate("INSERT INTO sampleTable(sampleColumn) VALUES(1)");
   s1.close();

   // This code disables all tracing on the connection
   ((com.ibm.db2.jcc.DB2Connection) c).setJccLogWriter(null);

   // The following INSERT statement is not traced
   java.sql.Statement s2 = c.createStatement();
   s2.executeUpdate("INSERT INTO sampleTable(sampleColumn) VALUES(1)");
   s2.close();

   c.close();
  }
  catch(java.sql.SQLException e) {
   com.ibm.db2.jcc.DB2ExceptionFormatter.printTrace(e,
    printWriter, "[TraceExample]");
  }
  finally {
    cleanup(c, printWriter);
    printWriter.flush();
  }
}

// If the code ran successfully, the connection should
// already be closed. Check whether the connection is closed.
// If so, just return.
// If a failure occurred, try to roll back and close the connection.

private static void cleanup(java.sql.Connection c,
 java.io.PrintWriter printWriter)
{
  if(c == null) return;

  try {
   if(c.isClosed()) {
```

```
      printWriter.println("[TraceExample] " +
       "The connection was successfully closed");
      return;
    }

    // If we get to here, something has gone wrong.
    // Roll back and close the connection.
    printWriter.println("[TraceExample] Rolling back the connection");
    try {
      c.rollback();
    }
    catch(java.sql.SQLException e) {
      printWriter.println("[TraceExample] " +
       "Trapped the following java.sql.SQLException while trying to roll back:");
      com.ibm.db2.jcc.DB2ExceptionFormatter.printTrace(e, printWriter,
       "[TraceExample]");
      printWriter.println("[TraceExample] " +
       "Unable to roll back the connection");
     }
     catch(java.lang.Throwable e) {
       printWriter.println("[TraceExample] Trapped the " +
        "following java.lang.Throwable while trying to roll back:");
       com.ibm.db2.jcc.DB2ExceptionFormatter.printTrace(e,
        printWriter, "[TraceExample]");
       printWriter.println("[TraceExample] Unable to " +
        "roll back the connection");
     }

     // Close the connection
     printWriter.println("[TraceExample] Closing the connection");
     try {
       c.close();
     }
     catch(java.sql.SQLException e) {
       printWriter.println("[TraceExample] Exception while " +
        "trying to close the connection");
       printWriter.println("[TraceExample] Deadlocks could " +
        "occur if the connection is not closed.");
       com.ibm.db2.jcc.DB2ExceptionFormatter.printTrace(e, printWriter,
        "[TraceExample]");
     }
     catch(java.lang.Throwable e) {
       printWriter.println("[TraceExample] Throwable caught " +
        "while trying to close the connection");
       printWriter.println("[TraceExample] Deadlocks could " +
        "occur if the connection is not closed.");
       com.ibm.db2.jcc.DB2ExceptionFormatter.printTrace(e, printWriter,
        "[TraceExample]");
     }
   }
   catch(java.lang.Throwable e) {
     printWriter.println("[TraceExample] Unable to " +
      "force the connection to close");
     printWriter.println("[TraceExample] Deadlocks " +
      "could occur if the connection is not closed.");
     com.ibm.db2.jcc.DB2ExceptionFormatter.printTrace(e, printWriter,
      "[TraceExample]");
   }
}
private static void sampleConnectWithURLUsingDriverManager()
{
  java.sql.Connection c = null;

  // This time, send the printWriter to a file.
  java.io.PrintWriter printWriter = null;
  try {
    printWriter =
```

```
    new java.io.PrintWriter(
      new java.io.BufferedOutputStream(
        new java.io.FileOutputStream("/temp/driverLog.txt"), 4096), true);
}
catch(java.io.FileNotFoundException e) {
  java.lang.System.err.println("Unable to establish a print writer for trace");
  java.lang.System.err.flush();
  return;
}

try {
  Class.forName("com.ibm.db2.jcc.DB2Driver");
}
catch(ClassNotFoundException e) {
  printWriter.println("[TraceExample] " +
   "IBM Data Server Driver for JDBC and SQLJ type 4 connectivity " +
   "is not in the application classpath. Unable to load driver.");
  printWriter.flush();
  return;
}

// This URL describes the target data source for Type 4 connectivity.
// The traceLevel property is established through the URL syntax,
// and driver tracing is directed to file "/temp/driverLog.txt"
// The traceLevel property has type int. The constants
// com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DRDA_FLOWS and
// com.ibm.db2.jcc.DB2BaseDataSource.TRACE_CONNECTS represent
// int values. Those constants cannot be used directly in the
// first getConnection parameter. Resolve the constants to their
// int values by assigning them to a variable. Then use the
// variable as the first parameter of the getConnection method.
String databaseURL =
 "jdbc:db2://sysmvs1.stl.ibm.com:5021" +
 "/sample:traceFile=/temp/driverLog.txt;traceLevel=" +
 (com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DRDA_FLOWS |
 com.ibm.db2.jcc.DB2BaseDataSource.TRACE_CONNECTS) + ";";

// Set other properties
java.util.Properties properties = new java.util.Properties();
properties.setProperty("user", "myname");
properties.setProperty("password", "mypass");

try {
 // This connection request is traced using trace level
 // TRACE_CONNECTS | TRACE_DRDA_FLOWS
 c = java.sql.DriverManager.getConnection(databaseURL, properties);

 // Change the trace level for all subsequent requests
 // on the connection to TRACE_ALL
 ((com.ibm.db2.jcc.DB2Connection) c).setJccLogWriter(printWriter,
  com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL);

 // The following INSERT is traced using trace level TRACE_ALL
 java.sql.Statement s1 = c.createStatement();
 s1.executeUpdate("INSERT INTO sampleTable(sampleColumn) VALUES(1)");
 s1.close();

 // Disable all tracing on the connection
 ((com.ibm.db2.jcc.DB2Connection) c).setJccLogWriter(null);

  // The following SQL insert code is not traced
  java.sql.Statement s2 = c.createStatement();
  s2.executeUpdate("insert into sampleTable(sampleColumn) values(1)");
  s2.close();

  c.close();
}
```

```
    catch(java.sql.SQLException e) {
     com.ibm.db2.jcc.DB2ExceptionFormatter.printTrace(e, printWriter,
      "[TraceExample]");
    }
    finally {
      cleanup(c, printWriter);
      printWriter.flush();
    }
  }
}
```

Chapter 9. System monitoring for the IBM Data Server Driver for JDBC and SQLJ

To assist you in monitoring the performance of your applications with the IBM Data Server Driver for JDBC and SQLJ, the driver provides two methods to collect information for a connection.

That information is:

Core driver time
The sum of elapsed monitored API times that were collected while system monitoring was enabled, in microseconds. In general, only APIs that might result in network I/O or database server interaction are monitored.

Network I/O time
The sum of elapsed network I/O times that were collected while system monitoring was enabled, in microseconds.

Server time
The sum of all reported database server elapsed times that were collected while system monitoring was enabled, in microseconds.

Currently, IBM Informix Dynamic Server databases do not support this function.

Application time
The sum of the application, JDBC driver, network I/O, and database server elapsed times, in milliseconds.

The two methods are:

- The DB2SystemMonitor interface
- The TRACE_SYSTEM_MONITOR trace level

To collect system monitoring data using the DB2SystemMonitor interface: Perform these basic steps:

1. Invoke the DB2Connection.getDB2SystemMonitor method to create a DB2SystemMonitor object.
2. Invoke the DB2SystemMonitor.enable method to enable the DB2SystemMonitor object for the connection.
3. Invoke the DB2SystemMonitor.start method to start system monitoring.
4. When the activity that is to be monitored is complete, invoke DB2SystemMonitor.stop to stop system monitoring.
5. Invoke the DB2SystemMonitor.getCoreDriverTimeMicros, DB2SystemMonitor.getNetworkIOTimeMicros, `DB2SystemMonitor.getServerTimeMicros`, or DB2SystemMonitor.getApplicationTimeMillis methods to retrieve the elapsed time data.

For example, the following code demonstrates how to collect each type of elapsed time data. The numbers to the right of selected statements correspond to the previously described steps.

```
import java.sql.*;
import com.ibm.db2.jcc.*;
public class TestSystemMonitor
{
  public static void main(String[] args)
  {
    String url = "jdbc:db2://sysmvs1.svl.ibm.com:5021/san_jose";
    String user="db2adm";
    String password="db2adm";
    try
    {
      // Load the IBM Data Server Driver for JDBC and SQLJ
      Class.forName("com.ibm.db2.jcc.DB2Driver");
      System.out.println("**** Loaded the JDBC driver");

      // Create the connection using the IBM Data Server Driver for JDBC and SQLJ
      Connection conn = DriverManager.getConnection (url,user,password);
      // Commit changes manually
      conn.setAutoCommit(false);
      System.out.println("**** Created a JDBC connection to the data source");
      DB2SystemMonitor systemMonitor =                                    1
        ((DB2Connection)conn).getDB2SystemMonitor();
      systemMonitor.enable(true);                                         2
      systemMonitor.start(DB2SystemMonitor.RESET_TIMES);                  3
      Statement stmt = conn.createStatement();
      int numUpd = stmt.executeUpdate(
        "UPDATE EMPLOYEE SET PHONENO='4657' WHERE EMPNO='000010'");
      systemMonitor.stop();                                               4
      System.out.println("Server elapsed time (microseconds)="
        + systemMonitor.getServerTimeMicros());                           5
      System.out.println("Network I/O elapsed time (microseconds)="
        + systemMonitor.getNetworkIOTimeMicros());
      System.out.println("Core driver elapsed time (microseconds)="
        + systemMonitor.getCoreDriverTimeMicros());
      System.out.println("Application elapsed time (milliseconds)="
        + systemMonitor.getApplicationTimeMillis());
      conn.rollback();
      stmt.close();
      conn.close();
    }
    // Handle errors
    catch(ClassNotFoundException e)
    {
      System.err.println("Unable to load the driver, " + e);
    }
    catch(SQLException e)
    {
      System.out.println("SQLException: " + e);
      e.printStackTrace();
    }
  }
}
```

Figure 58. Example of using DB2SystemMonitor methods to collect system monitoring data

To collect system monitoring information using the trace method: Start a JDBC trace, using configuration properties or Connection or DataSource properties. Include TRACE_SYSTEM_MONITOR when you set the traceLevel property. For example:

```
String url = "jdbc:db2://sysmvs1.stl.ibm.com:5021/san_jose" +
 ":traceFile=/u/db2p/jcctrace;" +
 "traceLevel=" + com.ibm.db2.jcc.DB2BaseDataSource.TRACE_SYSTEM_MONITOR + ";";
```

The trace records with system monitor information look similar to this:

```
[jcc][SystemMonitor:start]
...
[jcc][SystemMonitor:stop] core: 565.67ms | network: 211.695ms | server: 207.771ms
```

IBM Data Server Driver for JDBC and SQLJ remote trace controller

The IBM Data Server Driver for JDBC and SQLJ provides a facility for controlling IBM Data Server Driver for JDBC and SQLJ traces dynamically.

This remote trace controller lets you perform operations like these for multiple driver instances:

- Start, stop, or resume a trace
- Change the output trace file or directory location
- Change the trace level

The remote trace controller uses the Java Management Extensions (JMX) architecture, which is part of the Java Standard Edition, Version 6, or later. The JMX consists of:

- A set of built-in management utilities, which let you do monitoring from a management console such as the Java Monitoring and Management Console (JConsole).
- A set of APIs that let you write applications to perform the same functions.

Enabling the remote trace controller

Enabling the remote trace controller involves enabling Java Management Extensions (JMX) in the IBM Data Server Driver for JDBC and SQLJ, and making the JMX agent available to clients.

The remote trace controller requires Java Standard Edition, Version 6 or later.

The steps for enabling the remote trace controller are:

1. Enable JMX to the IBM Data Server Driver for JDBC and SQLJ by setting the db2.jcc.jmxEnabled global configuration property to true or yes.

   For example, include this string in DB2JccConfiguration.properties:

   ```
   db2.jcc.jmxEnabled=true
   ```

2. Make the JMX agent (the platform MBean server) available to local or remote clients.
   - For local clients:

     Monitoring and management capabilities are automatically made available when the JVM is started. After your application is started, you can use a JMX client such as JConsole to connect locally to your Java process.
   - For remote clients, use one of the following methods:
     - Use the out-of-the-box JMX agent.

       Out-of-the-box management uses JMX built-in management utilities. To enable out-of-the-box management, you need to set a number of Java system properties. You must at least set the following property:

       ```
       com.sun.management.jmxremote.port=portNum
       ```

       In addition, you should ensure that authentication and SSL are properly configured.

       Full information on enabling out-of-the-box management is at the following URL:

       ```
       http://java.sun.com/javase/6/docs/technotes/guides/management/agent.html
       ```

– Write a JMX agent. This technique is also discussed at:

  http://java.sun.com/javase/6/docs/technotes/guides/management/agent.html

  In the following example, an RMI connector server is created for the PlatformMBeanServer using the MyCustomJMXAuthenticator object. The MyCustomJMXAuthenticator class defines how remote credentials are converted into a JAAS Subject by implementing the JMXAuthenticator interface:

```
...
HashMap<String> env = new HashMap<String>();
env.put(JMXConnectorServer.AUTHENTICATOR, new MyCustomJMXAuthenticator());
env.put("jmx.remote.x.access.file", "my.access.file");

MBeanServer mbs =
  java.lang.management.ManagementFactory.getPlatformMBeanServer();
JMXServiceURL url =
  new JMXServiceURL("service:jmx:rmi:///jndi/rmi://:9999/jmxrmi");

JMXConnectorServer cs =
  JMXConnectorServerFactory.newJMXConnectorServer(url, env, mbs);
cs.start();
...
public class MyCustomJMXAuthenticator implements JMXAuthenticator {

  public Subject authenticate(Object credentials) {
    // the hash contains username, password, etc...
    Hashtable <String> credentialsHash
      = (Hashtable <String>) credentials;

    ...
    // Authenticate using the provided credentials
    ...
    if (authentication-successful) {
      return new Subject(true,
        Collections.singleton
          (new JMXPrincipal(credentialsHash.get("username"))),
        Collections.EMPTY_SET,
        Collections.EMPTY_SET);
    }
    throw new SecurityException("Invalid credentials");
  }
}
```

Accessing the remote trace controller

You can access the remote trace controller through out-of-the-box management tools, or through an application.

You use out-of-the-box management through a JMX-compliant management client, such as JConsole, which is part of Java Standard Edition, Version 6. Information on using JConsole for out-of-the-box management is at the following URL:

http://java.sun.com/javase/6/docs/technotes/guides/management/jconsole.html

In an application that accesses the remote trace controller, the remote trace controller is a managed bean (MBean). JMX manages resources through JMX agents. A JMX agent is an MBean server. Each MBean represents a resource. Every MBean has a name, which you define through an object of class javax.management.ObjectName. You use the ObjectName object to register and retrieve MBeans in the MBeanServer.

The MBean name has two parts: the domain and the key properties. For the ObjectName for the IBM Data Server Driver for JDBC and SQLJ remote trace controller, the domain is com.ibm.db2.jcc, and the key properties are name=DB2TraceManager.

An application that accesses the remote trace controller must include these steps:

1. Establish a Remote Method Invocation (RMI) connection to an MBean server.
2. Perform a lookup on the remote trace controller in the MBean server.
3. Invoke trace operations on the MBean.

   You can operate on the MBean in the following ways:

   - Using an MBean proxy
   - Without a proxy, through an MBeanServerConnection.

Example: accessing the remote trace controller without proxies: This example demonstrates accessing MBeans directly from an MBeanServerConnection. This method is the most generic because it does not require matching interface definitions on the JMX client application.

```
Hashtable<String> env = new Hashtable<String>();
env.put(Context.INITIAL_CONTEXT_FACTORY,
 "com.sun.jndi.fscontext.RefFSContextFactory");

try {
  System.out.println ("");
  System.out.println ("-------------------------------------------------");
  System.out.println ("Establish an RMI connection to an MBeanServer");
  System.out.println ("-------------------------------------------------");
  JMXServiceURL url =
    new JMXServiceURL ("service:jmx:rmi:///jndi/rmi://localhost:9999/jmxrmi");
  JMXConnector jmxc = JMXConnectorFactory.connect (url, env);
  MBeanServerConnection mbsc = jmxc.getMBeanServerConnection();

  System.out.println ("");
  System.out.println ("-------------------------------------------------");
  System.out.println ("Processing MBean");
  System.out.println ("-------------------------------------------------");
  String objectNameString = "com.ibm.db2.jcc:name=DB2TraceManager";
  ObjectName name = new ObjectName(objectNameString);
  System.out.println ("ObjectName="+objectNameString);

  System.out.println ("");
  System.out.println ("-------------------------------------------------");
  System.out.println ("Print all attributes of the MBean");
  System.out.println ("-------------------------------------------------");

  System.out.println(
    "TraceDirectory  = "+mbsc.getAttribute (name, "TraceDirectory"));
  System.out.println(
    "TraceFile       = "+mbsc.getAttribute (name, "TraceFile"));
  System.out.println(
    "TraceFileAppend = "+mbsc.getAttribute (name, "TraceFileAppend"));
  System.out.println(
    "TraceLevel      = "+mbsc.getAttribute (name, "TraceLevel"));

  System.out.println ("");
  System.out.println ("-------------------------------------------------");
  System.out.println ("Invoke some operations on the MBean");
  System.out.println ("-------------------------------------------------");
  System.out.print ("Invoking suspendTrace()...");
  mbsc.invoke (name, "suspendTrace", null , null);
  System.out.println ("success");

  System.out.print ("Invoking resumeTrace()...");
```

```
  mbsc.invoke (name, "resumeTrace", null , null);
  System.out.println ("success");
}
catch (Exception e) {
  System.out.println ("failure");
  e.printStackTrace ();
}
```

Example: accessing the remote trace controller with proxies: This example demonstrates the creation of a proxy to an MBean. The proxy implements the com.ibm.db2.jcc.mx.DB2TraceManagerMXBean interface. The application makes calls directly on the proxy, and the underlying proxy implementation invokes the MBean operation on the remote MBean server.

```
Hashtable<String> env = new Hashtable<String>();
env.put(Context.INITIAL_CONTEXT_FACTORY,
 "com.sun.jndi.fscontext.RefFSContextFactory");

try {
  System.out.println ("");
  System.out.println ("-------------------------------------------------");
  System.out.println ("Establish an RMI connection to an MBeanServer");
  System.out.println ("-------------------------------------------------");
  JMXServiceURL url =
    new JMXServiceURL ("service:jmx:rmi:///jndi/rmi://localhost:9999/jmxrmi");
  JMXConnector jmxc = JMXConnectorFactory.connect (url, env);
  MBeanServerConnection mbsc = jmxc.getMBeanServerConnection();

  System.out.println ("");
  System.out.println ("-------------------------------------------------");
  System.out.println ("Processing MBean");
  System.out.println ("-------------------------------------------------");
  String objectNameString = "com.ibm.db2.jcc:name=DB2TraceManager";
  ObjectName name = new ObjectName(objectNameString);
  System.out.println ("ObjectName="+objectNameString);

  System.out.println ("");
  System.out.println ("-------------------------------------------------");
  System.out.println ("Print all attributes of the MBean");
  System.out.println ("-------------------------------------------------");
  com.ibm.db2.jcc.mx.DB2TraceManagerMXBean mbeanProxy =
    JMX.newMBeanProxy(mbsc, name,
      com.ibm.db2.jcc.mx.DB2TraceManagerMXBean.class, true);
  System.out.println ("TraceDirectory  = "+mbeanProxy.getTraceDirectory ());
  System.out.println ("TraceFile       = "+mbeanProxy.getTraceFile ());
  System.out.println ("TraceFileAppend = "+mbeanProxy.getTraceFileAppend ());
  System.out.println ("TraceLevel      = "+mbeanProxy.getTraceLevel ());
  System.out.println ("");
  System.out.println ("-------------------------------------------------");
  System.out.println ("Invoke some operations on the MBean");
  System.out.println ("-------------------------------------------------");
  System.out.print ("Invoking suspendTrace()...");
  mbeanProxy.suspendTrace();
  System.out.println ("success");
  System.out.print ("Invoking resumeTrace()...");
  mbeanProxy.resumeTrace();
  System.out.println ("success");
}
catch (Exception e) {
  System.out.println ("failure");
  e.printStackTrace ();
}
```

Chapter 10. Java 2 Platform, Enterprise Edition

The Java 2 Platform, Enterprise Edition (J2EE), reduces the cost and complexity of developing these multi-tier services, resulting in services that can be rapidly deployed and easily enhanced based on the requirements of the enterprise.

In today's global business environment, organizations need to extend their reach, lower their costs, and lower their response times by providing services that are easily accessible to their customers, employees, suppliers, and other business partners. These services need to have the following characteristics:

- Highly available, to meet the requirements of global business environment
- Secure, to protect the privacy of the users and the integrity of the enterprise
- Reliable and scalable, so that business transactions are accurately and promptly processed

In most cases, these services are provided with the help of multi-tier applications with each tier serving a specific purpose.

J2EE achieves these benefits by defining a standard architecture that is delivered as the following elements:

- J2EE Application Model, a standard application model for developing multi-tier, thin-client services
- J2EE Platform, a standard platform for hosting J2EE applications
- J2EE Compatibility Test Suite for verifying that a J2EE platform product complies with the J2EE platform standard
- J2EE Reference Implementation for demonstrating the capabilities of J2EE, and for providing an operational definition of the J2EE platform

Application components of Java 2 Platform, Enterprise Edition support

The Java 2 Platform, Enterprise Edition (J2EE) provides the runtime environment for hosting J2EE applications.

The runtime environment defines four application component types that a J2EE product must support:

- Application clients are Java programming language programs that are typically GUI programs that execute on a desktop computer. Application clients have access to all of the facilities of the J2EE middle tier.
- Applets are GUI components that typically execute in a web browser, but can execute in a variety of other applications or devices that support the applet programming model.
- Servlets, JavaServer Pages (JSPs), filters, and web event listeners typically execute in a web server and might respond to HTTP requests from web clients. Servlets, JSPs, and filters can be used to generate HTML pages that are an application's user interface. They can also be used to generate XML or other format data that is consumed by other application components. Servlets, pages created with the JSP technology, web filters, and web event listeners are referred to collectively in this specification as *web components*. Web applications are composed of web components and other data such as HTML pages.

- Enterprise JavaBeans™ (EJB) components execute in a managed environment that supports transactions. Enterprise beans typically contain the business logic for a J2EE application.

The application components listed above can divided into three categories, based on how they can be deployed and managed:

- Components that are deployed, managed, and executed on a J2EE server.
- Components that are deployed, managed on a J2EE server, but are loaded to and executed on a client machine.
- Components whose deployment and management are not completely defined by this specification. Application clients can be under this category.

The runtime support for these components is provided by *containers*.

Java 2 Platform, Enterprise Edition containers

A container provides a federated view of the underlying Java 2 Platform, Enterprise Edition (J2EE) APIs to the application components.

A typical J2EE product will provide a container for each application component type; application client container, applet container, web container, and enterprise bean container. The container tools also understand the file formats for packaging the application components for deployment.

The specification requires that these containers provide a Java-compatible runtime environment. This specification defines a set of standard services that each J2EE product must support. These standard services are:

- HTTP service
- HTTPS service
- Java transaction API
- Remote invocation method
- Java IDL
- JDBC API
- Java message service
- Java naming and directory interface
- JavaMail
- JavaBeans activation framework
- Java API for XML parsing
- Connector architecture
- Java authentication and authorization service

Java 2 Platform, Enterprise Edition Server

Underlying a Java 2 Platform, Enterprise Edition (J2EE) container is the server of which the container is a part.

A J2EE Product Provider typically implements the J2EE server-side functionality. The J2EE client functionality is typically built on J2SE technology.

The IBM WebSphere Application Server is a J2EE-compliant server.

Java 2 Platform, Enterprise Edition database requirements

Java 2 Platform, Enterprise Edition requires a database, accessible through the JDBC API, for the storage of business data.

The database is accessible from web components, enterprise beans, and application client components. The database need not be accessible from applets.

Java Naming and Directory Interface (JNDI)

JNDI enables Java platform-based applications to access multiple naming and directory services.

It is a part of the Java Enterprise application programming interface (API) set. JNDI makes it possible for developers to create portable applications that are enabled for a number of different naming and directory services, including: file systems; directory services such as Lightweight Directory Access Protocol (LDAP) and Novell Directory Services, and distributed object systems such as the Common Object Request Broker Architecture (CORBA), Java Remote Method Invocation (RMI), and Enterprise JavaBeans (EJB).

The JNDI API has two parts: an application-level interface used by the application components to access naming and directory services and a service provider interface to attach a provider of a naming and directory service.

Java transaction management

Java 2 Platform, Enterprise Edition (J2EE) simplifies application programming for distributed transaction management.

J2EE includes support for distributed transactions through two specifications, Java Transaction API (JTA) and Java Transaction Service (JTS). JTA is a high-level, implementation-independent, protocol-independent API that allows applications and application servers to access transactions. In addition, the JTA is always enabled.

The IBM Data Server Driver for JDBC and SQLJ and the DB2 JDBC Type 2 Driver for Linux, UNIX and Windows implement the JTA and JTS specifications.

For IBM Data Server Driver for JDBC and SQLJ type 4 connectivity distributed transactions are supported to DB2 Database for Linux, UNIX, and Windows, DB2 for z/OS, and DB2 for i5/OS servers.

JTA specifies standard Java interfaces between a transaction manager and the parties involved in a distributed transaction system: the resource manager, the application server, and the transactional applications.

JTS specifies the implementation of a Transaction Manager which supports JTA and implements the Java mapping of the OMG Object Transaction Service (OTS) 1.1 specification at the level below the API. JTS propagates transactions using IIOP.

JTA and JTS allow application J2EE servers to take the burden of transaction management off of the component developer. Developers can define the transactional properties of EJB technology based components during design or deployment using declarative statements in the deployment descriptor. The application server takes over the transaction management responsibilities.

In the DB2 and WebSphere Application Server environment, WebSphere Application Server assumes the role of transaction manager, and DB2 acts as a resource manager. WebSphere Application Server implements JTS and part of JTA,

and the JDBC drivers also implement part of JTA so that WebSphere Application Server and DB2 can provide coordinated distributed transactions.

It is not necessary to configure DB2 to be JTA-enabled in the WebSphere Application Server environment because the JDBC drivers automatically detect this environment.

The DB2 JDBC Type 2 Driver provides these two DataSource classes:
- COM.ibm.db2.jdbc.DB2ConnectionPoolDataSource
- COM.ibm.db2.jdbc.DB2XADataSource

The IBM Data Server Driver for JDBC and SQLJ provides these two DataSource classes:
- com.ibm.db2.jcc.DB2ConnectionPoolDataSource
- com.ibm.db2.jcc.DB2XADataSource

WebSphere Application Server provides pooled connections to databases. If the application will be involved in a distributed transaction, the com.ibm.db2.jdbc.DB2XADataSource class should be used when defining DB2 data sources within the WebSphere Application Server.

For the detail information about how to configure the WebSphere Application Server with DB2, refer to WebSphere Application Server InfoCenter at:

`http://www.ibm.com/software/webservers/appserv/library.html`

Example of a distributed transaction that uses JTA methods

Distributed transactions typically involve multiple connections to the same data source or different data sources, which can include data sources from different manufacturers.

The best way to demonstrate distributed transactions is to contrast them with local transactions. With local transactions, a JDBC application makes changes to a database permanent and indicates the end of a unit of work in one of the following ways:
- By calling the Connection.commit or Connection.rollback methods after executing one or more SQL statements
- By calling the Connection.setAutoCommit(true) method at the beginning of the application to commit changes after every SQL statement

Figure 59 outlines code that executes local transactions.

```
con1.setAutoCommit(false);  // Set autocommit off
// execute some SQL
...
con1.commit();              // Commit the transaction
// execute some more SQL
...
con1.rollback();            // Roll back the transaction
con1.setAutoCommit(true);   // Enable commit after every SQL statement
...
// Execute some more SQL, which is automatically committed after
// every SQL statement.
```

Figure 59. Example of a local transaction

In contrast, applications that participate in distributed transactions cannot call the Connection.commit, Connection.rollback, or Connection.setAutoCommit(true) methods within the distributed transaction. With distributed transactions, the

Connection.commit or Connection.rollback methods do not indicate transaction boundaries. Instead, your applications let the application server manage transaction boundaries.

Figure 60 demonstrates an application that uses distributed transactions. While the code in the example is running, the application server is also executing other EJBs that are part of this same distributed transaction. When all EJBs have called utx.commit(), the entire distributed transaction is committed by the application server. If any of the EJBs are unsuccessful, the application server rolls back all the work done by all EJBs that are associated with the distributed transaction.

```
javax.transaction.UserTransaction utx;
// Use the begin method on a UserTransaction object to indicate
// the beginning of a distributed transaction.
utx.begin();
...
// Execute some SQL with one Connection object.
// Do not call Connection methods commit or rollback.
...
// Use the commit method on the UserTransaction object to
// drive all transaction branches to commit and indicate
// the end of the distributed transaction.

utx.commit();
...
```

Figure 60. Example of a distributed transaction under an application server

Figure 61 illustrates a program that uses JTA methods to execute a distributed transaction. This program acts as the transaction manager and a transactional application. Two connections to two different data sources do SQL work under a single distributed transaction.

Figure 61. Example of a distributed transaction that uses the JTA

```
class XASample
{
  javax.sql.XADataSource xaDS1;
  javax.sql.XADataSource xaDS2;
  javax.sql.XAConnection xaconn1;
  javax.sql.XAConnection xaconn2;
  javax.transaction.xa.XAResource xares1;
  javax.transaction.xa.XAResource xares2;
  java.sql.Connection conn1;
  java.sql.Connection conn2;

  public static void main (String args []) throws java.sql.SQLException
  {
    XASample xat = new XASample();
    xat.runThis(args);
  }
  // As the transaction manager, this program supplies the global
  // transaction ID and the branch qualifier. The global
  // transaction ID and the branch qualifier must not be
  // equal to each other, and the combination must be unique for
  // this transaction manager.
  public void runThis(String[] args)
  {
    byte[] gtrid = new byte[] { 0x44, 0x11, 0x55, 0x66 };
    byte[] bqual = new byte[] { 0x00, 0x22, 0x00 };
    int rc1 = 0;
    int rc2 = 0;
```

```
    try
    {

      javax.naming.InitialContext context = new javax.naming.InitialContext();
      /*
        * Note that javax.sql.XADataSource is used instead of a specific
        * driver implementation such as com.ibm.db2.jcc.DB2XADataSource.
        */
      xaDS1 = (javax.sql.XADataSource)context.lookup("checkingAccounts");
      xaDS2 = (javax.sql.XADataSource)context.lookup("savingsAccounts");

      // The XADatasource contains the user ID and password.
      // Get the XAConnection object from each XADataSource
      xaconn1 = xaDS1.getXAConnection();
      xaconn2 = xaDS2.getXAConnection();

      // Get the java.sql.Connection object from each XAConnection
      conn1 = xaconn1.getConnection();
      conn2 = xaconn2.getConnection();

      // Get the XAResource object from each XAConnection
      xares1 = xaconn1.getXAResource();
      xares2 = xaconn2.getXAResource();
      // Create the Xid object for this distributed transaction.
      // This example uses the com.ibm.db2.jcc.DB2Xid implementation
      // of the Xid interface. This Xid can be used with any JDBC driver
      // that supports JTA.
      javax.transaction.xa.Xid xid1 =
                              new com.ibm.db2.jcc.DB2Xid(100, gtrid, bqual);

      // Start the distributed transaction on the two connections.
      // The two connections do NOT need to be started and ended together.
      // They might be done in different threads, along with their SQL operations.
      xares1.start(xid1, javax.transaction.xa.XAResource.TMNOFLAGS);
      xares2.start(xid1, javax.transaction.xa.XAResource.TMNOFLAGS);
...
      // Do the SQL operations on connection 1.
      // Do the SQL operations on connection 2.
...
      // Now end the distributed transaction on the two connections.
      xares1.end(xid1, javax.transaction.xa.XAResource.TMSUCCESS);
      xares2.end(xid1, javax.transaction.xa.XAResource.TMSUCCESS);

      // If connection 2 work had been done in another thread,
      // a thread.join() call would be needed here to wait until the
      // connection 2 work is done.

      try
      { // Now prepare both branches of the distributed transaction.
        // Both branches must prepare successfully before changes
        // can be committed.
        // If the distributed transaction fails, an XAException is thrown.
        rc1 = xares1.prepare(xid1);
        if(rc1 == javax.transaction.xa.XAResource.XA_OK)
        { // Prepare was successful. Prepare the second connection.
          rc2 = xares2.prepare(xid1);
          if(rc2 == javax.transaction.xa.XAResource.XA_OK)
          { // Both connections prepared successfully and neither was read-only.
            xares1.commit(xid1, false);
            xares2.commit(xid1, false);
          }
          else if(rc2 == javax.transaction.xa.XAException.XA_RDONLY)
          { // The second connection is read-only, so just commit the
            // first connection.
            xares1.commit(xid1, false);
          }
```

```
    }
    else if(rc1 == javax.transaction.xa.XAException.XA_RDONLY)
    { // SQL for the first connection is read-only (such as a SELECT).
      // The prepare committed it. Prepare the second connection.
      rc2 = xares2.prepare(xid1);
      if(rc2 == javax.transaction.xa.XAResource.XA_OK)
      { // The first connection is read-only but the second is not.
        // Commit the second connection.
        xares2.commit(xid1, false);
      }
      else if(rc2 == javax.transaction.xa.XAException.XA_RDONLY)
      { // Both connections are read-only, and both already committed,
        // so there is nothing more to do.
      }
    }
  }      catch (javax.transaction.xa.XAException xae)
  { // Distributed transaction failed, so roll it back.
    // Report XAException on prepare/commit.
    System.out.println("Distributed transaction prepare/commit failed. " +
                       "Rolling it back.");
    System.out.println("XAException error code = " + xae.errorCode);
    System.out.println("XAException message = " + xae.getMessage());
    xae.printStackTrace();
    try
    {
      xares1.rollback(xid1);
    }
    catch (javax.transaction.xa.XAException xae1)
    { // Report failure of rollback.
      System.out.println("distributed Transaction rollback xares1 failed");
      System.out.println("XAException error code = " + xae1.errorCode);
      System.out.println("XAException message = " + xae1.getMessage());
    }
    try
    {
      xares2.rollback(xid1);
    }
    catch (javax.transaction.xa.XAException xae2)
    { // Report failure of rollback.
      System.out.println("distributed Transaction rollback xares2 failed");
      System.out.println("XAException error code = " + xae2.errorCode);
      System.out.println("XAException message = " + xae2.getMessage());
    }
  }

  try
  {
    conn1.close();
    xaconn1.close();
  }
  catch (Exception e)
  {
    System.out.println("Failed to close connection 1: " + e.toString());
    e.printStackTrace();
  }
  try
  {
    conn2.close();
    xaconn2.close();
  }
  catch (Exception e)
  {
    System.out.println("Failed to close connection 2: " + e.toString());
    e.printStackTrace();
  }
}
catch (java.sql.SQLException sqe)
```

```
    {
      System.out.println("SQLException caught: " + sqe.getMessage());
      sqe.printStackTrace();
    }
    catch (javax.transaction.xa.XAException xae)
    {
      System.out.println("XA error is " + xae.getMessage());
      xae.printStackTrace();
    }
    catch (javax.naming.NamingException nme)
    {
      System.out.println(" Naming Exception: " + nme.getMessage());
    }
  }
}
```

Recommendation: For better performance, complete a distributed transaction before you start another distributed or local transaction.

Setting the transaction timeout value for an XAResource instance

Use the XAResource.setTransactionTimeout method to reduce occurrences of deadlocks in a DB2 database that is the target of distributed transactions.

A distributed transaction to DB2 Database for Linux, UNIX, and Windows that ends, but cannot be prepared, is not an indoubt transaction. Therefore, the transaction manager cannot recover the transaction, and the DB2 resource manager does not put the transaction in its list of indoubt transactions. The DB2 resource manager does not roll back the transaction immediately, but waits until all connections to the database are released. During this period of inactivity, the transaction continues to hold locks on the database. If the transaction manager does not disconnect all connections to the database to allow rollback, the ended transaction continues to lock database records. If another application attempts to access those locked records, a deadlock can occur.

In a Java application that uses distributed transactions and IBM Data Server Driver for JDBC and SQLJ type 4 connectivity, you can prevent a transaction from holding locks on a database indefinitely by calling the XAResource.setTransactionTimeout method to set a timeout value on transactions. To do that, follow these steps:

1. On the DB2 Database for Linux, UNIX, and Windows instance, issue this command to cause the instance to check for timeout values.

   ```
   DB2 UPDATE DBM CFG USING RESYNC_INTERVAL seconds
   ```

   seconds needs to be less than the minimum timeout value that you set for a transaction.
2. In your application, after you create an XAResource object, call the XAResource.setTransactionTimeout method to set the timeout value.

   You can check the current timeout value by calling XAResource.getTransactionTimeout.

Enterprise Java Beans

The Enterprise Java beans architecture is a component architecture for the development and deployment of component-based distributed business applications.

Applications that are written using the Enterprise Java beans architecture can be written once, and then deployed on any server platform that supports the Enterprise Java beans specification. Java 2 Platform, Enterprise Edition (J2EE) applications implement server-side business components using Enterprise Java beans (EJBs) that include session beans and entity beans.

Session beans represent business services and are not shared between users. Entity beans are multi-user, distributed transactional objects that represent persistent data. The transactional boundaries of a EJB application can be set by specifying either container-managed or bean-managed transactions.

The sample program `AccessEmployee.ear` uses Enterprise Java beans to implement a J2EE application to access a data source. You can find this sample in the `SQLLIB/samples/websphere` directory.

The EJB sample application provides two business services. One service allows the user to access information about an employee (which is stored in the EMPLOYEE table of the **sample** database) through that employee's employee number. The other service allows the user to retrieve a list of the employee numbers, so that the user can obtain an employee number to use for querying employee data.

The following sample uses EJBs to implement a J2EE application to access a data source. The sample utilizes the Model-View-Controller (MVC) architecture, which is a commonly-used GUI architecture. The JSP is used to implement the view (the presentation component). A servlet acts as the controller in the sample. It controls the workflow and delegates the user's request to the model, which is implemented using EJBs. The model component of the sample consists of two EJBs, one session bean and one entity bean. The container-managed persistence (CMP) bean, Employee, represents the distributed transactional objects that represent the persistent data in the EMPLOYEE table of the sample database. The term container-managed persistence means that the EJB container handles all database access required by the entity bean. The bean's code contains no database access (SQL) calls. As a result, the bean's code is not tied to a specific persistent storage mechanism (database). The session bean, AccessEmployee, acts as the Façade of the entity bean and provides provide a uniform client access strategy. This Façade design reduces the network traffic between the EJB client and the entity bean and is more efficient in distributed transactions than if the EJB client accesses the entity bean directly. Access to the database server can be provided from the session bean or entity bean. The two services of the sample application demonstrate both approaches to accessing the database server. In the first service, the entity bean is used:

```
//=====================================================
// This method returns an employee's information by
// interacting with the entity bean located by the
// provided employee number
public EmployeeInfo getEmployeeInfo(String empNo)
throws java.rmi.RemoteException
}
Employee employee = null;
try
}
employee = employeeHome.findByPrimaryKey(new EmployeeKey(empNo));
EmployeeInfo empInfo = new EmployeeInfo(empNo);
//set the employee's information to the dependent value object
empInfo.setEmpno(employee.getEmpno());
empInfo.setFirstName (employee.getFirstName());
empInfo.setMidInit(employee.getMidInit());
empInfo.setLastName(employee.getLastName());
empInfo.setWorkDept(employee.getWorkDept());
```

```
empInfo.setPhoneNo(employee.getPhoneNo());
empInfo.setHireDate(employee.getHireDate());
empInfo.setJob(employee.getJob());
empInfo.setEdLevel(employee.getEdLevel());
empInfo.setSex(employee.getSex());
empInfo.setBirthDate(employee.getBirthDate());
empInfo.setSalary(employee.getSalary());
empInfo.setBonus(employee.getBonus());
empInfo.setComm(employee.getComm());
return empInfo;
}
catch (java.rmi.RemoteException rex)
{
......
```

In the second service, which displays employee numbers, the session bean, AccessEmployee, directly accesses the database table.

```
/============================================
* Get the employee number list.
* @return Collection
*/
public Collection getEmpNoList()
{
ResultSet rs = null;
PreparedStatement ps = null;
Vector list = new Vector();
DataSource ds = null;
Connection con = null;
try
{
ds = getDataSource();
con = ds.getConnection();
String schema = getEnvProps(DBschema);
String query = "Select EMPNO from " + schema + ".EMPLOYEE";
ps = con.prepareStatement(query);
ps.executeQuery();
rs = ps.getResultSet();
EmployeeKey pk;
while (rs.next())
{
pk = new EmployeeKey();
pk.employeeId = rs.getString(1);
list.addElement(pk.employeeId);
}
rs.close();
return list;
```

Chapter 11. JDBC and SQLJ connection pooling support

Connection pooling is part of JDBC DataSource support, and is supported by the IBM Data Server Driver for JDBC and SQLJ.

The IBM Data Server Driver for JDBC and SQLJ provides a factory of pooled connections that are used by WebSphere Application Server or other application servers. The application server actually does the pooling. Connection pooling is completely transparent to a JDBC or SQLJ application.

Connection pooling is a framework for caching physical data source connections, which are equivalent to DB2 threads. When JDBC reuses physical data source connections, the expensive operations that are required for the creation and subsequent closing of java.sql.Connection objects are minimized.

Without connection pooling, each java.sql.Connection object represents a physical connection to the data source. When the application establishes a connection to a data source, DB2 creates a new physical connection to the data source. When the application calls the java.sql.Connection.close method, DB2 terminates the physical connection to the data source.

In contrast, with connection pooling, a java.sql.Connection object is a temporary, logical representation of a physical data source connection. The physical data source connection can be serially reused by logical java.sql.Connection instances. The application can use the logical java.sql.Connection object in exactly the same manner as it uses a java.sql.Connection object when there is no connection pooling support.

With connection pooling, when a JDBC application invokes the DataSource.getConnection method, the data source determines whether an appropriate physical connection exists. If an appropriate physical connection exists, the data source returns a java.sql.Connection instance to the application. When the JDBC application invokes the java.sql.Connection.close method, JDBC does not close the physical data source connection. Instead, JDBC closes only JDBC resources, such as Statement or ResultSet objects. The data source returns the physical connection to the connection pool for reuse.

Connection pooling can be *homogeneous* or *heterogeneous*.

With homogeneous pooling, all Connection objects that come from a connection pool should have the same properties. The first logical Connection that is created with the DataSource has the properties that were defined for the DataSource. However, an application can change those properties. When a Connection is returned to the connection pool, an application server or a pooling module should reset the properties to their original values. However, an application server or pooling module might not reset the changed properties. The JDBC driver does not modify the properties. Therefore, depending on the application server or pool module design, a reused logical Connection might have the same properties as those that are defined for the DataSource or different properties.

With heterogeneous pooling, Connection objects with different properties can share the same connection pool.

Chapter 12. JDBC connection concentrator and Sysplex workload balancing

Java applications that use IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to access DB2 for z/OS servers can take advantage of the connection concentrator and Sysplex workload balancing functions.

The IBM Data Server Driver for JDBC and SQLJ connection concentrator and Sysplex workload balancing functions are similar to the connection concentrator and Sysplex workload balancing functions of DB2 Connect.

The IBM Data Server Driver for JDBC and SQLJ connection concentrator function can reduce the resources that DB2 for z/OS data sources require to support large numbers of client applications. The IBM Data Server Driver for JDBC and SQLJ connection concentrator function lets many connection objects use the same physical connection, which reduces the total number of physical connections to the data source.

IBM Data Server Driver for JDBC and SQLJ Sysplex workload balancing can improve availability of a data sharing group. When Sysplex workload balancing is enabled, the driver gets frequent status information about the members of a data sharing group. The driver uses this information to determine the data sharing member to which the next transaction should be routed. With Sysplex workload balancing, the DB2 for z/OS server and Workload Manager for z/OS (WLM) ensure that work is distributed efficiently among members of the data sharing group and that work is transferred to another member of a data sharing group if one member has a failure.

The IBM Data Server Driver for JDBC and SQLJ uses *transport objects* and a *global transport objects pool* to support the connection concentrator and Sysplex workload balancing. There is one transport object for each physical connection to the database source. When you enable the connection concentrator and Sysplex workload balancing, you set the maximum number of physical connections to the database source at any point in time by setting the maximum number of transport objects.

At the driver level, you set limits on the number of transport objects using IBM Data Server Driver for JDBC and SQLJ configuration properties.

At the connection level, you can use DataSource properties to enable and disable the IBM Data Server Driver for JDBC and SQLJ connection concentrator and Sysplex workload balancing and set limits on the number of transport objects. You can set these properties when you obtain a connection using the DataSource interface or the DriverManager interface.

You can monitor the global transport objects pool in either of the following ways:

- Using traces that you start using IBM Data Server Driver for JDBC and SQLJ configuration properties
- Using an application programming interface

Example of enabling the IBM Data Server Driver for JDBC and SQLJ connection concentrator

Before you can use the IBM Data Server Driver for JDBC and SQLJ connection concentrator and Sysplex workload balancing functions with WebSphere Application Server, you need to configure these functions.

Server requirements:
- WLM for z/OS
- DB2 UDB for OS/390 and z/OS Version 7 or later, set up for data sharing

  The default values for special registers in all members of the data sharing group must be the same. The reason for this is that when the IBM Data Server Driver for JDBC and SQLJ balances the loads on each member of the data sharing group, it moves the user's connection from one member to another. If the user has set any special register values on the original data sharing member, the driver resets all special registers to their default values and then applies any special register changes to the new member. However, the IBM Data Server Driver for JDBC and SQLJ has no way to determine the default values for all members. If two members have different default values, the result of an SQL statement can differ, depending on which member the statement runs on.

Client requirements:
- IBM Data Server Driver for JDBC and SQLJ at the FixPak 10 level
- WebSphere Application Server, Version 5.1 or later

The following procedure is an example of enabling the IBM Data Server Driver for JDBC and SQLJ connection concentrator and Sysplex workload balancing functions with WebSphere Application Server. The values that are specified are not intended to be recommended values. You need to determine values based on factors like these:
- Availability of system resources
- The number of physical connections available
- The desired ratio of connection objects to transport objects

1. Verify that the IBM Data Server Driver for JDBC and SQLJ is at the correct level to support the connection concentrator and Sysplex workload balancing by following these steps:
   a. Issue the following command in the command line processor
      ```
      java com.ibm.db2.jcc.DB2Jcc -version
      ```
   b. Find a line in the output like this, and check that *nnn* is 2.7 or later.
      ```
      [jcc] Driver: IBM Data Server Driver for JDBC and SQLJ Architecture nnn xxx
      ```
2. Set IBM Data Server Driver for JDBC and SQLJ configuration properties to enable the connection concentrator or Sysplex workload balancing for all DataSource or Connection instances that are created under the driver. Set the configuration properties in a DB2JccConfiguration.properties file by following these steps:
   a. Create a DB2JccConfiguration.properties file or edit the existing DB2JccConfiguration.properties file.
   b. Set the following configuration properties:
      - db2.jcc.minTransportObjects
      - db2.jcc.maxTransportObjects
      - db2.jcc.maxTransportObjectWaitTime
      - db2.jcc.dumpPool
      - db2.jcc.dumpPoolStatisticsOnScheduleFile

Start with settings similar to these:

```
db2.jcc.minTransportObjects=0
db2.jcc.maxTransportObjects=1500
db2.jcc.maxTransportObjectWaitTime=-1
db2.jcc.dumpPool=0
db2.jcc.dumpPoolStatisticsOnScheduleFile=/home/WAS/logs/srv1/poolstats
```

c. Add the directory path for DB2JccConfiguration.properties to the WebSphere Application Server IBM Data Server Driver for JDBC and SQLJ classpath.

3. Set IBM Data Server Driver for JDBC and SQLJ data source properties to enable the connection concentrator or Sysplex workload balancing:

   In the WebSphere Application Server administrative console, set the following properties for the data source that your application uses to connect to the data source:
   - enableSysplexWLB
   - enableConnectionConcentrator
   - maxTransportObjects

   Assume that you want the connection concentrator function as well the Sysplex workload balancing function. Start with settings similar to these:

Table 27. Example of data source property settings for IBM Data Server Driver for JDBC and SQLJ connection concentrator and Sysplex workload balancing

Property	Setting
enableSysplexWLB	true[1]
maxTransportObjects	100

Note:

1. enableConnectionConcentrator is set to true by default because enableSysplexWLB is set to true.

4. Restart WebSphere Application Server.

Techniques for monitoring IBM Data Server Driver for JDBC and SQLJ connection concentrator and Sysplex workload balancing

To monitor the IBM Data Server Driver for JDBC and SQLJ connection concentrator and Sysplex workload balancing, you need to monitor the global transport objects pool.

You can monitor the global transport objects pool in either of the following ways:
- Using traces that you start by setting IBM Data Server Driver for JDBC and SQLJ configuration properties
- Using an application programming interface

Configuration properties for monitoring the global transport objects pool

The db2.jcc.dumpPool, db2.jcc.dumpPoolStatisticsOnSchedule, and db2.jcc.dumpPoolStatisticsOnScheduleFile configuration properties control tracing of the global transport objects pool.

For example, the following set of configuration property settings cause Sysplex error messages and dump pool error messages to be written every 60 seconds to a file named /home/WAS/logs/srv1/poolstats:

```
db2.jcc.dumpPool=DUMP_SYSPLEX_MSG|DUMP_POOL_ERROR
db2.jcc.dumpPoolStatisticsOnSchedule=60
db2.jcc.dumpPoolStatisticsOnScheduleFile=/home/WAS/logs/srv1/poolstats
```

An entry in the pool statistics file looks like this:

```
time Scheduled PoolStatistics npr:2575 nsr:2575 lwroc:439 hwroc:1764 coc:372
aooc:362 rmoc:362 nbr:2872 tbt:857520 tpo:10
```

The meanings of the fields are:

npr
The total number of requests that the IBM Data Server Driver for JDBC and SQLJ has made to the pool since the pool was created.

nsr
The number of successful requests that the IBM Data Server Driver for JDBC and SQLJ has made to the pool since the pool was created. A successful request means that the pool returned an object.

lwroc
The number of objects that were reused but were not in the pool. This can happen if a Connection object releases a transport object at a transaction boundary. If the Connection object needs a transport object later, and the original transport object has not been used by any other Connection object, the Connection object can use that transport object.

hwroc
The number of objects that were reused from the pool.

coc
The number of objects that the IBM Data Server Driver for JDBC and SQLJ created since the pool was created.

aooc
The number of objects that exceeded the idle time that was specified by db2.jcc.maxTransportObjectIdleTime and were deleted from the pool.

rmoc
The number of objects that have been deleted from the pool since the pool was created.

nbr
The number of requests that the IBM Data Server Driver for JDBC and SQLJ made to the pool that the pool blocked because the pool reached its maximum capacity. A blocked request might be successful if an object is returned to the pool before the db2.jcc.maxTransportObjectWaitTime is exceeded and an exception is thrown.

tbt
The total time in milliseconds for requests that were blocked by the pool. This time can be much larger than the elapsed execution time of the application if the application uses multiple threads.

sbt
The shortest time in milliseconds that a thread waited to get a transport object from the pool. If the time is under one millisecond, the value in this field is zero.

lbt
The longest time in milliseconds that a thread waited to get a transport object from the pool.

abt
The average amount of time in milliseconds that threads waited to get a transport object from the pool. This value is tbt/nbr.

tpo
The number of objects that are currently in the pool.

Application programming interfaces for monitoring the global transport objects pool

You can write applications to gather statistics on the global transport objects pool. Those applications create objects in the DB2PoolMonitor class and invoke methods to retrieve information about the pool.

For example, the following code creates an object for monitoring the global transport objects pool:

```
import com.ibm.db2.jcc.DB2PoolMonitor;
DB2PoolMonitor transportObjectPoolMonitor =
        DB2PoolMonitor.getPoolMonitor (DB2PoolMonitor.TRANSPORT_OBJECT);
```

After you create the DB2PoolMonitor object, you can use methods in the DB2PoolMonitor class to monitor the pool.

Chapter 13. JDBC and SQLJ reference information

The IBM implementations of JDBC and SQLJ provide a number of application programming interfaces, properties, and commands for developing JDBC and SQLJ applications.

Data types that map to database data types in Java applications

To write efficient JDBC and SQLJ programs, you need to use the best mappings between Java data types and table column data types.

The following tables summarize the mappings of Java data types to JDBC and database data types for a DB2 Database for Linux, UNIX, and Windows, DB2 for z/OS, or IBM Informix Dynamic Server (IDS) system.

Data types for updating table columns

The following table summarizes the mappings of Java data types to database data types for PreparedStatement.setXXX or ResultSet.updateXXX methods in JDBC programs, and for input host expressions in SQLJ programs. When more than one Java data type is listed, the first data type is the recommended data type.

Table 28. Mappings of Java data types to database server data types for updating database tables

Java data type	Database data type
short	SMALLINT
boolean[1], byte[1], java.lang.Boolean	SMALLINT
int, java.lang.Integer	INTEGER
long, java.lang.Long	BIGINT
float, java.lang.Float	REAL
double, java.lang.Double	DOUBLE
java.math.BigDecimal	DECIMAL(*p*,*s*)[2]
java.math.BigDecimal	DECFLOAT(*n*)[3,4]
java.lang.String	CHAR(*n*)[5]
java.lang.String	GRAPHIC(*m*)[6]
java.lang.String	VARCHAR(*n*)[7]
java.lang.String	VARGRAPHIC(*m*)[8]
java.lang.String	CLOB[9]
java.lang.String	XML
byte[]	CHAR(*n*) FOR BIT DATA[5]
byte[]	VARCHAR(*n*) FOR BIT DATA[7]
byte[]	BINARY(*n*)[5]
byte[]	VARBINARY(*n*)[7]
byte[]	BLOB[9]
byte[]	ROWID
byte[]	XML

Table 28. Mappings of Java data types to database server data types for updating database tables (continued)

Java data type	Database data type
java.sql.Blob	BLOB
java.sql.Blob	XML
java.sql.Clob	CLOB
java.sql.Clob	DBCLOB[9]
java.sql.Clob	XML
java.sql.Date	DATE
java.sql.Time	TIME
java.sql.Timestamp	TIMESTAMP
java.io.ByteArrayInputStream	BLOB
java.io.StringReader	CLOB
java.io.ByteArrayInputStream	CLOB
java.io.InputStream	XML
com.ibm.db2.jcc.DB2RowID (deprecated)	ROWID
java.sql.RowId	ROWID
com.ibm.db2.jcc.DB2Xml (deprecated)	XML
java.sql.SQLXML	XML

Notes:

1. The database server has no exact equivalent for the Java boolean or byte data types, but the best fit is SMALLINT.
2. *p* is the decimal precision and *s* is the scale of the table column.

   You should design financial applications so that java.math.BigDecimal columns map to DECIMAL columns. If you know the precision and scale of a DECIMAL column, updating data in the DECIMAL column with data in a java.math.BigDecimal variable results in better performance than using other combinations of data types.
3. *n*=16 or *n*=34.
4. DECFLOAT is valid for connections to DB2 Version 9.1 for z/OS or later database servers or DB2 V9.5 for Linux, UNIX, and Windows or later database servers. Use of DECFLOAT requires the SDK for Java Version 5 (1.5) or later.
5. *n*<=254.
6. *m*<=127.
7. *n*<=32672.
8. *m*<=16336.
9. This mapping is valid only if the database server can determine the data type of the column.

Data types for retrieval from table columns

The following table summarizes the mappings of DB2 or IDS data types to Java data types for ResultSet.getXXX methods in JDBC programs, and for iterators in SQLJ programs. This table does not list Java numeric wrapper object types, which are retrieved using ResultSet.getObject.

Table 29. Mappings of database server data types to Java data types for retrieving data from database server tables

SQL data type	Recommended Java data type or Java object type	Other supported Java data types
SMALLINT	short	byte, int, long, float, double, java.math.BigDecimal, boolean, java.lang.String

Table 29. Mappings of database server data types to Java data types for retrieving data from database server tables (continued)

SQL data type	Recommended Java data type or Java object type	Other supported Java data types
INTEGER	int	short, byte, long, float, double, java.math.BigDecimal, boolean, java.lang.String
BIGINT	long	int, short, byte, float, double, java.math.BigDecimal, boolean, java.lang.String
DECIMAL(*p*,*s*) or NUMERIC(*p*,*s*)	java.math.BigDecimal	long, int, short, byte, float, double, boolean, java.lang.String
DECFLOAT(*n*)[1,2]	java.math.BigDecimal	long, int, short, byte, float, double, java.math.BigDecimal, boolean, java.lang.String
REAL	float	long, int, short, byte, double, java.math.BigDecimal, boolean, java.lang.String
DOUBLE	double	long, int, short, byte, float, java.math.BigDecimal, boolean, java.lang.String
CHAR(*n*)	java.lang.String	long, int, short, byte, float, double, java.math.BigDecimal, boolean, java.sql.Date, java.sql.Time, java.sql.Timestamp, java.io.InputStream, java.io.Reader
VARCHAR(*n*)	java.lang.String	long, int, short, byte, float, double, java.math.BigDecimal, boolean, java.sql.Date, java.sql.Time, java.sql.Timestamp, java.io.InputStream, java.io.Reader
CHAR(*n*) FOR BIT DATA	byte[]	java.lang.String, java.io.InputStream, java.io.Reader
VARCHAR(*n*) FOR BIT DATA	byte[]	java.lang.String, java.io.InputStream, java.io.Reader
BINARY(*n*)	byte[]	None
VARBINARY(*n*)	byte[]	None
GRAPHIC(*m*)	java.lang.String	long, int, short, byte, float, double, java.math.BigDecimal, boolean, java.sql.Date, java.sql.Time, java.sql.Timestamp, java.io.InputStream, java.io.Reader
VARGRAPHIC(*m*)	java.lang.String	long, int, short, byte, float, double, java.math.BigDecimal, boolean, java.sql.Date, java.sql.Time, java.sql.Timestamp, java.io.InputStream, java.io.Reader
CLOB(*n*)	java.sql.Clob	java.lang.String
BLOB(*n*)	java.sql.Blob	byte[][3]
DBCLOB(*m*)	No exact equivalent. Use java.sql.Clob.	

Table 29. Mappings of database server data types to Java data types for retrieving data from database server tables (continued)

SQL data type	Recommended Java data type or Java object type	Other supported Java data types
ROWID	java.sql.RowId	byte[], com.ibm.db2.jcc.DB2RowID (deprecated)
XML	java.sql.SQLXML	byte[], java.lang.String, java.io.InputStream, java.io.Reader
DATE	java.sql.Date	java.sql.String, java.sql.Timestamp
TIME	java.sql.Time	java.sql.String, java.sql.Timestamp
TIMESTAMP	java.sql.Timestamp	java.sql.String, java.sql.Date, java.sql.Time, java.sql.Timestamp

Notes:

1. *n*=16 or *n*=34.
2. DECFLOAT is valid for connections to DB2 Version 9.1 for z/OS or later database servers or DB2 V9.5 for Linux, UNIX, and Windows or later database servers. Use of DECFLOAT requires the SDK for Java Version 5 (1.5) or later.
3. This mapping is valid only if the database server can determine the data type of the column.

Data types for calling stored procedures and user-defined functions

The following table summarizes mappings of Java data types to JDBC data types and DB2 or IDS data types for calling user-defined function and stored procedure parameters. The mappings of Java data types to JDBC data types are for CallableStatement.registerOutParameter methods in JDBC programs. The mappings of Java data types to database server data types are for parameters in stored procedure or user-defined function invocations.

If more than one Java data type is listed in the following table, the first data type is the **recommended** data type.

Table 30. Mappings of Java, JDBC, and SQL data types for calling stored procedures and user-defined functions

Java data type	JDBC data type	SQL data type
boolean[1]	BIT	SMALLINT
byte[1]	TINYINT	SMALLINT
short, java.lang.Short	SMALLINT	SMALLINT
int, java.lang.Integer	INTEGER	INTEGER
long	BIGINT	BIGINT
float, java.lang.Float	REAL	REAL
float, java.lang.Float	FLOAT	REAL
double, java.lang.Double	DOUBLE	DOUBLE
java.math.BigDecimal	NUMERIC	DECIMAL
java.math.BigDecimal	DECIMAL	DECIMAL
java.lang.String	CHAR	CHAR
java.lang.String	CHAR	GRAPHIC
java.lang.String	VARCHAR	VARCHAR
java.lang.String	VARCHAR	VARGRAPHIC

Table 30. Mappings of Java, JDBC, and SQL data types for calling stored procedures and user-defined functions (continued)

Java data type	JDBC data type	SQL data type
java.lang.String	LONGVARCHAR	VARCHAR
java.lang.String	VARCHAR	CLOB
java.lang.String	LONGVARCHAR	CLOB
java.lang.String	CLOB	CLOB
byte[]	BINARY	CHAR FOR BIT DATA
byte[]	VARBINARY	VARCHAR FOR BIT DATA
byte[]	BINARY	BINARY
byte[]	VARBINARY	VARBINARY
byte[]	LONGVARBINARY	VARCHAR FOR BIT DATA
byte[]	VARBINARY	BLOB[3]
byte[]	LONGVARBINARY	BLOB[3]
java.sql.Date	DATE	DATE
java.sql.Time	TIME	TIME
java.sql.Timestamp	TIMESTAMP	TIMESTAMP
java.sql.Blob	BLOB	BLOB
java.sql.Clob	CLOB	CLOB
java.sql.Clob	CLOB	DBCLOB
java.io.ByteArrayInputStream	None	BLOB
java.io.StringReader	None	CLOB
java.io.ByteArrayInputStream	None	CLOB
com.ibm.db2.jcc.DB2RowID (deprecated)	com.ibm.db2.jcc.DB2Types.ROWID	ROWID
java.sql.RowId	java.sql.Types.ROWID	ROWID
com.ibm.db2.jcc.DB2Xml (deprecated)	com.ibm.db2.jcc.DB2Types.XML	XML AS CLOB
java.sql.SQLXML	java.sql.Types.SQLXML	XML AS CLOB
java.sql.Array[4]	java.sql.Types.ARRAY	ARRAY

Notes:

1. A stored procedure or user-defined function that is defined with a SMALLINT parameter can be invoked with a boolean or byte parameter. However, this is not recommended.
2. DECFLOAT parameters in Java routines are valid only for connections to DB2 Version 9.1 for z/OS or later database servers. DECFLOAT parameters in Java routines are not supported for connections to for Linux, UNIX, and Windows. Use of DECFLOAT requires the SDK for Java Version 5 (1.5) or later.
3. This mapping is valid only if the database server can determine the data type of the column.
4. ARRAY parameters are supported for stored procedures only.

Data types in Java stored procedures and user-defined functions

The following table summarizes mappings of the SQL parameter data types in a CREATE PROCEDURE or CREATE FUNCTION statement to the data types in the corresponding Java stored procedure or user-defined function method.

For DB2 Database for Linux, UNIX, and Windows, if more than one Java data type is listed for an SQL data type, only the **first** Java data type is valid.

For DB2 for z/OS, if more than one Java data type is listed, and you use a data type other than the first data type as a method parameter, you need to include a method signature in the EXTERNAL clause of your CREATE PROCEDURE or CREATE FUNCTION statement that specifies the Java data types of the method parameters.

Table 31. Mappings of SQL data types in a CREATE PROCEDURE or CREATE FUNCTION statement to data types in the corresponding Java stored procedure or user-defined function program

SQL data type in CREATE PROCEDURE or CREATE FUNCTION	Data type in Java stored procedure or user-defined function method[1]
SMALLINT	short, java.lang.Integer
INTEGER	int, java.lang.Integer
BIGINT	long, java.lang.Long
REAL	float, java.lang.Float
DOUBLE	double, java.lang.Double
DECIMAL	java.math.BigDecimal
DECFLOAT[2]	java.math.BigDecimal
CHAR	java.lang.String
VARCHAR	java.lang.String
CHAR FOR BIT DATA	byte[]
VARCHAR FOR BIT DATA	byte[]
BINARY	byte[]
VARBINARY	byte[]
DATE	java.sql.Date
TIME	java.sql.Time
TIMESTAMP	java.sql.Timestamp
BLOB	java.sql.Blob
CLOB	java.sql.Clob
DBCLOB	java.sql.Clob
ROWID	java.sql.Types.ROWID
XML AS CLOB	java.sql.Types.SQLXML

Notes:

1. For a stored procedure or user-defined function on a DB2 Database for Linux, UNIX, and Windows server, only the **first** data type is valid.
2. DECFLOAT parameters in Java routines are valid only for connections to DB2 Version 9.1 for z/OS or later database servers. DECFLOAT parameters in Java routines are not supported for connections to for Linux, UNIX, and Windows. Use of DECFLOAT requires the SDK for Java Version 5 (1.5) or later.

Properties for the IBM Data Server Driver for JDBC and SQLJ

IBM Data Server Driver for JDBC and SQLJ properties define how the connection to a particular data source should be made. Most properties can be set for a DataSource object or for a Connection object.

Methods for setting the properties

Properties can be set in one of the following ways:

- Using setXXX methods, where `XXX` is the unqualified property name, with the first character capitalized.

  Properties are applicable to the following IBM Data Server Driver for JDBC and SQLJ-specific implementations that inherit from com.ibm.db2.jcc.DB2BaseDataSource:
  - com.ibm.db2.jcc.DB2SimpleDataSource
  - com.ibm.db2.jcc.DB2ConnectionPoolDataSource
  - com.ibm.db2.jcc.DB2XADataSource
- In a java.util.Properties value in the *info* parameter of a DriverManager.getConnection call.
- In a `java.lang.String` value in the *url* parameter of a DriverManager.getConnection call.

  Some properties with an int data type have predefined constant field values. You must resolve constant field values to their integer values before you can use those values in the *url* parameter. For example, you cannot use com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL in a *url* parameter. However, you can build a URL string that includes com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL, and assign the URL string to a String variable. Then you can use the String variable in the *url* parameter:

```
String url =
 "jdbc:db2://sysmvs1.stl.ibm.com:5021" +
 "user=dbadm;password=dbadm;" +
 "traceLevel=" +
 (com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL) + ";";

 Connection con =
   java.sql.DriverManager.getConnection(url);
```

Common IBM Data Server Driver for JDBC and SQLJ properties for all supported database products

Most of the IBM Data Server Driver for JDBC and SQLJ properties apply to all database products that the driver supports.

Unless otherwise noted, all properties are in com.ibm.db2.jcc.DB2BaseDataSource.

Those properties are:

blockingReadConnectionTimeout
The amount of time in seconds before a connection socket read times out. This property applies only to IBM Data Server Driver for JDBC and SQLJ type 4 connectivity, and affects all requests that are sent to the data source after a connection is successfully established. The default is 0. A value of 0 means that there is no timeout.

databaseName
Specifies the name for the data source. This name is used as the *database* portion of the connection URL. The name depends on whether IBM Data Server Driver for JDBC and SQLJ type 4 connectivity or IBM Data Server Driver for JDBC and SQLJ type 2 connectivity is used.

For IBM Data Server Driver for JDBC and SQLJ type 4 connectivity:

- If the connection is to a DB2 for z/OS server, the databaseName value is the DB2 location name that is defined during installation. All characters in this

value must be uppercase characters. You can determine the location name by executing the following SQL statement on the server:

```
SELECT CURRENT SERVER FROM SYSIBM.SYSDUMMY1;
```

- If the connection is to a DB2 Database for Linux, UNIX, and Windows server, the databaseName value is the database name that is defined during installation.
- If the connection is to an IDS server, *database* is the database name. The name is case-insensitive. The server converts the name to lowercase.
- If the connection is to an IBM Cloudscape server, the databaseName value is the fully-qualified name of the file that contains the database. This name must be enclosed in double quotation marks (″). For example:

  ```
  "c:/databases/testdb"
  ```

If this property is not set, connections are made to the local site.

For IBM Data Server Driver for JDBC and SQLJ type 2 connectivity:

- The databaseName value is the database name that is defined during installation, if the value of the serverName connection property is null. If the value of serverName property is not null, the databaseName value is a database alias.

defaultIsolationLevel

Specifies the default transaction isolation level for new connections. The data type of this property is int. When defaultIsolationLevel is set on a DataSource, all connections that are created from that DataSource have the default isolation level that is specified by defaultIsolationLevel.

For DB2 data sources, the default is `java.sql.Connection.TRANSACTION_READ_COMMITTED`.

For IBM Informix Dynamic Server (IDS) databases, the default depends on the type of data source. The following table shows the defaults.

Table 32. Default isolation levels for IDS databases

Type of data source	Default isolation level
ANSI-compliant database with logging	java.sql.Connection.TRANSACTION_SERIALIZABLE
Database without logging	java.sql.Connection.TRANSACTION_READ_UNCOMMITTED
Non-ANSI-compliant database with logging	java.sql.Connection.TRANSACTION_READ_COMMITTED

deferPrepares

Specifies whether invocation of the Connection.prepareStatement method results in immediate preparation of an SQL statement on the data source, or whether statement preparation is deferred until the PreparedStatement.execute method is executed. The data type of this property is boolean.

deferPrepares is supported for IBM Data Server Driver for JDBC and SQLJ type 2 connectivity to DB2 Database for Linux, UNIX, and Windows, and for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

Possible values are:

true Statement preparation on the data source does not occur until the PreparedStatement.execute method is executed. This is the default.

false Statement preparation on the data source occurs when the Connection.prepareStatement method is executed.

Deferring prepare operations can reduce network delays. However, if you defer prepare operations, you need to ensure that input data types match table column types.

description
A description of the data source. The data type of this property is String.

downgradeHoldCursorsUnderXa
Specifies whether held cursors can be opened under XA connections.

downgradeHoldCursorsUnderXa applies to:

- IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to DB2 for z/OS servers.
- IBM Data Server Driver for JDBC and SQLJ type 4 connectivity or IBM Data Server Driver for JDBC and SQLJ type 2 connectivity to DB2 Database for Linux, UNIX, and Windows servers.

The default is `false`, which means that held cursors cannot be opened under XA connections.

If downgradeHoldCursorsUnderXa is set to `true`, held cursors can be opened under XA connections. However, cursors under XA connections have the following restrictions:

- Held cursors that are opened under an XA connection do not have WITH HOLD behavior. Held cursors that are opened under an XA connection are closed at XA End.
- Any cursors that are open before XA Start on a local transaction are closed at XA Start.

driverType
For the DataSource interface, determines which driver to use for connections. The data type of this property is int. Valid values are 2 or 4. 2 is the default.

fullyMaterializeLobData
Indicates whether the driver retrieves LOB locators for FETCH operations. The data type of this property is boolean.

The effect of fullyMaterializeLobData depends on whether the data source supports progressive streaming:

- If the data source does not support progressive streaming:

  If the value of fullyMaterializeLobData is `true`, LOB data is fully materialized within the JDBC driver when a row is fetched. If the value is `false`, LOB data is streamed. The driver uses locators internally to retrieve LOB data in chunks on an as-needed basis It is highly recommended that you set this value to `false` when you retrieve LOBs that contain large amounts of data. The default is `true`.
- If the data source supports progressive streaming:

  The JDBC driver ignores the value of fullyMaterializeLobData if the progressiveStreaming property is set to `DB2BaseDataSource.YES` or `DB2BaseDataSource.NOT_SET`.

This property has no effect on stored procedure parameters or on LOBs that are fetched using scrollable cursors. LOB stored procedure parameters are always fully materialized. LOBs that are fetched using scrollable cursors use LOB locators if progressive streaming is not in effect.

loginTimeout
The maximum time in seconds to wait for a connection to a data source. After the number of seconds that are specified by loginTimeout have elapsed, the driver closes the connection to the data source. The data type of this property is int. The default is 0. A value of 0 means that the timeout value is the default system timeout value. This property is not supported for IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS.

logWriter
The character output stream to which all logging and trace messages for the DataSource object are printed. The data type of this property is java.io.PrinterWriter. The default value is null, which means that no logging or tracing for the DataSource is output.

password
The password to use for establishing connections. The data type of this property is String. When you use the DataSource interface to establish a connection, you can override this property value by invoking this form of the DataSource.getConnection method:

```
getConnection(user, password);
```

portNumber
The port number where the DRDA server is listening for requests. The data type of this property is int.

resultSetHoldability
Specifies whether cursors remain open after a commit operation. The data type of this property is int. Valid values are:

DB2BaseDataSource.HOLD_CURSORS_OVER_COMMIT (1)
Close cursors after a commit operation.

DB2BaseDataSource.CLOSE_CURSORS_AT_COMMIT (2)
Leave cursors open after a commit operation.

DB2BaseDataSource.NOT_SET (0)
Close cursors after a commit operation. This is the default value.

securityMechanism
Specifies the DRDA security mechanism. The data type of this property is int. Possible values are:

CLEAR_TEXT_PASSWORD_SECURITY (3)
User ID and password

USER_ONLY_SECURITY (4)
User ID only

ENCRYPTED_PASSWORD_SECURITY (7)
User ID, encrypted password

ENCRYPTED_USER_AND_PASSWORD_SECURITY (9)
Encrypted user ID and password

KERBEROS_SECURITY (11)
Kerberos. This value does not apply to connections to IDS.

ENCRYPTED_USER_AND_DATA_SECURITY (12)
Encrypted user ID and encrypted security-sensitive data. This value applies to connections to DB2 for z/OS only.

ENCRYPTED_USER_PASSWORD_AND_DATA_SECURITY (13)
Encrypted user ID and password, and encrypted security-sensitive data. This value does not apply to connections to IDS.

PLUGIN_SECURITY (15)
Plug-in security. This value applies to connections to DB2 Database for Linux, UNIX, and Windows only.

ENCRYPTED_USER_ONLY_SECURITY (16)
Encrypted user ID. This value does not apply to connections to IDS.

If this property is specified, the specified security mechanism is the only mechanism that is used. If the security mechanism is not supported by the connection, an exception is thrown.

The default value for securityMechanism is CLEAR_TEXT_PASSWORD_SECURITY. If the server does not support CLEAR_TEXT_PASSWORD_SECURITY but supports ENCRYPTED_USER_AND_PASSWORD_SECURITY, the IBM Data Server Driver for JDBC and SQLJ driver updates the security mechanism to ENCRYPTED_USER_AND_PASSWORD_SECURITY and attempts to connect to the server. Any other mismatch in security mechanism support between the requester and the server results in an error.

sendDataAsIs
Specifies that the IBM Data Server Driver for JDBC and SQLJ does not convert input parameter values to the target column data types. The data type of this property is boolean. The default is `false`.

You should use this property only for applications that always ensure that the data types in the application match the data types in the corresponding database tables.

serverName
The host name or the TCP/IP address of the data source. The data type of this property is String.

traceDirectory
Specifies a directory into which trace information is written. The data type of this property is `String`. When traceDirectory is specified, trace information for multiple connections on the same DataSource is written to multiple files.

When traceDirectory is specified, a connection is traced to a file named traceFile_*origin*_*n*.

n is the *n*th connection for a DataSource.

origin indicates the origin of the log writer that is in use. Possible values of *origin* are:

cpds The log writer for a DB2ConnectionPoolDataSource object.

driver The log writer for a DB2Driver object.

global The log writer for a DB2TraceManager object.

sds The log writer for a DB2SimpleDataSource object.

xads The log writer for a DB2XADataSource object.

If the traceFile property is also specified, the traceDirectory value is not used.

traceFile
Specifies the name of a file into which the IBM Data Server Driver for JDBC

and SQLJ writes trace information. The data type of this property is `String`. The traceFile property is an alternative to the logWriter property for directing the output trace stream to a file.

traceFileAppend
Specifies whether to append to or overwrite the file that is specified by the traceFile property. The data type of this property is boolean. The default is `false`, which means that the file that is specified by the traceFile property is overwritten.

traceLevel
Specifies what to trace. The data type of this property is int.

You can specify one or more of the following traces with the traceLevel property:

- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_NONE` (X'00')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_CONNECTION_CALLS` (X'01')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_STATEMENT_CALLS` (X'02')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_RESULT_SET_CALLS` (X'04')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DRIVER_CONFIGURATION` (X'10')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_CONNECTS` (X'20')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DRDA_FLOWS` (X'40')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_RESULT_SET_META_DATA` (X'80')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_PARAMETER_META_DATA` (X'100')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DIAGNOSTICS` (X'200')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_SQLJ` (X'400')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_XA_CALLS ( IBM Data Server Driver for JDBC and SQLJ type 2 connectivity for DB2 Database for Linux, UNIX, and Windows only)` (X'800')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_META_CALLS` (X'2000')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DATASOURCE_CALLS` (X'4000')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_LARGE_OBJECT_CALLS` (X'8000')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_SYSTEM_MONITOR` (X'20000')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_TRACEPOINTS` (X'40000')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL` (X'FFFFFFFF')

To specify more than one trace, use one of these techniques:

- Use bitwise OR (`|`) operators with two or more trace values. For example, to trace DRDA flows and connection calls, specify this value for traceLevel:
  ```
  TRACE_DRDA_FLOWS|TRACE_CONNECTION_CALLS
  ```
- Use a bitwise complement (~) operator with a trace value to specify all except a certain trace. For example, to trace everything except DRDA flows, specify this value for traceLevel:
  ```
  ~TRACE_DRDA_FLOWS
  ```

user
The user ID to use for establishing connections. The data type of this property is String. When you use the DataSource interface to establish a connection, you can override this property value by invoking this form of the DataSource.getConnection method:

```
getConnection(user, password);
```

xaNetworkOptimization
Specifies whether XA network optimization is enabled for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity. You might need to disable XA network optimization in an environment in which an XA Start and XA End are issued from one Java process, and an XA Prepare and an XA Commit are

issued from another Java process. With XA network optimization, the XA Prepare can reach the data source before the XA End, which results in an XAER_PROTO error. To prevent the XAER_PROTO error, disable XA network optimization.

The default is `true`, which means that XA network optimization is enabled. If xaNetworkOptimization is `false`, which means that XA network optimization is disabled, the driver closes any open cursors at XA End time.

xaNetworkOptimization can be set on a DataSource object, or in the *url* parameter in a getConnection call. The value of xaNetworkOptimization cannot be changed after a connection is obtained.

com.ibm.db2.jcc.DB2ConnectionPoolDataSource.maxStatements
Controls an internal statement cache that is associated with a PooledConnection. The data type of this property is int. Possible values are:

positive integer
Enables the internal statement cache for a PooledConnection, and specifies the number of statements that the IBM Data Server Driver for JDBC and SQLJ keeps open in the cache.

0 or negative integer
Disables internal statement caching for the PooledConnection. 0 is the default.

maxStatements controls the internal statement cache that is associated with a PooledConnection only when the PooledConnection object is created. maxStatements has no effect on caching in an already existing PooledConnection object.

maxStatements applies only to IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

Common IBM Data Server Driver for JDBC and SQLJ properties for DB2 for z/OS and DB2 Database for Linux, UNIX, and Windows

Some of the IBM Data Server Driver for JDBC and SQLJ properties apply to DB2 for z/OS and DB2 Database for Linux, UNIX, and Windows only.

Unless otherwise noted, all properties are in com.ibm.db2.jcc.DB2BaseDataSource.

Those properties are:

clientRerouteAlternateServerName
Specifies one or more alternate server names for client reroute. clientRerouteAlternateServerName is used when client reroute is set up without a JNDI store. The data type of this property is String.

If more than one server name is specified, delimit the server names with commas (,). The number of values that is specified for clientRerouteAlternateServerName must match the number of values that is specified for clientRerouteAlternatePortNumber.

clientRerouteAlternateServerName applies to IBM Data Server Driver for JDBC and SQLJ type 2 connectivity to DB2 Database for Linux, UNIX, and Windows and IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

clientRerouteAlternatePortNumber
Specifies one or more alternate port numbers for client reroute.

clientRerouteAlternatePortNumber is used when client reroute is set up without a JNDI store. The data type of this property is String.

If more than one port number is specified, delimit the port numbers with commas (,). The number of values that is specified for clientRerouteAlternatePortNumber must match the number of values that is specified for clientRerouteAlternateServerName.

clientRerouteAlternatePortNumber applies to IBM Data Server Driver for JDBC and SQLJ type 2 connectivity to DB2 Database for Linux, UNIX, and Windows and IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

clientRerouteServerListJNDIName
Identifies a JNDI reference to a DB2ClientRerouteServerList instance in a JNDI repository of reroute server information. clientRerouteServerListJNDIName applies only to IBM Data Server Driver for JDBC and SQLJ type 4 connectivity, and to connections that are established through the DataSource interface.

If the value of clientRerouteServerListJNDIName is not null, clientRerouteServerListJNDIName provides the following functions:
- Allows information about reroute servers to persist across JVMs
- Provides an alternate server location if the first connection to the data source fails

clientRerouteServerListJNDIContext
Specifies the JNDI context that is used for binding and lookup of the DB2ClientRerouteServerList instance. clientRerouteServerListJNDIContext applies only to IBM Data Server Driver for JDBC and SQLJ type 4 connectivity, and to connections that are established through the DataSource interface.

If clientRerouteServerListJNDIContext is not set, the IBM Data Server Driver for JDBC and SQLJ creates an initial context using system properties or the jndi.properties file.

clientRerouteServerListJNDIContext can be set **only** by using the following method:

```
public void setClientRerouteServerListJNDIContext(javax.naming.Context registry)
```

currentDegree
Specifies the degree of parallelism for the execution of queries that are dynamically prepared. The type of this property is String. The currentDegree value is used to set the CURRENT DEGREE special register on the data source. If currentDegree is not set, no value is passed to the data source.

currentFunctionPath
Specifies the SQL path that is used to resolve unqualified data type names and function names in SQL statements that are in JDBC programs. The data type of this property is String. For a DB2 Database for Linux, UNIX, and Windows server, the maximum length is 254 bytes. For a DB2 for z/OS server, the maximum length is 2048 bytes. The value is a comma-separated list of schema names. Those names can be ordinary or delimited identifiers.

currentMaintainedTableTypesForOptimization
Specifies a value that identifies the types of objects that can be considered when the data source optimizes the processing of dynamic SQL queries. This register contains a keyword representing table types. The data type of this property is String.

Possible values of currentMaintainedTableTypesForOptimization are:

ALL
Indicates that all materialized query tables will be considered.

NONE
Indicates that no materialized query tables will be considered.

SYSTEM
Indicates that only system-maintained materialized query tables that are refresh deferred will be considered.

USER
Indicates that only user-maintained materialized query tables that are refresh deferred will be considered.

currentPackagePath
Specifies a comma-separated list of collections on the server. The database server searches these collections for JDBC and SQLJ packages.

The precedence rules for the currentPackagePath and currentPackageSet properties follow the precedence rules for the CURRENT PACKAGESET and CURRENT PACKAGE PATH special registers.

currentPackageSet
Specifies the collection ID to search for JDBC and SQLJ packages. The data type of this property is String. The default is NULLID. If currentPackageSet is set, its value overrides the value of jdbcCollection.

Multiple instances of the IBM Data Server Driver for JDBC and SQLJ can be installed at a database server by running the DB2Binder utility multiple times. The DB2binder utility includes a -collection option that lets the installer specify the collection ID for each IBM Data Server Driver for JDBC and SQLJ instance. To choose an instance of the IBM Data Server Driver for JDBC and SQLJ for a connection, you specify a currentPackageSet value that matches the collection ID for one of the IBM Data Server Driver for JDBC and SQLJ instances.

The precedence rules for the currentPackagePath and currentPackageSet properties follow the precedence rules for the CURRENT PACKAGESET and CURRENT PACKAGE PATH special registers.

currentRefreshAge
Specifies a timestamp duration value that is the maximum duration since a REFRESH TABLE statement was processed on a system-maintained REFRESH DEFERRED materialized query table such that the materialized query table can be used to optimize the processing of a query. This property affects dynamic statement cache matching. The data type of this property is long.

currentSchema
Specifies the default schema name that is used to qualify unqualified database objects in dynamically prepared SQL statements. The value of this property sets the value in the CURRENT SCHEMA special register on the database server.

cursorSensitivity
Specifies whether the `java.sql.ResultSet.TYPE_SCROLL_SENSITIVE` value for a JDBC ResultSet maps to the SENSITIVE DYNAMIC attribute, the SENSITIVE STATIC attribute, or the ASENSITIVE attribute for the underlying database cursor. The data type of this property is int. Possible values are `TYPE_SCROLL_SENSITIVE_STATIC` (0), `TYPE_SCROLL_SENSITIVE_DYNAMIC` (1), or `TYPE_SCROLL_ASENSITIVE` (2). The default is `TYPE_SCROLL_SENSITIVE_STATIC`.

If the data source does not support sensitive dynamic scrollable cursors, and `TYPE_SCROLL_SENSITIVE_DYNAMIC` is requested, the JDBC driver accumulates a warning and maps the sensitivity to SENSITIVE STATIC. For DB2 for i5/OS

database servers, which do not support sensitive static cursors, `java.sql.ResultSet.TYPE_SCROLL_SENSITIVE` always maps to SENSITIVE DYNAMIC.

dateFormat
Specifies:

- The format in which the String argument of the PreparedStatement.setString method against a DATE column must be specified.
- The format in which the result of the ResultSet.getString or CallableStatement.getString method against a DATE column is returned.

The data type of dateFormat is int.

Possible values of dateFormat are:

Constant	Integer value	Format
`com.ibm.db2.jcc.DB2BaseDataSource.ISO`	1	*yyyy-mm-dd*
`com.ibm.db2.jcc.DB2BaseDataSource.USA`	2	*mm/dd/yyyy*
`com.ibm.db2.jcc.DB2BaseDataSource.EUR`	3	*dd.mm.yyyy*
`com.ibm.db2.jcc.DB2BaseDataSource.JIS`	4	*yyyy-mm-dd*

The default is `com.ibm.db2.jcc.DB2BaseDataSource.ISO`.

decimalRoundingMode
Specifies the rounding mode for decimal floating-point values on DB2 for z/OS or DB2 Database for Linux, UNIX, and Windows database servers.

Possible values are:

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_DOWN (1)
Rounds the value towards 0 (truncation). The discarded digits are ignored.

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_CEILING (2)
Rounds the value towards positive infinity. If all of the discarded digits are zero or if the sign is negative the result is unchanged other than the removal of the discarded digits. Otherwise, the result coefficient is incremented by 1.

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_HALF_EVEN (3)
Rounds the value to the nearest value; if the values are equidistant, rounds the value so that the final digit is even. If the discarded digits represents greater than half (0.5) of the value of one in the next left position then the result coefficient is incremented by 1. If they represent less than half, then the result coefficient is not adjusted (that is, the discarded digits are ignored). Otherwise the result coefficient is unaltered if its rightmost digit is even, or is incremented by 1 if its rightmost digit is odd (to make an even digit).

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_HALF_UP (4)
Rounds the value to the nearest value; if the values are equidistant, rounds the value away from zero. If the discarded digits represent greater than or equal to half (0.5) of the value of one in the next left position then the result coefficient is incremented by 1. Otherwise the discarded digits are ignored.

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_FLOOR (6)
Rounds the value towards negative infinity. If all of the discarded digits are zero or if the sign is positive the result is unchanged other

than the removal of discarded digits. Otherwise, the sign is negative and the result coefficient is incremented by 1.

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_UNSET (-2147483647)
No rounding mode was explicitly set. The IBM Data Server Driver for JDBC and SQLJ does not use the decimalRoundingMode to set the rounding mode on the data source.

The IBM Data Server Driver for JDBC and SQLJ uses the following values for its rounding mode:

- For DB2 for z/OS or DB2 Database for Linux, UNIX, and Windows database servers, the rounding mode is ROUND_HALF_EVEN for decimal floating-point values.

If decimalRoundingMode is set, the decimalRoundingMode value is used to set the CURRENT DECFLOAT ROUNDING MODE special register on DB2 for z/OS database servers.

fullyMaterializeInputStreams
Indicates whether streams are fully materialized before they are sent from the client to a data source. The data type of this property is boolean. The default is `false`.

If the value of `fullyMaterializeInputStreams` is `true`, the JDBC driver fully materialized the streams before sending them to the server.

gssCredential
For a data source that uses Kerberos security, specifies a delegated credential that is passed from another principal. The data type of this property is org.ietf.jgss.GSSCredential. Delegated credentials are used in multi-tier environments, such as when a client connects to WebSphere Application Server, which, in turn, connects to the data source. You obtain a value for this property from the client, by invoking the GSSContext.getDelegCred method. GSSContext is part of the IBM Java Generic Security Service (GSS) API. If you set this property, you also need to set the Mechanism and KerberosServerPrincipal properties.

This property is applicable only to IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

For more information on using Kerberos security with the IBM Data Server Driver for JDBC and SQLJ, see ″Using Kerberos security under the IBM Data Server Driver for JDBC and SQLJ″.

kerberosServerPrincipal
For a data source that uses Kerberos security, specifies the name that is used for the data source when it is registered with the Kerberos Key Distribution Center (KDC). The data type of this property is String.

This property is applicable only to IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

maxRetriesForClientReroute
During automatic client reroute, limit the number of retries if the primary connection to the data source fails.

The data type of this property is int.

The IBM Data Server Driver for JDBC and SQLJ uses the maxRetriesForClientReroute property only if the retryIntervalForClientReroute property is also set. The default value for maxRetriesForClientReroute is MAX_RETRIES_NOT_SET (-1).

If maxRetriesForClientReroute or retryIntervalForClientReroute is not set, the IBM Data Server Driver for JDBC and SQLJ performs retries for 10 minutes.

progressiveStreaming
Specifies whether the JDBC driver uses progressive streaming when progressive streaming is supported on the data source. With progressive streaming, the data source dynamically determines the most efficient mode in which to return LOB or XML data, based on the size of the LOBs or XML objects. The value of the streamBufferSize parameter determines whether the data is materialized when it is returned.

The data type of progressiveStreaming is int. Valid values are `DB2BaseDataSource.YES` (1) and `DB2BaseDataSource.NO` (2). If the progressiveStreaming property is not specified, the progressiveStreaming value is `DB2BaseDataSource.NOT_SET` (0).

If the connection is to a data source that supports progressive streaming, and the value of progressiveStreaming is `DB2BaseDataSource.YES` or `DB2BaseDataSource.NOT_SET`, the JDBC driver uses progressive streaming to return LOBs and XML data.

If the value of progressiveStreaming is `DB2BaseDataSource.NO`, or the data source does not support progressive streaming, the way in which the JDBC driver returns LOB or XML data depends on the value of the fullyMaterializeLobData property.

readOnly
Specifies whether the connection is read-only. The data type of this property is boolean. The default is `false`.

resultSetHoldabilityForCatalogQueries
Specifies whether cursors for queries that are executed on behalf of DatabaseMetaData methods remain open after a commit operation. The data type of this property is int.

When an application executes DatabaseMetaData methods, the IBM Data Server Driver for JDBC and SQLJ executes queries against the catalog of the target data source. By default, the holdability of those cursors is the same as the holdability of application cursors. To use different holdability for catalog queries, use the resultSetHoldabilityForCatalogQueries property. Possible values are:

DB2BaseDataSource.HOLD_CURSORS_OVER_COMMIT (1)
Close cursors for catalog queries after a commit operation, regardless of the resultSetHoldability setting.

DB2BaseDataSource.CLOSE_CURSORS_AT_COMMIT (2)
Leave cursors for catalog queries open after a commit operation, regardless of the resultSetHoldability setting.

DB2BaseDataSource.NOT_SET (0)
Use the resultSetHoldability setting for catalog queries. This is the default value.

Valid values are `HOLD_CURSORS_OVER_COMMIT` (1) or `CLOSE_CURSORS_AT_COMMIT` (2). These values are the same as the `ResultSet.HOLD_CURSORS_OVER_COMMIT` and `ResultSet.CLOSE_CURSORS_AT_COMMIT` constants that are defined in JDBC 3.0.

retryIntervalForClientReroute
For automatic client reroute, specifies the amount of time in seconds between connection retries.

The data type of this property is int.

The IBM Data Server Driver for JDBC and SQLJ uses the retryIntervalForClientReroute property only if the maxRetriesForClientReroute property is also set. The default value for retryIntervalForClientReroute is RETRY_INTERVAL_NOT_SET (-1).

If maxRetriesForClientReroute or retryIntervalForClientReroute is not set, the IBM Data Server Driver for JDBC and SQLJ performs retries for 10 minutes.

returnAlias
Specifies whether the JDBC driver returns rows for table aliases and synonyms for DatabaseMetaData methods that return table information, such as getTables. The data type of returnAlias is int. Possible values are:

0 Do not return rows for aliases or synonyms of tables in output from DatabaseMetaData methods that return table information.

1 For tables that have aliases or synonyms, return rows for aliases and synonyms of those tables, as well as rows for the tables, in output from DatabaseMetaData methods that return table information. This is the default.

sslConnection
Specifies whether the IBM Data Server Driver for JDBC and SQLJ uses an SSL socket to connect to the data source. If sslConnection is set to `true`, the connection uses an SSL socket. If sslConnection is set to `false`, the connection uses a plain socket.

streamBufferSize
Specifies the size, in bytes, of the JDBC driver buffers for chunking LOB or XML data. The JDBC driver uses the streamBufferSize value whether or not it uses progressive streaming. The data type of streamBufferSize is int. The default is 1048576.

If the JDBC driver uses progressive streaming, LOB or XML data is materialized if it fits in the buffers, and the driver does not use the fullyMaterializeLobData property.

supportsAsynchronousXARollback
Specifies whether the IBM Data Server Driver for JDBC and SQLJ supports asynchronous XA rollback operations. The data type of this property is int. The default is `DB2BaseDataSource.NO` (2). If the application runs against a BEA WebLogic Server application server, set supportsAsynchronousXARollback to `DB2BaseDataSource.YES` (1).

sysSchema
Specifies the schema of the shadow catalog tables or views that are searched when an application invokes a DatabaseMetaData method. The sysSchema property was formerly called cliSchema.

timeFormat
Specifies:

- The format in which the String argument of the PreparedStatement.setString method against a TIME column must be specified.
- The format in which the result of the ResultSet.getString or CallableStatement.getString method against a TIME column is returned.

The data type of timeFormat is int.

Possible values of timeFormat are:

Constant	Integer value	Format
com.ibm.db2.jcc.DB2BaseDataSource.ISO	1	*hh:mm:ss*
com.ibm.db2.jcc.DB2BaseDataSource.USA	2	*h:mm* am or *h:mm* pm
com.ibm.db2.jcc.DB2BaseDataSource.EUR	3	*hh.mm.ss*
com.ibm.db2.jcc.DB2BaseDataSource.JIS	4	*hh:mm:ss*

The default is com.ibm.db2.jcc.DB2BaseDataSource.ISO.

useCachedCursor
Specifies whether the underlying cursor for PreparedStatement objects is cached and reused on subsequent executions of the PreparedStatement. The data type of useCachedCursor is boolean.

If useCachedCursor is set to true, the cursor for PreparedStatement objects is cached, which can improve performance. true is the default.

Set useCachedCursor to false if PreparedStatement objects access tables whose column types or lengths change between executions of those PreparedStatement objects.

useJDBC4ColumnNameAndLabelSemantics
Specifies how the IBM Data Server Driver for JDBC and SQLJ handles column labels in ResultSetMetaData.getColumnName, ResultSetMetaData.getColumnLabel, and ResultSet.findColumn method calls. Possible values are:

com.ibm.db2.jcc.DB2BaseDataSource.YES (1)
The IBM Data Server Driver for JDBC and SQLJ uses the following rules, which conform to the JDBC 4.0 specification, to determine the value that ResultSetMetaData.getColumnName, ResultSetMetaData.getColumnLabel, and ResultSet.findColumn return:

- The column name that is returned by ResultSetMetaData.getColumnName is its name from the database.
- The column label that is returned by ResultSetMetaData.getColumnLabel is the label that is specified with the SQL AS clause. If the SQL AS clause is not specified, the label is the name of the column.
- ResultSet.findColumn takes the label for the column, as specified with the SQL AS clause, as input. If the SQL AS clause was not specified, the label is the column name.
- The IBM Data Server Driver for JDBC and SQLJ does not use a column label that is assigned by the SQL LABEL ON statement.

These rules apply to IBM Data Server Driver for JDBC and SQLJ Version 4.0 and later, for connections to the following database systems:
- DB2 for z/OS Version 8 or later
- DB2 Database for Linux, UNIX, and Windows Version 8.1 or later
- DB2 for i5/OS V5R3 or later

For earlier versions of these database systems, the rules for a useJDBC4ColumnNameAndLabelSemantics value of com.ibm.db2.jcc.DB2BaseDataSource.NO apply.

com.ibm.db2.jcc.DB2BaseDataSource.NO (2)

The IBM Data Server Driver for JDBC and SQLJ uses the following rules to determine the values that ResultSetMetaData.getColumnName, ResultSetMetaData.getColumnLabel, and ResultSet.findColumn return:

If the data source does not support the LABEL ON statement, or the source column is not defined with the LABEL ON statement:

- The value that is returned by ResultSetMetaData.getColumnName is its name from the database, if no SQL AS clause is specified. If the SQL AS clause is specified, the value that is returned is the column label.
- The value that is returned by ResultSetMetaData.getColumnLabel is the label that is specified with the SQL AS clause. If the SQL AS clause is not specified, the value that is returned is the name of the column.
- ResultSet.findColumn takes the column name as input.

If the source column is defined with the LABEL ON statement:

- The value that is returned by ResultSetMetaData.getColumnName is the column name from the database, if no SQL AS clause is specified. If the SQL AS clause is specified, the value that is returned is the column label that is specified in the AS clause.
- The value that is returned by ResultSetMetaData.getColumnLabel is the label that is specified in the LABEL ON statement.
- ResultSet.findColumn takes the column name as input.

These rules conform to the behavior of the IBM Data Server Driver for JDBC and SQLJ before Version 3.50.

com.ibm.db2.jcc.DB2BaseDataSource.NOT_SET (0)

This is the default behavior.

For the IBM Data Server Driver for JDBC and SQLJ Version 3.50 and earlier, the default behavior for useJDBC4ColumnNameAndLabelSemantics is the same as the behavior for com.ibm.db2.jcc.DB2BaseDataSource.NO.

For the IBM Data Server Driver for JDBC and SQLJ Version 4.0 and later:

- The default behavior for useJDBC4ColumnNameAndLabelSemantics is the same as the behavior for com.ibm.db2.jcc.DB2BaseDataSource.YES, for connections to the following database systems:
  - DB2 for z/OS Version 8 or later
  - DB2 Database for Linux, UNIX, and Windows Version 8.1 or later
  - DB2 for i5/OS V5R3 or later
- For connections to earlier versions of these database systems, the default behavior for useJDBC4ColumnNameAndLabelSemantics is com.ibm.db2.jcc.DB2BaseDataSource.NO.

com.ibm.db2.jcc.DB2ConnectionPoolDataSource.maxStatements

Controls an internal statement cache that is associated with a PooledConnection. The data type of this property is int. Possible values are:

positive integer

Enables the internal statement cache for a PooledConnection, and

specifies the number of statements that the IBM Data Server Driver for JDBC and SQLJ keeps open in the cache.

0 or negative integer
Disables internal statement caching for the PooledConnection. 0 is the default.

maxStatements controls the internal statement cache that is associated with a PooledConnection only when the PooledConnection object is created. maxStatements has no effect on caching in an already existing PooledConnection object.

maxStatements applies only to IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

Common IBM Data Server Driver for JDBC and SQLJ properties for DB2 for z/OS and IBM Informix Dynamic Server

Some of the IBM Data Server Driver for JDBC and SQLJ properties apply to IDS and DB2 for z/OS database servers.

Those properties are:

keepDynamic
Specifies whether the data source keeps already prepared dynamic SQL statements in the dynamic statement cache after commit points so that those prepared statements can be reused. The data type of this property is int. Valid values are `DB2BaseDataSource.YES` (1) and `DB2BaseDataSource.NO` (2).

If the keepDynamic property is not specified, the keepDynamic value is `DB2BaseDataSource.NOT_SET` (0). If the connection is to a DB2 for z/OS server, caching of dynamic statements for a connection is not done if the property is not set. If the connection is to an IDS data source, caching of dynamic statements for a connection is done if the property is not set.

keepDynamic is used with the DB2Binder -keepdynamic option. The keepDynamic property value that is specified must match the -keepdynamic value that was specified when DB2Binder was run.

For a DB2 for z/OS database server, dynamic statement caching can be done only if the EDM dynamic statement cache is enabled on the data source. The CACHEDYN subsystem parameter must be set to `DB2BaseDataSource.YES` to enable the dynamic statement cache.

retrieveMessagesFromServerOnGetMessage
Specifies whether JDBC SQLException.getMessage or SQLWarning.getMessage calls cause the IBM Data Server Driver for JDBC and SQLJ to invoke a DB2 for z/OS stored procedure that retrieves the message text for the error. The data type of this property is boolean. The default is `false`, which means that the full message text is not returned to the client.

For example, if retrieveMessagesFromServerOnGetMessage is set to `true`, a message similar to this one is returned by SQLException.getMessage after an attempt to perform an SQL operation on nonexistent table ADMF001.NO_TABLE:

```
ADMF001.NO_TABLE IS AN UNDEFINED NAME. SQLCODE=-204,
SQLSTATE=42704, DRIVER=3.50.54
```

If retrieveMessagesFromServerOnGetMessage is set to `false`, a message similar to this one is returned:

```
DB2 SQL Error: SQLCODE=-204, SQLSTATE=42704, DRIVER=3.50.54
```

An alternative to setting this property to `true` is to use the IBM Data Server Driver for JDBC and SQLJ-only `DB2Sqlca.getMessage` method in applications. Both techniques result in a stored procedure call, which starts a unit of work.

Common IBM Data Server Driver for JDBC and SQLJ properties for IBM Informix Dynamic Server and DB2 Database for Linux, UNIX, and Windows database servers

Some of the IBM Data Server Driver for JDBC and SQLJ properties apply to IBM Informix Dynamic Server (IDS) and DB2 Database for Linux, UNIX, and Windows database servers.

Those properties are:

currentLockTimeout
Specifies whether DB2 Database for Linux, UNIX, and Windows servers wait for a lock when the lock cannot be obtained immediately. The data type of this property is int. Possible values are:

integer Wait for integer *seconds*. *integer* is between -1 and 32767, inclusive.

LOCK_TIMEOUT_NO_WAIT
Do not wait for a lock. This is the default.

LOCK_TIMEOUT_WAIT_INDEFINITELY
Wait indefinitely for a lock.

LOCK_TIMEOUT_NOT_SET
Use the default for the data source.

queryDataSize
Specifies a hint that is used to control the amount of query data, in bytes, that is returned from the data source on each fetch operation. This value can be used to optimize the application by controlling the number of trips to the data source that are required to retrieve data.

Use of a larger value for queryDataSize can result in less network traffic, which can result in better performance. For example, if the result set size is 50 KB, and the value of queryDataSize is 32768 (32KB), two trips to the database server are required to retrieve the result set. However, if queryDataSize is set to 61440 (60 KB), only one trip to the data source is required to retrieve the result set.

The following table lists minimum, maximum, and default values of queryDataSize for each data source.

Table 33. Minimum, maximum, and default values of queryDataSize

Data source	Minimum queryDataSize value	Maximum queryDataSize value	Default queryDataSize value
DB2 Database for Linux, UNIX, and Windows	4096	65535	32767
IDS	4096	10485760	32767
DB2 for i5/OS	4096	65535	32767
DB2 for z/OS	Not applicable	Not applicable	Query data size is always 32767.

IBM Data Server Driver for JDBC and SQLJ properties for DB2 Database for Linux, UNIX, and Windows

Some of the IBM Data Server Driver for JDBC and SQLJ properties apply only to DB2 Database for Linux, UNIX, and Windows servers.

Those properties are:

connectNode
Specifies the target database partition server that an application connects to. The data type of this property is int. The value can be between 0 and 999. The default is database partition server that is defined with port 0. connectNode applies to IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to DB2 Database for Linux, UNIX, and Windows servers only.

currentExplainMode
Specifies the value for the CURRENT EXPLAIN MODE special register. The CURRENT EXPLAIN MODE special register enables and disables the Explain facility. The data type of this property is String. The maximum length is 254 bytes. This property applies only to connections to data sources that support the CURRENT EXPLAIN MODE special register, such as DB2 Database for Linux, UNIX, and Windows.

currentExplainSnapshot
Specifies the value for the CURRENT EXPLAIN SNAPSHOT special register. The CURRENT EXPLAIN SNAPSHOT special register enables and disables the Explain snapshot facility. The data type of this property is String. The maximum length is eight bytes. This property applies only to connections to data sources that support the CURRENT EXPLAIN SNAPSHOT special register, such as DB2 Database for Linux, UNIX, and Windows.

currentQueryOptimization
Specifies a value that controls the class of query optimization that is performed by the database manager when it binds dynamic SQL statements. The data type of this property is int. The possible values of currentQueryOptimization are:

0 Specifies that a minimal amount of optimization is performed to generate an access plan. This class is most suitable for simple dynamic SQL access to well-indexed tables.

1 Specifies that optimization roughly comparable to DB2 Database for Linux, UNIX, and Windows Version 1 is performed to generate an access plan.

2 Specifies a level of optimization higher than that of DB2 Database for Linux, UNIX, and Windows Version 1, but at significantly less optimization cost than levels 3 and above, especially for very complex queries.

3 Specifies that a moderate amount of optimization is performed to generate an access plan.

5 Specifies a significant amount of optimization is performed to generate an access plan. For complex dynamic SQL queries, heuristic rules are used to limit the amount of time spent selecting an access plan. Where possible, queries will use materialized query tables instead of the underlying base tables.

7 Specifies a significant amount of optimization is performed to generate an access plan. This value is similar to 5 but without the heuristic rules.

9 Specifies the maximum amount of optimization is performed to generate an access plan. This can greatly expand the number of possible access plans that are evaluated. This class should be used to determine if a better access plan can be generated for very complex and very long-running queries using large tables. Explain and performance measurements can be used to verify that a better plan has been generated.

optimizationProfile
Specifies an optimization profile that is used during SQL optimization. The data type of this property is String. The optimizationProfile value is used to set the OPTIMIZATION PROFILE special register. The default is null.

optimizationProfile applies to DB2 Database for Linux, UNIX, and Windows servers only.

optimizationProfileToFlush
Specifies the name of an optimization profile that is to be removed from the optimization profile cache. The data type of this property is String. The default is null.

plugin
The name of a client-side JDBC security plug-in. This property has the `Object` type and contains a new instance of the JDBC security plug-in method.

pluginName
The name of a server-side security plug-in module.

useTransactionRedirect
Specifies whether the DB2 system directs SQL statements to different database partitions for better performance. The data type of this property is boolean. The default is `false`.

This property is applicable only under the following conditions:

- The connection is to a DB2 Database for Linux, UNIX, and Windows server that uses the Database Partitioning Feature (DPF).
- The partitioning key remains constant throughout a transaction.

If useTransactionRedirect is `true`, the IBM Data Server Driver for JDBC and SQLJ sends connection requests to the DPF node that contains the target data of the first directable statement in the transaction. DB2 Database for Linux, UNIX, and Windows then directs the SQL statement to different partitions as needed.

IBM Data Server Driver for JDBC and SQLJ properties for DB2 for z/OS

Some of the IBM Data Server Driver for JDBC and SQLJ properties apply only to DB2 for z/OS servers.

Those properties are:

accountingInterval
Specifies whether DB2 for z/OS accounting records are produced at commit points or on termination of the physical connection to the data source. The data type of this property is String. If the value of accountingInterval is

"COMMIT", accounting records are produced at commit points. Otherwise, accounting records are produced on termination of the physical connection to the data source.

accountingInterval applies only to IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS. accountingInterval is not applicable to connections under CICS or IMS, or for Java stored procedures.

The accountingInterval property overrides the db2.jcc.accountingInterval configuration property.

charOutputSize
Specifies the maximum number of bytes to use for INOUT or OUT stored procedure parameters that are registered as `Types.CHAR` charOutputSize applies only to IBM Data Server Driver for JDBC and SQLJ type 2 connectivity to DB2 for z/OS database servers.

Because DESCRIBE information for stored procedure INOUT and OUT parameters is not available at run time, by default, the IBM Data Server Driver for JDBC and SQLJ sets the maximum length of each character INOUT or OUT parameter to 32767. For stored procedures with many `Types.CHAR` parameters, this maximum setting can result in allocation of much more storage than is necessary.

To use storage more efficiently, set charOutputSize to the largest expected length for any `Types.CHAR` INOUT or OUT parameter.

charOutputSize has no effect on INOUT or OUT parameters that are registered as `Types.VARCHAR` or `Types.LONGVARCHAR`. The driver uses the default length of 32767 for `Types.VARCHAR` and `Types.LONGVARCHAR` parameters.

The value that you choose for charOutputSize needs to take into account the possibility of expansion during character conversion. Because the IBM Data Server Driver for JDBC and SQLJ has no information about the server-side CCSID that is used for output parameter values, the driver requests the stored procedure output data in UTF-8 Unicode. The charOutputSize value needs to be the maximum number of bytes that are needed after the parameter value is converted to UTF-8 Unicode. UTF-8 Unicode characters can require up to three bytes. (The euro symbol is an example of a three-byte UTF-8 character.) To ensure that the value of charOutputSize is large enough, if you have no information about the output data, set charOutputSize to three times the defined length of the largest CHAR parameter.

clientAccountingInformation
Specifies accounting information for the current client for the connection. This information is for client accounting purposes. This value can change during a connection. The data type of this property is String. For a DB2 for z/OS server, the maximum length is 255 bytes. A Java empty string ("") is valid for this value, but a Java `null` value is not valid.

This property applies only to IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS.

clientApplicationInformation
Specifies the application or transaction name of the end user's application. You can use this property to provide the identity of the client end user for accounting and monitoring purposes. This value can change during a connection. The data type of this property is String. For a DB2 for z/OS server, the maximum length is 32 bytes. A Java empty string ("") is valid for this value, but a Java `null` value is not valid.

This property applies only to IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS.

clientDebugInfo
Specifies a value for the CLIENT DEBUGINFO connection attribute, to notify the DB2 for z/OS server that stored procedures and user-defined functions that are using the connection are running in debug mode. CLIENT DEBUGINFO is used by the DB2 Unified Debugger. The data type of this property is String. The maximum length is 254 bytes.

This property applies only to IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS.

clientProgramId
Specifies a value for the client program ID that can be used to identify the end user. The data type of this property is String, and the length is 80 bytes. If the program ID value is less than 80 bytes, the value must be padded with blanks.

This property applies only to IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS.

clientProgramName
Specifies an application ID that is fixed for the duration of a physical connection for a client. The value of this property becomes the correlation ID on a DB2 for z/OS server. Database administrators can use this property to correlate work on a DB2 for z/OS server to client applications. The data type of this property is String. The maximum length is 12 bytes. If this value is `null`, the IBM Data Server Driver for JDBC and SQLJ supplies a value of db2jcc*thread-name*.

clientUser
Specifies the current client user name for the connection. This information is for client accounting purposes. Unlike the JDBC connection user name, this value can change during a connection. For a DB2 for z/OS server, the maximum length is 16 bytes.

This property applies only to IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS.

clientWorkstation
Specifies the workstation name for the current client for the connection. This information is for client accounting purposes. This value can change during a connection. The data type of this property is String. For a DB2 for z/OS server, the maximum length is 18 bytes. A Java empty string ("") is valid for this value, but a Java `null` value is not valid.

This property applies only to IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS.

currentSQLID
Specifies:

- The authorization ID that is used for authorization checking on dynamically prepared CREATE, GRANT, and REVOKE SQL statements.
- The owner of a table space, database, storage group, or synonym that is created by a dynamically issued CREATE statement.
- The implicit qualifier of all table, view, alias, and index names specified in dynamic SQL statements.

currentSQLID sets the value in the CURRENT SQLID special register on a DB2 for z/OS server. If the currentSQLID property is not set, the default schema name is the value in the CURRENT SQLID special register.

enableConnectionConcentrator
Indicates whether the connection concentrator function of the IBM Data Server Driver for JDBC and SQLJ is enabled. The connection concentrator function is available only for connections to DB2 for z/OS servers.

The data type of enableConnectionConcentrator is boolean. The default is `false`. However, if enableSysplexWLB is set to `true`, the default is `true`.

enableSysplexWLB
Indicates whether the Sysplex workload balancing function of the IBM Data Server Driver for JDBC and SQLJ is enabled. The Sysplex workload balancing function is available only for connections to DB2 for z/OS servers.

The data type of enableSysplexWLB is boolean. The default is `false`. If enableSysplexWLB is set to `true`, enableConnectionConcentrator is set to true by default.

jdbcCollection
Specifies the collection ID for the packages that are used by an instance of the IBM Data Server Driver for JDBC and SQLJ at run time. The data type of jdbcCollection is String. The default is NULLID.

This property is used with the DB2Binder -collection option. The DB2Binder utility must have previously bound IBM Data Server Driver for JDBC and SQLJ packages at the server using a -collection value that matches the jdbcCollection value.

The jdbcCollection setting does not determine the collection that is used for SQLJ applications. For SQLJ, the collection is determined by the -collection option of the SQLJ customizer.

jdbcCollection does not apply to IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS.

maxTransportObjects
Specifies the maximum number of transport objects that can be used for all connections with the associated DataSource object. The IBM Data Server Driver for JDBC and SQLJ uses transport objects and a global transport objects pool to support the connection concentrator and Sysplex workload balancing. There is one transport object for each physical connection to the data source.

The data type of this property is int.

The maxTransportObjects value is ignored if the enableConnectionConcentrator or enableSysplexWLB properties are not set to enable the use of the connection concentrator or Sysplex workload balancing.

If the maxTransportObjects value has not been reached, and a transport object is not available in the global transport objects pool, the pool creates a new transport object. If the maxTransportObjects value has been reached, the application waits for the amount of time that is specified by the db2.jcc.maxTransportObjectWaitTime configuration property. After that amount of time has elapsed, if there is still no available transport object in the pool, the pool throws an SQLException.

maxTransportObjects does **not** override the db2.jcc.maxTransportObjects configuration property. maxTransportObjects has no effect on connections from other DataSource objects. If the maxTransportObjects value is larger than the db2.jcc.maxTransportObjects value, maxTransportObjects does not increase the db2.jcc.maxTransportObjects value.

The default value for maxTransportObjects is -1, which means that the number of transport objects for the DataSource is limited only by the db2.jcc.maxTransportObjects value for the driver.

queryCloseImplicit
Specifies whether cursors are closed immediately after all rows are fetched. queryCloseImplicit applies only to IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to DB2 for z/OS database servers. Possible values are `DB2BaseDataSource.QUERY_CLOSE_IMPLICIT_YES` (1) and `DB2BaseDataSource.QUERY_CLOSE_IMPLICIT_NO` (2). The default is `DB2BaseDataSource.QUERY_CLOSE_IMPLICIT_YES`.

A value of `DB2BaseDataSource.QUERY_CLOSE_IMPLICIT_YES` can provide better performance because this setting results in less network traffic.

sendCharInputsUTF8
Specifies whether the IBM Data Server Driver for JDBC and SQLJ converts character input data to the CCSID of the DB2 for z/OS database server, or sends the data in UTF-8 encoding for conversion by the database server. sendCharInputsUTF8 applies to IBM Data Server Driver for JDBC and SQLJ type 2 connectivity to DB2 for z/OS database servers only. The data type of this property is int. If this property is also set at the driver level (db2.jcc.sendCharInputsUTF8), this value overrides the driver-level value.

Possible values are:

com.ibm.db2.jcc.DB2BaseDataSource.NO (2)
Specifies that the IBM Data Server Driver for JDBC and SQLJ converts character input data to the target encoding before the data is sent to the DB2 for z/OS database server.
com.ibm.db2.jcc.DB2BaseDataSource.NO is the default.

com.ibm.db2.jcc.DB2BaseDataSource.YES (1)
Specifies that the IBM Data Server Driver for JDBC and SQLJ sends character input data to the DB2 for z/OS database server in UTF-8 encoding. The database server converts the data from UTF-8 encoding to the target CCSID.

Specify com.ibm.db2.jcc.DB2BaseDataSource.YES only if conversion to the target CCSID by the SDK for Java causes character conversion problems. The most common problem occurs when you use IBM Data Server Driver for JDBC and SQLJ type 2 connectivity to insert a Unicode line feed character (U+000A) into a table column that has CCSID 37, and then retrieve that data from a non-z/OS client. If the SDK for Java does the conversion during insertion of the character into the column, the line feed character is converted to the EBCDIC new line character X'15'. However, during retrieval, some SDKs for Java on operating systems other than z/OS convert the X'15' character to the Unicode next line character (U+0085) instead of the line feed character (U+000A). The next line character causes unexpected behavior for some XML parsers. If you set sendCharInputsUTF8 to com.ibm.db2.jcc.DB2BaseDataSource.YES, the DB2 for z/OS database server converts the U+000A character to the EBCDIC line feed character X'25' during insertion into the column, so the character is always retrieved as a line feed character.

Conversion of data to the target CCSID on the database server might cause the IBM Data Server Driver for JDBC and SQLJ to use more memory than conversion by the driver. The driver allocates memory for conversion of character data from the source encoding to the

encoding of the data that it sends to the database server. The amount of space that the driver allocates for character data that is sent to a table column is based on the maximum possible length of the data. UTF-8 data can require up to three bytes for each character. Therefore, if the driver sends UTF-8 data to the database server, the driver needs to allocate three times the maximum number of characters in the input data. If the driver does the conversion, and the target CCSID is a single-byte CCSID, the driver needs to allocate only the maximum number of characters in the input data.

sqljEnableClassLoaderSpecificProfiles
Specifies whether the IBM Data Server Driver for JDBC and SQLJ allows using and loading of SQLJ profiles with the same Java name in multiple J2EE application (.ear) files. The data type of this property is boolean. The default is `false`. sqljEnableClassLoaderSpecificProfiles is a DataSource property. This property is primarily intended for use with WebSphere Application Server.

useRowsetCursor
Specifies whether the IBM Data Server Driver for JDBC and SQLJ always uses multiple-row FETCH for scrollable cursors if the data source supports multiple-row fetch. The data type of this property is boolean. The default is `true`. useRowsetCursor applies to connections to DB2 for z/OS database servers only.

Applications that use the JDBC 1 technique for performing positioned update or delete operations can continue to produce the desired results by setting useRowSetCursor to `false`. The JDBC 1 technique involves using the ResultSet.getCursorName method to obtain the name of the cursor for the ResultSet, and defining a positioned UPDATE or DELETE statement of the following form:

```
UPDATE table SET col1=value1,...coln=valueN WHERE CURRENT OF cursorname
DELETE FROM table WHERE CURRENT OF cursorname
```

Those applications do not operate properly if the IBM Data Server Driver for JDBC and SQLJ uses multiple-row FETCH. Setting useRowSetCursor to `false` ensures that each fetch operation returns a single row.

IBM Data Server Driver for JDBC and SQLJ properties for IBM Informix Dynamic Server

Some of the IBM Data Server Driver for JDBC and SQLJ properties apply only to IBM Informix Dynamic Server (IDS) databases. Those properties correspond to IDS environment variables.

IDS-specific properties must be specified in uppercase. getXXX and setXXX methods for IDS-specific properties are formed by prepending the uppercase property name with get or set. For example:

```
boolean dbDate = DB2BaseDateSource.getDBDATE();
```

The IDS-specific properties are:

DBANSIWARN
Specifies whether the IBM Data Server Driver for JDBC and SQLJ instructs the IDS database to return an SQLWarning to the application if an SQL statement does not use ANSI-standard syntax. The data type of this property is boolean. Possible values are:

false or 0
Do not send a value to the IDS database that instructs the database to return an SQLWarning to the application if an SQL statement does not use ANSI-standard syntax. This is the default.

true or 1
Send a value to the IDS database that instructs the database to return an SQLWarning to the application if an SQL statement does not use ANSI-standard syntax.

You can use the DBANSIWARN IBM Data Server Driver for JDBC and SQLJ property to set the DBANSIWARN IDS property, but you cannot use the DBANSIWARN IBM Data Server Driver for JDBC and SQLJ property to reset the DBANSIWARN IDS property.

DBDATE
Specifies the end-user format of DATE values. The data type of this property is String. Possible values are in the description of the DBDATE environment variable in *IBM Informix Guide to SQL: Reference*.

The default value is ″Y4MD-″.

DBPATH
Specifies a colon-separated list of values that identify the database servers that contain databases. The date type of this property is String. Each value can be:
- A full path name
- A relative path name
- The server name of an IDS database server
- A server name and full path name

The default ″.″.

DBSPACETEMP
Specifies a comma-separated or colon-separated list of existing dbspaces in which temporary tables are placed. The data type of this property is String.

If this property is not set, no value is sent to the server. The value for the DBSPACETEMP environment variable is used.

DBTEMP
Specifies the full path name of an existing directory in which temporary files and temporary tables are placed. The data type of this property is String. The default is ″/tmp″.

DBUPSPACE
Specifies the maximum amount of system disk space and maximum amount of memory, in kilobytes, that the UPDATE STATISTICS statement can use when it constructs multiple column distributions simultaneously. The data type of this property is String.

The format of DBUPSPACE is *″maximum-disk-space*:*maximum-memory″*.

If this property is not set, no value is sent to the server. The value for the DBUPSPACE environment variable is used.

DELIMIDENT
Specifies whether delimited SQL identifiers can be used in an application. The data type of this property is boolean. Possible values are:

false The application cannot contain delimited SQL identifiers. Double quotation marks (″) or single quotation marks (′) delimit literal strings. This is the default.

true The application can contain delimited SQL identifiers. Delimited SQL identifiers must be enclosed in double quotation marks (″). Single quotation marks (′) delimit literal strings.

IFX_DIRECTIVES
Specifies whether the optimizer allows query optimization directives from within a query. The data type of this property is String. Possible values are:

″**1**″ **or** ″**ON**″
Optimization directives are accepted.

″**0**″ **or** ″**OFF**″
Optimization directives are not accepted.

If this property is not set, no value is sent to the server. The value for the IFX_DIRECTIVES environment variable is used.

IFX_EXTDIRECTIVES
Specifies whether the optimizer allows external query optimization directives from the sysdirectives system catalog table to be applied to queries in existing applications. Possible values are:

″**1**″ **or** ″**ON**″
External query optimization directives are accepted.

″**0**″ **or** ″**OFF**″
External query optimization are not accepted.

If this property is not set, no value is sent to the server. The value for the IFX_EXTDIRECTIVES environment variable is used.

IFX_UPDDESC
Specifies whether a DESCRIBE of an UPDATE statement is permitted. The data type of this property is String.

Any non-null value indicates that a DESCRIBE of an UPDATE statement is permitted. The default is ″1″.

IFX_XASTDCOMPLIANCE_XAEND
Specifies whether global transactions are freed only after an explicit rollback, or after any rollback. The data type of this property is String. Possible values are:

″**0**″ Global transactions are freed only after an explicit rollback. This behavior conforms to the X/Open XA standard.

″**1**″ Global transactions are freed after any rollback.

If this property is not set, no value is sent to the server. The value for the IFX_XASTDCOMPLIANCE_XAEND environment variable is used.

INFORMIXOPCACHE
Specifies the size of the memory cache, in kilobytes, for the staging-area blobspace of the client application. The data type of this property is String. A value of ″0″ indicates that the cache is not used.

If this property is not set, no value is sent to the server. The value for the INFORMIXOPCACHE environment variable is used.

INFORMIXSTACKSIZE
Specifies the stack size, in kilobytes, that the database server uses for the primary thread of a client session. The data type of this property is String.

If this property is not set, no value is sent to the server. The value for the INFORMIXSTACKSIZE environment variable is used.

NODEFDAC
Specifies whether the database server prevents default table privileges (SELECT, INSERT, UPDATE, and DELETE) from being granted to PUBLIC when a new table is created during the current session, in a database that is not ANSI compliant. The data type of this property is String. Possible values are:

"**yes**" The database server prevents default table privileges from being granted to PUBLIC when a new table is created during the current session, in a database that is not ANSI compliant.

"**no**" The database server does not prevent default table privileges from being granted to PUBLIC when a new table is created during the current session, in a database that is not ANSI compliant. This is the default.

OPTCOMPIND
Specifies the preferred method for performing a join operation on an ordered pair of tables. The data type of this property is String. Possible values are:

"**0**" The optimizer chooses a nested-loop join, where possible, over a sort-merge join or a hash join.

"**1**" When the isolation level is repeatable read, the optimizer chooses a nested-loop join, where possible, over a sort-merge join or a hash join. When the isolation level is not repeatable read, the optimizer chooses a join method based on costs.

"**2**" The optimizer chooses a join method based on costs, regardless of the transaction isolation mode.

If this property is not set, no value is sent to the server. The value for the OPTCOMPIND environment variable is used.

OPTOFC
Specifies whether to enable optimize-OPEN-FETCH-CLOSE functionality. The data type of this property is String. Possible values are:

"**0**" Disable optimize-OPEN-FETCH-CLOSE functionality for all threads of applications.

"**1**" Enable optimize-OPEN-FETCH-CLOSE functionality for all cursors in all threads of applications.

If this property is not set, no value is sent to the server. The value for the OPTOFCD environment variable is used.

PDQPRIORITY
Specifies the degree of parallelism that the database server uses. The PDQPRIORITY value affects how the database server allocates resources, including memory, processors, and disk reads. The data type of this property is String. Possible values are:

"**HIGH**"
When the database server allocates resources among all users, it gives as many resources as possible to queries.

"**LOW**" **or** "**1**"
The database server fetches values from fragmented tables in parallel.

"**OFF**" **or** "**0**"
Parallel processing is disabled.

If this property is not set, no value is sent to the server. The value for the PDQPRIORITY environment variable is used.

PSORT_DBTEMP
Specifies the full path name of a directory in which the database server writes temporary files that are used for a sort operation. The data type of this property is String.

If this property is not set, no value is sent to the server. The value for the PSORT_DBTEMP environment variable is used.

PSORT_NPROCS
Specifies the maximum number of threads that the database server can use to sort a query. The data type of this property is String. The maximum value of PSORT_NPROCS is ″10″.

If this property is not set, no value is sent to the server. The value for the PSORT_NPROCS environment variable is used.

STMT_CACHE
Specifies whether the shared-statement cache is enabled. The data type of this property is String. Possible values are:

″**0**″ The shared-statement cache is disabled.

″**1**″ A 512 KB shared-statement cache is enabled.

If this property is not set, no value is sent to the server. The value for the STMT_CACHE environment variable is used.

IBM Data Server Driver for JDBC and SQLJ configuration properties

The IBM Data Server Driver for JDBC and SQLJ configuration properties have driver-wide scope.

You can set any of the following IBM Data Server Driver for JDBC and SQLJ configuration properties. All properties are optional.

db2.jcc.currentSchema or db2.jcc.override.currentSchema
Specifies the default schema name that is used to qualify unqualified database objects in dynamically prepared SQL statements. This value of this property sets the value in the CURRENT SCHEMA special register on the database server.

decimalRoundingMode
Specifies the rounding mode for decimal or decimal floating-point values on DB2 for z/OS or DB2 Database for Linux, UNIX, and Windows database servers, and for decimal values on all other data sources that support the decimal data type.

Possible values are:

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_UP (0)
Rounds the value away from 0. If all of the discarded digits are zero the result is unchanged other than the removal of discarded digits. Otherwise, the result coefficient is incremented by 1. This rounding mode is not recommended when creating a portable application because it is not supported by the IEEE draft standard for floating-point arithmetic.

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_DOWN (1)
Rounds the value towards 0 (truncation). The discarded digits are ignored.

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_CEILING (2)
Rounds the value towards positive infinity. If all of the discarded digits are zero or if the sign is negative the result is unchanged other than the removal of the discarded digits. Otherwise, the result coefficient is incremented by 1.

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_HALF_EVEN (3)
Rounds the value to the nearest value; if the values are equidistant, rounds the value so that the final digit is even. If the discarded digits represents greater than half (0.5) of the value of one in the next left position then the result coefficient is incremented by 1. If they represent less than half, then the result coefficient is not adjusted (that is, the discarded digits are ignored). Otherwise the result coefficient is unaltered if its rightmost digit is even, or is incremented by 1 if its rightmost digit is odd (to make an even digit).

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_HALF_UP (4)
Rounds the value to the nearest value; if the values are equidistant, rounds the value away from zero. If the discarded digits represent greater than or equal to half (0.5) of the value of one in the next left position then the result coefficient is incremented by 1. Otherwise the discarded digits are ignored.

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_HALF_DOWN (5)
Rounds the value to the nearest value; if the values are equidistant, rounds the value towards zero. If the discarded digits represent greater than half (0.5) of the value of a one in the next left position then the result coefficient is incremented by 1. Otherwise the discarded digits are ignored. This rounding mode is not recommended when creating a portable application because it is not supported by the IEEE draft standard for floating-point arithmetic.

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_FLOOR (6)
Rounds the value towards negative infinity. If all of the discarded digits are zero or if the sign is positive the result is unchanged other than the removal of discarded digits. Otherwise, the sign is negative and the result coefficient is incremented by 1.

com.ibm.db2.jcc.DB2BaseDataSource.ROUND_UNSET (-2147483647)
No rounding mode was explicitly set. The IBM Data Server Driver for JDBC and SQLJ does not use the decimalRoundingMode to set the rounding mode on the data source.

The IBM Data Server Driver for JDBC and SQLJ uses the following values for its rounding mode:

- If the data source is DB2 for z/OS or DB2 Database for Linux, UNIX, and Windows, the rounding mode is ROUND_HALF_EVEN for decimal or decimal floating-point values.
- For any other data source, the rounding mode is ROUND_DOWN for decimal values.

db2.jcc.jmxEnabled
Specifies whether the Java Management Extensions (JMX) is enabled for the IBM Data Server Driver for JDBC and SQLJ instance. JMX must be enabled before applications can use the remote trace controller.

Possible values are:

true or yes
Indicates that JMX is enabled.

Any other value
Indicates that JMX is disabled. This is the default.

A value of

db2.jcc.traceDirectory or db2.jcc.override.traceDirectory
Enables the IBM Data Server Driver for JDBC and SQLJ trace for Java driver code, and specifies a directory into which trace information is written. When db2.jcc.override.traceDirectory is specified, trace information for multiple connections on the same DataSource is written to multiple files.

When db2.jcc.override.traceDirectory is specified, a connection is traced to a file named *file-name_origin_n*.

- *n* is the *n*th connection for a DataSource.
- If neither db2.jcc.traceFileName nor db2.jcc.override.traceFileName is specified, *file-name* is traceFile. If db2.jcc.traceFileName or db2.jcc.override.traceFileName is also specified, *file-name* is the value of db2.jcc.traceFileName or db2.jcc.override.traceFileName.
- *origin* indicates the origin of the log writer that is in use. Possible values of *origin* are:

  cpds The log writer for a DB2ConnectionPoolDataSource object.

  driver The log writer for a DB2Driver object.

  global The log writer for a DB2TraceManager object.

  sds The log writer for a DB2SimpleDataSource object.

  xads The log writer for a DB2XADataSource object.

The db2.jcc.override.traceDirectory property overrides the `traceDirectory` property for a Connection or DataSource object.

For example, specifying the following setting for db2.jcc.override.traceDirectory enables tracing of the IBM Data Server Driver for JDBC and SQLJ Java code to files in a directory named /SYSTEM/tmp:

```
db2.jcc.override.traceDirectory=/SYSTEM/tmp
```

You should set the trace properties under the direction of IBM Software Support.

db2.jcc.traceLevel or db2.jcc.override.traceLevel
Specifies what to trace.

The db2.jcc.override.traceLevel property overrides the `traceLevel` property for a Connection or DataSource object.

You specify one or more trace levels by specifying a decimal value. The trace levels are the same as the trace levels that are defined for the traceLevel property on a Connection or DataSource object.

To specify more than one trace level, do an OR (`|`) operation on the values, and specify the result in decimal in the db2.jcc.traceLevel or db2.jcc.override.traceLevel specification.

For example, suppose that you want to specify TRACE_DRDA_FLOWS and TRACE_CONNECTIONS for db2.jcc.override.traceLevel. TRACE_DRDA_FLOWS has a hexadecimal value of X'40'. TRACE_CONNECTION_CALLS has a hexadecimal value of X'01'. To specify both traces, do a bitwise OR operation on the two values, which results in X'41'. The decimal equivalent is 65, so you specify:

```
db2.jcc.override.traceLevel=65
```

db2.jcc.sqljUncustomizedWarningOrException
Specifies the action that the IBM Data Server Driver for JDBC and SQLJ takes when an uncustomized SQLJ application runs. db2.jcc.sqljUncustomizedWarningOrException can have the following values:

0 The IBM Data Server Driver for JDBC and SQLJ does not throw a Warning or Exception when an uncustomized SQLJ application is run. This is the default.

1 The IBM Data Server Driver for JDBC and SQLJ throws a Warning when an uncustomized SQLJ application is run.

2 The IBM Data Server Driver for JDBC and SQLJ throws an Exception when an uncustomized SQLJ application is run.

db2.jcc.traceFile or db2.jcc.override.traceFile
Enables the IBM Data Server Driver for JDBC and SQLJ trace for Java driver code, and specifies the name on which the trace file names are based.

Specify a fully qualified z/OS UNIX System Services file name for the db2.jcc.override.traceFile property value.

The db2.jcc.override.traceFile property overrides the `traceFile` property for a Connection or DataSource object.

For example, specifying the following setting for db2.jcc.override.traceFile enables tracing of the IBM Data Server Driver for JDBC and SQLJ Java code to a file named /SYSTEM/tmp/jdbctrace:

```
db2.jcc.override.traceFile=/SYSTEM/tmp/jdbctrace
```

You should set the trace properties under the direction of IBM Software Support.

db2.jcc.traceFileAppend or db2.jcc.override.traceFileAppend
Specifies whether to append to or overwrite the file that is specified by the db2.jcc.override.traceFile property. The data type of this property is boolean. The default is `false`, which means that the file that is specified by the traceFile property is overwritten.

The db2.jcc.override.traceFileAppend property overrides the `traceFileAppend` property for a Connection or DataSource object.

For example, specifying the following setting for db2.jcc.override.traceFileAppend causes trace data to be added to the existing trace file:

```
db2.jcc.override.traceFileAppend=true
```

You should set the trace properties under the direction of IBM Software Support.

Driver support for JDBC APIs

The JDBC drivers that are supported by DB2 and IBM Informix Dynamic Server (IDS) database systems have different levels of support for JDBC methods.

The following tables list the JDBC interfaces and indicate which drivers supports them. The drivers and their supported platforms are:

Table 34. JDBC drivers for DB2 and IDS database systems

JDBC driver name	Associated data source
IBM Data Server Driver for JDBC and SQLJ	DB2 Database for Linux, UNIX, and Windows, DB2 for z/OS, or IBM Informix Dynamic Server (IDS)
DB2 JDBC Type 2 Driver for Linux, UNIX and Windows (deprecated)	DB2 Database for Linux, UNIX, and Windows
IBM Informix JDBC Driver (IDS JDBC Driver)	IDS

If a method has JDBC 2.0 and JDBC 3.0 forms, the IBM Data Server Driver for JDBC and SQLJ supports all forms. The DB2 JDBC Type 2 Driver for Linux, UNIX and Windows supports only the JDBC 2.0 forms.

Table 35. Support for Array methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ1 support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
free[2]	Yes	No	No
getArray	Yes	No	Yes
getBaseType	Yes	No	Yes
getBaseTypeName	Yes	No	Yes
getResultSet	Yes	No	Yes

Notes:

1. Under the IBM Data Server Driver for JDBC and SQLJ, `Array` methods are supported for connections to DB2 Database for Linux, UNIX, and Windows data sources only.
2. This is a JDBC 4.0 method.

Table 36. Support for BatchUpdateException methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	Yes	Yes
getUpdateCounts	Yes	Yes	Yes

Table 37. Support for Blob methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
free[1]	Yes	No	No
getBinaryStream	Yes[2]	Yes	Yes
getBytes	Yes	Yes	Yes

Table 37. Support for Blob methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
length	Yes	Yes	Yes
position	Yes	Yes	Yes
setBinaryStream[3]	Yes	No	No
setBytes[3]	Yes	No	No
truncate[3]	Yes	No	No

Notes:

1. This is a JDBC 4.0 method.
2. Supported forms of this method include the following JDBC 4.0 form:
   `getBinaryStream(long pos, long length)`
3. This method cannot be used under the following circumstances:
   - If the `fullyMaterializeLobData` property is set to false.
   - For a Blob that is passed to a Java stored procedure.

Table 38. Support for CallableStatement methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.sql.Statement	Yes	Yes	Yes
Methods inherited from java.sql.PreparedStatement	Yes[1]	Yes	Yes
getArray	No	No	No
getBigDecimal	Yes[3]	Yes	Yes
getBlob	Yes[3]	Yes	Yes
getBoolean	Yes[3]	Yes	Yes
getByte	Yes[3]	Yes	Yes
getBytes	Yes[3]	Yes	Yes
getClob	Yes[3]	Yes	Yes
getDate	Yes[3,4]	Yes[4]	Yes
getDouble	Yes[3]	Yes	Yes
getFloat	Yes[3]	Yes	Yes
getInt	Yes[3]	Yes	Yes
getLong	Yes[3]	Yes	Yes
getObject	Yes[3,5]	Yes[5]	Yes
getRef	No	No	No
getRowId[2]	Yes	No	No
getShort	Yes[3]	Yes	Yes
getString	Yes[3]	Yes	Yes
getTime	Yes[3,4]	Yes[4]	Yes
getTimestamp	Yes[3,4]	Yes[4]	Yes
getURL	Yes	No	No

Table 38. Support for CallableStatement methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
registerOutParameter	Yes[6]	Yes[6]	Yes[6]
setAsciiStream	Yes[7]	No	Yes
setBigDecimal	Yes[7]	No	Yes
setBinaryStream	Yes[7]	No	Yes
setBoolean	Yes[7]	No	Yes
setByte	Yes[7]	No	Yes
setBytes	Yes[7]	No	Yes
setCharacterStream	Yes[7]	No	Yes
setDate	Yes[7]	No	Yes
setDouble	Yes[7]	No	Yes
setFloat	Yes[7]	No	Yes
setInt	Yes[7]	No	Yes
setLong	Yes[7]	No	Yes
setNull	Yes[7,8]	No	Yes
setObject	Yes[7]	No	Yes
setShort	Yes[7]	No	Yes
setString	Yes[7]	No	Yes
setTime	Yes[7]	No	Yes
setTimestamp	Yes[7]	No	Yes
setURL	Yes	No	No
wasNull	Yes	Yes	Yes

Notes:

1. The inherited getParameterMetaData method is not supported if the data source is DB2 for z/OS.
2. This is a JDBC 4.0 method.
3. The following forms of CallableStatement.getXXX methods are not supported if the data source is DB2 for z/OS:
   `get`*`XXX`*`(String` *`parameterName`*`)`
4. The database server does no timezone adjustment for datetime values. The JDBC driver adjusts a value for the local timezone after retrieving the value from the server if you specify a form of the getDate, getTime, or getTimestamp method that includes a java.util.Calendar parameter.
5. The following form of the getObject method is not supported:
   `getObject(int` *`parameterIndex`*`, java.util.Map` *`map`*`)`
6. The following form of the registerOutParameter method is not supported:
   `registerOutParameter(int` *`parameterIndex`*`, int` *`jdbcType`*`, String` *`typeName`*`)`
7. Not supported if the data source is DB2 for z/OS.
8. The following form of setNull is not supported:
   `setNull(int` *`parameterIndex`*`, int` *`jdbcType`*`, String` *`typeName`*`)`

Table 39. Support for Clob methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
free[1]	Yes	No	No
getAsciiStream	Yes	Yes	Yes
getCharacterStream	Yes2	Yes	Yes
getSubString	Yes	Yes	Yes
length	Yes	Yes	Yes
position	Yes	Yes	Yes
setAsciiStream[3]	Yes	No	Yes
setCharacterStream[3]	Yes	No	Yes
setString[3]	Yes	No	Yes
truncate[3]	Yes	No	Yes

Notes:

1. This is a JDBC 4.0 method.
2. Supported forms of this method include the following JDBC 4.0 form:
   `getCharacterStream(long pos, long length)`
3. This method cannot be used under the following circumstances:
   - If the `fullyMaterializeLobData` property is set to false.
   - For a Clob that is passed to a Java stored procedure.

Table 40. Support for Connection methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
clearWarnings	Yes	Yes	Yes
close	Yes	Yes	Yes
commit	Yes	Yes	Yes
createStatement	Yes	Yes[2]	Yes
createBlob[1]	Yes	No	No
createClob[1]	Yes	No	No
getAutoCommit	Yes	Yes	Yes
getCatalog	Yes	Yes	Yes
getClientInfo[3]	Yes	No	No
getHoldability	Yes	No	No
getMetaData	Yes	Yes	Yes
getTransactionIsolation	Yes	Yes	Yes
getTypeMap	No	No	Yes
getWarnings	Yes	Yes	Yes
isClosed	Yes	Yes	Yes
isReadOnly	Yes	Yes	Yes
isValid[3]	Yes	No	No
nativeSQL	Yes	Yes	Yes

Table 40. Support for Connection methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
prepareCall	Yes[4]	Yes	Yes
prepareStatement	Yes	Yes[2]	Yes
releaseSavepoint	Yes	No	No
rollback	Yes	Yes[2]	Yes
setAutoCommit	Yes	Yes	Yes
setCatalog	Yes	Yes	No
setClientInfo[3]	Yes	No	No
setReadOnly	Yes[5]	Yes	No
setSavepoint	Yes	No	Yes
setTransactionIsolation	Yes	Yes	Yes
setTypeMap	No	No	Yes

Notes:

1. This is a JDBC 4.0 method.
2. The DB2 JDBC Type 2 Driver for Linux, UNIX and Windows does not support the JDBC 3.0 forms of this method.
3. This is a JDBC 4.0 method.
4. If the stored procedure in the CALL statement is on DB2 for z/OS, the parameters of the CALL statement cannot be expressions.
5. The driver does not use the setting. For the IBM Data Server Driver for JDBC and SQLJ, a connection can be set as read-only through the `readOnly` property for a Connection or DataSource object.

Table 41. Support for ConnectionEvent methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.util.EventObject	Yes	Yes	Yes
getSQLException	Yes	Yes	Yes

Table 42. Support for ConnectionEventListener methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
connectionClosed	Yes	Yes	Yes
connectionErrorOccurred	Yes	Yes	Yes

Table 43. Support for ConnectionPoolDataSource methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getLoginTimeout	Yes	Yes	Yes
getLogWriter	Yes	Yes	Yes
getPooledConnection	Yes	Yes	Yes

Table 43. Support for ConnectionPoolDataSource methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
setLoginTimeout	Yes[1]	Yes	Yes
setLogWriter	Yes	Yes	Yes

Note:

1. This method is not supported for IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS.

Table 44. Support for DatabaseMetaData methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
allProceduresAreCallable	Yes	Yes	Yes
allTablesAreSelectable	Yes[1]	Yes	Yes[1]
dataDefinitionCausesTransactionCommit	Yes	Yes	Yes
dataDefinitionIgnoredInTransactions	Yes	Yes	Yes
deletesAreDetected	Yes	Yes	Yes
doesMaxRowSizeIncludeBlobs	Yes	Yes	Yes
getAttributes	Yes[2]	No	No
getBestRowIdentifier	Yes	Yes	Yes
getCatalogs	Yes	Yes	Yes
getCatalogSeparator	Yes	Yes	Yes
getCatalogTerm	Yes	Yes	Yes
getClientInfoProperties[6]	Yes	No	No
getColumnPrivileges	Yes	Yes	Yes
getColumns	Yes[7]	Yes[10]	Yes[10]
getConnection	Yes	Yes	Yes
getCrossReference	Yes	Yes	Yes
getDatabaseMajorVersion	Yes	No	No
getDatabaseMinorVersion	Yes	No	No
getDatabaseProductName	Yes	Yes	Yes
getDatabaseProductVersion	Yes	Yes	Yes
getDefaultTransactionIsolation	Yes	Yes	Yes
getDriverMajorVersion	Yes	Yes	Yes
getDriverMinorVersion	Yes	Yes	Yes
getDriverName	Yes[8]	Yes	Yes
getDriverVersion	Yes	Yes	Yes
getExportedKeys	Yes	Yes	Yes
getFunctionColumns[6]	Yes	No	No
getFunctions[6]	Yes	No	No

Table 44. Support for DatabaseMetaData methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getExtraNameCharacters	Yes	Yes	Yes
getIdentifierQuoteString	Yes	Yes	Yes
getImportedKeys	Yes	Yes	Yes
getIndexInfo	Yes	Yes	Yes
getJDBCMajorVersion	Yes	No	No
getJDBCMinorVersion	Yes	No	No
getMaxBinaryLiteralLength	Yes	Yes	Yes
getMaxCatalogNameLength	Yes	Yes	Yes
getMaxCharLiteralLength	Yes	Yes	Yes
getMaxColumnNameLength	Yes	Yes	Yes
getMaxColumnsInGroupBy	Yes	Yes	Yes
getMaxColumnsInIndex	Yes	Yes	Yes
getMaxColumnsInOrderBy	Yes	Yes	Yes
getMaxColumnsInSelect	Yes	Yes	Yes
getMaxColumnsInTable	Yes	Yes	Yes
getMaxConnections	Yes	Yes	Yes
getMaxCursorNameLength	Yes	Yes	Yes
getMaxIndexLength	Yes	Yes	Yes
getMaxProcedureNameLength	Yes	Yes	Yes
getMaxRowSize	Yes	Yes	Yes
getMaxSchemaNameLength	Yes	Yes	Yes
getMaxStatementLength	Yes	Yes	Yes
getMaxStatements	Yes	Yes	Yes
getMaxTableNameLength	Yes	Yes	Yes
getMaxTablesInSelect	Yes	Yes	Yes
getMaxUserNameLength	Yes	Yes	Yes
getNumericFunctions	Yes	Yes	Yes
getPrimaryKeys	Yes	Yes	Yes
getProcedureColumns	Yes7 on page 260	Yes	Yes
getProcedures	Yes7 on page 260	Yes	Yes
getProcedureTerm	Yes	Yes	Yes
getResultSetHoldability	Yes	No	No
getRowIdLifetime[6]	Yes	No	No
getSchemas	Yes9 on page 260	Yes[10]	Yes[10]

Table 44. Support for DatabaseMetaData methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getSchemaTerm	Yes	Yes	Yes
getSearchStringEscape	Yes	Yes	Yes
getSQLKeywords	Yes	Yes	Yes
getSQLStateType	Yes	No	No
getStringFunctions	Yes	Yes	Yes
getSuperTables	Yes[2]	No	No
getSuperTypes	Yes[2]	No	No
getSystemFunctions	Yes	Yes	Yes
getTablePrivileges	Yes	Yes	Yes
getTables	Yes	Yes[10]	Yes[10]
getTableTypes	Yes	Yes	Yes
getTimeDateFunctions	Yes	Yes	Yes
getTypeInfo	Yes	Yes	Yes
getUDTs	No	Yes[11]	Yes[11]
getURL	Yes	Yes	Yes
getUserName	Yes	Yes	Yes
getVersionColumns	Yes	Yes	Yes
insertsAreDetected	Yes	Yes	Yes
isCatalogAtStart	Yes	Yes	Yes
isReadOnly	Yes	Yes	Yes
locatorsUpdateCopy	Yes[3]	Yes	Yes[3]
nullPlusNonNullIsNull	Yes	Yes	Yes
nullsAreSortedAtEnd	Yes[4]	Yes	Yes[4]
nullsAreSortedAtStart	Yes	Yes	Yes
nullsAreSortedHigh	Yes[5]	Yes	Yes[5]
nullsAreSortedLow	Yes[1]	Yes	Yes[1]
othersDeletesAreVisible	Yes	Yes	Yes
othersInsertsAreVisible	Yes	Yes	Yes
othersUpdatesAreVisible	Yes	Yes	Yes
ownDeletesAreVisible	Yes	Yes	Yes
ownInsertsAreVisible	Yes	Yes	Yes
ownUpdatesAreVisible	Yes	Yes	Yes
storesLowerCaseIdentifiers	Yes[1]	Yes	Yes[1]
storesLowerCaseQuotedIdentifiers	Yes[4]	Yes	Yes[4]
storesMixedCaseIdentifiers	Yes	Yes	Yes
storesMixedCaseQuotedIdentifiers	Yes	Yes	Yes

Table 44. Support for DatabaseMetaData methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
storesUpperCaseIdentifiers	Yes[5]	Yes	Yes[5]
storesUpperCaseQuotedIdentifiers	Yes	Yes	Yes
supportsAlterTableWithAddColumn	Yes	Yes	Yes
supportsAlterTableWithDropColumn	Yes[1]	Yes	Yes[1]
supportsANSI92EntryLevelSQL	Yes	Yes	Yes
supportsANSI92FullSQL	Yes	Yes	Yes
supportsANSI92IntermediateSQL	Yes	Yes	Yes
supportsBatchUpdates	Yes	Yes	Yes
supportsCatalogsInDataManipulation	Yes[1]	Yes	Yes[1]
supportsCatalogsInIndexDefinitions	Yes	Yes	Yes
supportsCatalogsInPrivilegeDefinitions	Yes	Yes	Yes
supportsCatalogsInProcedureCalls	Yes[1]	Yes	Yes[1]
supportsCatalogsInTableDefinitions	Yes	Yes	Yes
SupportsColumnAliasing	Yes	Yes	Yes
supportsConvert	Yes	Yes	Yes
supportsCoreSQLGrammar	Yes	Yes	Yes
supportsCorrelatedSubqueries	Yes	Yes	Yes
supportsDataDefinitionAndDataManipulationTransactions	Yes	Yes	Yes
supportsDataManipulationTransactionsOnly	Yes	Yes	Yes
supportsDifferentTableCorrelationNames	Yes[4]	Yes	Yes[4]
supportsExpressionsInOrderBy	Yes	Yes	Yes
supportsExtendedSQLGrammar	Yes	Yes	Yes
supportsFullOuterJoins	Yes[3]	Yes	Yes[3]
supportsGetGeneratedKeys	Yes	No	No
supportsGroupBy	Yes	Yes	Yes
supportsGroupByBeyondSelect	Yes	Yes	Yes
supportsGroupByUnrelated	Yes	Yes	Yes
supportsIntegrityEnhancementFacility	Yes	Yes	Yes
supportsLikeEscapeClause	Yes	Yes	Yes
supportsLimitedOuterJoins	Yes	Yes	Yes
supportsMinimumSQLGrammar	Yes	Yes	Yes
supportsMixedCaseIdentifiers	Yes	Yes	Yes
supportsMixedCaseQuotedIdentifiers	Yes[3]	Yes	Yes[3]
supportsMultipleOpenResults	Yes[5]	No	Yes[5]
supportsMultipleResultSets	Yes[5]	Yes	Yes[5]
supportsMultipleTransactions	Yes	Yes	Yes

Table 44. Support for DatabaseMetaData methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
supportsNamedParameters	Yes	No	No
supportsNonNullableColumns	Yes	Yes	Yes
supportsOpenCursorsAcrossCommit	Yes[3]	Yes	Yes[3]
supportsOpenCursorsAcrossRollback	Yes	Yes	Yes
supportsOpenStatementsAcrossCommit	Yes[3]	Yes	Yes[3]
supportsOpenStatementsAcrossRollback	Yes[3]	Yes	Yes[3]
supportsOrderByUnrelated	Yes	Yes	Yes
supportsOuterJoins	Yes	Yes	Yes
supportsPositionedDelete	Yes	Yes	Yes
supportsPositionedUpdate	Yes	Yes	Yes
supportsResultSetConcurrency	Yes	Yes	Yes
supportsResultSetHoldability	Yes	No	No
supportsResultSetType	Yes	Yes	Yes
supportsSavepoints	Yes[5]	No	Yes[5]
supportsSchemasInDataManipulation	Yes	Yes	Yes
supportsSchemasInIndexDefinitions	Yes	Yes	Yes
supportsSchemasInPrivilegeDefinitions	Yes	Yes	Yes
supportsSchemasInProcedureCalls	Yes	Yes	Yes
supportsSchemasInTableDefinitions	Yes	Yes	Yes
supportsSelectForUpdate	Yes	Yes	Yes
supportsStoredProcedures	Yes	Yes	Yes
supportsSubqueriesInComparisons	Yes	Yes	Yes
supportsSubqueriesInExists	Yes	Yes	Yes
supportsSubqueriesInIns	Yes	Yes	Yes
supportsSubqueriesInQuantifieds	Yes	Yes	Yes
supportsSuperTables	Yes	No	No
supportsSuperTypes	Yes	No	No
supportsTableCorrelationNames	Yes	Yes	Yes
supportsTransactionIsolationLevel	Yes	Yes	Yes
supportsTransactions	Yes	Yes	Yes
supportsUnion	Yes	Yes	Yes
supportsUnionAll	Yes	Yes	Yes
updatesAreDetected	Yes	Yes	Yes
usesLocalFilePerTable	Yes	Yes	Yes
usesLocalFiles	Yes	Yes	Yes

Table 44. Support for DatabaseMetaData methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support

Notes:

1. DB2 data sources return `false` for this method. IDS data sources return `true`.
2. This method is supported for connections to DB2 Database for Linux, UNIX, and Windows and IDS only.
3. Under the IBM Data Server Driver for JDBC and SQLJ, DB2 data sources and IDS data sources return `true` for this method. Under the IDS JDBC Driver, IDS data sources return `false`.
4. Under the IBM Data Server Driver for JDBC and SQLJ, DB2 data sources and IDS data sources return `false` for this method. Under the IDS JDBC Driver, IDS data sources return `true`.
5. DB2 data sources return `true` for this method. IDS data sources return `false`.
6. This is a JDBC 4.0 method.
7. This method returns the additional column that is described by the JDBC 4.0 specification.
8. JDBC 3.0 and earlier implementations of the IBM Data Server Driver for JDBC and SQLJ return ″IBM DB2 JDBC Universal Driver Architecture.″

   The JDBC 4.0 implementation of the IBM Data Server Driver for JDBC and SQLJ returns ″IBM Data Server Driver for JDBC and SQLJ.″
9. The JDBC 4.0 form and previous forms of this method are supported.
10. The DB2 JDBC Type 2 Driver for Linux, UNIX and Windows does not support the JDBC 3.0 form of this method.
11. The method can be executed, but it returns an empty ResultSet.

Table 45. Support for DataSource methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getConnection	Yes	Yes	Yes
getLoginTimeout	Yes	Yes[1]	Yes
getLogWriter	Yes	Yes	Yes
setLoginTimeout	Yes[2]	Yes[1]	Yes
setLogWriter	Yes	Yes	Yes

Notes:

1. The DB2 JDBC Type 2 Driver does not use this setting.
2. This method is not supported for IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS.

Table 46. Support for DataTruncation methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Throwable	Yes	Yes	Yes
Methods inherited from java.sql.SQLException	Yes	Yes	Yes
Methods inherited from java.sql.SQLWarning	Yes	Yes	Yes

Table 46. Support for DataTruncation methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getDataSize	Yes	Yes	Yes
getIndex	Yes	Yes	Yes
getParameter	Yes	Yes	Yes
getRead	Yes	Yes	Yes
getTransferSize	Yes	Yes	Yes

Table 47. Support for Driver methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
acceptsURL	Yes	Yes	Yes
connect	Yes	Yes	Yes
getMajorVersion	Yes	Yes	Yes
getMinorVersion	Yes	Yes	Yes
getPropertyInfo	Yes	Yes	Yes
jdbcCompliant	Yes	Yes	Yes

Table 48. Support for DriverManager methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
deregisterDriver	Yes	Yes	Yes
getConnection	Yes	Yes	Yes
getDriver	Yes	Yes	Yes
getDrivers	Yes	Yes	Yes
getLoginTimeout	Yes	Yes[1]	Yes[1]
getLogStream	Yes	Yes	Yes
getLogWriter	Yes	Yes	Yes
println	Yes	Yes	Yes
registerDriver	Yes	Yes	Yes
setLoginTimeout	Yes[2]	Yes[1]	Yes[1]
setLogStream	Yes	Yes	Yes
setLogWriter	Yes	Yes	Yes

Notes:

1. The DB2 JDBC Type 2 Driver does not use this setting.
2. This method is not supported for IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS.

Table 49. Support for ParameterMetaData methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getParameterClassName	No	No	No
getParameterCount	Yes	No	No
getParameterMode	Yes	No	No
getParameterType	Yes	No	No
getParameterTypeName	Yes	No	No
getPrecision	Yes	No	No
getScale	Yes	No	No
isNullable	Yes	No	No
isSigned	Yes	No	No

Table 50. Support for PooledConnection methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
addConnectionEventListener	Yes	Yes	Yes
addStatementEventListener[1]	Yes	No	No
close	Yes	Yes	Yes
getConnection	Yes	Yes	Yes
removeConnectionEventListener	Yes	Yes	Yes
removeStatementEventListener[1]	Yes	No	No

Notes:

1. This is a JDBC 4.0 method.

Table 51. Support for PreparedStatement methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.sql.Statement	Yes	Yes	Yes
addBatch	Yes	Yes	Yes
clearParameters	Yes	Yes	Yes
execute	Yes	Yes	Yes
executeQuery	Yes	Yes	Yes
executeUpdate	Yes	Yes	Yes
getMetaData	Yes	Yes	Yes
getParameterMetaData	Yes	Yes	Yes
setArray	No	No	No
setAsciiStream	Yes[1,2]	Yes	Yes
setBigDecimal	Yes	Yes	Yes
setBinaryStream	Yes[1,3]	Yes	Yes

Table 51. Support for PreparedStatement methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
setBlob	Yes[4]	Yes	Yes
setBoolean	Yes	Yes	Yes
setByte	Yes	Yes	Yes
setBytes	Yes	Yes	Yes
setCharacterStream	Yes[1,5]	Yes	Yes
setClob	Yes[6]	Yes	Yes
setDate	Yes[8]	Yes[8]	Yes[8]
setDouble	Yes	Yes	Yes
setFloat	Yes	Yes	Yes
setInt	Yes	Yes	Yes
setLong	Yes	Yes	Yes
setNull	Yes[9]	Yes[9]	Yes[9]
setObject	Yes	Yes	Yes
setRef	No	No	No
setRowId[7]	Yes	No	No
setShort	Yes	Yes	Yes
setString	Yes[10]	Yes[10]	Yes[10]
setTime	Yes[8]	Yes[8]	Yes[8]
setTimestamp	Yes[8]	Yes[8]	Yes[8]
setUnicodeStream	Yes	Yes	Yes
setURL	Yes	Yes	Yes

Table 51. Support for PreparedStatement methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support

Notes:

1. If the value of the *length* parameter is -1, all of the data from the InputStream or Reader is read and sent to the data source.
2. Supported forms of this method include the following JDBC 4.0 forms:
   ```
   setAsciiStream(int parameterIndex, InputStream x, long length)
   setAsciiStream(int parameterIndex, InputStream x)
   ```
3. Supported forms of this method include the following JDBC 4.0 forms:
   ```
   setBinaryStream(int parameterIndex, InputStream x, long length)
   setBinaryStream(int parameterIndex, InputStream x)
   ```
4. Supported forms of this method include the following JDBC 4.0 form:
   ```
   setBlob(int parameterIndex, InputStream inputStream, long length)
   ```
5. Supported forms of this method include the following JDBC 4.0 forms:
   ```
   setCharacterStream(int parameterIndex, Reader reader, long length)
   setCharacterStream(int parameterIndex, Reader reader)
   ```
6. Supported forms of this method include the following JDBC 4.0 form:
   ```
   setClob(int parameterIndex, Reader reader, long length)
   ```
7. This is a JDBC 4.0 method.
8. The database server does no timezone adjustment for datetime values. The JDBC driver adjusts a value for the local timezone before sending the value to the server if you specify a form of the setDate, setTime, or setTimestamp method that includes a java.util.Calendar parameter.
9. The following form of setNull is not supported:
   ```
   setNull(int parameterIndex, int jdbcType, String typeName)
   ```
10. setString is not supported if the column has the FOR BIT DATA attribute or the data type is BLOB.

Table 52. Support for Ref methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
get BaseTypeName	No	No	No

Table 53. Support for ResultSet methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
absolute	Yes	Yes	Yes
afterLast	Yes	Yes	Yes
beforeFirst	Yes	Yes	Yes
cancelRowUpdates	Yes	No	No
clearWarnings	Yes	Yes	Yes
close	Yes	Yes	Yes
deleteRow	Yes	No	No
findColumn	Yes	Yes	Yes
first	Yes	Yes	Yes
getArray	No	No	No

Table 53. Support for ResultSet methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getAsciiStream	Yes	Yes	Yes
getBigDecimal	Yes	Yes	Yes
getBinaryStream	Yes[1]	Yes	Yes
getBlob	Yes	Yes	Yes
getBoolean	Yes	Yes	Yes
getByte	Yes	Yes	Yes
getBytes	Yes	Yes	Yes
getCharacterStream	Yes	Yes	Yes
getClob	Yes	Yes	Yes
getConcurrency	Yes	Yes	Yes
getCursorName	Yes	Yes	Yes
getDate	Yes[2]	Yes[2]	Yes[2]
getDouble	Yes	Yes	Yes
getFetchDirection	Yes	Yes	Yes
getFetchSize	Yes	Yes	Yes
getFloat	Yes	Yes	Yes
getInt	Yes	Yes	Yes
getLong	Yes	Yes	Yes
getMetaData	Yes	Yes	Yes
getObject	Yes[3]	Yes[3]	Yes[3]
getRef	No	No	No
getRow	Yes	Yes	Yes
getRowId[9]	Yes	No	No
getShort	Yes	Yes	Yes
getStatement	Yes	Yes	Yes
getString	Yes	Yes	Yes
getTime	Yes[2]	Yes[2]	Yes[2]
getTimestamp	Yes[2]	Yes[2]	Yes[2]
getType	Yes	Yes	Yes
getUnicodeStream	Yes	Yes	Yes
getURL	Yes	Yes	Yes
getWarnings	Yes	Yes	Yes
insertRow	Yes	No	No
isAfterLast	Yes	Yes	Yes
isBeforeFirst	Yes	Yes	Yes
isFirst	Yes	Yes	Yes
isLast	Yes	Yes	Yes
last	Yes	Yes	Yes

Table 53. Support for ResultSet methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
moveToCurrentRow	Yes	No	No
moveToInsertRow	Yes	No	No
next	Yes	Yes	Yes
previous	Yes	Yes	Yes
refreshRow	Yes	No	No
relative	Yes	Yes	Yes
rowDeleted	Yes	No	No
rowInserted	Yes	No	No
rowUpdated	Yes	No	No
setFetchDirection	Yes	Yes	Yes
setFetchSize	Yes	Yes	Yes
updateArray	No	No	No
updateAsciiStream	Yes[4]	No	No
updateBigDecimal	Yes	No	No
updateBinaryStream	Yes[5]	No	No
updateBlob	Yes[6]	No	No
updateBoolean	Yes	No	No
updateByte	Yes	No	No
updateBytes	Yes	No	No
updateCharacterStream	Yes[7]	No	No
updateClob	Yes[8]	No	No
updateDate	Yes	No	No
updateDouble	Yes	No	No
updateFloat	Yes	No	No
updateInt	Yes	No	No
updateLong	Yes	No	No
updateNull	Yes	No	No
updateObject	Yes	No	No
updateRef	No	No	No
updateRow	Yes	No	No
updateRowId[9]	Yes	No	No
updateShort	Yes	No	No
updateString	Yes	No	No
updateTime	Yes	No	No
updateTimestamp	Yes	No	No
wasNull	Yes	Yes	Yes

Table 53. Support for ResultSet methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support

Notes:

1. getBinaryStream is not supported for CLOB columns.
2. The database server does no timezone adjustment for datetime values. The JDBC driver adjusts a value for the local timezone after retrieving the value from the server if you specify a form of the getDate, getTime, or getTimestamp method that includes a java.util.Calendar parameter.
3. The following form of the getObject method is not supported:

   ```
   getObject(int parameterIndex, java.util.Map  map)
   ```

4. Supported forms of this method include the following JDBC 4.0 forms:

   ```
   updateAsciiStream(int columnIndex, InputStream x)
   updateAsciiStream(String columnLabel, InputStream x)
   updateAsciiStream(int columnIndex, InputStream x, long length)
   updateAsciiStream(String columnLabel, InputStream x, long length)
   ```

5. Supported forms of this method include the following JDBC 4.0 forms:

   ```
   updateBinaryStream(int columnIndex, InputStream x)
   updateBinaryStream(String columnLabel, InputStream x)
   updateBinaryStream(int columnIndex, InputStream x, long length)
   updateBinaryStream(String columnLabel, InputStream x, long length)
   ```

6. Supported forms of this method include the following JDBC 4.0 forms:

   ```
   updateBlob(int columnIndex, InputStream x)
   updateBlob(String columnLabel, InputStream x)
   updateBlob(int columnIndex, InputStream x, long length)
   updateBlob(String columnLabel, InputStream x, long length)
   ```

7. Supported forms of this method include the following JDBC 4.0 forms:

   ```
   updateCharacterStream(int columnIndex, Reader reader)
   updateCharacterStream(String columnLabel, Reader reader)
   updateCharacterStream(int columnIndex, Reader reader, long length)
   updateCharacterStream(String columnLabel, Reader reader, long length)
   ```

8. Supported forms of this method include the following JDBC 4.0 forms:

   ```
   updateClob(int columnIndex, Reader reader)
   updateClob(String columnLabel, Reader reader)
   updateClob(int columnIndex, Reader reader, long length)
   updateClob(String columnLabel, Reader reader, long length)
   ```

9. This is a JDBC 4.0 method.

Table 54. Support for ResultSetMetaData methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getCatalogName	Yes	Yes	Yes
getColumnClassName	No	Yes	Yes
getColumnCount	Yes	Yes	Yes
getColumnDisplaySize	Yes	Yes	Yes
getColumnLabel	Yes	Yes	Yes
getColumnName	Yes	Yes	Yes
getColumnType	Yes	Yes	Yes
getColumnTypeName	Yes	Yes	Yes
getPrecision	Yes	Yes	Yes

Table 54. Support for ResultSetMetaData methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getScale	Yes	Yes	Yes
getSchemaName	Yes	Yes	Yes
getTableName	Yes[1]	Yes	Yes
isAutoIncrement	Yes	Yes	Yes
isCaseSensitive	Yes	Yes	Yes
isCurrency	Yes	Yes	Yes
isDefinitelyWritable	Yes	Yes	Yes
isNullable	Yes	Yes	Yes
isReadOnly	Yes	Yes	Yes
isSearchable	Yes	Yes	Yes
isSigned	Yes	Yes	Yes
isWritable	Yes	Yes	Yes

Notes:

1. For IDS data sources, getTableName does not return a value.

Table 55. Support for RowId methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support[2]	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
equals	Yes	No	No
getBytes	Yes	No	No
hashCode	No	No	No
toString	Yes	No	No

Notes:

1. These methods are JDBC 4.0 methods.
2. These methods are supported for connections to DB2 for z/OS, DB2 for i5/OS, and IDS data sources.

Table 56. Support for SQLClientInfoException methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No
getFailedProperties	Yes	No	No

Note:

1. This is a JDBC 4.0 class.

Table 57. Support for SQLData methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getSQLTypeName	No	No	No
readSQL	No	No	No
writeSQL	No	No	No

Table 58. Support for SQLDataException methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No

Note:

1. This is a JDBC 4.0 class.

Table 59. Support for SQLException methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	Yes	Yes
getSQLState	Yes	Yes	Yes
getErrorCode	Yes	Yes	Yes
getNextException	Yes	Yes	Yes
setNextException	Yes	Yes	Yes

Table 60. Support for SQLFeatureNotSupported methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No

Note:

1. This is a JDBC 4.0 class.

Table 61. Support for SQLInput methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
readArray	No	No	No
readAsciiStream	No	No	No
readBigDecimal	No	No	No
readBinaryStream	No	No	No
readBlob	No	No	No
readBoolean	No	No	No
readByte	No	No	No
readBytes	No	No	No
readCharacterStream	No	No	No
readClob	No	No	No
readDate	No	No	No
readDouble	No	No	No
readFloat	No	No	No
readInt	No	No	No
readLong	No	No	No
readObject	No	No	No
readRef	No	No	No
readShort	No	No	No
readString	No	No	No
readTime	No	No	No
readTimestamp	No	No	No
wasNull	No	No	No

Table 62. Support for SQLIntegrityConstraintViolationException methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No

Note:

1. This is a JDBC 4.0 class.

Table 63. Support for SQLInvalidAuthorizationSpecException methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No

Note:

1. This is a JDBC 4.0 class.

Table 64. Support for SQLNonTransientConnectionException methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No

Note:

1. This is a JDBC 4.0 class.

Table 65. Support for SQLNonTransientException methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No

Note:

1. This is a JDBC 4.0 class.

Table 66. Support for SQLOutput methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
writeArray	No	No	No
writeAsciiStream	No	No	No
writeBigDecimal	No	No	No
writeBinaryStream	No	No	No
writeBlob	No	No	No

Table 66. Support for SQLOutput methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
writeBoolean	No	No	No
writeByte	No	No	No
writeBytes	No	No	No
writeCharacterStream	No	No	No
writeClob	No	No	No
writeDate	No	No	No
writeDouble	No	No	No
writeFloat	No	No	No
writeInt	No	No	No
writeLong	No	No	No
writeObject	No	No	No
writeRef	No	No	No
writeShort	No	No	No
writeString	No	No	No
writeStruct	No	No	No
writeTime	No	No	No
writeTimestamp	No	No	No

Table 67. Support for SQLRecoverableException methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No

Note:

1. This is a JDBC 4.0 class.

Table 68. Support for SQLSyntaxErrorException methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No

Table 68. Support for SQLSyntaxErrorException methods[1] (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support

Note:

1. This is a JDBC 4.0 class.

Table 69. Support for SQLTimeoutException methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No

Note:

1. This is a JDBC 4.0 class.

Table 70. Support for SQLTransientConnectionException methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No

Note:

1. This is a JDBC 4.0 class.

Table 71. Support for SQLTransientException methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No

Note:

1. This is a JDBC 4.0 class.

Table 72. Support for SQLTransientRollbackException methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from java.lang.Exception	Yes	No	No
Methods inherited from java.lang.Throwable	Yes	No	No
Methods inherited from java.lang.Object	Yes	No	No

Note:

1. This is a JDBC 4.0 class.

Table 73. Support for SQLXML methods[1]

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
free	Yes	No	No
getBinaryStream	Yes	No	No
getCharacterStream	Yes	No	No
getSource	Yes	No	No
getString	Yes	No	No
setBinaryStream	Yes	No	No
setCharacterStream	Yes	No	No
setResult	Yes	No	No
setString	Yes	No	No

Notes:

1. These are JDBC 4.0 methods.

Table 74. Support for Statement methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
addBatch	Yes	Yes	Yes
cancel	Yes[1]	Yes[2]	Yes
clearBatch	Yes	Yes	Yes
clearWarnings	Yes	Yes	Yes
close	Yes	Yes	Yes
execute	Yes	Yes[3]	Yes[3]
executeBatch	Yes	Yes	Yes
executeQuery	Yes	Yes	Yes
executeUpdate	Yes	Yes[3]	Yes[3]
getConnection	Yes	Yes	Yes
getFetchDirection	Yes	Yes	Yes
getFetchSize	Yes	Yes	Yes

Table 74. Support for Statement methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getGeneratedKeys	Yes	No	No
getMaxFieldSize	Yes	Yes	Yes
getMaxRows	Yes	Yes	Yes
getMoreResults	Yes	Yes[3]	Yes[3]
getQueryTimeout	Yes[2]	Yes	Yes
getResultSet	Yes	Yes	Yes
getResultSetConcurrency	Yes	Yes	Yes
getResultSetHoldability	Yes	No	No
getResultSetType	Yes	Yes	Yes
getUpdateCount[4]	Yes	Yes	Yes
getWarnings	Yes	Yes	Yes
isClosed[6]	Yes	No	No
isPoolable[6]	Yes	No	No
setCursorName	Yes	Yes	Yes
setEscapeProcessing	Yes	Yes	Yes
setFetchDirection	Yes	Yes	Yes
setFetchSize	Yes	Yes	Yes
setMaxFieldSize	Yes	Yes	Yes
setMaxRows	Yes	Yes	Yes
setPoolable[6]	Yes	No	No
setQueryTimeout	Yes[5]	Yes	Yes

Notes:

1. For the IBM Data Server Driver for JDBC and SQLJ, Statement.cancel() is supported only in the following environments:
   - Type 2 and type 4 connectivity from a Linux, UNIX, or Windows client to a DB2 Database for Linux, UNIX, and Windows server, Version 8 or later
   - Type 2 and type 4 connectivity from a Linux, UNIX, or Windows client to a DB2 for z/OS server, Version 9 or later
   - Type 4 connectivity from a z/OS client to a DB2 Database for Linux, UNIX, and Windows server, Version 8 or later
   - Type 4 connectivity from a z/OS client to a DB2 for z/OS server, Version 9 or later
2. For the DB2 JDBC Type 2 Driver for Linux, UNIX and Windows, Statement.cancel() is supported only in the following environments:
   - Connections to a DB2 Database for Linux, UNIX, and Windows server, Version 8 or later
   - Connections to a DB2 for z/OS server, Version 9 or later
3. The DB2 JDBC Type 2 Driver for Linux, UNIX and Windows does not support the JDBC 3.0 form of this method.
4. Not supported for stored procedure ResultSets.
5. For IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS and for DB2 for i5/OS, this method is supported only for a *seconds* value of 0.
6. This is a JDBC 4.0 method.

Table 75. Support for Struct methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getSQLTypeName	No	No	No
getAttributes	No	No	No

Table 76. Support for Wrapper methods

JDBC method[1]	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
isWrapperFor	Yes	No	No
unWrap	Yes	No	No

Notes:

1. These are JDBC 4.0 methods.

Table 77. Support for javax.sql.XAConnection methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support[1]	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
Methods inherited from javax.sql.PooledConnection	Yes	Yes	Yes
getXAResource	Yes	Yes	Yes

Notes:

1. These methods are supported for IBM Data Server Driver for JDBC and SQLJ type 2 connectivity to a DB2 Database for Linux, UNIX, and Windows server or IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

Table 78. Support for XADataSource methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
getLoginTimeout	Yes	Yes	Yes
getLogWriter	Yes	Yes	Yes
getXAConnection	Yes	Yes	Yes
setLoginTimeout	Yes	Yes	Yes
setLogWriter	Yes	Yes	Yes

Table 79. Support for javax.transaction.xa.XAResource methods

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
commit	Yes[1]	Yes	Yes
end	Yes[1]	Yes	Yes
forget	Yes[1]	Yes	Yes
getTransactionTimeout	Yes[2]	Yes	Yes
isSameRM	Yes[1]	Yes	Yes

Table 79. Support for javax.transaction.xa.XAResource methods (continued)

JDBC method	IBM Data Server Driver for JDBC and SQLJ support	DB2 JDBC Type 2 Driver for Linux, UNIX and Windows support	IDS JDBC Driver support
prepare	Yes[1]	Yes	Yes
recover	Yes[1]	Yes	Yes
rollback	Yes[1]	Yes	Yes
setTransactionTimeout	Yes[2]	Yes	Yes
start	Yes[1]	Yes	Yes

Notes:

1. These method is supported for IBM Data Server Driver for JDBC and SQLJ type 2 connectivity to a DB2 Database for Linux, UNIX, and Windows server or IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.
2. This method is supported for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity to DB2 Database for Linux, UNIX, and Windows Version 9.1 at later.

SQLJ statement reference information

SQLJ statements are used for transaction control and SQL statement execution.

SQLJ clause

The SQL statements in an SQLJ program are in SQLJ clauses.

Syntax

Usage notes

Keywords in an SQLJ clause are case sensitive, unless those keywords are part of an SQL statement in an executable clause.

SQLJ host-expression

A host expression is a Java variable or expression that is referenced by SQLJ clauses in an SQLJ application program.

Syntax

Description

: Indicates that the variable or expression that follows is a host expression. The colon must immediately precede the variable or expression.

IN | OUT | INOUT
For a host expression that is used as a parameter in a stored procedure call,

identifies whether the parameter provides data to the stored procedure (IN), retrieves data from the stored procedure (OUT), or does both (INOUT). The default is IN.

simple-variable
Specifies a Java unqualified identifier.

complex-expression
Specifies a Java expression that results in a single value.

Usage notes

- A complex expression must be enclosed in parentheses.
- ANSI/ISO rules govern where a host expression can appear in a static SQL statement.

SQLJ implements-clause

The implements clause derives one or more classes from a Java interface.

Syntax

interface-element:

Description

interface-element
Specifies a user-defined Java interface, the SQLJ interface sqlj.runtime.ForUpdate or the SQLJ interface sqlj.runtime.Scrollable.

You need to implement sqlj.runtime.ForUpdate when you declare an iterator for a positioned UPDATE or positioned DELETE operation. See ″Perform positioned UPDATE and DELETE operations in an SQLJ application″ for information on performing a positioned UPDATE or positioned DELETE operation in SQLJ.

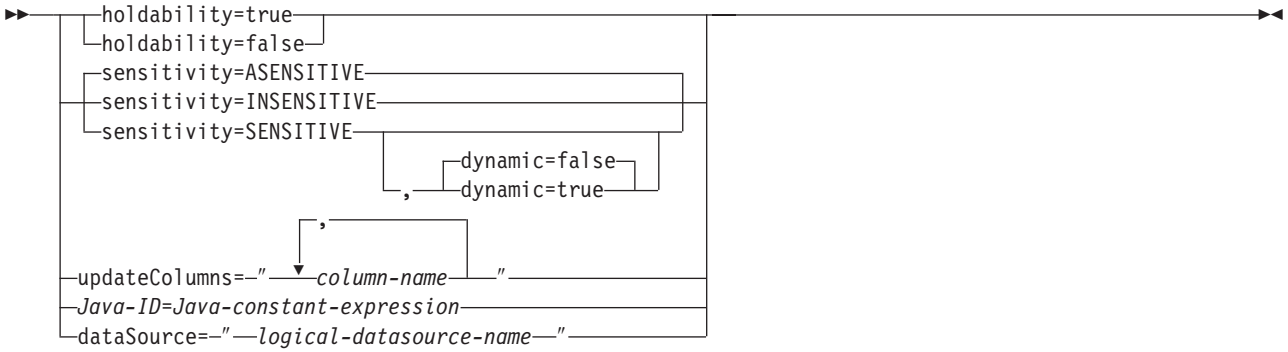
You need to implement sqlj.runtime.Scrollable when you declare a scrollable iterator. See ″Use scrollable iterators in an SQLJ application″ for information on scrollable iterators.

SQLJ with-clause

The with clause specifies a set of one or more attributes for an iterator or a connection context.

Syntax

with-element:



Description

holdability
For an iterator, specifies whether an iterator keeps its position in a table after a COMMIT is executed. The value for holdability must be `true` or `false`.

sensitivity
For an iterator, specifies whether changes that are made to the underlying table can be visible to the iterator after it is opened. The value must be INSENSITIVE, SENSITIVE, or ASENSITIVE. The default is ASENSITIVE.

dynamic
For an iterator that is defined with sensitivity=SENSITIVE, specifies whether the following cases are true:

- When the application executes positioned UPDATE and DELETE statements with the iterator, those changes are visible to the iterator.
- When the application executes INSERT, UPDATE, and DELETE statements within the application but outside the iterator, those changes are visible to the iterator.

The value for dynamic must be `true` or `false`. The default is `false`.

DB2 Database for Linux, UNIX, and Windows servers do not support dynamic scrollable cursors. Specify `true` only if your application accesses data on DB2 for z/OS servers, at Version 9 or later.

updateColumns
For an iterator, specifies the columns that are to be modified when the iterator is used for a positioned UPDATE statement. The value for updateColumns must be a literal string that contains the column names, separated by commas.

column-name
For an iterator, specifies a column of the result table that is to be updated using the iterator.

Java-ID
For an iterator or connection context, specifies a Java variable that identifies a

user-defined attribute of the iterator or connection context. The value of *Java-constant-expression* is also user-defined.

dataSource
For a connection context, specifies the logical name of a separately-created DataSource object that represents the data source to which the application will connect. This option is available only for the IBM Data Server Driver for JDBC and SQLJ.

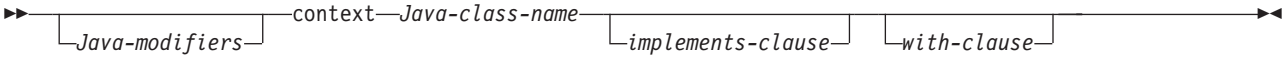
Usage notes

- The value on the left side of a with element must be unique within its with clause.
- If you specify updateColumns in a with element of an iterator declaration clause, the iterator declaration clause must also contain an implements clause that specifies the sqlj.runtime.ForUpdate interface.
- If you do not customize your SQLJ program, the JDBC driver ignores the value of holdability that is in the with clause. Instead, the driver uses the JDBC driver setting for holdability.

SQLJ connection-declaration-clause

The connection declaration clause declares a connection to a data source in an SQLJ application program.

Syntax



Description

Java-modifiers
Specifies modifiers that are valid for Java class declarations, such as static, public, private, or protected.

Java-class-name
Specifies a valid Java identifier. During the program preparation process, SQLJ generates a connection context class whose name is this identifier.

implements-clause
See ″SQLJ implements-clause″ for a description of this clause. In a connection declaration clause, the interface class to which the implements clause refers must be a user-defined interface class.

with-clause
See ″SQLJ with-clause″ for a description of this clause.

Usage notes

- SQLJ generates a connection class declaration for each connection declaration clause you specify. SQLJ data source connections are objects of those generated connection classes.
- You can specify a connection declaration clause anywhere that a Java class definition can appear in a Java program.

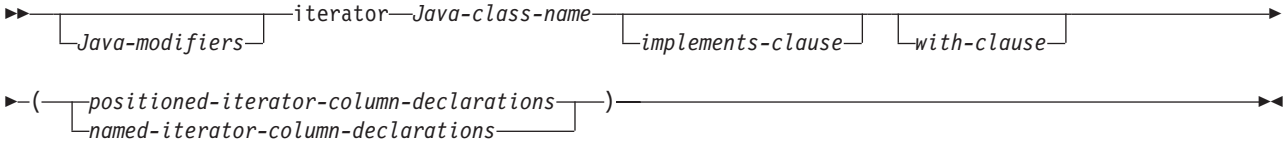
SQLJ iterator-declaration-clause

An iterator declaration clause declares a positioned iterator class or a named iterator class in an SQLJ application program.

An iterator contains the result table from a query. SQLJ generates an iterator class for each iterator declaration clause you specify. An iterator is an object of an iterator class.

An iterator declaration clause has a form for a positioned iterator and a form for a named iterator. The two kinds of iterators are distinct and incompatible Java types that are implemented with different interfaces.

Syntax



positioned-iterator-column declarations:

named-iterator-column-declarations:

Description

Java-modifiers
Any modifiers that are valid for Java class declarations, such as static, public, private, or protected.

Java-class-name
Any valid Java identifier. During the program preparation process, SQLJ generates an iterator class whose name is this identifier.

implements-clause
See ″SQLJ implements-clause″ for a description of this clause. For an iterator declaration clause that declares an iterator for a positioned UPDATE or positioned DELETE operation, the implements clause must specify interface sqlj.runtime.ForUpdate. For an iterator declaration clause that declares a scrollable iterator, the implements clause must specify interface sqlj.runtime.Scrollable.

with-clause
See ″SQLJ with-clause″ for a description of this clause.

positioned-iterator-column-declarations
Specifies a list of Java data types, which are the data types of the columns in

the positioned iterator. The data types in the list must be separated by commas. The order of the data types in the positioned iterator declaration is the same as the order of the columns in the result table. For online checking during serialized profile customization to succeed, the data types of the columns in the iterator must be compatible with the data types of the columns in the result table. See "Java, JDBC, and SQL data types" for a list of compatible data types.

named-iterator-column-declarations
Specifies a list of Java data types and Java identifiers, which are the data types and names of the columns in the named iterator. Pairs of data types and names must be separated by commas. The name of a column in the iterator must match, except for case, the name of a column in the result table. For online checking during serialized profile customization to succeed, the data types of the columns in the iterator must be compatible with the data types of the columns in the result table. See "Java, JDBC, and SQL data types" for a list of compatible data types.

Usage notes

- An iterator declaration clause can appear anywhere in a Java program that a Java class declaration can appear.
- When a named iterator declaration contains more than one pair of Java data types and Java IDs, all Java IDs within the list must be unique. Two Java IDs are not unique if they differ only in case.

SQLJ executable-clause

An executable clause contains an SQL statement or an assignment statement. An assignment statement assigns the result of an SQL operation to a Java variable.

This topic describes the general form of an executable clause.

Syntax

Usage notes

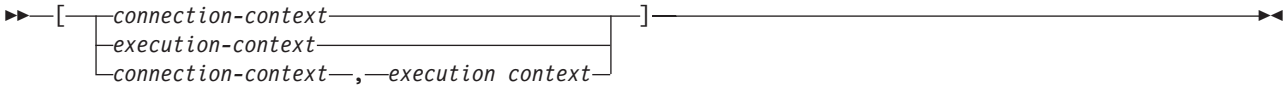
- An executable clause can appear anywhere in a Java program that a Java statement can appear.
- SQLJ reports negative SQL codes from executable clauses through class java.sql.SQLException.

  If SQLJ raises a run-time exception during the execution of an executable clause, the value of any host expression of type OUT or INOUT is undefined.

SQLJ context-clause

A context clause specifies a connection context, an execution context, or both. You use a connection context to connect to a data source. You use an execution context to monitor and modify SQL statement execution.

Syntax



Description

connection-context
Specifies a valid Java identifier that is declared earlier in the SQLJ program. That identifier must be declared as an instance of the connection context class that SQLJ generates for a connection declaration clause.

execution-context
Specifies a valid Java identifier that is declared earlier in the SQLJ program. That identifier must be declared as an instance of class sqlj.runtime.ExecutionContext.

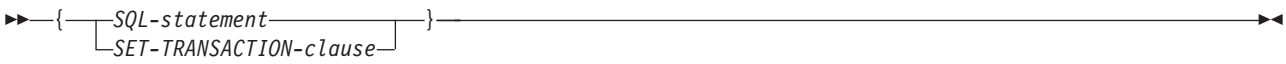
Usage notes

- If you do not specify a connection context in an executable clause, SQLJ uses the default connection context.
- If you do not specify an execution context, SQLJ obtains the execution context from the connection context of the statement.

SQLJ statement-clause

A statement clause contains an SQL statement or a SET TRANSACTION clause.

Syntax



Description

SQL-statement
You can include the DB2 Database for Linux, UNIX, and Windows SQL statements in Table 80 in a statement clause.

SET-TRANSACTION-clause
Sets the isolation level for SQL statements in the program and the access mode for the connection. The SET TRANSACTION clause is equivalent to the SET TRANSACTION statement, which is described in the ANSI/ISO SQL standard of 1992 and is supported in some implementations of SQL. See ″SQLJ SET-TRANSACTION-clause″ for more information.

Table 80. Valid SQL statements in an SQLJ statement clause

ALTER DATABASE
ALTER FUNCTION
ALTER INDEX
ALTER PROCEDURE
ALTER STOGROUP
ALTER TABLE
ALTER TABLESPACE
CALL
COMMENT ON

Table 80. Valid SQL statements in an SQLJ statement clause (continued)

COMMIT
CREATE ALIAS
CREATE DATABASE
CREATE DISTINCT TYPE
CREATE FUNCTION
CREATE GLOBAL TEMPORARY TABLE
CREATE INDEX
CREATE PROCEDURE
CREATE STOGROUP
CREATE SYNONYM
CREATE TABLE
CREATE TABLESPACE
CREATE TRIGGER
CREATE VIEW
DECLARE GLOBAL TEMPORARY TABLE
DELETE
DROP ALIAS
DROP DATABASE
DROP DISTINCT TYPE
DROP FUNCTION
DROP INDEX
DROP PACKAGE
DROP PROCEDURE
DROP STOGROUP
DROP SYNONYM
DROP TABLE
DROP TABLESPACE
DROP TRIGGER
DROP VIEW
FETCH
GRANT
INSERT
LOCK TABLE
MERGE
REVOKE
ROLLBACK
SAVEPOINT
SELECT INTO
SET CURRENT DEFAULT TRANSFORM GROUP
SET CURRENT DEGREE
SET CURRENT EXPLAIN MODE
SET CURRENT EXPLAIN SNAPSHOT
SET CURRENT ISOLATION
SET CURRENT MAINTAINED TABLE TYPES FOR OPTIMIZATION
SET CURRENT OPTIMIZATION HINT
SET CURRENT PACKAGESET (USER is not supported)
SET CURRENT PRECISION
SET CURRENT QUERY OPTIMIZATION
SET CURRENT REFRESH AGE
SET CURRENT SCHEMA
SET PATH
UPDATE

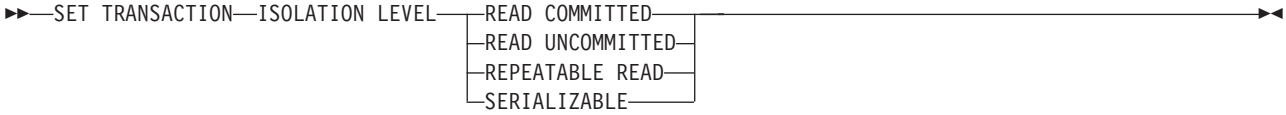
Usage notes

- SQLJ supports both positioned and searched DELETE and UPDATE operations.
- For a FETCH statement, a positioned DELETE statement, or a positioned UPDATE statement, you must use an iterator to refer to rows in a result table.

SQLJ SET-TRANSACTION-clause

The SET TRANSACTION clause sets the isolation level for the current unit of work.

Syntax



Description

ISOLATION LEVEL
Specifies one of the following isolation levels:

READ COMMITTED
Specifies that the current DB2 isolation level is cursor stability.

READ UNCOMMITTED
Specifies that the current DB2 isolation level is uncommitted read.

REPEATABLE READ
Specifies that the current DB2 isolation level is read stability.

SERIALIZABLE
Specifies that the current DB2 isolation level is repeatable read.

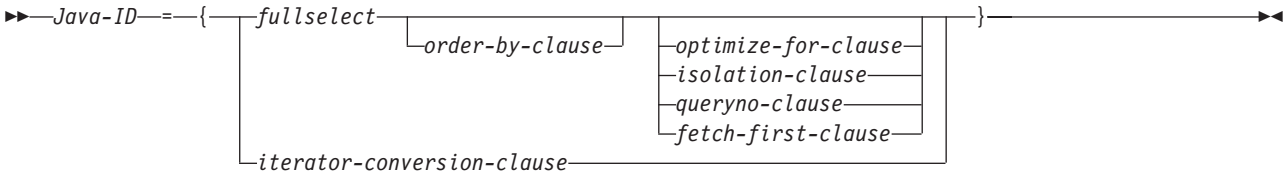
Usage notes

You can execute SET TRANSACTION only at the beginning of a transaction.

SQLJ assignment-clause

The assignment clause assigns the result of an SQL operation to a Java variable.

Syntax



Description

Java-ID
Identifies an iterator that was declared previously as an instance of an iterator class.

fullselect
Generates a result table.

iterator-conversion-clause
See "SQLJ iterator-conversion-clause" for a description of this clause.

Usage notes

- If the object that is identified by *Java-ID* is a positioned iterator, the number of columns in the result set must match the number of columns in the iterator. In addition, the data type of each column in the result set must be compatible with the data type of the corresponding column in the iterator. See "Java, JDBC, and SQL data types" for a list of compatible Java and SQL data types.
- If the object that is identified by *Java-ID* is a named iterator, the name of each accessor method must match, except for case, the name of a column in the result set. In addition, the data type of the object that an accessor method returns must be compatible with the data type of the corresponding column in the result set.
- You can put an assignment clause anywhere in a Java program that a Java assignment statement can appear. However, you cannot put an assignment clause where a Java assignment expression can appear. For example, you cannot specify an assignment clause in the control list of a for statement.

SQLJ iterator-conversion-clause

The iterator conversion clause converts a JDBC ResultSet to an iterator.

Syntax

Description

host-expression
Identifies the JDBC ResultSet that is to be converted to an SQLJ iterator.

Usage notes

- If the iterator to which the JDBC ResultSet is to be converted is a positioned iterator, the number of columns in the ResultSet must match the number of columns in the iterator. In addition, the data type of each column in the ResultSet must be compatible with the data type of the corresponding column in the iterator.
- If the iterator is a named iterator, the name of each accessor method must match, except for case, the name of a column in the ResultSet. In addition, the data type of the object that an accessor method returns must be compatible with the data type of the corresponding column in the ResultSet.
- When an iterator that is generated through the iterator conversion clause is closed, the ResultSet from which the iterator is generated is also closed.

Interfaces and classes in the sqlj.runtime package

The sqlj.runtime package defines the run-time classes and interfaces that are used directly or indirectly by the SQLJ programmer.

Classes such as AsciiStream are used directly by the SQLJ programmer. Interfaces such as ResultSetIterator are implemented as part of generated class declarations.

sqlj.runtime interfaces

The following table summarizes the interfaces in sqlj.runtime.

Table 81. Summary of sqlj.runtime interfaces

Interface name	Purpose
ConnectionContext	Manages the SQL operations that are performed during a connection to a data source.
ForUpdate	Implemented by iterators that are used in a positioned UPDATE or DELETE statement.
NamedIterator	Implemented by iterators that are declared as named iterators.
PositionedIterator	Implemented by iterators that are declared as positioned iterators.
ResultSetIterator	Implemented by all iterators to allow query results to be processed using a JDBC ResultSet.
Scrollable	Provides a set of methods for manipulating scrollable iterators.

sqlj.runtime classes

The following table summarizes the classes in sqlj.runtime.

Table 82. Summary of sqlj.runtime classes

Class name	Purpose
AsciiStream	A class for handling an input stream whose bytes should be interpreted as ASCII.
BinaryStream	A class for handling an input stream whose bytes should be interpreted as binary.
CharacterStream	A class for handling an input stream whose bytes should be interpreted as Character.
DefaultRuntime	Implemented by SQLJ to satisfy the expected runtime behavior of SQLJ for most JVM environments. This class is for internal use only and is not described in this documentation.
ExecutionContext	Implemented when an SQLJ execution context is declared, to control the execution of SQL operations.
RuntimeContext	Defines system-specific services that are provided by the runtime environment. This class is for internal use only and is not described in this documentation.
SQLNullException	Derived from the java.sql.SQLException class. An sqlj.runtime.SQLNullException is thrown when an SQL NULL value is fetched into a host identifier with a Java primitive type.
StreamWrapper	Wraps a java.io.InputStream instance.
UnicodeStream	A class for handling an input stream whose bytes should be interpreted as Unicode.

sqlj.runtime.ConnectionContext interface

The sqlj.runtime.ConnectionContext interface provides a set of methods that manage SQL operations that are performed during a session with a specific data source.

Translation of an SQLJ connection declaration clause causes SQLJ to create a connection context class. A connection context object maintains a JDBC Connection object on which dynamic SQL operations can be performed. A connection context object also maintains a default ExecutionContext object.

Variables

CLOSE_CONNECTION

Format:

```
public static final boolean CLOSE_CONNECTION=true;
```

A constant that can be passed to the close method. It indicates that the underlying JDBC Connection object should be closed.

KEEP_CONNECTION

Format:

```
public static final boolean KEEP_CONNECTION=false;
```

A constant that can be passed to the close method. It indicates that the underlying JDBC Connection object should not be closed.

Methods

close()

Format:

```
public abstract void close() throws SQLException
```

Performs the following functions:

- Releases all resources that are used by the given connection context object
- Closes any open ConnectedProfile objects
- Closes the underlying JDBC Connection object

close() is equivalent to close(CLOSE_CONNECTION).

close(boolean)

Format:

```
public abstract void close (boolean close-connection)
 throws SQLException
```

Performs the following functions:

- Releases all resources that are used by the given connection context object
- Closes any open ConnectedProfile objects
- Closes the underlying JDBC Connection object, depending on the value of the *close-connection* parameter

Parameters:

close-connection

Specifies whether the underlying JDBC Connection object is closed when a connection context object is closed:

CLOSE_CONNECTION

Closes the underlying JDBC Connection object.

KEEP_CONNECTION

Does not close the underlying JDBC Connection object.

getConnectedProfile

Format:

```
public abstract ConnectedProfile getConnectedProfile(Object profileKey)
 throws SQLException
```

This method is used by code that is generated by the SQLJ translator. It is not intended for direct use by application programs.

getConnection

Format:

```
public abstract Connection getConnection()
```

Returns the underlying JDBC Connection object for the given connection context object.

getExecutionContext

Format:

```
public abstract ExecutionContext getExecutionContect()
```

Returns the default ExecutionContext object that is associated with the given connection context object.

isClosed

Format:

```
public abstract boolean isClosed()
```

Returns `true` if the given connection context object has been closed. Returns `false` if the connection context object has not been closed.

Constructors

The following constructors are defined in a concrete implementation of the ConnectionContext interface that results from translation of the statement `#sql context Ctx;`:

Ctx(String, boolean)

Format:

```
public Ctx(String url, boolean autocommit)
 throws SQLException
```

Parameters:

url The representation of a data source, as specified in the JDBC getConnection method.

autocommit
Whether autocommit is enabled for the connection. A value of `true` means that autocommit is enabled. A value of `false` means that autocommit is disabled.

Ctx(String, String, String, boolean)

Format:

```
public Ctx(String url, String user, String password,
 boolean autocommit)
 throws SQLException
```

Parameters:

url The representation of a data source, as specified in the JDBC getConnection method.

user
The user ID under which the connection to the data source is made.

password
The password for the user ID under which the connection to the data source is made.

autocommit
Whether autocommit is enabled for the connection. A value of `true` means that autocommit is enabled. A value of `false` means that autocommit is disabled.

Ctx(String, Properties, boolean)

Format:

```
public Ctx(String url, Properties info, boolean autocommit)
 throws SQLException
```

Parameters:

url The representation of a data source, as specified in the JDBC getConnection method.

info
An object that contains a set of driver properties for the connection. Any of the IBM Data Server Driver for JDBC and SQLJ properties can be specified.

autocommit
Whether autocommit is enabled for the connection. A value of `true` means that autocommit is enabled. A value of `false` means that autocommit is disabled.

Ctx(Connection)

Format:

```
public Ctx(java.sql.Connection JDBC-connection-object)
 throws SQLException
```

Parameters:

JDBC-connection-object
A previously created JDBC Connection object.

If the constructor call throws an SQLException, the JDBC Connection object remains open.

Ctx(ConnectionContext)

Format:

```
public Ctx(sqlj.runtime.ConnectionContext SQLJ-connection-context-object)
 throws SQLException
```

Parameters:

SQLJ-connection-context-object
A previously created SQLJ ConnectionContext object.

The following constructors are defined in a concrete implementation of the ConnectionContext interface that results from translation of the statement `#sql context Ctx with (dataSource ="jdbc/TestDS");`:

Ctx()

Format:

```
public Ctx()
 throws SQLException
```

Ctx(String, String)

Format:

```
public Ctx(String user, String password,
)
 throws SQLException
```

Parameters:

user
The user ID under which the connection to the data source is made.

password
The password for the user ID under which the connection to the data source is made.

Ctx(Connection)
Format:

```
public Ctx(java.sql.Connection JDBC-connection-object)
 throws SQLException
```

Parameters:

JDBC-connection-object
A previously created JDBC Connection object.

If the constructor call throws an SQLException, the JDBC Connection object remains open.

Ctx(ConnectionContext)
Format:

```
public Ctx(sqlj.runtime.ConnectionContext SQLJ-connection-context-object)
 throws SQLException
```

Parameters:

SQLJ-connection-context-object
A previously created SQLJ ConnectionContext object.

Methods

The following additional methods are generated in a concrete implementation of the ConnectionContext interface that results from translation of the statement `#sql context Ctx;`:

getDefaultContext
Format:

```
public static Ctx getDefaultContext()
```

Returns the default connection context object for the Ctx class.

getProfileKey
Format:

```
public static Object getProfileKey(sqlj.runtime.profile.Loader loader,
String profileName) throws SQLException
```

This method is used by code that is generated by the SQLJ translator. It is not intended for direct use by application programs.

getProfile
Format:

```
public static sqlj.runtime.profile.Profile getProfile(Object key)
```

This method is used by code that is generated by the SQLJ translator. It is not intended for direct use by application programs.

getTypeMap
Format:

```
public static java.util.Map getTypeMap()
```

Returns an instance of a class that implements java.util.Map, which is the user-defined type map that is associated with the ConnectionContext. If there is no associated type map, Java null is returned.

This method is used by code that is generated by the SQLJ translator for executable clauses and iterator declaration clauses, but it can also be invoked in an SQLJ application for direct use in JDBC statements.

SetDefaultContext

Format:

```
public static void Ctx setDefaultContext(Ctx default-context)
```

Sets the default connection context object for the Ctx class.

Recommendation: Do not use this method for multithreaded applications. Instead, use explicit contexts.

sqlj.runtime.ForUpdate interface

SQLJ implements the sqlj.runtime.ForUpdate interface in SQLJ programs that contain an iterator declaration clause with `implements sqlj.runtime.ForUpdate`.

An SQLJ program that does positioned UPDATE or DELETE operations (UPDATE...WHERE CURRENT OF or DELETE...WHERE CURRENT OF) must include an iterator declaration clause with `implements sqlj.runtime.ForUpdate`.

Methods

getCursorName

Format:

```
public abstract String getCursorName() throws SQLException
```

This method is used by code that is generated by the SQLJ translator. It is not intended for direct use by application programs.

sqlj.runtime.NamedIterator interface

The sqlj.runtime.NamedIterator interface is implemented when an SQLJ application executes an iterator declaration clause for a named iterator.

A named iterator includes result table column names, and the order of the columns in the iterator is not important.

An implementation of the sqlj.runtime.NamedIterator interface includes an accessor method for each column in the result table. An accessor method returns the data from its column of the result table. The name of an accessor method matches the name of the corresponding column in the named iterator.

Methods (inherited from the ResultSetIterator interface)

close

Format:

```
public abstract void close() throws SQLException
```

Releases database resources that the iterator uses.

isClosed

Format:

```
public abstract boolean isClosed() throws SQLException
```

Returns a value of `true` if the close method has been invoked. Returns `false` if the close method has not been invoked.

next

Format:

```
public abstract boolean next() throws SQLException
```

Advances the iterator to the next row. Before an instance of the next method is invoked for the first time, the iterator is positioned before the first row of the result table. next returns a value of `true` when a next row is available and `false` when all rows have been retrieved.

sqlj.runtime.PositionedIterator interface

The sqlj.runtime.PositionedIterator interface is implemented when an SQLJ application executes an iterator declaration clause for a positioned iterator.

The order of columns in a positioned iterator must be the same as the order of columns in the result table, and a positioned iterator does not include result table column names.

Methods

sqlj.runtime.PositionedIterator inherits all **ResultSetIterator** methods, and includes the following additional method:

endFetch

Format:

```
public abstract boolean endFetch() throws SQLException
```

Returns a value of `true` if the iterator is not positioned on a row. Returns a value of `false` if the iterator is positioned on a row.

sqlj.runtime.ResultSetIterator interface

The sqlj.runtime.ResultSetIterator interface is implemented by SQLJ for all iterator declaration clauses.

An untyped iterator can be generated by declaring an instance of the sqlj.runtime.ResultSetIterator interface directly. In general, use of untyped iterators is not recommended.

Variables

ASENSITIVE

Format:

```
public static final int ASENSITIVE
```

A constant that can be returned by the getSensitivity method. It indicates that the iterator is defined as ASENSITIVE.

FETCH_FORWARD

Format:

```
public static final int FETCH_FORWARD
```

A constant that can be used by the following methods:
- Set by sqlj.runtime.Scrollable.setFetchDirection and sqlj.runtime.ExecutionContext.setFetchDirection
- Returned by sqlj.runtime.ExecutionContext.getFetchDirection

It indicates that the iterator fetches rows in a result table in the forward direction, from first to last.

FETCH_REVERSE

Format:

```
public static final int FETCH_REVERSE
```

A constant that can be used by the following methods:
- Set by sqlj.runtime.Scrollable.setFetchDirection and sqlj.runtime.ExecutionContext.setFetchDirection
- Returned by sqlj.runtime.ExecutionContext.getFetchDirection

It indicates that the iterator fetches rows in a result table in the backward direction, from last to first.

FETCH_UNKNOWN

Format:

```
public static final int FETCH_UNKNOWN
```

A constant that can be used by the following methods:
- Set by sqlj.runtime.Scrollable.setFetchDirection and sqlj.runtime.ExecutionContext.setFetchDirection
- Returned by sqlj.runtime.ExecutionContext.getFetchDirection

It indicates that the iterator fetches rows in a result table in an unknown order.

INSENSITIVE

Format:

```
public static final int INSENSITIVE
```

A constant that can be returned by the getSensitivity method. It indicates that the iterator is defined as INSENSITIVE.

SENSITIVE

Format:

```
public static final int SENSITIVE
```

A constant that can be returned by the getSensitivity method. It indicates that the iterator is defined as SENSITIVE.

Methods

clearWarnings

Format:

```
public abstract void clearWarnings() throws SQLException
```

After clearWarnings is called, getWarnings returns null until a new warning is reported for the iterator.

close

Format:

```
public abstract void close() throws SQLException
```

Closes the iterator and releases underlying database resources.

getFetchSize

Format:

```
synchronized public int getFetchSize() throws SQLException
```

Returns the number of rows that should be fetched by SQLJ when more rows are needed. The returned value is the value that was set by the setFetchSize method, or 0 if no value was set by setFetchSize.

getResultSet

Format:

```
public abstract ResultSet getResultSet() throws SQLException
```

Returns the JDBC ResultSet object that is associated with the iterator.

getRow

Format:

```
synchronized public int getRow() throws SQLException
```

Returns the current row number. The first row is number 1, the second is number 2, and so on. If the iterator is not positioned on a row, 0 is returned.

getSensitivity

Format:

```
synchronized public int getSensitivity() throws SQLException
```

Returns the sensitivity of the iterator. The sensitivity is determined by the sensitivity value that was specified or defaulted in the with clause of the iterator declaration clause.

getWarnings

Format:

```
public abstract SQLWarning getWarnings() throws SQLException
```

Returns the first warning that is reported by calls on the iterator. Subsequent iterator warnings are be chained to this SQLWarning. The warning chain is automatically cleared each time the iterator moves to a new row.

isClosed

Format:

```
public abstract boolean isClosed() throws SQLException
```

Returns a value of `true` if the iterator is closed. Returns `false` otherwise.

next

Format:

```
public abstract boolean next() throws SQLException
```

Advances the iterator to the next row. Before next is invoked for the first time, the iterator is positioned before the first row of the result table. next returns a value of `true` when a next row is available and `false` when all rows have been retrieved.

setFetchSize

Format:

```
synchronized public void setFetchSize(int number-of-rows) throws SQLException
```

Gives SQLJ a hint as to the number of rows that should be fetched when more rows are needed.

Parameters:

number-of-rows
The expected number of rows that SQLJ should fetch for the iterator that is associated with the given execution context.

If *number-of-rows* is less than 0 or greater than the maximum number of rows that can be fetched, an SQLException is thrown.

sqlj.runtime.Scrollable interface

sqlj.runtime.Scrollable provides methods to move around in the result table and to check the position in the result table.

sqlj.runtime.Scrollable is implemented when a scrollable iterator is declared.

Methods

absolute(int)
Format:

```
public abstract boolean absolute (int n) throws SQLException
```

Moves the iterator to a specified row.

If *n*>0, positions the iterator on row *n* of the result table. If *n*<0, and *m* is the number of rows in the result table, positions the iterator on row *m+n+1* of the result table.

If the absolute value of *n* is greater than the number of rows in the result table, positions the cursor after the last row if *n* is positive, or before the first row if *n* is negative.

absolute(0) is the same as beforeFirst(). absolute(1) is the same as first(). absolute(-1) is the same as last().

Returns `true` if the iterator is on a row. Otherwise, returns `false`.

afterLast()
Format:

```
public abstract void afterLast() throws SQLException
```

Moves the iterator after the last row of the result table.

beforeFirst()
Format:

```
public abstract void beforeFirst() throws SQLException
```

Moves the iterator before the first row of the result table.

first()
Format:

```
public abstract boolean first() throws SQLException
```

Moves the iterator to the first row of the result table.

Returns `true` if the iterator is on a row. Otherwise, returns `false`.

getFetchDirection()
Format:

```
public abstract int getFetchDirection() throws SQLException
```

Returns the fetch direction of the iterator. Possible values are:

sqlj.runtime.ResultSetIterator.FETCH_FORWARD
Rows are processed in a forward direction, from first to last.

sqlj.runtime.ResultSetIterator.FETCH_REVERSE
Rows are processed in a backward direction, from last to first.

sqlj.runtime.ResultSetIterator.FETCH_UNKNOWN
The order of processing is not known.

isAfterLast()
Format:

```
public abstract boolean isAfterLast() throws SQLException
```

Returns `true` if the iterator is positioned after the last row of the result table. Otherwise, returns `false`.

isBeforeFirst()
Format:

```
public abstract boolean isBeforeFirst() throws SQLException
```

Returns `true` if the iterator is positioned before the first row of the result table. Otherwise, returns `false`.

isFirst()
Format:

```
public abstract boolean isFirst() throws SQLException
```

Returns `true` if the iterator is positioned on the first row of the result table. Otherwise, returns `false`.

isLast()
Format:

```
public abstract boolean isLast() throws SQLException
```

Returns `true` if the iterator is positioned on the last row of the result table. Otherwise, returns `false`.

last()
Format:

```
public abstract boolean last() throws SQLException
```

Moves the iterator to the last row of the result table.

Returns `true` if the iterator is on a row. Otherwise, returns `false`.

previous()
Format:

```
public abstract boolean previous() throws SQLException
```

Moves the iterator to the previous row of the result table.

Returns `true` if the iterator is on a row. Otherwise, returns `false`.

relative(int)
Format:

```
public abstract boolean relative(int n) throws SQLException
```

If $n>0$, positions the iterator on the row that is n rows after the current row. If $n<0$, positions the iterator on the row that is n rows before the current row. If $n=0$, positions the iterator on the current row.

The cursor must be on a valid row of the result table before you can use this method. If the cursor is before the first row or after the last throw, the method throws an SQLException.

Suppose that m is the number of rows in the result table and x is the current row number in the result table. If $n>0$ and $x+n>m$, the iterator is positioned after the last row. If $n<0$ and $x+n<1$, the iterator is positioned before the first row.

Returns `true` if the iterator is on a row. Otherwise, returns `false`.

setFetchDirection(int)

Format:

```
public abstract void setFetchDirection (int) throws SQLException
```

Gives the SQLJ runtime environment a hint as to the direction in which rows of this iterator object are processed. Possible values are:

sqlj.runtime.ResultSetIterator.FETCH_FORWARD
Rows are processed in a forward direction, from first to last.

sqlj.runtime.ResultSetIterator.FETCH_REVERSE
Rows are processed in a backward direction, from last to first.

sqlj.runtime.ResultSetIterator.FETCH_UNKNOWN
The order of processing is not known.

sqlj.runtime.AsciiStream class

The sqlj.runtime.AsciiStream class is for an input stream of ASCII data with a specified length.

The sqlj.runtime.AsciiStream class is derived from the java.io.InputStream class, and extends the sqlj.runtime.StreamWrapper class. SQLJ interprets the bytes in an sqlj.runtime.AsciiStream object as ASCII characters. An InputStream object with ASCII characters needs to be passed as a sqlj.runtime.AsciiStream object.

Constructors

AsciiStream(InputStream)

Format:

```
public AsciiStream(java.io.InputStream input-stream)
```

Creates an ASCII java.io.InputStream object with an unspecified length.

Parameters:

input-stream
The InputStream object that SQLJ interprets as an AsciiStream object.

AsciiStream(InputStream, int)

Format:

```
public AsciiStream(java.io.InputStream input-stream, int length)
```

Creates an ASCII java.io.InputStream object with a specified length.

Parameters:

input-stream
The InputStream object that SQLJ interprets as an AsciiStream object.

length
The length of the InputStream object that SQLJ interprets as an AsciiStream object.

sqlj.runtime.BinaryStream class

The sqlj.runtime.BinaryStream class is for an input stream of binary data with a specified length.

The sqlj.runtime.BinaryStream class is derived from the java.io.InputStream class, and extends the sqlj.runtime.StreamWrapper class. SQLJ interprets the bytes in an sqlj.runtime.BinaryStream object are interpreted as Binary characters. An InputStream object with Binary characters needs to be passed as a sqlj.runtime.BinaryStream object.

Constructors

BinaryStream(InputStream)
Format:

```
public BinaryStream(java.io.InputStream input-stream)
```

Creates an Binary java.io.InputStream object with an unspecified length.

Parameters:

input-stream
The InputStream object that SQLJ interprets as an BinaryStream object.

BinaryStream(InputStream, int)
Format:

```
public BinaryStream(java.io.InputStream input-stream, int length)
```

Creates an Binary java.io.InputStream object with a specified length.

Parameters:

input-stream
The InputStream object that SQLJ interprets as an BinaryStream object.

length
The length of the InputStream object that SQLJ interprets as an BinaryStream object.

sqlj.runtime.CharacterStream class

The sqlj.runtime.CharacterStream class is for an input stream of character data with a specified length.

The sqlj.runtime.CharacterStream class is derived from the java.io.Reader class, and extends the java.io.FilterReader class. SQLJ interprets the bytes in an sqlj.runtime.CharacterStream object are interpreted as Unicode data. A Reader object with Unicode data needs to be passed as a sqlj.runtime.CharacterStream object.

Constructors

CharacterStream(InputStream)

Format:

```
public CharacterStream(java.io.Reader input-stream)
```

Creates a character java.io.Reader object with an unspecified length.

Parameters:

input-stream
The Reader object that SQLJ interprets as an CharacterStream object.

CharacterStream(InputStream, int)

Format:

```
public CharacterStream(java.io.Reader input-stream, int length)
```

Creates a character java.io.Reader object with a specified length.

Parameters:

input-stream
The Reader object that SQLJ interprets as an CharacterStream object.

length
The length of the Reader object that SQLJ interprets as an CharacterStream object.

Methods

getReader

Format:

```
public Reader getReader()
```

Returns the underlying Reader object that is wrapped by the CharacterStream object.

getLength

Format:

```
public void getLength()
```

Returns the length in characters of the wrapped Reader object, as specified by the constructor or in the last call to setLength.

setLength

Format:

```
public void setLength (int length)
```

Sets the number of characters that are read from the Reader object when the object is passed as an input argument to an SQL operation.

Parameters:

length
The number of characters that are read from the Reader object.

sqlj.runtime.ExecutionContext class

The sqlj.runtime.ExecutionContext class is defined for execution contexts. An execution context is used to control the execution of SQL statements.

Variables

ADD_BATCH_COUNT

Format:

```
public static final int ADD_BATCH_COUNT
```

A constant that can be returned by the getUpdateCount method. It indicates that the previous statement was not executed but was added to the existing statement batch.

AUTO_BATCH

Format:

```
public static final int AUTO_BATCH
```

A constant that can be passed to the setBatchLimit method. It indicates that implicit batch execution should be performed, and that SQLJ should determine the batch size.

EXEC_BATCH_COUNT

Format:

```
public static final int EXEC_BATCH_COUNT
```

A constant that can be returned from the getUpdateCount method. It indicates that a statement batch was just executed.

EXCEPTION_COUNT

Format:

```
public static final int EXCEPTION_COUNT
```

A constant that can be returned from the getUpdateCount method. It indicates that an exception was thrown before the previous execution completed, or that no operation has been performed on the execution context object.

NEW_BATCH_COUNT

Format:

```
public static final int NEW_BATCH_COUNT
```

A constant that can be returned from the getUpdateCount method. It indicates that the previous statement was not executed, but was added to a new statement batch.

QUERY_COUNT

Format:

```
public static final int QUERY_COUNT
```

A constant that can be passed to the setBatchLimit method. It indicates that the previous execution produced a result set.

UNLIMITED_BATCH

Format:

```
public static final int UNLIMITED_BATCH
```

A constant that can be returned from the getUpdateCount method. It indicates that statements should continue to be added to a statement batch, regardless of the batch size.

Constructors:

ExecutionContext

Format:

```
public ExecutionContext()
```

Creates an ExecutionContext instance.

Methods

cancel

Format:

```
public void cancel() throws SQLException
```

Cancels an SQL operation that is currently being executed by a thread that uses the execution context object. If there is a pending statement batch on the execution context object, the statement batch is canceled and cleared.

The cancel method throws an SQLException if the statement cannot be canceled.

execute

Format:

```
public boolean execute ( ) throws SQLException
```

This method is used by code that is generated by the SQLJ translator. It is not intended for direct use by application programs.

executeBatch

Format:

```
public synchronized int[] executeBatch() throws SQLException
```

Executes the pending statement batch and returns an array of update counts. If no pending statement batch exists, null is returned. When this method is called, the statement batch is cleared, even if the call results in an exception.

Each element in the returned array can be one of the following values:

-2 This value indicates that the SQL statement executed successfully, but the number of rows that were updated could not be determined.

-3 This value indicates that the SQL statement failed.

Other integer
This value is the number of rows that were updated by the statement.

The executeBatch method throws an SQLException if a database error occurs while the statement batch executes.

executeQuery

Format:

```
public RTResultSet executeQuery ( ) throws SQLException
```

This method is used by code that is generated by the SQLJ translator. It is not intended for direct use by application programs.

executeUpdate

Format:

```
public int executeUpdate() throws SQLException
```

This method is used by code that is generated by the SQLJ translator. It is not intended for direct use by application programs.

getBatchLimit

Format:

```
synchronized public int getBatchLimit()
```

Returns the number of statements that are added to a batch before the batch is implicitly executed.

The returned value is one of the following values:

UNLIMITED_BATCH
This value indicates that the batch size is unlimited.

AUTO_BATCH
This value indicates that the batch size is finite but unknown.

Other integer
The current batch limit.

getBatchUpdateCounts

Format:

```
public synchronized int[] getBatchUpdateCounts()
```

Returns an array that contains the number of rows that were updated by each statement that successfully executed in a batch. The order of elements in the array corresponds to the order in which statements were inserted into the batch. Returns null if no statements in the batch completed successfully.

Each element in the returned array can be one of the following values:

-2 This value indicates that the SQL statement executed successfully, but the number of rows that were updated could not be determined.

-3 This value indicates that the SQL statement failed.

Other integer
This value is the number of rows that were updated by the statement.

getFetchDirection

Format:

```
synchronized public int getFetchDirection() throws SQLException
```

Returns the current fetch direction for scrollable iterator objects that were generated from the given execution context. If a fetch direction was not set for the execution context, sqlj.runtime.ResultSetIterator.FETCH_FORWARD is returned.

getFetchSize

Format:

```
synchronized public int getFetchSize() throws SQLException
```

Returns the number of rows that should be fetched by SQLJ when more rows are needed. This value applies only to iterator objects that were generated from the given execution context. The returned value is the value that was set by the setFetchSize method, or 0 if no value was set by setFetchSize.

getMaxFieldSize

Format:

```
public synchronized int getMaxFieldSize()
```

Returns the maximum number of bytes that are returned for any string (character, graphic, or varying-length binary) column in queries that use the given execution context. If this limit is exceeded, SQLJ discards the remaining bytes. A value of 0 means that the maximum number of bytes is unlimited.

getMaxRows

Format:

```
public synchronized int getMaxRows()
```

Returns the maximum number of rows that are returned for any query that uses the given execution context. If this limit is exceeded, SQLJ discards the remaining rows. A value of 0 means that the maximum number of rows is unlimited.

getNextResultSet()

Format:

```
public ResultSet getNextResultSet() throws SQLException
```

After a stored procedure call, returns a result set from the stored procedure.

A null value is returned if any of the following conditions are true:

- There are no more result sets to be returned.
- The stored procedure call did not produce any result sets.
- A stored procedure call has not been executed under the execution context.

When you invoke getNextResultSet(), SQLJ closes the currently-open result set and advances to the next result set.

If an error occurs during a call to getNextResultSet, resources for the current JDBC ResultSet object are released, and an SQLException is thrown. Subsequent calls to getNextResultSet return null.

getNextResultSet(int)

Formats:

```
public ResultSet getNextResultSet(int current)
```

After a stored procedure call, returns a result set from the stored procedure.

A null value is returned if any of the following conditions are true:

- There are no more result sets to be returned.
- The stored procedure call did not produce any result sets.
- A stored procedure call has not been executed under the execution context.

If an error occurs during a call to getNextResultSet, resources for the current JDBC ResultSet object are released, and an SQLException is thrown. Subsequent calls to getNextResultSet return null.

Parameters:

current

Indicates what SQLJ does with the currently open result set before it advances to the next result set:

java.sql.Statement.CLOSE_CURRENT_RESULT

Specifies that the current ResultSet object is closed when the next ResultSet object is returned.

java.sql.Statement.KEEP_CURRENT_RESULT
Specifies that the current ResultSet object stays open when the next ResultSet object is returned.

java.sql.Statement.CLOSE_ALL_RESULTS
Specifies that all open ResultSet objects are closed when the next ResultSet object is returned.

getQueryTimeout
Format:

```
public synchronized int getQueryTimeout()
```

Returns the maximum number of seconds that SQL operations that use the given execution context object can execute. If an SQL operation exceeds the limit, an SQLException is thrown. The returned value is the value that was set by the setQueryTimeout method, or 0 if no value was set by setQueryTimeout. 0 means that execution time is unlimited.

getUpdateCount
Format:

```
public abstract int getUpdateCount() throws SQLException
```

Returns:

ExecutionContext.ADD_BATCH_COUNT
If the statement was added to an existing batch.

ExecutionContext.NEW_BATCH_COUNT
If the statement was the first statement in a new batch.

ExecutionContext.EXCEPTION_COUNT
If the previous statement generated an SQLException, or no previous statement was executed.

ExecutionContext.EXEC_BATCH_COUNT
If the statement was part of a batch, and the batch was executed.

ExecutionContext.QUERY_COUNT
If the previous statement created an iterator object or JDBC ResultSet.

Other integer
If the statement was executed rather than added to a batch. This value is the number of rows that were updated by the statement.

getWarnings
Format:

```
public synchronized SQLWarning getWarnings()
```

Returns the first warning that was reported by the last SQL operation that was executed using the given execution context. Subsequent warnings are chained to the first warning. If no warnings occurred, null is returned.

getWarnings is used to retrieve positive SQLCODEs.

isBatching
Format:

```
public synchronized boolean isBatching()
```

Returns `true` if batching is enabled for the execution context. Returns `false` if batching is disabled.

registerStatement

Format:

```
public RTStatement registerStatement(ConnectionContext connCtx,
 Object profileKey, int stmtNdx)
 throws SQLException
```

This method is used by code that is generated by the SQLJ translator. It is not intended for direct use by application programs.

releaseStatement

Format:

```
public void releaseStatement() throws SQLException
```

This method is used by code that is generated by the SQLJ translator. It is not intended for direct use by application programs.

setBatching

Format:

```
public synchronized void setBatching(boolean batching)
```

Parameters:

batching
Indicates whether batchable statements that are registered with the given execution context can be added to a statement batch:

true
Statements can be added to a statement batch.

false
Statements are executed individually.

setBatching affects only statements that occur in the program after setBatching is called. It does not affect previous statements or an existing statement batch.

setBatchLimit

Format:

```
public synchronized void setBatchLimit(int batch-size)
```

Sets the maximum number of statements that are added to a batch before the batch is implicitly executed.

Parameters:

batch-size
One of the following values:

ExecutionContext.UNLIMITED_BATCH
Indicates that implicit execution occurs only when SQLJ encounters a statement that is batchable but incompatible, or not batchable. Setting this value is the same as not invoking setBatchLimit.

ExecutionContext.AUTO_BATCH
Indicates that implicit execution occurs when the number of statements in the batch reaches a number that is set by SQLJ.

Positive integer
The number of statements that are added to the batch before SQLJ executes the batch implicitly. The batch might be executed before this many statements have been added if SQLJ encounters a statement that is batchable but incompatible, or not batchable.

setBatchLimit affects only statements that occur in the program after setBatchLimit is called. It does not affect an existing statement batch.

setFetchDirection

Format:

```
public synchronized void setFetchDirection(int direction) throws SQLException
```

Gives SQLJ a hint as to the current fetch direction for scrollable iterator objects that were generated from the given execution context.

Parameters:

direction
One of the following values:

sqlj.runtime.ResultSetIterator.FETCH_FORWARD
Rows are fetched in a forward direction. This is the default.

sqlj.runtime.ResultSetIterator.FETCH_REVERSE
Rows are fetched in a backward direction.

sqlj.runtime.ResultSetIterator.FETCH_UNKNOWN
The order of fetching is unknown.

Any other input value results in an SQLException.

setFetchSize

Format:

```
synchronized public void setFetchSize(int number-of-rows) throws SQLException
```

Gives SQLJ a hint as to the number of rows that should be fetched when more rows are needed.

Parameters:

number-of-rows
The expected number of rows that SQLJ should fetch for the iterator that is associated with the given execution context.

If *number-of-rows* is less than 0 or greater than the maximum number of rows that can be fetched, an SQLException is thrown.

setMaxFieldSize

Format:

```
public void setMaxFieldSize(int max-bytes)
```

Specifies the maximum number of bytes that are returned for any string (character, graphic, or varying-length binary) column in queries that use the given execution context. If this limit is exceeded, SQLJ discards the remaining bytes.

Parameters:

max-bytes
The maximum number of bytes that SQLJ should return from a BINARY, VARBINARY, CHAR, VARCHAR, GRAPHIC, or VARGRAPHIC column. A value of 0 means that the number of bytes is unlimited. 0 is the default.

setMaxRows

Format:

```
public synchronized void setMaxRows(int max-rows)
```

Specifies the maximum number of rows that are returned for any query that uses the given execution context. If this limit is exceeded, SQLJ discards the remaining rows.

Parameters:

max-rows
The maximum number of rows that SQLJ should return for a query that uses the given execution context. A value of 0 means that the number of rows is unlimited. 0 is the default.

setQueryTimeout
Format:

```
public synchronized void setQueryTimeout(int timeout-value)
```

Specifies the maximum number of seconds that SQL operations that use the given execution context object can execute. If an SQL operation exceeds the limit, an SQLException is thrown.

Parameters:

timeout-value
The maximum number of seconds that SQL operations that use the given execution context object can execute. 0 means that execution time is unlimited. 0 is the default.

sqlj.runtime.SQLNullException class

The sqlj.runtime.SQLNullException class is derived from the java.sql.SQLException class.

An sqlj.runtime.SQLNullException is thrown when an SQL NULL value is fetched into a host identifier with a Java primitive type. The SQLSTATE value for an instance of SQLNullException is '22002'.

sqlj.runtime.StreamWrapper class

The sqlj.runtime.StreamWrapper class wraps a java.io.InputStream instance and extends the java.io.InputStream class.

The sqlj.runtime.AsciiStream, sqlj.runtime.BinaryStream, and sqlj.runtime.UnicodeStream classes extend sqlj.runtime.StreamWrapper. `sqlj.runtime.StreamWrapper` supports methods for specifying the length of sqlj.runtime.AsciiStream, sqlj.runtime.BinaryStream, and sqlj.runtime.UnicodeStream objects.

Constructors

StreamWrapper(InputStream)
Format:

```
protected StreamWrapper(InputStream input-stream)
```

Creates an sqlj.runtime.StreamWrapper object with an unspecified length.

Parameters:

input-stream
The InputStream object that the sqlj.runtime.StreamWrapper object wraps.

StreamWrapper(InputStream, int)
Format:

```
protected StreamWrapper(java.io.InputStream input-stream, int length)
```

Creates an sqlj.runtime.StreamWrapper object with a specified length.

Parameters:

input-stream
The InputStream object that the sqlj.runtime.StreamWrapper object wraps.

length
The length of the InputStream object in bytes.

Methods

getInputStream
Format:

```
public InputStream getInputStream()
```

Returns the underlying InputStream object that is wrapped by the StreamWrapper object.

getLength
Format:

```
public void getLength()
```

Returns the length in bytes of the wrapped InputStream object, as specified by the constructor or in the last call to setLength.

setLength
Format:

```
public void setLength (int length)
```

Sets the number of bytes that are read from the wrapped InputStream object when the object is passed as an input argument to an SQL operation.

Parameters:

length
The number of bytes that are read from the wrapped InputStream object.

sqlj.runtime.UnicodeStream class

The sqlj.runtime.UnicodeStream class is for an input stream of Unicode data with a specified length.

The sqlj.runtime.UnicodeStream class is derived from the java.io.InputStream class, and extends the sqlj.runtime.StreamWrapper class. SQLJ interprets the bytes in an sqlj.runtime.UnicodeStream object as Unicode characters. An InputStream object with Unicode characters needs to be passed as a sqlj.runtime.UnicodeStream object.

Constructors

UnicodeStream(InputStream)
Format:

```
public UnicodeStream(java.io.InputStream input-stream)
```

Creates a Unicode java.io.InputStream object with an unspecified length.

Parameters:

input-stream
The InputStream object that SQLJ interprets as an UnicodeStream object.

UnicodeStream(InputStream, int)
Format:

```
public UnicodeStream(java.io.InputStream input-stream, int length)
```

Creates a Unicode java.io.InputStream object with a specified length.

Parameters:

input-stream
The InputStream object that SQLJ interprets as an UnicodeStream object.

length
The length of the InputStream object that SQLJ interprets as an UnicodeStream object.

IBM Data Server Driver for JDBC and SQLJ extensions to JDBC

The IBM Data Server Driver for JDBC and SQLJ provides a set of extensions to the support that is provided by the JDBC specification.

To use IBM Data Server Driver for JDBC and SQLJ-only methods in classes that have corresponding, standard classes, cast an instance of the related, standard JDBC class to an instance of the IBM Data Server Driver for JDBC and SQLJ-only class. For example:

```
javax.sql.DataSource ds =
 new com.ibm.db2.jcc.DB2SimpleDataSource();
((com.ibm.db2.jcc.DB2BaseDataSource) ds).setServerName("sysmvs1.stl.ibm.com");
```

Table 83 summarizes the IBM Data Server Driver for JDBC and SQLJ-only interfaces.

Table 83. Summary of IBM Data Server Driver for JDBC and SQLJ-only interfaces provided by the IBM Data Server Driver for JDBC and SQLJ

Interface name	Applicable data sources	Purpose
DB2Connection	1 on page 311, 2 on page 311, 3 on page 311	Extends the java.sql.Connection interface.
DB2DatabaseMetaData	1 on page 311, 2 on page 311, 3 on page 311	Extends the java.sql.DatabaseMetaData interface.
DB2Diagnosable	1 on page 311, 2 on page 311, 3 on page 311	Provides a mechanism for getting DB2 diagnostics from a DB2 SQLException.
DB2PreparedStatement	1 on page 311, 2 on page 311, 3 on page 311	Extends the com.ibm.db2.jcc.DB2Statement and java.sql.PreparedStatement interfaces.
DB2RowID	1 on page 311, 2 on page 311	Used for declaring Java objects for use with the ROWID data type.
DB2Statement	1 on page 311, 2 on page 311, 3 on page 311	Extends the java.sql.Statement interface.
DB2TraceManagerMXBean	1 on page 311, 2 on page 311, 3 on page 311	Provides the MBean interface for the remote trace controller.

Table 83. Summary of IBM Data Server Driver for JDBC and SQLJ-only interfaces provided by the IBM Data Server Driver for JDBC and SQLJ (continued)

Interface name	Applicable data sources	Purpose
DB2SystemMonitor	1, 2, 3	Used for collecting system monitoring data for a connection.
DB2Xml	1, 2	Used for updating data in XML columns and retrieving data from XML columns.

Note: The interface applies to connections to the following data sources:

1. DB2 for z/OS
2. DB2 Database for Linux, UNIX, and Windows
3. IBM Informix Dynamic Server

Table 84 summarizes the IBM Data Server Driver for JDBC and SQLJ-only classes.

Table 84. Summary of IBM Data Server Driver for JDBC and SQLJ-only classes provided by the IBM Data Server Driver for JDBC and SQLJ

Class name	Applicable data sources	Purpose
DB2Administrator (DB2 Database for Linux, UNIX, and Windows only)	2 on page 312	Instances of the DB2Administrator class are used to retrieve DB2CataloguedDatabase objects.
DB2BaseDataSource	1 on page 312, 2 on page 312, 3 on page 312	The abstract data source parent class for all IBM Data Server Driver for JDBC and SQLJ-specific implementations of javax.sql.DataSource, javax.sql.ConnectionPoolDataSource, and javax.sql.XADataSource.
DB2CataloguedDatabase	2 on page 312	Contains methods that retrieve information about a local DB2 Database for Linux, UNIX, and Windows database.
DB2ClientRerouteServerList	1 on page 312, 2 on page 312	Implements the java.io.Serializable and javax.naming.Referenceable interfaces.
DB2ConnectionPoolDataSource	1 on page 312, 2 on page 312, 3 on page 312	A factory for PooledConnection objects.
DB2ExceptionFormatter	1 on page 312, 2 on page 312, 3 on page 312	Contains methods for printing diagnostic information to a stream.
DB2JCCPlugin	2 on page 312	The abstract class for implementation of JDBC security plug-ins.
DB2PooledConnection	1 on page 312, 2 on page 312, 3 on page 312	Provides methods that an application server can use to switch users on a preexisting trusted connection.
DB2PoolMonitor	1 on page 312, 2 on page 312	Provides methods for monitoring the global transport objects pool for the connection concentrator and Sysplex workload balancing.
DB2SimpleDataSource	1 on page 312, 2 on page 312, 3 on page 312	Extends the DataBaseDataSource class. Does not support connection pooling or distributed transactions.
DB2Sqlca	1 on page 312, 2 on page 312, 3 on page 312	An encapsulation of the DB2 SQLCA.
DB2TraceManager	1 on page 312, 2 on page 312, 3 on page 312	Controls the global log writer.

Table 84. Summary of IBM Data Server Driver for JDBC and SQLJ-only classes provided by the IBM Data Server Driver for JDBC and SQLJ (continued)

Class name	Applicable data sources	Purpose
DB2XADataSource	1, 2, 3	A factory for XADataSource objects. An object that implements this interface is registered with a naming service that is based on the Java Naming and Directory Interface (JNDI).

Note: The class applies to connections to the following data sources:

1. DB2 for z/OS
2. DB2 Database for Linux, UNIX, and Windows
3. IBM Informix Dynamic Server

DB2Administrator class

Instances of the com.ibm.db2.jcc.DB2Administrator class are used to retrieve DB2CataloguedDatabase objects. DB2Administrator applies to DB2 Database for Linux, UNIX, and Windows databases only.

DB2Administrator methods

getInstance

Format:

```
public static DB2Administrator getInstance()
```

Returns an instance of the DB2Administrator class.

getCataloguedDatabases

Format:

```
public DB2CataloguedDatabase[] getCataloguedDatabases()
 throws java.sql.SQLException
```

Retrieves an array that contains a DB2CataloguedDatabase object for each local database in the local database directory.

If a local DB2 system is available, and the catalog contains no databases, an array with length zero is returned. If no local DB2 system is available, null is returned. If the local system is not a DB2 Database for Linux, UNIX, and Windows system, an SQLException is thrown.

DB2BaseDataSource class

The com.ibm.db2.jcc.DB2BaseDataSource class is the abstract data source parent class for all IBM Data Server Driver for JDBC and SQLJ-specific implementations of javax.sql.DataSource, javax.sql.ConnectionPoolDataSource, and javax.sql.XADataSource.

DB2BaseDataSource implements the java.sql.Wrapper interface.

DB2BaseDataSource properties

The following properties are defined only for the IBM Data Server Driver for JDBC and SQLJ.

Each of these properties has a setXXX method to set the value of the property and a getXXX method to retrieve the value. A setXXX method has this form:

```
void setProperty-name(data-type property-value)
```

A getXXX method has this form:

```
data-type getProperty-name()
```

Property-name is the unqualified property name. For properties that are not specific to IBM Informix Dynamic Server (IDS), the first character of the property name is capitalized. For properties that are used only by IDS, all characters of the property name are capitalized.

The following table lists the IBM Data Server Driver for JDBC and SQLJ properties and their data types.

Table 85. DB2BaseDataSource properties and their data types

Property name	Applicable data sources	Data type
com.ibm.db2.jcc.DB2BaseDataSource.accountingInterval	1 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.blockingReadConnectionTimeout	1 on page 317, 2 on page 317, 3 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.charOutputSize	1 on page 317	short
com.ibm.db2.jcc.DB2BaseDataSource.clientAccountingInformation (IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS only)	1 on page 317, 2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.clientApplicationInformation (IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS only)	1 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.clientDebugInfo (IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS only)	1 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.clientProgramId (IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS only)	1 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.clientProgramName	1 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.clientRerouteAlternateServerName	1 on page 317, 2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.clientRerouteAlternatePortNumber	1 on page 317, 2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.clientRerouteServerListJNDIContext	1 on page 317, 2 on page 317	javax.naming.Context
com.ibm.db2.jcc.DB2BaseDataSource.clientRerouteServerListJNDIName	1 on page 317, 2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.clientUser (IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS only)	1 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.clientWorkstation (IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS only)	1 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.connectNode	2 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.currentDegree	1 on page 317, 2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.currentExplainMode	2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.currentExplainSnapshot	2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.currentFunctionPath	1 on page 317, 2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.currentLockTimeout	2 on page 317, 3 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.currentMaintainedTableTypesForOptimization	1 on page 317, 2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.currentPackagePath	1 on page 317, 2 on page 317	String

Table 85. DB2BaseDataSource properties and their data types (continued)

Property name	Applicable data sources	Data type
com.ibm.db2.jcc.DB2BaseDataSource.currentPackageSet	1 on page 317, 2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.currentQueryOptimization	2 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.currentRefreshAge	1 on page 317, 2 on page 317	long
com.ibm.db2.jcc.DB2BaseDataSource.currentSchema	1 on page 317, 2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.cursorSensitivity	1 on page 317, 2 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.currentSQLID	1 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.databaseName	1 on page 317, 2 on page 317, 3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.dateFormat	1 on page 317, 2 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.decimalRoundingMode	1 on page 317, 2 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.defaultIsolationLevel	1 on page 317, 2 on page 317, 3 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.deferPrepares	1 on page 317, 2 on page 317, 3 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.description	1 on page 317, 2 on page 317, 3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.downgradeHoldCursorsUnderXa	1 on page 317, 2 on page 317,3 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.driverType	1 on page 317, 2 on page 317, 3 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.enableConnectionConcentrator	1 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.enableSysplexWLB	1 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.fullyMaterializeInputStreams	1 on page 317, 2 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.fullyMaterializeLobData	1 on page 317, 2 on page 317, 3 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.gssCredential	1 on page 317, 2 on page 317	Object
com.ibm.db2.jcc.DB2BaseDataSource.jdbcCollection	1 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.keepDynamic	1 on page 317, 3 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.kerberosServerPrincipal	1 on page 317, 2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.loginTimeout (not supported for IBM Data Server Driver for JDBC and SQLJ type 2 connectivity on DB2 for z/OS)	1 on page 317, 2 on page 317, 3 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.logWriter	1 on page 317, 2 on page 317, 3 on page 317	PrintWriter

Table 85. DB2BaseDataSource properties and their data types (continued)

Property name	Applicable data sources	Data type
com.ibm.db2.jcc.DB2BaseDataSource.maxRetriesForClientReroute	1 on page 317, 2 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.maxTransportObjects	1 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.optimizationProfile	2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.optimizationProfileToFlush	2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.password	1 on page 317, 2 on page 317, 3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.pkList (IBM Data Server Driver for JDBC and SQLJ type 2 connectivity)	1 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.planName (IBM Data Server Driver for JDBC and SQLJ type 2 connectivity only)	1 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.plugin	2 on page 317	Object
com.ibm.db2.jcc.DB2BaseDataSource.pluginName	2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.portNumber	1 on page 317, 2 on page 317, 3 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.progressiveStreaming	1 on page 317, 2 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.queryDataSize	1 on page 317, 2 on page 317, 3 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.queryCloseImplicit	1 on page 317, 3 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.readOnly	1 on page 317, 2 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.resultSetHoldability	1 on page 317, 2 on page 317,3 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.resultSetHoldabilityForCatalogQueries	1 on page 317, 2 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.retrieveMessagesFromServerOnGetMessage	1 on page 317, 3 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.retryIntervalForClientReroute	1 on page 317, 2 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.returnAlias	1 on page 317, 2 on page 317	short
com.ibm.db2.jcc.DB2BaseDataSource.securityMechanism	1 on page 317, 2 on page 317, 3 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.sendCharInputsUTF8	1 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.sendDataAsIs	1 on page 317, 2 on page 317, 3 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.serverName	1 on page 317, 2 on page 317, 3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.sqljEnableClassLoaderSpecificProfiles	1 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.sslConnection	1 on page 317, 2 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.streamBufferSize	1 on page 317, 2 on page 317	int

Table 85. DB2BaseDataSource properties and their data types (continued)

Property name	Applicable data sources	Data type
com.ibm.db2.jcc.DB2BaseDataSource.supportsAsynchronousXARollback	1 on page 317, 2 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.sysSchema	1 on page 317, 2 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.timeFormat	1 on page 317, 2 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.traceDirectory	1 on page 317, 2 on page 317, 3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.traceFile	1 on page 317, 2 on page 317, 3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.traceFileAppend	1 on page 317, 2 on page 317, 3 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.traceLevel	1 on page 317, 2 on page 317, 3 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.useCachedCursor	1 on page 317, 2 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.useJDBC4ColumnNameAndLabelSemantics	1 on page 317, 2 on page 317	int
com.ibm.db2.jcc.DB2BaseDataSource.user	1 on page 317, 2 on page 317, 3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.useRowsetCursor	1 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.useTransactionRedirect	2 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.xaNetworkOptimization	1 on page 317, 2 on page 317, 3 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.DBANSIWARN	3 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.DBDATE	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.DBPATH	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.DBSPACETEMP	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.DBTEMP	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.DBUPSPACE	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.DELIMIDENT	3 on page 317	boolean
com.ibm.db2.jcc.DB2BaseDataSource.IFX_DIRECTIVES	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.IFX_EXTDIRECTIVES	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.IFX_UPDDESC	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.IFX_XASTDCOMPLIANCE_XAEND	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.INFORMIXOPCACHE	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.INFORMIXSTACKSIZE	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.NODEFDAC	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.OPTCOMPIND	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.OPTOFC	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.PDQPRIORITY	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.PSORT_DBTEMP	3 on page 317	String
com.ibm.db2.jcc.DB2BaseDataSource.PSORT_NPROCS	3 on page 317	String

Table 85. DB2BaseDataSource properties and their data types (continued)

Property name	Applicable data sources	Data type
com.ibm.db2.jcc.DB2BaseDataSource.STMT_CACHE	3	String

Note: The property applies to connections to the following data sources:

1. DB2 for z/OS
2. DB2 Database for Linux, UNIX, and Windows
3. IBM Informix Dynamic Server

DB2BaseDataSource methods

In addition to the getXXX and setXXX methods for the DB2BaseDataSource properties, the following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

getReference

Format:

```
public javax.naming.Reference getReference()
  throws javax.naming.NamingException
```

Retrieves the Reference of a DataSource object. For an explanation of a Reference, see the description of javax.naming.Referenceable in the JNDI documentation at:

```
http://java.sun.com/products/jndi/docs.html
```

DB2CataloguedDatabase class

The com.ibm.db2.jcc.DB2CataloguedDatabase class contains methods that retrieve information about a local DB2 Database for Linux, UNIX, and Windows database.

No database connection is needed for calling DB2CataloguedDatabase methods.

DB2CataloguedDatabase methods

getServerName

Format:

```
public String getServerName()
```

Retrieves the name of the server on which the database resides.

getPortNumber

Format:

```
public int getPortNumber()
```

Retrieves the port number that is associated with the DB2 instance.

getDatabaseName

Format:

```
public String getDatabaseName()
```

Retrieves the database name.

getDatabaseAlias

Format:

```
public String getDatabaseAlias()
```

Retrieves the database alias.

DB2ClientRerouteServerList class

The com.ibm.db2.jcc.DB2ClientRerouteServerList class implements the java.io.Serializable and javax.naming.Referenceable interfaces.

DB2ClientRerouteServerList methods

getAlternatePortNumber

Format:

```
public int[] getAlternatePortNumber()
```

Retrieves the port numbers that are associated with the alternate servers.

getAlternateServerName

Format:

```
public String[] getAlternateServerName()
```

Retrieves an array that contains the names of the alternate servers. These values are IP addresses or DNS server names.

getPrimaryPortNumber

Format:

```
public int getPrimaryPortNumber()
```

Retrieves the port number that is associated with the primary server.

getPrimaryServerName

Format:

```
public String[] getPrimaryServerName()
```

Retrieves the name of the primary server. This value is an IP address or a DNS server name.

setAlternatePortNumber

Format:

```
public void setAlternatePortNumber(int[] alternatePortNumberList)
```

Sets the port numbers that are associated with the alternate servers.

setAlternateServerName

Format:

```
public void setAlternateServerName(String[] alternateServer)
```

Sets the alternate server names for servers. These values are IP addresses or DNS server names.

setPrimaryPortNumber

Format:

```
public void setPrimaryPortNumber(int primaryPortNumber)
```

Sets the port number that is associated with the primary server.

setPrimaryServerName

Format:

```
public void setPrimaryServerName(String primaryServer)
```

Sets the primary server name for a server. This value is an IP address or a DNS server name.

DB2Connection interface

The com.ibm.db2.jcc.DB2Connection interface extends the java.sql.Connection interface.

DB2Connection implements the java.sql.Wrapper interface.

DB2Connection methods

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

alternateWasUsedOnConnect

Format:

```
public boolean alternateWasUsedOnConnect()
  throws java.sql.SQLException
```

Returns `true` if the driver used alternate server information to obtain the connection. The alternate server information is available in the transient clientRerouteServerList information on the DB2BaseDataSource, which the database server updates as primary and alternate servers change.

changeDB2Password

Format:

```
public abstract void changeDB2Password(String oldPassword,
  String newPassword)
  throws java.sql.SQLException
```

Changes the password for accessing the data source, for the user of the Connection object.

Parameter descriptions:

oldPassword
The original password for the Connection.

newPassword
The new password for the Connection.

createArrayOf

Format:

```
Array createArrayOf(String typeName,
  Object[] elements)
  throws SQLException;
```

Creates a java.sql.Array object.

Parameter descriptions:

typeName
The SQL data type of the elements of the array map to. typeName can be a built-in data type or a distinct type.

elements
The elements that populate the Array object.

deregisterDB2XmlObject

Formats:

```
public void deregisterDB2XmlObject(String sqlIdSchema,
  String sqlIdName)
  throws SQLException
```

Removes a previously registered XML schema from the data source. deregisterDB2XmlObject calls the SYSPROC.XSR_REMOVE stored procedure to remove the XML schema.

Parameter descriptions:

sqlIdSchema
The SQL schema name for the XML schema. sqlIdSchema is a String value with a maximum length of 128 bytes. The value of sqlIdSchema must conform to the naming rules for any SQL schema name. The name cannot begin with the string 'SYS'. If the value of sqlIdSchema is null, the database system uses the value in the CURRENT SCHEMA special register.

sqlIdName
The SQL name for the XML schema. sqlIdName is a String value with a maximum length of 128 bytes. The value of sqlIdName must conform to the rules for an SQL identifier. If the value of sqlIdSchema is null, the value of sqlIdName can be null, In that case, the database system generates the value for sqlIdName.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

getDB2ClientProgramId
Format:

```
public String getDB2ClientProgramId()
  throws java.sql.SQLException
```

Returns the user-defined program identifier for the client. The program identifier can be used to identify the application at the data source.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

getDB2ClientAccountingInformation
Format:

```
public String getDB2ClientAccountingInformation()
  throws SQLException
```

Returns accounting information for the current client.

Important: getDB2ClientAccountingInformation is deprecated in the JDBC 4.0 implementation of the IBM Data Server Driver for JDBC and SQLJ. Use java.sql.Connection.getClientInfo instead.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

getDB2ClientApplicationInformation
Format:

```
public String getDB2ClientApplicationInformation()
  throws java.sql.SQLException
```

Returns application information for the current client.

Important: getDB2ClientApplicationInformation is deprecated in the JDBC 4.0 implementation of the IBM Data Server Driver for JDBC and SQLJ. Use java.sql.Connection.getClientInfo instead.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

getDB2ClientUser

Format:

```
public String getDB2ClientUser()
  throws java.sql.SQLException
```

Returns the current client user name for the connection. This name is not the user value for the JDBC connection.

Important: getDB2ClientUser is deprecated in the JDBC 4.0 implementation of the IBM Data Server Driver for JDBC and SQLJ. Use java.sql.Connection.getClientInfo instead.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

getDB2ClientWorkstation

Format:

```
public String getDB2ClientWorkstation()
  throws java.sql.SQLException
```

Returns current client workstation name for the current client.

Important: getDB2ClientWorkstation is deprecated in the JDBC 4.0 implementation of the IBM Data Server Driver for JDBC and SQLJ. Use java.sql.Connection.getClientInfo instead.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

getDB2Correlator

Format:

```
String getDB2Correlator()
  throws java.sql.SQLException
```

Returns the value of the crrtkn (correlation token) instance variable that DRDA sends with the ACCRDB command. The correlation token uniquely identifies a logical connection to a server.

getDB2CurrentPackagePath

Format:

```
public String getDB2CurrentPackagePath()
  throws java.sql.SQLException
```

Returns the list of DB2 package collections that are searched for JDBC and SQLJ packages.

The getDB2CurrentPackagePath method applies only to connections to DB2 database systems.

getDB2CurrentPackageSet

Format:

```
public String getDB2CurrentPackageSet()
  throws java.sql.SQLException
```

Returns the collection ID for the connection.

The getDB2CurrentPackageSet method applies only to connections to DB2 database systems.

getDB2SecurityMechanism

Format:

```
public int getDB2SecurityMechanism()
  throws java.sql.SQLException
```

Returns the security mechanism that is in effect for the connection:

3 Clear text password security

4 User ID-only security

7 Encrypted password security

9 Encrypted user ID and password security

11 Kerberos security

12 Encrypted user ID and data security

13 Encrypted user ID, password, and data security

15 Plugin security

16 Encrypted user ID-only security

getDB2SystemMonitor

Format:

```
public abstract DB2SystemMonitor getDB2SystemMonitor()
  throws java.sql.SQLException
```

Returns the system monitor object for the connection. Each IBM Data Server Driver for JDBC and SQLJ connection can have a single system monitor.

getJccLogWriter

Format:

```
public PrintWriter getJccLogWriter()
  throws java.sql.SQLException
```

Returns the current trace destination for the IBM Data Server Driver for JDBC and SQLJ trace.

installDB2JavaStoredProcedure

Format:

```
public void DB2Connection.installDB2JavaStoredProcedure(
  java.io.InputStream jarFile,
  int jarFileLength,
  String jarId)
  throws java.sql.SQLException
```

Invokes the sqlj.install_jar stored procedure on a DB2 Database for Linux, UNIX, and Windows server to create a new definition of a JAR file in the catalog for that server.

Parameter descriptions:

jarFile
The contents of the JAR file that is to be defined to the server.

jarFileLength
The length of the JAR file that is to be defined to the server.

jarId
The name of the JAR in the database, in the form *schema.JAR-id* or *JAR-id*. This is the name that you use when you refer to the JAR in SQL statements. If you omit *schema*, the database system uses the SQL authorization ID that is in the CURRENT SCHEMA special register. The owner of the JAR is the authorization ID in the CURRENT SQLID special register.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

isDB2Alive
Format:

```
public boolean DB2Connection.isDB2Alive()
  throws java.sql.SQLException
```

Returns `true` if the socket for a connection to the data source is still active.

Important: isDB2Alive is deprecated in the JDBC 4.0 implementation of the IBM Data Server Driver for JDBC and SQLJ. Use Connection.isValid instead.

isDB2GatewayConnection
Format:

```
public boolean DB2Connection.isDB2GatewayConnection()
  throws java.sql.SQLException
```

Returns `true` if the connection to the data source goes through an intermediate DB2 Connect gateway. Returns `false` otherwise.

prepareDB2OptimisticLockingQuery
Format:

```
public java.sql.PreparedStatement
  DB2Connection.prepareDB2OptimisticLockingQuery(String sql,
  int returnOptimisticLockingColumns)
  throws SQLException
```

Creates a PreparedStatement object that can request optimistic locking information.

Parameter descriptions:

sql
The SQL statement that is to be prepared.

returnOptimisticLockingColumns
Specifies whether optimistic locking columns are returned. Possible values are:

Table 86.

Value	Description
DB2Statement.RETURN_OPTLOCK_COLUMN_NONE (0)	Do not return optimistic locking columns.
DB2Statement.RETURN_OPTLOCK_COLUMN_ALWAYS (1)	Add row change columns to the result set even if they do not uniquely represent a single row. This setting is equivalent to the database prepare attribute WITH ROW CHANGE COLUMNS POSSIBLY DISTINCT.

Table 86. (continued)

Value	Description
DB2Statement.RETURN_OPTLOCK_COLUMN_NO_FALSE_NEGATIVES (2)	Add row change columns to the result set only if they uniquely represent a single row. This setting is equivalent to the database prepare attribute WITH ROW CHANGE COLUMNS ALWAYS DISTINCT.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

reconfigureDB2Connection

Format:

```
public void reconfigureDB2Connection(java.util.Properties properties)
  throws SQLException
```

Reconfigures a connection with new settings. The connection does not need to be returned to a connection pool before it is reconfigured. This method can be called while a transaction is in progress, and can be used for trusted or untrusted connections.

Parameter descriptions:

properties

New properties for the connection. These properties override any properties that are already defined on the DB2Connection instance.

registerDB2XmlSchema

Formats:

```
public void registerDB2XmlSchema(String[] sqlIdSchema,
  String[] sqlIdName,
  String[] xmlSchemaLocations,
  InputStream[] xmlSchemaDocuments,
  int[] xmlSchemaDocumentsLengths,
  InputStream[] xmlSchemaDocumentsProperties,
  int[] xmlSchemaDocumentsPropertiesLengths,
  InputStream xmlSchemaProperties,
  int xmlSchemaPropertiesLength,
  boolean isUsedForShredding)
  throws SQLException
public void registerDB2XmlSchema(String[] sqlIdSchema,
  String[] sqlIdName,
  String[] xmlSchemaLocations,
  String[] xmlSchemaDocuments,
  String[] xmlSchemaDocumentsProperties,
  String xmlSchemaProperties,
  boolean isUsedForShredding)
  throws SQLException
```

Provides one or more XML schema documents for registering an XML schema in the database. `registerDB2XmlSchema` calls the SYSPROC.XSR_REGISTER, SYSPROC.XSR_ADDSCHEMADOC, and SYSPROC.XSR_COMPLETE stored procedures to register an XML schema with one or more XML schema documents. If multiple XML schema documents are processed with one call to registerDB2XmlSchema, those documents are processed as part of a single transaction.

The first form of registerDB2XmlSchema is for XML schema documents that are read from an input stream. The second form of registerDB2XmlSchema is for XML schema documents that are read from strings.

Parameter descriptions:

sqlIdSchema
The SQL schema name for the XML schema. Only the first element of the sqlIdSchema array is used. sqlIdSchema is a String value with a maximum length of 128 bytes. The value of sqlIdSchema must conform to the naming rules for any SQL schema name. The name cannot begin with the string 'SYS'. If the value of sqlIdSchema is null, the database system uses the value in the CURRENT SCHEMA special register.

sqlIdName
The SQL name for the XML schema. Only the first element of the sqlIdName array is used. sqlIdName is a String value with a maximum length of 128 bytes. The value of sqlIdName must conform to the rules for an SQL identifier. If the value of sqlIdSchema is null, the value of sqlIdName can be null, In that case, the database system generates the value for sqlIdName.

xmlSchemaLocations
XML schema locations for the primary XML schema documents of the schemas that are being registered. XML schema location values are normally in URI format. Each xmlSchemaLocations value is a String value with a maximum length of 1000 bytes. The value is used only to match the information that is specified in the XML schema document that references this document. The database system does no validation of the format, and no attempt is made to resolve the URI.

xmlSchemaDocuments
The content of the primary XML schema documents. Each xmlSchemaDocuments value is a String or InputStream value with a maximum length of 30MB. The values must not be null.

xmlSchemaDocumentsLengths
The lengths of the XML schema documents in the xmlSchemaDocuments parameter, if the first form of registerDB2XmlSchema is used. Each xmlSchemaDocumentsLengths value is an int value.

xmlSchemaDocumentsProperties
Contains properties of the primary XML schema documents, such as properties that are used by an external XML schema versioning system. The database system does no validation of the contents of these values. They are stored in the XSR table for retrieval and used in other tools and XML schema repository implementations. Each xmlSchemaDocumentsProperties value is a String or InputStream value with a maximum length of 5MB. A value is null if there are no properties to be passed.

xmlSchemaDocumentsPropertiesLengths
The lengths of the XML schema properties in the xmlSchemaDocumentsProperties parameter, if the first form of registerDB2XmlSchema is used. Each xmlSchemaDocumentsPropertiesLengths value is an int value.

xmlSchemaProperties
Contains properties of the entire XML schema, such as properties that are used by an external XML schema versioning system. The database system does no validation of the contents of this value. They are stored in the XSR table for retrieval and used in other tools and XML schema repository

implementations. The xmlSchemaProperties value is a String or InputStream value with a maximum length of 5MB. The value is null if there are no properties to be passed.

xmlSchemaPropertiesLengths
The length of the XML schema property in the xmlSchemaProperties parameter, if the first form of registerDB2XmlSchema is used. The xmlSchemaPropertiesLengths value is an int value.

isUsedForShredding
Indicates whether there are annotations in the schema that are to be used for XML decomposition. isUsedForShredding is a boolean value.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

updateDB2XmlSchema
Format:

```
public void updateDB2XmlSchema(String[] targetSqlIdSchema,
  String[] targetSqlIdName,
  String[] sourceSqlIdSchema,
  String[] sourceSqlIdName,
  String[] xmlSchemaLocations,
  boolean dropSourceSchema)
  throws SQLException
```

Updates the contents of an XML schema with the contents of another XML schema in the XML schema repository, and optionally drops the source schema. UpdateDB2XmlSchema calls the SYSPROC.XSR_XSR_UPDATE stored procedure to update the XML schema. The schema documents in the target XML schema are replaced with the schema documents from the source XML schema. Before updateDB2XmlSchema can be called, registration of the source and target XML schemas must be completed.

The SQL ALTERIN privilege is required for updating the target XML schema. The SQL DROPIN privilege is required for dropping the source XML schema.

Parameter descriptions:

targetSqlIdSchema
The SQL schema name for a registered XML schema that is to be updated. targetSqlIdSchema is a String value with a maximum length of 128 bytes.

targetSqlIdName
The name of the registered XML schema that is to be updated. targetSqlIdName is a String value with a maximum length of 128 bytes.

sourceSqlIdSchema
The SQL schema name for a registered XML schema that is used to update the target XML schema. sourceSqlIdSchema is a String value with a maximum length of 128 bytes.

sourceSqlIdName
The name of the registered XML schema that is used to update the target XML schema. sourceSqlIdName is a String value with a maximum length of 128 bytes.

dropSourceSchema
Indicates whether the source XML schema is to be dropped after the target XML schema is updated. dropSourceSchema is a boolean value. `false` is the default.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

removeDB2JavaStoredProcedure

Format:

```
public void DB2Connection.removeDB2JavaStoredProcedure(
  String jarId)
  throws java.sql.SQLException
```

Invokes the sqlj.remove_jar stored procedure on a DB2 Database for Linux, UNIX, and Windows server to delete the definition of a JAR file from the catalog for that server.

Parameter descriptions:

jarId
The name of the JAR in the database, in the form *schema.JAR-id* or *JAR-id*. This is the name that you use when you refer to the JAR in SQL statements. If you omit *schema*, the database system uses the SQL authorization ID that is in the CURRENT SCHEMA special register.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

replaceDB2JavaStoredProcedure

Format:

```
public void DB2Connection.replaceDB2JavaStoredProcedure(
  java.io.InputStream jarFile,
  int jarFileLength,
  String jarId)
  throws java.sql.SQLException
```

Invokes the sqlj.replace_jar stored procedure on a DB2 Database for Linux, UNIX, and Windows server to replace the definition of a JAR file in the catalog for that server.

Parameter descriptions:

jarFile
The contents of the JAR file that is to be replaced on the server.

jarFileLength
The length of the JAR file that is to be replace on the server.

jarId
The name of the JAR in the database, in the form *schema.JAR-id* or *JAR-id*. This is the name that you use when you refer to the JAR in SQL statements. If you omit *schema*, the database system uses the SQL authorization ID that is in the CURRENT SCHEMA special register. The owner of the JAR is the authorization ID in the CURRENT SQLID special register.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

reuseDB2Connection (trusted connection reuse)

Formats:

```
public Connection reuseDB2Connection(byte[] cookie,
  String user,
  String password,
```

```
  String usernameRegistry,
  byte[] userSecToken,
  String originalUser,
  java.util.Properties properties)
  throws java.sql.SQLException
public Connection reuseDB2Connection(byte[] cookie,
  org.ietf.GSSCredential gssCredential,
  String usernameRegistry,
  byte[] userSecToken,
  String originalUser,
  java.util.Properties properties)
  throws java.sql.SQLException
```

Used by a trusted application server to reuse a preexisting trusted connection on behalf of a new user. Properties that can be reset are passed, including the new user ID. The database server resets the associated physical connection. If reuseDB2Connection executes successfully, the connection becomes available for immediate use, with different properties, by the new user.

The second form of reuseDB2Connection is supported only for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

Parameter descriptions:

cookie
A unique cookie that the JDBC driver generates for the Connection instance. The cookie is known only to the application server and the underlying JDBC driver that established the initial trusted connection. The application server passes the cookie that was created by the driver when the pooled connection instance was created. The JDBC driver checks that the supplied cookie matches the cookie of the underlying trusted physical connection to ensure that the request originated from the application server that established the trusted physical connection. If the cookies match, the connection becomes available for immediate use, with different properties, by the new user .

user
The client ID that the database system uses to establish the database authorization ID. If the user was not authenticated by the application server, the application server needs to pass a client ID that represents an unauthenticated user.

password
The password for *user*.

gssCredential
If the data source uses Kerberos security, specifies a delegated credential that is passed from another principal.

userNameRegistry
A name that identifies a mapping service that maps a workstation user ID to a z/OS RACF ID. An example of a mapping service is the Integrated Security Services Enterprise Identity Mapping (EIM). The mapping service is defined by a plugin. Valid values for *userNameRegistry* are defined by the plugin providers. If *userNameRegistry* is null, no mapping of *user* is done.

userSecToken
The client's security tokens. This value is traced as part of DB2 for z/OS accounting data. The content of *userSecToken* is described by the application server and is referred to by the database system as an application server security token.

originalUser
The original user ID that was used by the application server.

properties
Properties for the reused connection.

reuseDB2Connection (untrusted reuse with reauthentication)
Formats:

```
public DB2Connection reuseDB2Connection(String user,
  String password,
  java.util.Properties properties)
  throws java.sql.SQLException
public DB2Connection reuseDB2Connection(
  org.ietf.jgss.GSSCredential gssCredential,
  java.util.Properties properties)
  throws java.sql.SQLException
```

In a heterogeneous pooling environment, reuses an existing Connection instance after reauthentication.

Parameter description:

user
The authorization ID that is used to establish the connection.

password
The password for the authorization ID that is used to establish the connection.

gssCredential
If the data source uses Kerberos security, specifies a delegated credential that is passed from another principal.

properties
Properties for the reused connection. These properties override any properties that are already defined on the DB2Connection instance.

reuseDB2Connection (untrusted or trusted reuse without reauthentication)
Formats:

```
public DB2Connection reuseDB2Connection(java.util.Properties properties)
  throws java.sql.SQLException
```

Reuses an existing Connection instance without reauthentication. This method is intended for reuse of a Connection instance when the properties do not change.

This method is for *dirty reuse* of a connection. This means that the connection state is not reset when the object is reused from the pool. Special register settings and property settings remain in effect unless they are overridden by passed properties. Global temporary tables are not deleted. Properties that are not specified are not re-initialized. All JDBC standard transient properties, such as the isolation level, autocommit mode, and read-only mode are reset to their JDBC defaults. Certain properties, such as `user`, `password`, `databaseName`, `serverName`, `portNumber`, `planName`, and `pkList` remain unchanged.

Parameter description:

properties
Properties for the reused connection. These properties override any properties that are already defined on the DB2Connection instance.

setDB2ClientAccountingInformation

Format:

```
public void setDB2ClientAccountingInformation(String info)
  throws java.sql.SQLException
```

Specifies accounting information for the connection. This information is for client accounting purposes. This value can change during a connection.

Parameter description:

info

User-specified accounting information. The maximum length depends on the server. For a DB2 Database for Linux, UNIX, and Windows server, the maximum length is 255 bytes. For a DB2 for z/OS server, the maximum length is 22 bytes. A Java empty string ("") is valid for this parameter value, but a Java `null` value is not valid.

Important: setDB2ClientAccountingInformation is deprecated in the JDBC 4.0 implementation of the IBM Data Server Driver for JDBC and SQLJ. Use java.sql.Connection.setClientInfo instead.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

setDB2ClientDebugInfo

Formats:

```
public void setDB2ClientDebugInformation(String debugInfo)
  throws java.sql.SQLException
public void setDB2ClientDebugInformation(String mgrInfo,
  String traceInfo)
  throws java.sql.SQLException
```

Sets a value for the CLIENT DEBUGINFO connection attribute, to notify the database system that stored procedures and user-defined functions that are using the connection are running in debug mode. CLIENT DEBUGINFO is used by the DB2 Unified Debugger. Use the first form to set the entire CLIENT DEBUGINFO string. Use the second form to modify only the session manager and trace information in the CLIENT DEBUGINFO string.

The setDB2ClientDebugInfo method applies only to connections to DB2 for z/OS database systems.

Setting the CLIENT DEBUGINFO attribute to a string of length greater than zero requires one of the following privileges:

- The DEBUGSESSION privilege
- SYSADM authority

Parameter description:

debugInfo

A string of up to 254 bytes, in the following form:

`M`*`ip:port`*`,I`*`ip`*`,P`*`pid`*`,T`*`tid`*`,C`*`id`*`,L`*`lvl`*

The parts of the string are:

M*ip:port*
: Session manager IP address and port number

I*ip*
: Client IP address

P*pid* Client process ID

T*tid* Client thread ID (optional)

C*id* Data connection generated ID

L*lvl* Debug library diagnostic trace level

For example:

```
M9.72.133.89:8355,I9.72.133.89,P4552,T123,C1,L0
```

See the description of SET CLIENT DEBUGINFO for a detailed description of this string.

mgrInfo
A string of the following form, which specifies the IP address and port number for the Unified Debugger session manager.

```
M ip:port
```

For example:

```
M9.72.133.89:8355
```

See the description of SET CLIENT DEBUGINFO for a detailed description of this string.

trcInfo
A string of the following form, which specifies the debug library diagnostics trace level.

```
L lvl
```

For example:

```
L0
```

See the description of SET CLIENT DEBUGINFO for a detailed description of this string.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

setDB2ClientProgramId
Format:

```
public abstract void setDB2ClientProgramId(String program-ID)
  throws java.sql.SQLException
```

Sets a user-defined program identifier for the connection, on DB2 for z/OS servers. That program identifier is an 80-byte string that is used to identify the caller. The DB2 for z/OS server places the string in IFCID 316 trace records along with other statistics, so that you can identify which program is associated with a particular SQL statement.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

setDB2ClientUser
Format:

```
public void setDB2ClientUser(String user)
  throws java.sql.SQLException
```

Specifies the current client user name for the connection. This name is for client accounting purposes, and is not the user value for the JDBC connection. Unlike the user for the JDBC connection, the current client user name can change during a connection.

Parameter description:

user
The user ID for the current client.The maximum length depends on the server. For a DB2 Database for Linux, UNIX, and Windows server, the maximum length is 255 bytes. For a DB2 for z/OS server, the maximum length is 16 bytes. A Java empty string ("") is valid for this parameter value, but a Java `null` value is not valid.

Important: getDB2ClientUser is deprecated in the JDBC 4.0 implementation of the IBM Data Server Driver for JDBC and SQLJ. Use java.sql.Connection.getClientInfo instead.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

setDB2ClientWorkstation

Format:

```
public void setDB2ClientWorkstation(String name)
  throws java.sql.SQLException
```

Specifies the current client workstation name for the connection. This name is for client accounting purposes. The current client workstation name can change during a connection.

Parameter description:

name
The workstation name for the current client.The maximum length depends on the server. For a DB2 Database for Linux, UNIX, and Windows server, the maximum length is 255 bytes. For a DB2 for z/OS server, the maximum length is 18 bytes. A Java empty string ("") is valid for this parameter value, but a Java `null` value is not valid.

Important: getDB2ClientWorkstation is deprecated in the JDBC 4.0 implementation of the IBM Data Server Driver for JDBC and SQLJ. Use java.sql.Connection.getClientInfo instead.

This method does not apply to connections to IBM Informix Dynamic Server data sources.

setDB2CurrentPackagePath

Format:

```
public void setDB2CurrentPackagePath(String packagePath)
  throws java.sql.SQLException
```

Specifies a list of collection IDs that the database system searches for JDBC and SQLJ packages.

The setDB2CurrentPackagePath method applies only to connections to DB2 database systems.

Parameter description:

packagePath
A comma-separated list of collection IDs.

setDB2CurrentPackageSet
Format:

```
public void setDB2CurrentPackageSet(String packageSet)
  throws java.sql.SQLException
```

Specifies the collection ID for the connection. When you set this value, you also set the collection ID of the IBM Data Server Driver for JDBC and SQLJ instance that is used for the connection.

The setDB2CurrentPackageSet method applies only to connections to DB2 database systems.

Parameter description:

packageSet
The collection ID for the connection. The maximum length for the packageSet value is 18 bytes. You can invoke this method as an alternative to executing the SQL SET CURRENT PACKAGESET statement in your program.

setJccLogWriter
Formats:

```
public void setJccLogWriter(PrintWriter logWriter)
  throws java.sql.SQLException

public void setJccLogWriter(PrintWriter logWriter, int traceLevel)
  throws java.sql.SQLException
```

Enables or disables the IBM Data Server Driver for JDBC and SQLJ trace, or changes the trace destination during an active connection.

Parameter descriptions:

logWriter
An object of type java.io.PrintWriter to which the IBM Data Server Driver for JDBC and SQLJ writes trace output. To turn off the trace, set the value of *logWriter* to `null`.

traceLevel
Specifies the types of traces to collect. See the description of the traceLevel property in ″Properties for the IBM Data Server Driver for JDBC and SQLJ″ for valid values.

DB2ConnectionPoolDataSource class

DB2ConnectionPoolDataSource is a factory for PooledConnection objects. An object that implements this interface is registered with a naming service that is based on the Java Naming and Directory Interface (JNDI).

The com.ibm.db2.jcc.DB2ConnectionPoolDataSource class extends the com.ibm.db2.jcc.DB2BaseDataSource class, and implements the javax.sql.ConnectionPoolDataSource, java.io.Serializable, and javax.naming.Referenceable interfaces.

DB2ConnectionPoolDataSource properties

These properties are defined only for the IBM Data Server Driver for JDBC and SQLJ. ″Properties for the IBM Data Server Driver for JDBC and SQLJ″ for explanations of these properties.

These properties have a setXXX method to set the value of the property and a getXXX method to retrieve the value. A setXXX method has this form:

```
void setProperty-name(data-type property-value)
```

A getXXX method has this form:

```
data-type getProperty-name()
```

Property-name is the unqualified property name, with the first character capitalized.

The following table lists the IBM Data Server Driver for JDBC and SQLJ properties and their data types.

Table 87. DB2ConnectionPoolDataSource properties and their data types

Property name	Data type
com.ibm.db2.jcc.DB2ConnectionPoolDataSource.maxStatements	int

DB2ConnectionPoolDataSource methods

getDB2PooledConnection

Formats:

```
public DB2PooledConnection getDB2PooledConnection(String user,
  String password,
  java.util.Properties properties)
  throws java.sql.SQLException
public DB2PooledConnection getDB2PooledConnection(
  org.ietf.jgss.GSSCredential gssCredential,
  java.util.Properties properties)
  throws java.sql.SQLException
```

Establishes the initial untrusted connection in a heterogeneous pooling environment.

The first form getDB2PooledConnection provides a user ID and password. The second form of getDB2PooledConnection is for connections that use Kerberos security.

Parameter descriptions:

user
The authorization ID that is used to establish the connection.

password
The password for the authorization ID that is used to establish the connection.

gssCredential
If the data source uses Kerberos security, specifies a delegated credential that is passed from another principal.

properties
Properties for the connection.

getDB2TrustedPooledConnection

Formats:

```
public Object[] getDB2TrustedPooledConnection(String user,
  String password,
  java.util.Properties properties)
  throws java.sql.SQLException
public Object[] getDB2TrustedPooledConnection(
  java.util.Properties properties)
  throws java.sql.SQLException
public Object[] getDB2TrustedPooledConnection(
  org.ietf.jgss.GSSCredential gssCredential,
  java.util.Properties properties)
  throws java.sql.SQLException
```

An application server using a system authorization ID uses this method to establish a trusted connection. The following elements are returned in Object[]:

- The first element is a trusted DB2PooledConnection instance.
- The second element is a unique cookie for the generated pooled connection instance.

The first form getDB2TrustedPooledConnection provides a user ID and password, while the second form of getDB2TrustedPooledConnection uses the user ID and password of the DB2ConnectionPoolDataSource object. The third form of getDB2TrustedPooledConnection is for connections that use Kerberos security.

Parameter descriptions:

user
The DB2 authorization ID that is used to establish the trusted connection to the database server.

password
The password for the authorization ID that is used to establish the trusted connection.

gssCredential
If the data source uses Kerberos security, specifies a delegated credential that is passed from another principal.

properties
Properties for the connection.

DB2DatabaseMetaData interface

The com.ibm.db2.jcc.DB2DatabasemetaData extends the java.sql.DatabaseMetaData interface.

DB2DatabaseMetaData implements the java.sql.Wrapper interface.

DB2DatabaseMetaData methods:

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

isIDSDatabaseAnsiCompliant

Format:

```
public boolean isIDSDatabaseAnsiCompliant();
```

Returns `true` if the current active IBM Informix Dynamic Server (IDS) database is ANSI-compliant. Returns false otherwise.

An ANSI-compliant database is a database that was created with the WITH LOG MODE ANSI option.

This method applies to connections to IDS data sources only. An SQLException is thrown if the data source is not an IDS data source.

isIDSDatabaseLogging

Format:

```
public boolean isIDSDatabaseLogging();
```

Returns `true` if the current active IDS database supports logging. Returns false otherwise.

An IDS database that supports logging is a database that was created with the WITH LOG MODE ANSI option, the WITH BUFFERED LOG, or the WITH LOG option.

This method applies to connections to IDS data sources only. An SQLException is thrown if the data source is not an IDS data source.

isResetRequiredForDB2eWLM

Format:

```
public boolean isResetRequiredForDB2eWLM();
```

Returns `true` if the target database server requires clean reuse to support eWLM. Returns false otherwise.

supportsDB2ProgressiveStreaming

Format:

```
public boolean supportsDB2ProgressiveStreaming();
```

Returns `true` if the target data source supports progressive streaming. Returns false otherwise.

DB2Diagnosable interface

The com.ibm.db2.jcc.DB2Diagnosable interface provides a mechanism for getting DB2 diagnostics from an SQLException.

DB2Diagnosable methods

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

getSqlca

Format:

```
public DB2Sqlca getSqlca()
```

Returns a DB2Sqlca object from a java.sql.Exception that is produced under a IBM Data Server Driver for JDBC and SQLJ.

getThrowable

Format:

```
public Throwable getThrowable()
```

Returns a java.lang.Throwable object from a java.sql.Exception that is produced under a IBM Data Server Driver for JDBC and SQLJ.

printTrace

Format:

```
static public void printTrace(java.io.PrintWriter printWriter,
  String header)
```

Prints diagnostic information after a java.sql.Exception is thrown under a IBM Data Server Driver for JDBC and SQLJ.

Parameter descriptions:

printWriter
The destination for the diagnostic information.

header
User-defined information that is printed at the beginning of the output.

DB2ExceptionFormatter class

The com.ibm.db2.jcc.DB2ExceptionFormatter class contains methods for printing diagnostic information to a stream.

DB2ExceptionFormatter methods

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

printTrace

Formats:

```
static public void printTrace(java.sql.SQLException sqlException,
  java.io.PrintWriter printWriter, String header)

static public void printTrace(DB2Sqlca sqlca,
  java.io.PrintWriter printWriter, String header)

static public void printTrace(java.lang.Throwable throwable,
  java.io.PrintWriter printWriter, String header)
```

Prints diagnostic information after an exception is thrown.

Parameter descriptions:

sqlException | sqlca | throwable
The exception that was thrown during a previous JDBC or Java operation.

printWriter
The destination for the diagnostic information.

header
User-defined information that is printed at the beginning of the output.

DB2JCCPlugin class

The com.ibm.db2.jcc.DB2JCCPlugin class is an abstract class that defines methods that can be implemented to provide DB2 Database for Linux, UNIX, and Windows plug-in support. This class applies only to DB2 Database for Linux, UNIX, and Windows.

DB2JCCPlugin methods

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

getTicket

Format:

```
public abstract byte[] getTicket(String user,
  String password,
  byte[] returnedToken)
  throws org.ietf.jgss.GSSException
```

Retrieves a Kerberos ticket for a user.

Parameter descriptions:

user
The user ID for which the Kerberos ticket is to be retrieved.

password
The password for *user*.

returnedToken

DB2PooledConnection class

The com.ibm.db2.jcc.DB2PooledConnection class provides methods that an application server can use to switch users on a preexisting trusted connection.

DB2PooledConnection methods

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

getConnection (untrusted or trusted reuse without reauthentication)

Format:

```
public DB2Connection getConnection()
  throws java.sql.SQLException
```

This method is for *dirty reuse* of a connection. This means that the connection state is not reset when the object is reused from the pool. Special register settings and property settings remain in effect unless they are overridden by passed properties. Global temporary tables are not deleted. Properties that are not specified are not re-initialized. All JDBC standard transient properties, such as the isolation level, autocommit mode, and read-only mode are reset to their JDBC defaults. Certain properties, such as `user`, `password`, `databaseName`, `serverName`, `portNumber`, `planName`, and `pkList` remain unchanged.

getDB2Connection (trusted reuse)

Formats:

```
public DB2Connection getDB2Connection(byte[] cookie,
  String user,
  String password,
  String userRegistry,
  byte[] userSecToken,
  String originalUser,
  java.util.Properties properties)
  throws java.sql.SQLException
public Connection getDB2Connection(byte[] cookie,
  org.ietf.GSSCredential gssCredential,
  String usernameRegistry,
```

```
byte[] userSecToken,
String originalUser,
java.util.Properties properties)
throws java.sql.SQLException
```

Switches the user that is associated with a trusted connection without authentication.

The second form of reuseDB2Connection is supported only for IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

Parameter descriptions:

cookie
A unique cookie that the JDBC driver generates for the Connection instance. The cookie is known only to the application server and the underlying JDBC driver that established the initial trusted connection. The application server passes the cookie that was created by the driver when the pooled connection instance was created. The JDBC driver checks that the supplied cookie matches the cookie of the underlying trusted physical connection to ensure that the request originated from the application server that established the trusted physical connection. If the cookies match, the connection can become available, with different properties, for immediate use by a new user .

user
The client identity that is used by the data source to establish the authorization ID for the database server. If the user was not authenticated by the application server, the application server must pass a user identity that represents an unauthenticated user.

password
The password for *user*.

gssCredential
If the data source uses Kerberos security, specifies a delegated credential that is passed from another principal.

userNameRegistry
A name that identifies a mapping service that maps a workstation user ID to a z/OS RACF ID. An example of a mapping service is the Integrated Security Services Enterprise Identity Mapping (EIM). The mapping service is defined by a plugin. Valid values for *userNameRegistry* are defined by the plugin providers. If *userNameRegistry* is null, the connection does not use a mapping service.

userSecToken
The client's security tokens. This value is traced as part of DB2 for z/OS accounting data. The content of *userSecToken* is described by the application server and is referred to by the data source as an application server security token.

originalUser
The client identity that sends the original request to the application server. *originalUser* is included in DB2 for z/OS accounting data as the original user ID that was used by the application server.

properties
Properties for the reused connection. These properties override any properties that are already defined on the DB2PooledConnection instance.

getDB2Connection (untrusted reuse with reauthentication)

Formats:

```
public DB2Connection getDB2Connection(
  String user,
  String password,
  java.util.Properties properties)
  throws java.sql.SQLException
public DB2Connection getDB2Connection(org.ietf.jgss.GSSCredential gssCredential,
  java.util.Properties properties)
  throws java.sql.SQLException
```

Switches the user that is associated with a untrusted connection, with authentication.

The first form getDB2Connection provides a user ID and password. The second form of getDB2Connection is for connections that use Kerberos security.

Parameter descriptions:

user
The user ID that is used by the data source to establish the authorization ID for the database server.

password
The password for *user*.

properties
Properties for the reused connection. These properties override any properties that are already defined on the DB2PooledConnection instance.

getDB2Connection (untrusted or trusted reuse without reauthentication)

Formats:

```
public java.sql.Connection getDB2Connection(
  java.util.Properties properties)
  throws java.sql.SQLException
```

Reuses an untrusted connection, without reauthentication.

This method is for *dirty reuse* of a connection. This means that the connection state is not reset when the object is reused from the pool. Special register settings and property settings remain in effect unless they are overridden by passed properties. Global temporary tables are not deleted. Properties that are not specified are not re-initialized. All JDBC standard transient properties, such as the isolation level, autocommit mode, and read-only mode are reset to their JDBC defaults. Certain properties, such as `user`, `password`, `databaseName`, `serverName`, `portNumber`, `planName`, and `pkList` remain unchanged.

Parameter descriptions:

properties
Properties for the reused connection. These properties override any properties that are already defined on the DB2PooledConnection instance.

DB2PoolMonitor class

The com.ibm.db2.jcc.DB2PoolMonitor class provides methods for monitoring the global transport objects pool that is used for the connection concentrator and Sysplex workload balancing.

DB2PoolMonitor fields

The following fields are defined only for the IBM Data Server Driver for JDBC and SQLJ.

public static final int TRANSPORT_OBJECT = 1
This values is a parameter for the DB2PoolMonitor.getPoolMonitor method.

DB2PoolMonitor methods

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

agedOutObjectCount
Format:

```
public abstract int agedOutObjectCount()
```

Retrieves the number of objects that exceeded the idle time that was specified by db2.jcc.maxTransportObjectIdleTime and were deleted from the pool.

createdObjectCount
Format:

```
public abstract int createdObjectCount()
```

Retrieves the number of objects that the IBM Data Server Driver for JDBC and SQLJ created since the pool was created.

getMonitorVersion
Format:

```
public int getMonitorVersion()
```

Retrieves the version of the DB2PoolMonitor class that is shipped with the IBM Data Server Driver for JDBC and SQLJ.

getPoolMonitor
Format:

```
public static DB2PoolMonitor getPoolMonitor(int monitorType)
```

Retrieves an instance of the DB2PoolMonitor class.

Parameter descriptions:

monitorType
The monitor type. This value must be DB2PoolMonitor.TRANSPORT_OBJECT.

heavyWeightReusedObjectCount
Format:

```
public abstract int heavyWeightReusedObjectCount()
```

Retrieves the number of objects that were reused from the pool.

lightWeightReusedObjectCount
Format:

```
public abstract int lightWeightReusedObjectCount()
```

Retrieves the number of objects that were reused but were not in the pool. This can happen if a Connection object releases a transport object at a transaction boundary. If the Connection object needs a transport object later, and the

original transport object has not been used by any other Connection object, the Connection object can use that transport object.

longestBlockedRequestTime
Format:

```
public abstract long longestBlockedRequestTime()
```

Retrieves the longest amount of time that a request was blocked, in milliseconds.

numberOfConnectionReleaseRefused
Format:

```
public abstract int numberOfConnectionReleaseRefused()
```

Retrieves the number of times that the release of a connection was refused.

numberOfRequestsBlocked
Format:

```
public abstract int numberOfRequestsBlocked()
```

Retrieves the number of requests that the IBM Data Server Driver for JDBC and SQLJ made to the pool that the pool blocked because the pool reached its maximum capacity. A blocked request might be successful if an object is returned to the pool before the db2.jcc.maxTransportObjectWaitTime is exceeded and an exception is thrown.

numberOfRequestsBlockedDataSourceMax
Format:

```
public abstract int numberOfRequestsBlockedDataSourceMax()
```

Retrieves the number of requests that the IBM Data Server Driver for JDBC and SQLJ made to the pool that the pool blocked because the pool reached the maximum for the DataSource object.

numberOfRequestsBlockedPoolMax
Format:

```
public abstract int numberOfRequestsBlockedPoolMax()
```

Retrieves the number of requests that the IBM Data Server Driver for JDBC and SQLJ made to the pool that the pool blocked because the maximum number for the pool was reached.

removedObjectCount
Format:

```
public abstract int removedObjectCount()
```

Retrieves the number of objects that have been deleted from the pool since the pool was created.

shortestBlockedRequestTime
Format:

```
public abstract long shortestBlockedRequestTime()
```

Retrieves the shortest amount of time that a request was blocked, in milliseconds.

successfullRequestsFromPool
Format:

```
public abstract int successfullRequestsFromPool()
```

Retrieves the number of successful requests that the IBM Data Server Driver for JDBC and SQLJ has made to the pool since the pool was created. A successful request means that the pool returned an object.

totalPoolObjects

Format:

```
public abstract int totalPoolObjects()
```

Retrieves the number of objects that are currently in the pool.

totalRequestsToPool

Format:

```
public abstract int totalRequestsToPool()
```

Retrieves the total number of requests that the IBM Data Server Driver for JDBC and SQLJ has made to the pool since the pool was created.

totalTimeBlocked

Format:

```
public abstract long totalTimeBlocked()
```

Retrieves the total time in milliseconds for requests that were blocked by the pool. This time can be much larger than the elapsed execution time of the application if the application uses multiple threads.

DB2PreparedStatement interface

The com.ibm.db2.jcc.DB2PreparedStatement interface extends the com.ibm.db2.jcc.DB2Statement and java.sql.PreparedStatement interfaces.

DB2PreparedStatement methods

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

executeDB2QueryBatch

Format:

```
public void executeDB2QueryBatch()
  throws java.sql.SQLException
```

Executes a statement batch that contains queries with parameters.

This method is not supported for connections to IBM Informix Dynamic Server data sources.

DB2ResultSet interface

The com.ibm.db2.jcc.DB2ResultSet interface is used to create objects from which IBM Data Server Driver for JDBC and SQLJ-only query information can be obtained.

DB2ResultSet implements the java.sql.Wrapper interface.

DB2ResultSet methods:

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

getDB2RowChangeToken

Format:

```
public long DB2ResultSet.getDB2RowChangeToken()
  throws java.sql.SQLException
```

Returns the row change token for the current row, if it is available. Returns 0 if optimistic locking columns were not requested or are not available.

getDB2RID

Format:

```
public Object DB2ResultSet.getDB2RID()
  throws java.sql.SQLException
```

Returns the RID for the current row, if it is available. The RID is available if optimistic locking columns were requested and are available. Returns null if optimistic locking columns were not requested or are not available.

getDB2RIDType

Format:

```
public int DB2ResultSet.getDB2RIDType()
  throws java.sql.SQLException
```

Returns the data type of the RID column in a DB2ResultSet. The returned value maps to a `java.sql.Types` constant. If the DB2ResultSet does not contain a RID column, `java.sql.Types.NULL` is returned.

DB2ResultSetMetaData interface

The com.ibm.db2.jcc.DB2ResultSetMetaData interface provides methods that provide information about a ResultSet object.

Before a com.ibm.db2.jcc.DB2ResultSetMetaData method can be used, a java.sql.ResultSetMetaData object that is returned from a java.sql.ResultSet.getMetaData call needs to be cast to com.ibm.db2.jcc.DB2ResultSetMetaData.

DB2ResultSetMetaData methods:

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

getDB2OptimisticLockingColumns

Format:

```
public int getDB2OptimisticLockingColumns()
  throws java.sql.SQLException
```

Returns a value that indicates whether optimistic locking columns are available. Possible values are:

0 Optimistic locking columns are not available.

1 Optimistic locking columns are available, but the change token might not have the granularity to prevent false negatives.

2 Optimistic locking columns are available, and the change token has the granularity to prevent false negatives.

isDB2ColumnNameDerived

Format:

```
public boolean isDB2ColumnNameDerived (int column)
  throws java.sql.SQLException
```

Returns `true` if the name of a ResultSet column is derived from the SQL SELECT list that generated the ResultSet.

For example, suppose that a ResultSet is generated from the SQL statement SELECT EMPNAME, SUM(SALARY) FROM EMP. Column name EMPNAME ResultSet is derived from the SQL SELECT list, but the name of the column in the ResultSet that corresponds to SUM(SALARY) is not derived from the SELECT list.

Parameter descriptions:

column
The name of a column in the ResultSet.

DB2RowID interface

The com.ibm.db2.jcc.DB2RowID interface is used for declaring Java objects for use with the SQL ROWID data type.

DB2RowID methods

The following method is defined only for the IBM Data Server Driver for JDBC and SQLJ.

getBytes
Format:

```
public byte[] getBytes()
```

Converts a com.ibm.jcc.DB2RowID object to bytes.

DB2SimpleDataSource class

The com.ibm.db2.jcc.DB2SimpleDataSource class extends the DB2BaseDataSource class.

A DB2BaseDataSource object does not support connection pooling or distributed transactions. It contains all of the properties and methods that the DB2BaseDataSource class contains. In addition, DB2SimpleDataSource contains the following IBM Data Server Driver for JDBC and SQLJ-only properties.

DB2SimpleDataSource implements the java.sql.Wrapper interface.

DB2SimpleDataSource properties

The following property is defined only for the IBM Data Server Driver for JDBC and SQLJ. See ″Properties for the IBM Data Server Driver for JDBC and SQLJ″ for an explanation of this property.
String com.ibm.db2.jcc.DB2SimpleDataSource.password

DB2SimpleDataSource methods

The following method is defined only for the IBM Data Server Driver for JDBC and SQLJ.

setPassword
Format:

```
public void setPassword(String password)
```

Sets the password for the DB2SimpleDataSource object. There is no corresponding getPassword method. Therefore, the password cannot be encrypted because there is no way to retrieve the password so that you can decrypt it.

DB2Sqlca class

The com.ibm.db2.jcc.DB2Sqlca class is an encapsulation of the SQLCA.

DB2Sqlca methods

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

getMessage

Format:

```
public abstract String getMessage()
```

Returns error message text.

getSqlCode

Format:

```
public abstract int getSqlCode()
```

Returns an SQL error code value.

getSqlErrd

Format:

```
public abstract int[] getSqlErrd()
```

Returns an array, each element of which contains an SQLCA SQLERRD.

getSqlErrmc

Format:

```
public abstract String getSqlErrmc()
```

Returns a string that contains the SQLCA SQLERRMC values, delimited with spaces.

getSqlErrmcTokens

Format:

```
public abstract String[] getSqlErrmcTokens()
```

Returns an array, each element of which contains an SQLCA SQLERRMC token.

getSqlErrp

Format:

```
public abstract String getSqlErrp()
```

Returns the SQLCA SQLERRP value.

getSqlState

Format:

```
public abstract String getSqlState()
```

Returns the SQLCA SQLSTATE value.

getSqlWarn

Format:

```
public abstract char[] getSqlWarn()
```

Returns an array, each element of which contains an SQLCA SQLWARN value.

DB2Statement interface

The com.ibm.db2.jcc.DB2Statement interface extends the java.sql.Statement interface.

DB2Statement implements the java.sql.Wrapper interface.

DB2Statement fields

The following fields are defined only for the IBM Data Server Driver for JDBC and SQLJ.

public static final int RETURN_OPTLOCK_COLUMN_NONE = 0
public static final int RETURN_OPTLOCK_COLUMN_ALWAYS = 1
public static final int RETURN_OPTLOCK_COLUMN_NO_FALSE_NEGATIVES = 2

These values are arguments for the DB2Statement.executeDB2OptimisticLockingQuery method.

DB2Statement methods

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

executeDB2OptimisticLockingQuery

Format:

```
public java.sql.ResultSet DB2Statement.executeDB2OptimisticLockingQuery(
  String sql,
  int returnOptLockingColumn)
  throws java.sql.SQLException
```

Executes an SQL query statement, and returns a ResultSet that contains optimistic locking information, if it is requested.

Parameter descriptions:

sql
An SQL SELECT statement that returns a single ResultSet.

returnOptimisticLockingColumns
Specifies whether optimistic locking columns are returned. Possible values are:

Table 88.

Value	Description
DB2Statement.RETURN_OPTLOCK_COLUMN_NONE (0)	Do not return optimistic locking columns.
DB2Statement.RETURN_OPTLOCK_COLUMN_ALWAYS (1)	Add row change columns to the result set even if they do not uniquely represent a single row. This setting is equivalent to the database prepare attribute WITH ROW CHANGE COLUMNS POSSIBLY DISTINCT.

Table 88. (continued)

Value	Description
DB2Statement.RETURN_OPTLOCK_COLUMN_NO_FALSE_NEGATIVES (2)	Add row change columns to the result set only if they uniquely represent a single row. This setting is equivalent to the database prepare attribute WITH ROW CHANGE COLUMNS ALWAYS DISTINCT.

getDB2ClientProgramId

Format:

```
public String getDB2ClientProgramId()
  throws java.sql.SQLException
```

Returns the user-defined client program identifier for the connection, which is stored on the data source.

setDB2ClientProgramId

Format:

```
public abstract void setDB2ClientProgramId(String program-ID)
  throws java.sql.SQLException
```

Sets a user-defined program identifier for the connection, on DB2 for z/OS servers. That program identifier is an 80-byte string that is used to identify the caller. The DB2 for z/OS server places the string in IFCID 316 trace records along with other statistics, so that you can identify which program is associated with a particular SQL statement.

getIDSSerial

Format:

```
public int getIDSSerial()
  throws java.sql.SQLException
```

Retrieves an automatically generated key from the SERIAL column in the previously executed INSERT statement.

The following conditions must be true for getIDSSerial to execute successfully:

- The INSERT statement is the last SQL statement that is executed before this method is called.
- The table into which the row is inserted contains a SERIAL column.
- The form of the JDBC Connection.prepareStatement method or Statement.executeUpdate method that prepares or executes the INSERT statement does not have parameters that request automatically generated keys.

This method applies only to connections to IBM Informix Dynamic Server (IDS) databases.

getIDSSerial8

Format:

```
public long getIDSSerial8()
  throws java.sql.SQLException
```

Retrieves an automatically generated key from the SERIAL8 column in the previously executed INSERT statement.

The following conditions must be true for getIDSSerial8 to execute successfully:

- The INSERT statement is the last SQL statement that is executed before this method is called.
- The table into which the row is inserted contains a SERIAL8 column.
- The form of the JDBC Connection.prepareStatement method or Statement.executeUpdate method that prepares or executes the INSERT statement does not have parameters that request automatically generated keys.

This method applies only to connections to IDS data sources.

getIDSSQLStatementOffSet

Format:

```
public int getIDSSQLStatementOffSet()
  throws java.sql.SQLException
```

After an SQL statement executes on an IDS data source, if the statement has a syntax error, getIDSSQLStatementOffSet returns the offset into the statement text of the syntax error.

getIDSSQLStatementOffSet returns:

- 0, if the statement does not have a syntax error.
- -1, if the data source is not IDS.

This method applies only to connections to IDS data sources.

DB2SystemMonitor interface

The com.ibm.db2.jcc.DB2SystemMonitor interface is used for collecting system monitoring data for a connection. Each connection can have one DB2SystemMonitor instance.

DB2SystemMonitor fields

The following fields are defined only for the IBM Data Server Driver for JDBC and SQLJ.

public final static int RESET_TIMES
public final static int ACCUMULATE_TIMES

These values are arguments for the DB2SystemMonitor.start method. RESET_TIMES sets time counters to zero before monitoring starts. ACCUMULATE_TIMES does not set time counters to zero.

DB2SystemMonitor methods

The following methods are defined only for the IBM Data Server Driver for JDBC and SQLJ.

enable

Format:

```
public void enable(boolean on)
  throws java.sql.SQLException
```

Enables the system monitor that is associated with a connection. This method cannot be called during monitoring. All times are reset when enable is invoked.

getApplicationTimeMillis

Format:

```
public long getApplicationTimeMillis()
  throws java.sql.SQLException
```

Returns the sum of the application, JDBC driver, network I/O, and database server elapsed times. The time is in milliseconds.

A monitored elapsed time interval is the difference, in milliseconds, between these points in the JDBC driver processing:

Interval beginning
When start is called.

Interval end
When stop is called.

getApplicationTimeMillis returns 0 if system monitoring is disabled. Calling this method without first calling the stop method results in an SQLException.

getCoreDriverTimeMicros

Format:

```
public long getCoreDriverTimeMicros()
  throws java.sql.SQLException
```

Returns the sum of elapsed monitored API times that were collected while system monitoring was enabled. The time is in microseconds.

A monitored API is a JDBC driver method for which processing time is collected. In general, elapsed times are monitored only for APIs that might result in network I/O or database server interaction. For example, PreparedStatement.setXXX methods and ResultSet.getXXX methods are not monitored.

Monitored API elapsed time includes the total time that is spent in the driver for a method call. This time includes any network I/O time and database server elapsed time.

A monitored API elapsed time interval is the difference, in microseconds, between these points in the JDBC driver processing:

Interval beginning
When a monitored API is called by the application.

Interval end
Immediately before the monitored API returns control to the application.

getCoreDriverTimeMicros returns 0 if system monitoring is disabled. Calling this method without first calling the stop method, or calling this method when the underlying JVM does not support reporting times in microseconds results in an SQLException.

getNetworkIOTimeMicros

Format:

```
public long getNetworkIOTimeMicros()
  throws java.sql.SQLException
```

Returns the sum of elapsed network I/O times that were collected while system monitoring was enabled. The time is in microseconds.

Elapsed network I/O time includes the time to write and read DRDA data from network I/O streams. A network I/O elapsed time interval is the time interval to perform the following operations in the JDBC driver:

- Issue a TCP/IP command to send a DRDA message to the database server. This time interval is the difference, in microseconds, between points immediately before and after a write and flush to the network I/O stream is performed.
- Issue a TCP/IP command to receive DRDA reply messages from the database server. This time interval is the difference, in microseconds, between points immediately before and after a read on the network I/O stream is performed.

Network I/O time intervals are captured for all send and receive operations, including the sending of messages for commits and rollbacks.

The time spent waiting for network I/O might be impacted by delays in CPU dispatching at the database server for low-priority SQL requests.

getNetworkIOTimeMicros returns 0 if system monitoring is disabled. Calling this method without first calling the stop method, or calling this method when the underlying JVM does not support reporting times in microseconds results in an SQLException.

getServerTimeMicros

Format:

```
public long getServerTimeMicros()
  throws java.sql.SQLException
```

Returns the sum of all reported database server elapsed times that were collected while system monitoring was enabled. The time is in microseconds.

The database server reports elapsed times under these conditions:

- The database server supports returning elapsed time data to the client.

  DB2 Database for Linux, UNIX, and Windows Version 9.5 and later and DB2 for z/OS support this function.
- The database server performs operations that can be monitored. For example, database server elapsed time is not returned for commits or rollbacks.

The database server elapsed time is defined as the elapsed time to parse the request data stream, process the command, and generate the reply data stream at the database server. Network time to receive or send the data stream is not included.

The database server elapsed time interval is the difference, in microseconds, between these points in the database server processing:

Interval beginning
When the operating system dispatches the database server to process a TCP/IP message that is received from the JDBC driver.

Interval end
When the database server is ready to issue the TCP/IP command to return the reply message to the client.

getServerTimeMicros returns 0 if system monitoring is disabled. Calling this method without first calling the stop method results in an SQLException.

start

Format:

```
public void start (int lapMode)
  throws java.sql.SQLException
```

If the system monitor is enabled, start begins the collection of system monitoring data for a connection. Valid values for *lapMode* are RESET_TIMES or ACCUMULATE_TIMES.

Calling this method with system monitoring disabled does nothing. Calling this method more than once without an intervening stop call results in an SQLException.

stop

Format:

```
public void stop()
  throws java.sql.SQLException
```

If the system monitor is enabled, stop ends the collection of system monitoring data for a connection. After monitoring is stopped, monitored times can be obtained with the getXXX methods of DB2SystemMonitor.

Calling this method with system monitoring disabled does nothing. Calling this method without first calling start, or calling this method more than once without an intervening start call results in an SQLException.

DB2TraceManager class

The com.ibm.db2.jcc.DB2TraceManager class controls the global log writer.

The global log writer is driver-wide, and applies to all connections. The global log writer overrides any other JDBC log writers. In addition to starting the global log writer, the DB2TraceManager class provides the ability to suspend and resume tracing of any type of log writer. That is, the suspend and resume methods of the DB2TraceManager class apply to all current and future DriverManager log writers, DataSource log writers, or IBM Data Server Driver for JDBC and SQLJ-only connection-level log writers.

DB2TraceManager methods

getTraceManager

Format:

```
static public DB2TraceManager getTraceManager()
  throws java.sql.SQLException
```

Gets an instance of the global log writer.

setLogWriter

Formats:

```
public abstract void setLogWriter(String traceDirectory,
  String baseTraceFileName, int traceLevel)
  throws java.sql.SQLException
public abstract void setLogWriter(String traceFile,
  boolean fileAppend, int traceLevel)
```

```
  throws java.sql.SQLException
public abstract void setLogWriter(java.io.PrintWriter logWriter,
  int traceLevel)
  throws java.sql.SQLException
```

Enables a global trace. After setLogWriter is called, all calls for DataSource or Connection traces are discarded until DB2TraceManager.unsetLogWriter is called.

When setLogWriter is called, all future Connection or DataSource traces are redirected to a trace file or PrintWriter, depending on the form of setLogWriter that you use. If the global trace is suspended when setLogWriter is called, the specified settings take effect when the trace is resumed.

Parameter descriptions:

traceDirectory
Specifies a directory into which global trace information is written. This setting overrides the settings of the traceDirectory and logWriter properties for a DataSource or DriverManager connection.

When the form of setLogWriter with the traceDirectory parameter is used, the JDBC driver sets the traceFileAppend property to `false` when setLogWriter is called, which means that the existing log files are overwritten. Each JDBC driver connection is traced to a different file in the specified directory. The naming convention for the files in that directory depends on whether a non-null value is specified for baseTraceFileName:

- If a null value is specified for baseTraceFileName, a connection is traced to a file named traceFile_global_*n*.

  n is the *n*th JDBC driver connection.
- If a non-null value is specified for baseTraceFileName, a connection is traced to a file named *baseTraceFileName*_global_*n*.

  baseTraceFileName is the value of the baseTraceFileName parameter.

  n is the *n*th JDBC driver connection.

baseTraceFileName
Specifies the stem for the names of the files into which global trace information is written. The combination of baseTraceFileName and traceDirectory determines the full path name for the global trace log files.

traceFileName
Specifies the file into which global trace information is written. This setting overrides the settings of the traceFile and logWriter properties for a DataSource or DriverManager connection.

When the form of setLogWriter with the traceFileName parameter is used, only one log file is written.

traceFileName can include a directory path.

logWriter
Specifies a character output stream to which all global log records are written.

This value overrides the logWriter property on a DataSource or DriverManager connection.

traceLevel
Specifies what to trace.

You can specify one or more of the following traces with the traceLevel parameter:

- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_NONE (X'00')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_CONNECTION_CALLS (X'01')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_STATEMENT_CALLS (X'02')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_RESULT_SET_CALLS (X'04')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DRIVER_CONFIGURATION (X'10')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_CONNECTS (X'20')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DRDA_FLOWS (X'40')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_RESULT_SET_META_DATA (X'80')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_PARAMETER_META_DATA (X'100')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DIAGNOSTICS (X'200')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_SQLJ (X'400')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_XA_CALLS (IBM Data Server Driver for JDBC and SQLJ type 2 connectivity for DB2 Database for Linux, UNIX, and Windows only) (X'800')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_META_CALLS (X'2000')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DATASOURCE_CALLS (X'4000')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_LARGE_OBJECT_CALLS (X'8000')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_SYSTEM_MONITOR (X'20000')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_TRACEPOINTS (X'40000')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL (X'FFFFFFFF')

To specify more than one trace, use one of these techniques:

- Use bitwise OR (|) operators with two or more trace values. For example, to trace DRDA flows and connection calls, specify this value for traceLevel:

  ```
  TRACE_DRDA_FLOWS|TRACE_CONNECTION_CALLS
  ```

- Use a bitwise complement (tilde (~)) operator with a trace value to specify all except a certain trace. For example, to trace everything except DRDA flows, specify this value for traceLevel:

  ```
  ~TRACE_DRDA_FLOWS
  ```

fileAppend
Specifies whether to append to or overwrite the file that is specified by the traceFile parameter. true means that the existing file is not overwritten.

unsetLogWriter
Format:

```
public abstract void unsetLogWriter()
  throws java.sql.SQLException
```

Disables the global log writer override for future connections.

suspendTrace
Format:

```
public void suspendTrace()
  throws java.sql.SQLException
```

Suspends all global, Connection-level, or DataSource-level traces for current and future connections. suspendTrace can be called when the global log writer is enabled or disabled.

resumeTrace

Format:

```
public void resumeTrace()
  throws java.sql.SQLException
```

Resumes all global, Connection-level, or DataSource-level traces for current and future connections. resumeTrace can be called when the global log writer is enabled or disabled. If the global log writer is disabled, resumeTrace resumes Connection-level or DataSource-level traces. If the global log writer is enabled, resumeTrace resumes the global trace.

getLogWriter

Format:

```
public abstract java.io.PrintWriter getLogWriter()
  throws java.sql.SQLException
```

Returns the PrintWriter for the global log writer, if it is set. Otherwise, getLogWriter returns null.

getTraceFile

Format:

```
public abstract String getTraceFile()
  throws java.sql.SQLException
```

Returns the name of the destination file for the global log writer, if it is set. Otherwise, getTraceFile returns null.

getTraceDirectory

Format:

```
public abstract String getTraceDirectory()
  throws java.sql.SQLException
```

Returns the name of the destination directory for global log writer files, if it is set. Otherwise, getTraceDirectory returns null.

getTraceLevel

Format:

```
public abstract int getTraceLevel()
  throws java.sql.SQLException
```

Returns the trace level for the global trace, if it is set. Otherwise, getTraceLevel returns -1 (`TRACE_ALL`).

getTraceFileAppend

Format:

```
public abstract boolean getTraceFileAppend()
  throws java.sql.SQLException
```

Returns `true` if the global trace records are appended to the trace file. Otherwise, getTraceFileAppend returns `false`.

DB2TraceManagerMXBean interface

The com.ibm.db2.jcc.mx.DB2TraceManagerMXBean interface is the means by which an application makes DB2TraceManager available as an MXBean for the remote trace controller.

DB2TraceManagerMXBean methods

setTraceFile

Format:

```
public void setTraceFile(String traceFile,
  boolean fileAppend, int traceLevel)
  throws java.sql.SQLException
```

Specifies the name of the file into which the remote trace manager writes trace information, and the type of information that is to be traced.

Parameter descriptions:

traceFileName
Specifies the file into which global trace information is written. This setting overrides the settings of the traceFile and logWriter properties for a DataSource or DriverManager connection.

When the form of setLogWriter with the traceFileName parameter is used, only one log file is written.

traceFileName can include a directory path.

fileAppend
Specifies whether to append to or overwrite the file that is specified by the traceFile parameter. `true` means that the existing file is not overwritten.

traceLevel
Specifies what to trace.

You can specify one or more of the following traces with the traceLevel parameter:

- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_NONE` (X'00')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_CONNECTION_CALLS` (X'01')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_STATEMENT_CALLS` (X'02')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_RESULT_SET_CALLS` (X'04')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DRIVER_CONFIGURATION` (X'10')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_CONNECTS` (X'20')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DRDA_FLOWS` (X'40')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_RESULT_SET_META_DATA` (X'80')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_PARAMETER_META_DATA` (X'100')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DIAGNOSTICS` (X'200')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_SQLJ` (X'400')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_XA_CALLS ( IBM Data Server Driver for JDBC and SQLJ type 2 connectivity for DB2 Database for Linux, UNIX, and Windows only)` (X'800')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_META_CALLS` (X'2000')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DATASOURCE_CALLS` (X'4000')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_LARGE_OBJECT_CALLS` (X'8000')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_SYSTEM_MONITOR` (X'20000')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_TRACEPOINTS` (X'40000')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL` (X'FFFFFFFF')

To specify more than one trace, use one of these techniques:

- Use bitwise OR (|) operators with two or more trace values. For example, to trace DRDA flows and connection calls, specify this value for traceLevel:

  ```
  TRACE_DRDA_FLOWS|TRACE_CONNECTION_CALLS
  ```

- Use a bitwise complement (tilde (~)) operator with a trace value to specify all except a certain trace. For example, to trace everything except DRDA flows, specify this value for traceLevel:

  ```
  ~TRACE_DRDA_FLOWS
  ```

getTraceFile

Format:

```
public void getTraceFile()
  throws java.sql.SQLException
```

Returns the name of the destination file for the remote trace controller, if it is set. Otherwise, getTraceFile returns null.

setTraceDirectory

Format:

```
public void setTraceDirectory(String traceDirectory,
  String baseTraceFileName,
  int traceLevel) throws java.sql.SQLException
```

Specifies the name of the directory into which the remote trace controller writes trace information, and the type of information that is to be traced.

Parameter descriptions:

traceDirectory

Specifies a directory into which trace information is written. This setting overrides the settings of the traceDirectory and logWriter properties for a DataSource or DriverManager connection.

Each JDBC driver connection is traced to a different file in the specified directory. The naming convention for the files in that directory depends on whether a non-null value is specified for baseTraceFileName:

- If a null value is specified for baseTraceFileName, a connection is traced to a file named traceFile_global_*n*.

  n is the *n*th JDBC driver connection.

- If a non-null value is specified for baseTraceFileName, a connection is traced to a file named *baseTraceFileName*_global_*n*.

  baseTraceFileName is the value of the baseTraceFileName parameter.

  n is the *n*th JDBC driver connection.

baseTraceFileName

Specifies the stem for the names of the files into which global trace information is written. The combination of baseTraceFileName and traceDirectory determines the full path name for the global trace log files.

traceLevel

Specifies what to trace.

You can specify one or more of the following traces with the traceLevel parameter:

- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_NONE` (X'00')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_CONNECTION_CALLS` (X'01')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_STATEMENT_CALLS` (X'02')
- `com.ibm.db2.jcc.DB2BaseDataSource.TRACE_RESULT_SET_CALLS` (X'04')

- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DRIVER_CONFIGURATION (X'10')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_CONNECTS (X'20')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DRDA_FLOWS (X'40')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_RESULT_SET_META_DATA (X'80')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_PARAMETER_META_DATA (X'100')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DIAGNOSTICS (X'200')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_SQLJ (X'400')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_XA_CALLS (IBM Data Server Driver for JDBC and SQLJ type 2 connectivity for DB2 Database for Linux, UNIX, and Windows only) (X'800')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_META_CALLS (X'2000')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_DATASOURCE_CALLS (X'4000')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_LARGE_OBJECT_CALLS (X'8000')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_SYSTEM_MONITOR (X'20000')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_TRACEPOINTS (X'40000')
- com.ibm.db2.jcc.DB2BaseDataSource.TRACE_ALL (X'FFFFFFFF')

To specify more than one trace, use one of these techniques:

- Use bitwise OR (|) operators with two or more trace values. For example, to trace DRDA flows and connection calls, specify this value for traceLevel:

  ```
  TRACE_DRDA_FLOWS|TRACE_CONNECTION_CALLS
  ```

- Use a bitwise complement (tilde (~)) operator with a trace value to specify all except a certain trace. For example, to trace everything except DRDA flows, specify this value for traceLevel:

  ```
  ~TRACE_DRDA_FLOWS
  ```

getTraceFileAppend

Format:

```
public abstract boolean getTraceFileAppend()
  throws java.sql.SQLException
```

Returns `true` if trace records that are generated by the trace controller are appended to the trace file. Otherwise, getTraceFileAppend returns `false`.

getTraceDirectory

Format:

```
public void getTraceDirectory()
  throws java.sql.SQLException
```

Returns the name of the destination directory for trace records that are generated by the trace controller, if it is set. Otherwise, getTraceDirectory returns null.

getTraceLevel

Format:

```
public void getTraceLevel()
  throws java.sql.SQLException
```

Returns the trace level for the trace records that are generated by the trace controller, if it is set. Otherwise, getTraceLevel returns -1 (`TRACE_ALL`).

unsetLogWriter

Format:

```
public abstract void unsetLogWriter()
  throws java.sql.SQLException
```

Disables the global log writer override for future connections.

suspendTrace

Format:

```
public void suspendTrace()
  throws java.sql.SQLException
```

Suspends all global, Connection-level, or DataSource-level traces for current and future connections. suspendTrace can be called when the global log writer is enabled or disabled.

resumeTrace

Format:

```
public void resumeTrace()
  throws java.sql.SQLException
```

Resumes all global, Connection-level, or DataSource-level traces for current and future connections. resumeTrace can be called when the global log writer is enabled or disabled. If the global log writer is disabled, resumeTrace resumes Connection-level or DataSource-level traces. If the global log writer is enabled, resumeTrace resumes the global trace.

DB2XADataSource class

DB2XADataSource is a factory for XADataSource objects. An object that implements this interface is registered with a naming service that is based on the Java Naming and Directory Interface (JNDI).

The com.ibm.db2.jcc.DB2XADataSource class extends the com.ibm.db2.jcc.DB2BaseDataSource class, and implements the javax.sql.XADataSource, java.io.Serializable, and javax.naming.Referenceable interfaces.

DB2XADataSource methods

getDB2TrustedXAConnection

Formats:

```
public Object[] getDB2TrustedXAConnection(String user,
  String password,
  java.util.Properties properties)
  throws java.sql.SQLException
public Object[] getDB2TrustedXAConnection(
  java.util.Properties properties)
  throws java.sql.SQLException
public Object[] getDB2TrustedXAConnection(
  org.ietf.jgss.GSSCredential gssCredential,
  java.util.Properties properties)
  throws java.sql.SQLException
```

An application server using a system authorization ID uses this method to establish a trusted connection. The following elements are returned in Object[]:

- The first element is a DB2TrustedXAConnection instance.
- The second element is a unique cookie for the generated XA connection instance.

The first form getDB2TrustedXAConnection provides a user ID and password. The second form of getDB2TrustedXAConnection uses the user ID and password of the DB2XADataSource object. The third form of getDB2TrustedXAConnection is for connections that use Kerberos security.

Parameter descriptions:

user
The authorization ID that is used to establish the trusted connection.

password
The password for the authorization ID that is used to establish the trusted connection.

gssCredential
If the data source uses Kerberos security, specifies a delegated credential that is passed from another principal.

properties
Properties for the connection.

getDB2TrustedPooledConnection

Format:

```
public Object[] getDB2TrustedPooledConnection(java.util.Properties properties)
  throws java.sql.SQLException
```

An application server using a system authorization ID uses this method to establish a trusted connection, using the user ID and password for the DB2XADataSource object. The following elements are returned in Object[]:

- The first element is a trusted DB2TrustedPooledConnection instance.
- The second element is a unique cookie for the generated pooled connection instance.

Parameter descriptions:

properties
Properties for the connection.

getDB2XAConnection

Formats:

```
public DB2XAConnection getDB2XAConnection(String user,
  String password,
  java.util.Properties properties)
  throws java.sql.SQLException
public DB2XAConnection getDB2XAConnection(
   org.ietf.jgss.GSSCredential gssCredential,
  java.util.Properties properties)
  throws java.sql.SQLException
```

Establishes the initial untrusted connection in a heterogeneous pooling environment.

The first form getDB2PooledConnection provides a user ID and password. The second form of getDB2XAConnection is for connections that use Kerberos security.

Parameter descriptions:

user
The authorization ID that is used to establish the connection.

password
The password for the authorization ID that is used to establish the connection.

gssCredential
If the data source uses Kerberos security, specifies a delegated credential that is passed from another principal.

properties
Properties for the connection.

DB2Xml interface

The com.ibm.db2.jcc.DB2Xml interface is used for declaring Java objects for use with the DB2 XML data type.

DB2Xml methods

The following method is defined only for the IBM Data Server Driver for JDBC and SQLJ.

closeDB2Xml
Format:

```
public void closeDB2Xml()
  throws SQLException
```

Releases the resources that are associated with a com.ibm.jcc.DB2Xml object.

getDB2AsciiStream
Format:

```
public java.io.InputStream getDB2AsciiStream()
  throws SQLExceptionn
```

Retrieves data from a DB2Xml object, and converts the data to US-ASCII encoding.

getDB2BinaryStream
Format:

```
public java.io.InputStream getDB2BinaryStream()
  throws SQLException
```

Retrieves data from a DB2Xml object as a binary stream. The character encoding of the bytes in the binary stream is defined in the XML 1.0 specification.

getDB2Bytes
Format:

```
public byte[] getDB2Bytes()
  throws SQLExceptionn
```

Retrieves data from a DB2Xml object as a byte array. The character encoding of the bytes is defined in the XML 1.0 specification.

getDB2CharacterStream
Format:

```
public java.io.Reader getDB2CharacterStream()
  throws SQLExceptionn
```

Retrieves data from a DB2Xml object as a java.io.Reader object.

getDB2String

Format:

```
public String getDB2String()
  throws SQLExceptionn
```

Retrieves data from a DB2Xml object as a `String` value.

getDB2XmlAsciiStream

Format:

```
public InputStream getDB2XmlAsciiStream()
  throws SQLExceptionn
```

Retrieves data from a DB2Xml object, converts the data to US-ASCII encoding, and imbeds an XML declaration with an encoding specification for US-ASCII in the returned data.

getDB2XmlBinaryStream

Format:

```
public java.io.InputStream getDB2XmlBinaryStream(String targetEncoding)
  throws SQLExceptionn
```

Retrieves data from a DB2Xml object as a binary stream, converts the data to *targetEncoding*, and imbeds an XML declaration with an encoding specification for *targetEncoding* in the returned data.

Parameter:

targetEncoding
A valid encoding name that is listed in the IANA Charset Registry. The encoding names that are supported by the DB2 server are listed in "Mappings of CCSIDs to encoding names for serialized XML output data".

getDB2XmlBytes

Format:

```
public byte[] getDB2XmlBytes(String targetEncoding)
  throws SQLExceptionn
```

Retrieves data from a DB2Xml object as a byte array, converts the data to *targetEncoding*, and imbeds an XML declaration with an encoding specification for *targetEncoding* in the returned data.

Parameter:

targetEncoding
A valid encoding name that is listed in the IANA Charset Registry. The encoding names that are supported by the DB2 server are listed in "Mappings of CCSIDs to encoding names for serialized XML output data".

getDB2XmlCharacterStream

Format:

```
public java.io.Reader getDB2XmlCharacterStream()
  throws SQLExceptionn
```

Retrieves data from a DB2Xml object as a java.io.Reader object, converts the data to ISO-10646-UCS-2 encoding, and imbeds an XML declaration with an encoding specification for ISO-10646-UCS-2 in the returned data.

getDB2XmlString

Format:

```
public String getDB2XmlString()
  throws SQLExceptionn
```

Retrieves data from a DB2Xml object as a `String` object, converts the data to ISO-10646-UCS-2 encoding, and imbeds an XML declaration with an encoding specification for ISO-10646-UCS-2 in the returned data.

isDB2XmlClosed

Format:

```
public boolean isDB2XmlClosed()
  throws SQLException
```

Indicates whether a com.ibm.jcc.DB2Xml object has been closed.

JDBC differences between the current IBM Data Server Driver for JDBC and SQLJ and earlier DB2 JDBC drivers

Before you can migrate your JDBC applications from older drivers to the IBM Data Server Driver for JDBC and SQLJ, you need to understand the differences between those drivers.

Important: The DB2 JDBC Type 2 Driver for Linux, UNIX and Windows (DB2 JDBC Type 2 Driver) is deprecated. This information is provided to assist you in moving your applications to the IBM Data Server Driver for JDBC and SQLJ.

Supported methods

For a comparison of method support by the JDBC drivers, see ″Driver support for JDBC APIs″.

Use of progressive streaming by the JDBC drivers

For IBM Data Server Driver for JDBC and SQLJ, Version 3.50 and later, progressive streaming behavior is the default for LOB retrieval, for connections to DB2 Database for Linux, UNIX, and Windows Version 9.5 and later.

Progressive streaming is supported in the IBM Data Server Driver for JDBC and SQLJ Version 3.1 and later, but for IBM Data Server Driver for JDBC and SQLJ Version 3.2 and later, progressive streaming behavior is the default for LOB and XML retrieval, for connections to DB2 for z/OS Version 9.1 and later.

Previous versions of the IBM Data Server Driver for JDBC and SQLJ and the DB2 JDBC Type 2 Driver did not support progressive streaming.

Important: With progressive streaming, when you retrieve a LOB or XML value from a ResultSet into an application variable, you can manipulate the contents of that application variable until you move the cursor or close the cursor on the ResultSet. After that, the contents of the application variable are no longer available to you. If you perform any actions on the LOB in the application variable, you receive an SQLException. For example, suppose that progressive streaming is enabled, and you execute statements like this:

```
...
ResultSet rs = stmt.executeQuery("SELECT CLOBCOL FROM MY_TABLE");
rs.next();                          // Retrieve the first row of the ResultSet
Clob clobFromRow1  = rs.getClob(1); // Put the CLOB from the first column of
                                    // the first row in an application variable
String substr1Clob = clobFromRow1.getSubString(1,50);
```

```
                                    // Retrieve the first 50 bytes of the CLOB
rs.next();                          // Move the cursor to the next row.
                                    // clobFromRow1 is no longer available.
// String substr2Clob = clobFromRow1.getSubString(51,100);
                                    // This statement would yield an SQLException
Clob clobFromRow2  = rs.getClob(1); // Put the CLOB from the first column of
                                    // the second row in an application variable
rs.close();                         // Close the ResultSet.
                                    // clobFromRow2 is also no longer available.
```

After you execute rs.next() to position the cursor at the second row of the ResultSet, the CLOB value in clobFromRow1 is no longer available to you. Similarly, after you execute rs.close() to close the ResultSet, the values in clobFromRow1 and clobFromRow2 are no longer available.

To avoid errors that are due to this changed behavior, you need to take one of the following actions:

- Modify your applications.

  Applications that retrieve LOB data into application variables can manipulate the data in those application variables only until the cursors that were used to retrieve the data are moved or closed.
- Disable progressive streaming by setting the `progressiveStreaming` property to `DB2BaseDataSource.NO` (2).

ResultSetMetaData values for IBM Data Server Driver for JDBC and SQLJ Version 4.0 and later

ResultSetMetaData.getColumnName and ResultSetMetaData.getColumnLabel values for IBM Data Server Driver for JDBC and SQLJ Version 4.0 and later differ from the values that are returned for earlier versions of the IBM Data Server Driver for JDBC and SQLJ or for other IBM JDBC drivers.

If you need to use IBM Data Server Driver for JDBC and SQLJ Version 4.0 or later, but your applications need to return the ResultSetMetaData.getColumnName and `ResultSetMetaData.getColumnLabel` values that were returned with older JDBC drivers, you can set the useJDBC4ColumnNameAndLabelSemantics Connection and `DataSource` property to `DB2BaseDataSource.NO` (2).

Batch updates with automatically generated keys cause an SQLException

With the IBM Data Server Driver for JDBC and SQLJ Version 3.50 or later, preparing an SQL statement for retrieval of automatically generated keys and using the PreparedStatement object for batch updates causes an SQLException.

Versions of the IBM Data Server Driver for JDBC and SQLJ before Version 3.50 do not throw an SQLException when an application calls the addBatch or executeBatch method on a PreparedStatement object that is prepared to return automatically generated keys. However, the PreparedStatement object does not return automatically generated keys.

Support for scrollable and updatable ResultSets

The IBM Data Server Driver for JDBC and SQLJ supports scrollable and updatable ResultSets.

The DB2 JDBC Type 2 Driver supports scrollable ResultSets but not updatable ResultSets.

Difference in URL syntax

The syntax of the *url* parameter in the DriverManager.getConnection method is different for each driver. See the following topics for more information:

- ″Connect to a data source using the DriverManager interface with the IBM Data Server Driver for JDBC and SQLJ″
- ″Connect to a data source using the DriverManager interface with the DB2 JDBC Type 2 Driver″

Difference in error codes and SQLSTATEs returned for driver errors

The IBM Data Server Driver for JDBC and SQLJ does not use existing SQLCODEs or SQLSTATEs for internal errors, as the other drivers do. See ″Error codes issued by the IBM Data Server Driver for JDBC and SQLJ″ and ″SQLSTATEs issued by the IBM Data Server Driver for JDBC and SQLJ″.

The JDBC/SQLJ driver for z/OS return ODBC SQLSTATEs when internal errors occur.

How much error message text is returned

With the IBM Data Server Driver for JDBC and SQLJ, when you execute SQLException.getMessage(), formatted message text is not returned unless you set the `retrieveMessagesFromServerOnGetMessage` property to `true`.

With the DB2 JDBC Type 2 Driver, when you execute SQLException.getMessage(), formatted message text is returned.

Security mechanisms

The JDBC drivers have different security mechanisms.

For information on IBM Data Server Driver for JDBC and SQLJ security mechanisms, see ″Security under the IBM Data Server Driver for JDBC and SQLJ″.

For information on security mechanisms for the DB2 JDBC Type 2 Driver, see ″Security under the DB2 JDBC Type 2 Driver″.

Support for read-only connections

With the IBM Data Server Driver for JDBC and SQLJ, you can make a connection read-only through the `readOnly` property for a Connection or DataSource object.

The DB2 JDBC Type 2 Driver uses the Connection.setReadOnly value when it determines whether to make a connection read-only. However, setting Connection.setReadOnly(true) does not guarantee that the connection is read-only.

Results returned from ResultSet.getString for a BIT DATA column

The IBM Data Server Driver for JDBC and SQLJ returns data from a ResultSet.getString call for a CHAR FOR BIT DATA or VARCHAR FOR BIT DATA column as a lowercase hexadecimal string.

The DB2 JDBC Type 2 Driver returns the data as an uppercase hexadecimal string.

Result of an executeUpdate call that affects no rows

The IBM Data Server Driver for JDBC and SQLJ generates an SQLWarning when an executeUpdate call affects no rows.

The DB2 JDBC Type 2 Driver does not generate an SQLWarning.

Result of a getDate or getTime call for a TIMESTAMP column

The IBM Data Server Driver for JDBC and SQLJ does not generate an SQLWarning when a getDate or getTime call is made against a TIMESTAMP column.

The DB2 JDBC Type 2 Driver generates an SQLWarning when a getDate or getTime call is made against a TIMESTAMP column.

When an exception is thrown for PreparedStatement.setXXXStream with a length mismatch

When you use the PreparedStatement.setBinaryStream , PreparedStatement.setCharacterStream, or PreparedStatement.setUnicodeStream method, the *length* parameter value must match the number of bytes in the input stream.

If the numbers of bytes do not match, the IBM Data Server Driver for JDBC and SQLJ does not throw an exception until the subsequent PreparedStatement.executeUpdate method executes. Therefore, for the IBM Data Server Driver for JDBC and SQLJ, some data might be sent to the server when the lengths to not match. That data is truncated or padded by the server. The calling application needs to issue a rollback request to undo the database updates that include the truncated or padded data.

The DB2 JDBC Type 2 Driver throws an exception after the PreparedStatement.setBinaryStream, PreparedStatement.setCharacterStream, or PreparedStatement.setUnicodeStream method executes.

Default mappings for PreparedStatement.setXXXStream

With the IBM Data Server Driver for JDBC and SQLJ, when you use the PreparedStatement.setBinaryStream , PreparedStatement.setCharacterStream, or PreparedStatement.setUnicodeStream method, and no information about the data type of the target column is available, the input data is mapped to a BLOB or CLOB data type.

For the DB2 JDBC Type 2 Driver, the input data is mapped to a VARCHAR FOR BIT DATA or VARCHAR data type.

How character conversion is done

When character data is transferred between a client and a server, the data must be converted to a form that the receiver can process.

For the IBM Data Server Driver for JDBC and SQLJ, character data that is sent from the data source to the client is converted using Java's built-in character

converters. The conversions that the IBM Data Server Driver for JDBC and SQLJ supports are limited to those that are supported by the underlying JRE implementation.

A IBM Data Server Driver for JDBC and SQLJ client using type 4 connectivity sends data to the data source as Unicode UTF-8.

For the DB2 JDBC Type 2 Driver, character conversions can be performed if the conversions are supported by the DB2 server.

Those drivers use CCSID information from the data source if it is available. The drivers convert input parameter data to the CCSID of the data source before sending the data. If target CCSID information is not available, the drivers send the data as Unicode UTF-8.

Implicit or explicit data type conversion for input parameters

If you execute a PreparedStatement.setXXX method, and the resulting data type from the setXXX method does not match the data type of the table column to which the parameter value is assigned, the driver returns an error unless data type conversion occurs.

With the IBM Data Server Driver for JDBC and SQLJ, conversion to the correct SQL data type occurs implicitly if the target data type is known and if the `deferPrepares` and `sendDataAsIs` connection properties are set to `false`. In this case, the implicit values override any explicit values in the setXXX call. If the `deferPrepares` connection property or the `sendDataAsIs` connection property is set to `true`, you must use the PreparedStatement.setObject method to convert the parameter to the correct SQL data type.

For the DB2 JDBC Type 2 Driver, if the data type of a parameter does not match its default SQL data type, you must use the PreparedStatement.setObject method to convert the parameter to the correct SQL data type.

Support for String to BINARY conversions for input parameters

The IBM Data Server Driver for JDBC and SQLJ does not support PreparedStatement.setObject calls of the following form when *x* is an object of type `String`:

```
setObject(parameterIndex, x, java.sqlTypes.BINARY)
```

The DB2 JDBC Type 2 Driver supports calls of this type. The driver interprets the value of *x* as a hexadecimal string.

Result of PreparedStatement.setObject with a decimal scale mismatch

With the IBM Data Server Driver for JDBC and SQLJ, if you call PreparedStatement.setObject with a decimal input parameter, and the scale of the input parameter is greater than the scale of the target column, the driver truncates the trailing digits of the input value before assigning the value to the column.

The DB2 JDBC Type 2 Driver rounds the trailing digits of the input value before assigning the value to the column.

Valid range for ResultSet.getBigDecimal scale parameter

The deprecated form of ResultSet.getBigDecimal has a *scale* parameter as the second parameter. The IBM Data Server Driver for JDBC and SQLJ allows a range of 0 to 32 for the scale parameter.

The DB2 JDBC Type 2 Driver allows a range of -1 to 32.

Support for conversions from the java.lang.Character data type for input parameters

For the following form of PreparedStatement.setObject, the IBM Data Server Driver for JDBC and SQLJ supports the standard data type mappings of Java objects to JDBC data types when it converts *x* to a JDBC data type:

`setObject(parameterIndex, x)`

The DB2 JDBC Type 2 Driver supports the non-standard mapping of *x* from `java.lang.Character` to CHAR.

Support for ResultSet.getBinaryStream against a character column

The IBM Data Server Driver for JDBC and SQLJ supports `ResultSet.getBinaryStream` with an argument that represents a character column only if the column has the FOR BIT DATA attribute.

For the DB2 JDBC Type 2 Driver, if the ResultSet.getBinaryStream argument is a character column, that column does not need to have the FOR BIT DATA attribute.

Data returned from ResultSet.getBinaryStream against a binary column

With the IBM Data Server Driver for JDBC and SQLJ, when you execute ResultSet.getBinaryStream against a binary column, the returned data is in the form of lowercase, hexadecimal digit pairs.

With the DB2 JDBC Type 2 Driver, when you execute ResultSet.getBinaryStream against a binary column, the returned data is in the form of uppercase, hexadecimal digit pairs.

Result of using setObject with a Boolean input type and a CHAR target type

With the IBM Data Server Driver for JDBC and SQLJ, when you execute `PreparedStatement.setObject(parameterIndex,x,CHAR)`, and *x* is Boolean, the value ″0″ or ″1″ is inserted into the table column.

With the DB2 JDBC Type 2 Driver, the string ″false″ or ″true″ is inserted into the table column. The table column length must be at least 5.

Result of using getBoolean to retrieve a value from a CHAR column

With the IBM Data Server Driver for JDBC and SQLJ, when you execute ResultSet.getBoolean or CallableStatement.getBoolean to retrieve a Boolean value

from a CHAR column, and the column contains the value ″false″ or ″0″, the value `false` is returned. If the column contains any other value, `true` is returned.

With the DB2 JDBC Type 2 Driver, when you execute ResultSet.getBoolean or CallableStatement.getBoolean to retrieve a Boolean value from a CHAR column, and the column contains the value ″true″ or ″1″, the value `true` is returned. If the column contains any other value, `false` is returned.

Result of executing ResultSet.next() on a closed cursor

With the IBM Data Server Driver for JDBC and SQLJ, when you execute ResultSet.next() on a closed cursor, an SQLException is thrown. This conforms with the JDBC standard.

With the DB2 JDBC Type 2 Driver, when you execute ResultSet.next() on a closed cursor, a value of `false` is returned, and no exception is thrown.

Result of specifying null arguments in DatabaseMetaData calls

With the IBM Data Server Driver for JDBC and SQLJ, you can specify `null` for an argument in a DatabaseMetaData method call only where the JDBC specification states that `null` is allowed. Otherwise, an exception is thrown.

With the DB2 JDBC Type 2 Driver, `null` means that the argument is not used to narrow the search.

Folding of method arguments to uppercase

The IBM Data Server Driver for JDBC and SQLJ does not fold any arguments in method calls to uppercase.

The DB2 JDBC Type 2 Driver folds the argument of a Statement.setCursorName call to uppercase. To prevent the cursor name from being folded to uppercase, precede and follow the cursor name with the characters \″. For example:

```
Statement.setCursorName("\"mycursor\"");
```

Support for timestamp escape clauses

The IBM Data Server Driver for JDBC and SQLJ supports the standard form of an escape clause for `TIME`:

```
{t 'hh:mm:ss'}
```

In addition to the standard form, the DB2 JDBC Type 2 Driver supports the following form of a `TIME` escape clause:

```
{ts 'hh:mm:ss'}
```

Including a CALL statement in a statement batch

The IBM Data Server Driver for JDBC and SQLJ supports CALL statements in a statement batch.

The DB2 JDBC Type 2 Driver does not support CALL statements in a statement batch.

Removal of extra characters from SQL statement text

The IBM Data Server Driver for JDBC and SQLJ does not remove white-space characters, such as spaces, tabs, and new-line characters, from SQL statement text before it passes that text to the data source.

The DB2 JDBC Type 2 Driver removes white-space characters from SQLstatement text before it passes that text to the data source.

Result of executing PreparedStatement.executeBatch

When a PreparedStatement.executeBatch statement is executed under the IBM Data Server Driver for JDBC and SQLJ, the driver returns an `int` array of update counts. Each element of the array contains the number of rows that were updated by a statement in the batch.

When a PreparedStatement.executeBatch statement is executed under the DB2 JDBC Type 2 Driver, the driver cannot determine the update counts, so it returns -3 for each update count.

Support for compound SQL

The IBM Data Server Driver for JDBC and SQLJ driver does not support compound SQL blocks.

Compound SQL allows multiple SQL statements to be grouped into a single executable block. For example:

```
EXEC SQL BEGIN COMPOUND ATOMIC STATIC
  UPDATE ACCOUNTS SET ABALANCE = ABALANCE + :delta
    WHERE AID = :aid;
  UPDATE TELLERS SET TBALANCE = TBALANCE + :delta
    WHERE TID = :tid;
  INSERT INTO TELLERS (TID, BID, TBALANCE) VALUES (:i, :branch_id, 0);
  COMMIT;
END COMPOUND;
```

The DB2 JDBC Type 2 Driver supports execution of compound SQL blocks with PreparedStatement.executeUpdate or Statement.executeUpdate.

Result of not setting a parameter in a batched update

The IBM Data Server Driver for JDBC and SQLJ driver throws an exception after a PreparedStatement.addBatch call if a parameter is not set.

The DB2 JDBC Type 2 Driver throws an exception after the PreparedStatement.executeBatch call if a parameter is not set for any of the statements in the batch.

Ability to call uncatalogued stored procedures

The IBM Data Server Driver for JDBC and SQLJ driver does not let you call stored procedures that are not defined in the DB2 catalog.

The DB2 JDBC Type 2 Driver lets you call stored procedures that are not defined in the DB2 catalog.

Specification of data types for stored procedure parameters

With the IBM Data Server Driver for JDBC and SQLJ driver, if the data source does not support dynamic execution of the CALL statement, you must specify CALL statement parameters **exactly** as they are specified in the stored procedure definition.

For example, DB2 for z/OS data sources do not support dynamic execution of CALL statements. Suppose that the first parameter of a stored procedure on a DB2 for z/OS server is defined like this in the CREATE PROCEDURE statement:

```
OUT PARM1 DECIMAL(3,0)
```

In the calling application, a statement like cs.registerOutParameter(1, Types.DECIMAL) is not correct. You need to use the form of the registerOutParameter method that specifies the scale as well as the data type: cs.registerOutParameter (1, Types.DECIMAL, 0).

The DB2 JDBC Type 2 Driver does not require that the parameter data types in a calling application match the data types in the CREATE PROCEDURE statement.

Examples of ResultSetMetaData.getColumnName and ResultSetMetaData.getColumnLabel values

For the IBM Data Server Driver for JDBC and SQLJ Version 4.0 and later, the values that are returned for ResultSetMetaData.getColumnName and `ResultSetMetaData.getColumnLabel` differ from the values that are returned for earlier JDBC drivers.

The following examples show the values that are returned for IBM Data Server Driver for JDBC and SQLJ Version 4.0, and for previous JDBC drivers, when the useJDBC4ColumnNameAndLabelSemantics property is not set.

All queries use a table that is defined like this:

```
CREATE TABLE MYTABLE(INTCOL INT)
```

Example: The following query contains an AS CLAUSE, which defines a label for a column in the result set:

```
SELECT MYCOL AS MYLABEL FROM MYTABLE
```

The following table lists the ResultSetMetaData.getColumnName and ResultSetMetaData.getColumnName values that are returned for the query:

Table 89. ResultSetMetaData.getColumnName and ResultSetMetaData.getColumnName before and after IBM Data Server Driver for JDBC and SQLJ Version 4.0 for a query with an AS CLAUSE

	Behavior before IBM Data Server Driver for JDBC and SQLJ Version 4.0		**Behavior for IBM Data Server Driver for JDBC and SQLJ Version 4.0 and later**	
Target data source	**getColumnName value**	**getColumnLabel value**	**getColumnName value**	**getColumnLabel value**
DB2 Database for Linux, UNIX, and Windows	MYLABEL	MYLABEL	MYCOL	MYLABEL
IBM Informix Dynamic Server	MYLABEL	MYLABEL	MYCOL	MYLABEL

Table 89. ResultSetMetaData.getColumnName and ResultSetMetaData.getColumnName before and after IBM Data Server Driver for JDBC and SQLJ Version 4.0 for a query with an AS CLAUSE (continued)

	Behavior before IBM Data Server Driver for JDBC and SQLJ Version 4.0		Behavior for IBM Data Server Driver for JDBC and SQLJ Version 4.0 and later	
Target data source	**getColumnName value**	**getColumnLabel value**	**getColumnName value**	**getColumnLabel value**
DB2 for z/OS Version 8 or later, and DB2 for i5/OS Version V5R3 and later	MYLABEL	MYLABEL	MYCOL	MYLABEL
DB2 for z/OS Version 7, and DB2 for i5/OS Version V5R2	MYLABEL	MYLABEL	MYLABEL	MYLABEL

Example: The following query contains no AS clause:

```
SELECT MYCOL FROM MYTABLE
```

The ResultSetMetaData.getColumnName and ResultSetMetaData.getColumnLabel methods on the query return MYCOL, regardless of the target data source.

Example: On a DB2 for z/OS or DB2 for i5/OS data source, a LABEL ON statement is used to define a label for a column:

```
LABEL ON COLUMN MYTABLE.MYCOL IS 'LABELONCOL'
```

The following query contains an AS CLAUSE, which defines a label for a column in the ResultSet:

```
SELECT MYCOL AS MYLABEL FROM MYTABLE
```

The following table lists the ResultSetMetaData.getColumnName and ResultSetMetaData.getColumnName values that are returned for the query.

Table 90. ResultSetMetaData.getColumnName and ResultSetMetaData.getColumnName before and after IBM Data Server Driver for JDBC and SQLJ Version 4.0 for a table column with a LABEL ON statement in a query with an AS CLAUSE

	Behavior before IBM Data Server Driver for JDBC and SQLJ Version 4.0		Behavior for IBM Data Server Driver for JDBC and SQLJ Version 4.0 and later	
Target data source	**getColumnName value**	**getColumnLabel value**	**getColumnName value**	**getColumnLabel value**
DB2 for z/OS Version 8 or later, and DB2 for i5/OS V5R3 and later	MYLABEL	LABELONCOL	MYCOL	MYLABEL
DB2 for z/OS Version 7, and DB2 for i5/OS V5R2	MYLABEL	LABELONCOL	MYCOL	LABELONCOL

Example: On a DB2 for z/OS or DB2 for i5/OS data source, a LABEL ON statement is used to define a label for a column:

```
LABEL ON COLUMN MYTABLE.MYCOL IS 'LABELONCOL'
```

The following query contains no AS CLAUSE:

```
SELECT MYCOL FROM MYTABLE
```

The following table lists the ResultSetMetaData.getColumnName and ResultSetMetaData.getColumnName values that are returned for the query.

Table 91. ResultSetMetaData.getColumnName and ResultSetMetaData.getColumnName before and after IBM Data Server Driver for JDBC and SQLJ Version 4.0 for a table column with a LABEL ON statement in a query with no AS CLAUSE

	Behavior before IBM Data Server Driver for JDBC and SQLJ Version 4.0		**Behavior for IBM Data Server Driver for JDBC and SQLJ Version 4.0**	
Target data source	**getColumnName value**	**getColumnLabel value**	**getColumnName value**	**getColumnLabel value**
DB2 for z/OS Version 8 or later, and DB2 for i5/OS V5R3 and later	MYCOL	LABELONCOL	MYCOL	MYCOL
DB2 for z/OS Version 7, and DB2 for i5/OS V5R2	MYCOL	LABELONCOL	MYLABEL	LABELONCOL

SQLJ differences between the IBM Data Server Driver for JDBC and SQLJ and other DB2 JDBC drivers

There are a number of differences between the IBM Data Server Driver for JDBC and SQLJ and the older JDBC drivers. When you move to the IBM Data Server Driver for JDBC and SQLJ, you need to modify your SQLJ programs to account for those differences.

Important: The DB2 JDBC Type 2 Driver for Linux, UNIX and Windows (DB2 JDBC Type 2 Driver) is deprecated. This information is provided to assist you in moving your applications to the IBM Data Server Driver for JDBC and SQLJ.

SQLJ support in the IBM Data Server Driver for JDBC and SQLJ differs from SQLJ support in the other DB2 JDBC drivers in the following areas:

db2sqljcustomize errors and the -collection parameter

The db2sqljcustomize utility that is part of the IBM Data Server Driver for JDBC and SQLJ has a -collection parameter. The db2profc utility that is part of the DB2 JDBC Type 2 Driver does not have a -collection parameter. If the db2sqljcustomize utility performs a bind operation on a DB2 for z/OS server, and the -collection parameter contains any lowercase characters, db2sqljcustomize returns a -4499 error because collection IDs cannot contain lowercase characters in DB2 for z/OS. This situation cannot occur with db2profc.

Differences in serialized profiles

The DB2 JDBC Type 2 Driver and the IBM Data Server Driver for JDBC and SQLJ produce different binary code when you execute their SQLJ translator and the SQLJ customizer utilities. Therefore, SQLJ applications that you translated and customized using the DB2 JDBC Type 2 Driver `sqlj` and `db2profc` utilities do not run under the IBM Data Server Driver for JDBC and SQLJ. ***Before you can run those SQLJ applications under the IBM Data Server Driver for JDBC and SQLJ, you must retranslate and recustomize the applications using the IBM Data Server Driver for JDBC and SQLJ `sqlj` and `db2sqljcustomize` utilities.*** You must do so even if you have not modified the applications.

SQL VALUES support

The DB2 JDBC Type 2 Driver supports the SQL VALUES statement in an SQLJ statement clause, but the IBM Data Server Driver for JDBC and SQLJ does not. Therefore, you need to modify your SQLJ applications that include VALUES statements.

Example: Suppose that an SQLJ program contains the following statement:

```
#sql [ctxt] hv = {VALUES (MY_ROUTINE(1))};
```

For the IBM Data Server Driver for JDBC and SQLJ, you need to change that statement to something like this:

```
#sql [ctxt] {SELECT MY_ROUTINE(1) INTO :hv FROM SYSIBM.SYSDUMMY1};
```

Compound SQL statement support

The DB2 JDBC Type 2 Driver supports compound SQL statements in an SQLJ statement clause, but the IBM Data Server Driver for JDBC and SQLJ does not. Therefore, you need to modify your SQLJ applications that include SQLJ statements with BEGIN COMPOUND and END COMPOUND. If you use compound statements to do batch updates, you can use the SQLJ batch update programming interfaces instead.

Difference in connection techniques

The connection techniques that are available, and the driver names and URLs that are used for those connection techniques, vary from driver to driver. See ″Connect to a data source using SQLJ″ for more information.

Support for scrollable and updatable iterators

SQLJ with the IBM Data Server Driver for JDBC and SQLJ supports scrollable and updatable iterators.

The DB2 JDBC Type 2 Driver for Linux, UNIX and Windows (DB2 JDBC Type 2 Driver) supports scrollable cursors but not updatable iterators.

Dynamic execution of SQL statements under WebSphere Application Server

For WebSphere Application Server Version 5.0.1 and above, if you customize your SQLJ program, SQL statements are executed statically.

Alternative names for db2sqljcustomize and db2sqljprint are not supported

The DB2 JDBC Type 2 Driver originally used the name db2profc for the SQLJ profile customizer command, and the name db2profp for the SQLJ profile printer command. For the IBM Data Server Driver for JDBC and SQLJ, the SQLJ profile customizer command is named db2sqljcustomize, and the SQLJ profile printer command is named db2sqljprint. In previous releases of DB2 Database for Linux, UNIX, and Windows, db2profc was accepted as an alternative name for db2sqljcustomize, and db2profp was accepted as an alternative name for db2sqljprint. These alternative names are no longer accepted.

SDK for Java differences that affect the IBM Data Server Driver for JDBC and SQLJ

Differences in the behavior among versions of the SDK for Java can cause variations in the results that you receive when you run programs under the IBM Data Server Driver for JDBC and SQLJ.

Retrieved values for DBCS substitution characters

When you retrieve a DBCS substitution character, such as X'FCFC' in code page Cp943, from a database table, the retrieved value differs, depending on whether you are using an IBM SDK for Java or a Sun SDK for Java.

For a Sun SDK for Java, the substitution character is retrieved as U+0000. For an IBM SDK for Java, the substitution character is retrieved as X'FFFD'.

Supported code pages

IBM SDKs for Java support more DBCS code pages than Sun SDKs for Java. Therefore, if you get errors because of unsupported code pages with a Sun SDK for Java, try using an IBM SDK for Java.

IBM SDK for Java requirement for encryption

The IBM SDKs for Java support 256-bit encryption, but the Sun SDKs for Java do not have this support. Therefore, if you use any of the IBM Data Server Driver for JDBC and SQLJ security mechanisms that include encryption, you need to use an IBM SDK for Java.

Support for system monitoring

Support for system monitoring in the IBM Data Server Driver for JDBC and SQLJ includes collection of core driver time and network I/O time. Retrieval of this information requires capabilities that are in any SDK for Java Version 5 or later. However, the IBM SDK for Java Version 1.4.2 also has support that enables collection of core driver time and network I/O time. If you use the IBM SDK for Java Version 1.4.2, the core driver time and network I/O time are rounded to the nearest microsecond. If you use an SDK for Java Version 5 or later, the core driver time and network I/O time are rounded to the nearest nanosecond.

Error codes issued by the IBM Data Server Driver for JDBC and SQLJ

Error codes in the ranges +4200 to +4299, +4450 to +4499, -4200 to -4299, and -4450 to -4499 are reserved for the IBM Data Server Driver for JDBC and SQLJ.

When you call the SQLException.getMessage method after a IBM Data Server Driver for JDBC and SQLJ error occurs, a string is returned that includes:

- Whether the connection is a type 2 or type 4 connection
- Diagnostic information for IBM Software Support
- The level of the driver
- An explanatory message
- The error code
- The SQLSTATE

For example:

```
[jcc][t4][20128][12071][3.50.54] Invalid queryBlockSize specified: 1,048,576,012.
Using default query block size of 32,767.  ERRORCODE=0, SQLSTATE=
```

Currently, the IBM Data Server Driver for JDBC and SQLJ issues the following error codes:

Table 92. Error codes issued by the IBM Data Server Driver for JDBC and SQLJ

Error Code	Message text and explanation	SQLSTATE
+4204	Errors were encountered and tolerated as specified by the RETURN DATA UNTIL clause. **Explanation:** Tolerated errors include federated connection, authentication, and authorization errors. This warning applies only to connections to DB2 Database for Linux, UNIX, and Windows servers. It is issued only when a cursor operation, such as a ResultSet.next or ResultSet.previous call, returns `false`.	02506
+4222	*text-from-getMessage* **Explanation:** A warning condition occurred during connection to the data source. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
+4223	*text-from-getMessage* **Explanation:** A warning condition occurred during initialization. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
+4225	*text-from-getMessage* **Explanation:** A warning condition occurred when data was sent to a server or received from a server. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
+4226	*text-from-getMessage* **Explanation:** A warning condition occurred during customization or bind of an SQLJ application. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
+4228	*text-from-getMessage* **Explanation:** An warning condition occurred that does not fit in another category. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
+4450	Feature not supported: *feature-name*	

Table 92. Error codes issued by the IBM Data Server Driver for JDBC and SQLJ (continued)

Error Code	Message text and explanation	SQLSTATE
+4460	*text-from-getMessage* **Explanation:** The specified value is not a valid option. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
+4461	*text-from-getMessage* **Explanation:** The specified value is invalid of out of range. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
+4462	*text-from-getMessage* **Explanation:** A required value is missing. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
+4470	*text-from-getMessage* **Explanation:** The requested operation cannot be performed because the target resource is closed. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
+4471	*text-from-getMessage* **Explanation:** The requested operation cannot be performed because the target resource is in use. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
+4472	*text-from-getMessage* **Explanation:** The requested operation cannot be performed because the target resource is because the target resource is unavailable. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
+4474	*text-from-getMessage* **Explanation:** The requested operation cannot be performed because the target resource cannot be changed. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4200	Invalid operation: An invalid COMMIT or ROLLBACK has been called in an XA environment during a Global Transaction. **Explanation:** An application that was in a global transaction in an XA environment issued a commit or rollback. A commit or rollback operation in a global transaction is invalid.	2D521

Table 92. Error codes issued by the IBM Data Server Driver for JDBC and SQLJ (continued)

Error Code	Message text and explanation	SQLSTATE
-4201	Invalid operation: setAutoCommit(true) is not allowed during Global Transaction. **Explanation:** An application that was in a global transaction in an XA environment executed the setAutoCommit(true) statement. Issuing setAutoCommit(true) in a global transaction is invalid.	2D521
-4203	Error executing *function*. Server returned *rc*. **:** An error occurred on an XA connection during execution of an SQL statement. For network optimization, the IBM Data Server Driver for JDBC and SQLJ delays some XA flows until the next SQL statement is executed. If an error occurs in a delayed XA flow, that error is reported as part of the SQLException that is thrown by the current SQL statement.	
-4210	Timeout getting a transport object from pool.	
-4211	Timeout getting an object from pool.	
-4212	Sysplex member unavailable.	
-4214	*text-from-getMessage* **Explanation:** Authorization failed. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	28000
-4220	*text-from-getMessage* **Explanation:** An error occurred during character conversion. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4221	*text-from-getMessage* **Explanation:** An error occurred during encryption or decryption. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4222	*text-from-getMessage* **Explanation:** An error occurred during connection to the data source. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4223	*text-from-getMessage* **Explanation:** An error occurred during initialization. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	

Table 92. Error codes issued by the IBM Data Server Driver for JDBC and SQLJ (continued)

Error Code	Message text and explanation	SQLSTATE
-4224	*text-from-getMessage* **Explanation:** An error occurred during resource cleanup. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4225	*text-from-getMessage* **Explanation:** An error occurred when data was sent to a server or received from a server. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4226	*text-from-getMessage* **Explanation:** An error occurred during customization or bind of an SQLJ application. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4227	*text-from-getMessage* **Explanation:** An error occurred during reset. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4228	*text-from-getMessage* **Explanation:** An error occurred that does not fit in another category. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4296	Exception *exception-class*: Error opening socket to server *server* on port *port* with message: *message*. **Explanation:** The driver was unable to establish a connection. **User response:** Verify that the host name or address and port number of the server are correct, and that the server is started. For a connection to a DB2 Database for Linux, UNIX, and Windows data source, verify that the svcename configuration parameter is properly configured.	08001
-4297	A communication error occurred during operations on the connection's underlying socket, socket input stream, or socket output stream. Error location: *function*. Message: *message*.	08001
-4298	The database manager is not able to accept new requests, has terminated all requests in progress, or has terminated this request due to unexpected error conditions that were detected at the target system.	58009
-4450	Feature not supported: *feature-name*	

Table 92. Error codes issued by the IBM Data Server Driver for JDBC and SQLJ (continued)

Error Code	Message text and explanation	SQLSTATE
-4460	*text-from-getMessage* **Explanation:** The specified value is not a valid option. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4461	*text-from-getMessage* **Explanation:** The specified value is invalid of out of range. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	42815
-4462	*text-from-getMessage* **Explanation:** A required value is missing. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4463	*text-from-getMessage* **Explanation:** The specified value has a syntax error. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	42601
-4470	*text-from-getMessage* **Explanation:** The requested operation cannot be performed because the target resource is closed. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4471	*text-from-getMessage* **Explanation:** The requested operation cannot be performed because the target resource is in use. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4472	*text-from-getMessage* **Explanation:** The requested operation cannot be performed because the target resource is unavailable. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4473	*text-from-getMessage* **Explanation:** The requested operation cannot be performed because the target resource is no longer available. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	

Table 92. Error codes issued by the IBM Data Server Driver for JDBC and SQLJ (continued)

Error Code	Message text and explanation	SQLSTATE
-4474	*text-from-getMessage* **Explanation:** The requested operation cannot be performed because the target resource cannot be changed. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4475	*text-from-getMessage* **Explanation:** The requested operation cannot be performed because access to the target resource is restricted. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4476	*text-from-getMessage* **Explanation:** The requested operation cannot be performed because the operation is not allowed on the target resource. **User response:** Call SQLException.getMessage to retrieve specific information about the problem.	
-4496	An SQL OPEN for a held cursor was issued on an XA connection. The JDBC driver does not allow a held cursor to be opened on the database server for an XA connection.	
-4497	The application must issue a rollback. The unit of work has already been rolled back in the DB2 server, but other resource managers involved in the unit of work might not have rolled back their changes. To ensure integrity of the application, all SQL requests are rejected until the application issues a rollback.	
-4498	A connection failed but has been reestablished. Host name or IP address: *host-name*, service name or port number: *port*, special register modification indicator: *rc*. **Explanation:** *host-name* and *port* indicate the data source at which the connection is reestablished. *rc* indicates whether SQL statements that set special register values were executed again: **1** SQL statements that set special register values were executed again. **2** SQL statements that set special register values might not have been executed again. For client reroute against DB2 for z/OS servers, special register values that were set after the last commit point are not re-established. The application is rolled back to the previous commit point.	
-4499	A fatal error occurred that resulted in a disconnect. The existing connection has become unusable. **Explanation:** One possible cause is that a network error caused a socket to disconnect.	
-30108	Client reroute exception for the Sysplex.	08506

Table 92. Error codes issued by the IBM Data Server Driver for JDBC and SQLJ (continued)

Error Code	Message text and explanation	SQLSTATE
-99999	The IBM Data Server Driver for JDBC and SQLJ issued an error that does not yet have an error code.	

SQLSTATEs issued by the IBM Data Server Driver for JDBC and SQLJ

SQLSTATEs in the range 46600 to 466ZZ are reserved for the IBM Data Server Driver for JDBC and SQLJ.

The following table lists the SQLSTATEs that are generated or used by the IBM Data Server Driver for JDBC and SQLJ.

Table 93. SQLSTATEs returned by the IBM Data Server Driver for JDBC and SQLJ

SQLSTATE class	SQLSTATE	Description
01*xxx*		Warning
02*xxx*		No data
	02501	The cursor position is not valid for a FETCH of the current row.
	02506	Tolerable error
08*xxx*		Connection exception
	08003	A connection does not exist
	08004	The application server rejected establishment of the connection
	08506	Client reroute exception
0A*xxx*		Feature not supported
	0A502	The action or operation is not enabled for this database instance
22*xxx*		Data exception
	22007	The string representation of a datetime value is invalid
	22021	A character is not in the coded character set
23*xxx*		Constraint violation
	23502	A value that is inserted into a column or updates a column is null, but the column cannot contain null values.
24*xxx*		Invalid cursor state
	24501	The identified cursor is not open
28*xxx*		Authorization exception
	28000	Authorization name is invalid.
2D*xxx*		Invalid transaction termination
	2D521	SQL COMMIT or ROLLBACK are invalid in the current operating environment.
34*xxx*		Invalid cursor name
	34000	Cursor name is invalid.
3B*xxx*		Invalid savepoint

Table 93. SQLSTATEs returned by the IBM Data Server Driver for JDBC and SQLJ (continued)

SQLSTATE class	SQLSTATE	Description
	3B503	A SAVEPOINT, RELEASE SAVEPOINT, or ROLLBACK TO SAVEPOINT statement is not allowed in a trigger or global transaction.
40*xxx*		Transaction rollback
42*xxx*		Syntax error or access rule violation
	42601	A character, token, or clause is invalid or missing
	42734	A duplicate parameter name, SQL variable name, cursor name, condition name, or label was detected.
	42807	The INSERT, UPDATE, or DELETE is not permitted on this object
	42808	A column identified in the insert or update operation is not updateable
	42815	The data type, length, scale, value, or CCSID is invalid
	42820	A numeric constant is too long, or it has a value that is not within the range of its data type
	42968	The connection failed because there is no current software license.
58*xxx*		System error
	58008	Execution failed due to a distribution protocol error that will not affect the successful execution of subsequent DDM commands or SQL statements
	58009	Execution failed due to a distribution protocol error that caused deallocation of the conversation
	58012	The bind process with the specified package name and consistency token is not active
	58014	The DDM command is not supported
	58015	The DDM object is not supported
	58016	The DDM parameter is not supported
	58017	The DDM parameter value is not supported

How to find IBM Data Server Driver for JDBC and SQLJ version and environment information

To determine the version of the IBM Data Server Driver for JDBC and SQLJ, as well as information about the environment in which the driver is running, run the DB2Jcc utility on the command line.

DB2Jcc syntax

DB2Jcc option descriptions

-version
Specifies that the IBM Data Server Driver for JDBC and SQLJ displays its name and version.

-configuration
Specifies that the IBM Data Server Driver for JDBC and SQLJ displays its name and version, and information about its environment, such as information about the Java runtime environment, operating system, path information, and license restrictions.

-help
Specifies that the DB2Jcc utility describes each of the options that it supports. If any other options are specified with -help, they are ignored.

DB2Jcc sample output

The following output is the result of invoking DB2Jcc with the -configuration parameter.

Figure 62. Sample DB2Jcc output

```
(myid@mymachine) /home/myusrid $ java com.ibm.db2.jcc.DB2Jcc -version
[jcc] Driver: IBM DB2 JDBC Universal Driver Architecture 3.50.137

(myid@mymachine) /home/myusrid $ java com.ibm.db2.jcc.DB2Jcc -configuration
[jcc] BEGIN TRACE_DRIVER_CONFIGURATION
[jcc] Driver: IBM DB2 JDBC Universal Driver Architecture 3.50.137
[jcc] Compatible JRE versions: { 1.4, 1.5 }
[jcc] Target server licensing restrictions: { z/OS: enabled; SQLDS: enabled; iSe
ries: enabled; DB2 for Unix/Windows: enabled; Cloudscape: enabled; Informix: ena
bled }
[jcc] Range checking enabled: true
[jcc] Bug check level: 0xff
[jcc] Default fetch size: 64
[jcc] Default isolation: 2
[jcc] Collect performance statistics: false
[jcc] No security manager detected.
[jcc] Detected local client host: lead.svl.ibm.com/9.30.10.102
[jcc] Access to package sun.io is permitted by security manager.
[jcc] JDBC 1 system property jdbc.drivers = null
[jcc] Java Runtime Environment version 1.4.2
[jcc] Java Runtime Environment vendor = IBM Corporation
[jcc] Java vendor URL = http://www.ibm.com/
[jcc] Java installation directory = /wsdb/v91/bldsupp/AIX5L64/jdk1.4.2_sr1/sh/..
/jre
[jcc] Java Virtual Machine specification version = 1.0
[jcc] Java Virtual Machine specification vendor = Sun Microsystems Inc.
[jcc] Java Virtual Machine specification name = Java Virtual Machine Specificati
on
[jcc] Java Virtual Machine implementation version = 1.4.2
[jcc] Java Virtual Machine implementation vendor = IBM Corporation
[jcc] Java Virtual Machine implementation name = Classic VM
[jcc] Java Runtime Environment specification version = 1.4
[jcc] Java Runtime Environment specification vendor = Sun Microsystems Inc.
[jcc] Java Runtime Environment specification name = Java Platform API Specificat
ion
[jcc] Java class format version number = 48.0
[jcc] Java class path = :.:/home2/myusrid/sqllib/java/db2java.zip:/lib/classes.z
ip:/home2/myusrid/sqllib/java/sqlj.zip:./test:/home2/myusrid/sqllib/java/db2jcc.
jar:/home2/myusrid/sqllib/java/db2jcc_license_cisuz.jar:...
[jcc] Java native library path = /wsdb/v91/bldsupp/AIX5L64/jdk1.4.2_sr1/sh/../jr
e/bin:/wsdb/v91/bldsupp/AIX5L64/jdk1.4.2_sr1/jre/bin/classic:/wsdb/v91/bldsupp/A
```

```
IX5L64/jdk1.4.2_sr1/jre/bin:/home2/myusrid/sqllib/lib:/local/cobol:/home2/myusri
d/sqllib/samples/c:/usr/lib
[jcc] Path of extension directory or directories = /wsdb/v91/bldsupp/AIX5L64/jdk
1.4.2_sr1/sh/../jre/lib/ext
[jcc] Operating system name = AIX
[jcc] Operating system architecture = ppc64
[jcc] Operating system version = 5.3
[jcc] File separator ("/" on UNIX) = /
[jcc] Path separator (":" on UNIX) = :
[jcc] User's account name = myusrid
[jcc] User's home directory = /home2/myusrid
[jcc] User's current working directory = /home2/myusrid
[jcc] Dumping all system properties: { java.assistive=ON, java.runtime.name=Java
(TM) 2 Runtime Environment, Standard Edition, sun.boot.library.path=/wsdb/v91/bl
dsupp/AIX5L64/jdk1.4.2_sr1/sh/../jre/bin, java.vm.version=1.4.2, java.vm.vendor=
IBM Corporation, java.vendor.url=http://www.ibm.com/, path.separator=:, java.vm.
name=Classic VM, file.encoding.pkg=sun.io, user.country=US, sun.os.patch.level=u
nknown, ... }
[jcc] Dumping all file properties: {  }
[jcc] END TRACE_DRIVER_CONFIGURATION
```

Commands for SQLJ program preparation

To prepare SQLJ programs for execution, you use commands to translate SQLJ source code into Java source code, compile the Java source code, create and customize SQLJ serialized profiles, and bind DB2 packages.

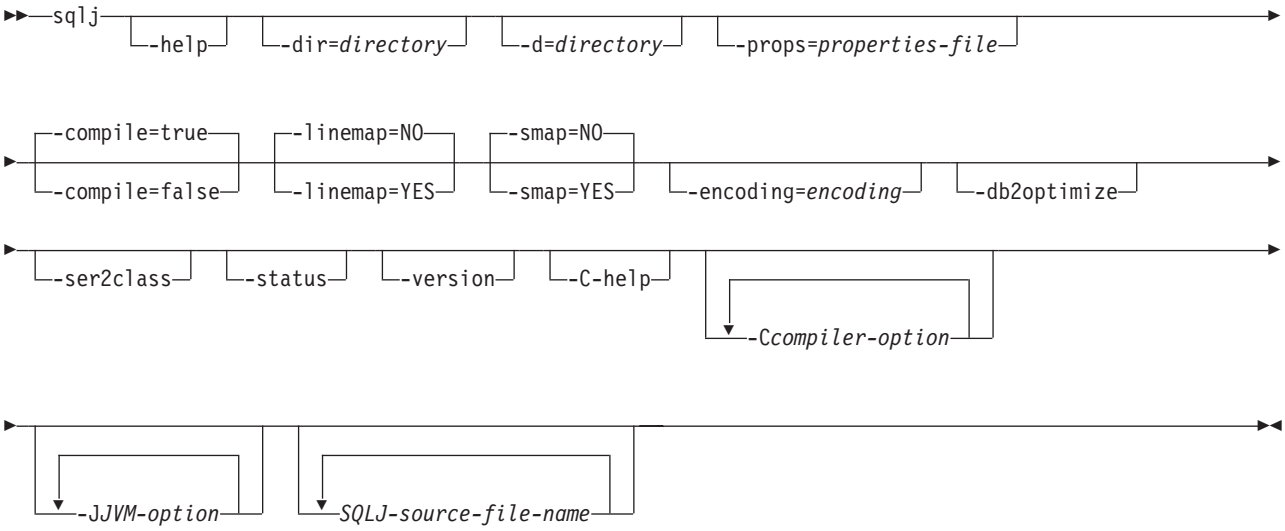
sqlj - SQLJ translator

The sqlj command translates an SQLJ source file into a Java source file and zero or more SQLJ serialized profiles. By default, the sqlj command also compiles the Java source file.

Authorization

None

Command syntax



Command parameters

-help
Specifies that the SQLJ translator describes each of the options that the translator supports. If any other options are specified with -help, they are ignored.

-dir=*directory*
Specifies the name of the directory into which SQLJ puts .java files that are generated by the translator and .class files that are generated by the compiler. The default is the directory that contains the SQLJ source files.

The translator uses the directory structure of the SQLJ source files when it puts the generated files in directories. For example, suppose that you want the translator to process two files:
- file1.sqlj, which is not in a Java package
- file2.sqlj, which is in Java package sqlj.test

Also suppose that you specify the parameter -dir=/src when you invoke the translator. The translator puts the Java source file for file1.sqlj in directory /src and puts the Java source file for file2.sqlj in directory /src/sqlj/test.

-d=*directory*
Specifies the name of the directory into which SQLJ puts the binary files that are generated by the translator and compiler. These files include the .ser files, the *name*_SJProfileKeys.class files, and the .class files that are generated by the compiler.

The default is the directory that contains the SQLJ source files.

The translator uses the directory structure of the SQLJ source files when it puts the generated files in directories. For example, suppose that you want the translator to process two files:
- file1.sqlj, which is not in a Java package
- file2.sqlj, which is in Java package sqlj.test

Also suppose that you specify the parameter -d=/src when you invoke the translator. The translator puts the serialized profiles for file1.sqlj in directory /src and puts the serialized profiles for file2.sqlj in directory /src/sqlj/test.

-compile=true | false
Specifies whether the SQLJ translator compiles the generated Java source into bytecodes.

true
The translator compiles the generated Java source code. This is the default.

false
The translator does not compile the generated Java source code.

-linemap=no | yes
Specifies whether line numbers in Java exceptions match line numbers in the SQLJ source file (the .sqlj file), or line numbers in the Java source file that is generated by the SQLJ translator (the .java file).

no Line numbers in Java exceptions match line numbers in the Java source file. This is the default.

yes
Line numbers in Java exceptions match line numbers in the SQLJ source file.

-smap=no | yes
Specifies whether the SQLJ translator generates a source map (SMAP) file for each SQLJ source file. An SMAP file is used by some Java language debug tools. This file maps lines in the SQLJ source file to lines in the Java source file that is generated by the SQLJ translator. The file is in the Unicode UTF-8 encoding scheme. Its format is described by Original Java Specification Request (JSR) 45, which is available from this web site:

```
http://www.jcp.org
```

no Do not generated SMAP files. This is the default.

yes
Generate SMAP files. An SMAP file name is *SQLJ-source-file-name*.java.smap. The SQLJ translator places the SMAP file in the same directory as the generated Java source file.

-encoding=*encoding-name*
Specifies the encoding of the source file. Examples are JIS or EUC. If this option is not specified, the default converter for the operating system is used.

-db2optimize
Specifies that the SQLJ translator generates code for a connection context class that is optimized for DB2. -db2optimize optimizes the code for the user-defined context but not the default context.

When you run the SQLJ translator with the -db2optimize option, if your applications use JDBC 3.0 or earlier functions, the IBM Data Server Driver for JDBC and SQLJ file db2jcc.jar must be in the CLASSPATH for compiling the generated Java application. If your applications use JDBC 4.0 or earlier functions, the IBM Data Server Driver for JDBC and SQLJ file db2jcc4.jar must be in the CLASSPATH for compiling the generated Java application.

-ser2class
Specifies that the SQLJ translator converts .ser files to .class files.

-status
Specifies that the SQLJ translator displays status messages as it runs.

-version
Specifies that the SQLJ translator displays the version of the IBM Data Server Driver for JDBC and SQLJ. The information is in this form:

```
IBM SQLJ xxxx.xxxx.xx
```

-C-help
Specifies that the SQLJ translator displays help information for the Java compiler.

-C*compiler-option*
Specifies a valid Java compiler option that begins with a dash (-). Do not include spaces between -C and the compiler option. If you need to specify multiple compiler options, precede each compiler option with -C. For example:

```
-C-g -C-verbose
```

All options are passed to the Java compiler and are not used by the SQLJ translator, **except** for the following options:

-classpath
Specifies the user class path that is to be used by the SQLJ translator and the Java compiler. This value overrides the CLASSPATH environment variable.

-sourcepath
Specifies the source code path that the SQLJ translator and the Java compiler search for class or interface definitions. The SQLJ translator searches for .sqlj and .java files only in directories, not in JAR or zip files.

-J*JVM-option*
Specifies an option that is to be passed to the Java virtual machine (JVM) in which the sqlj command runs. The option must be a valid JVM option that begins with a dash (-). Do not include spaces between -J and the JVM option. If you need to specify multiple JVM options, precede each compiler option with -J. For example:

```
-J-Xmx128m -J-Xmine2M
```

SQLJ-source-file-name
Specifies a list of SQLJ source files to be translated. This is a required parameter. All SQLJ source file names must have the extension .sqlj.

Output

For each source file, *program-name*.sqlj, the SQLJ translator produces the following files:

- The generated source program

  The generated source file is named *program-name*.java.
- A serialized profile file for each connection context class that is used in an SQLJ executable clause

  A serialized profile name is of the following form:

  *program-name*_SJProfile*IDNumber*.ser
- If the SQLJ translator invokes the Java compiler, the class files that the compiler generates.

Examples

```
sqlj -encoding=UTF8 -C-O MyApp.sqlj
```

db2sqljcustomize - SQLJ profile customizer

db2sqljcustomize processes an SQLJ profile, which contains embedded SQL statements.

By default, db2sqljcustomize produces four DB2 packages: one for each isolation level. db2sqljcustomize augments the profile with DB2-specific information for use at run time.

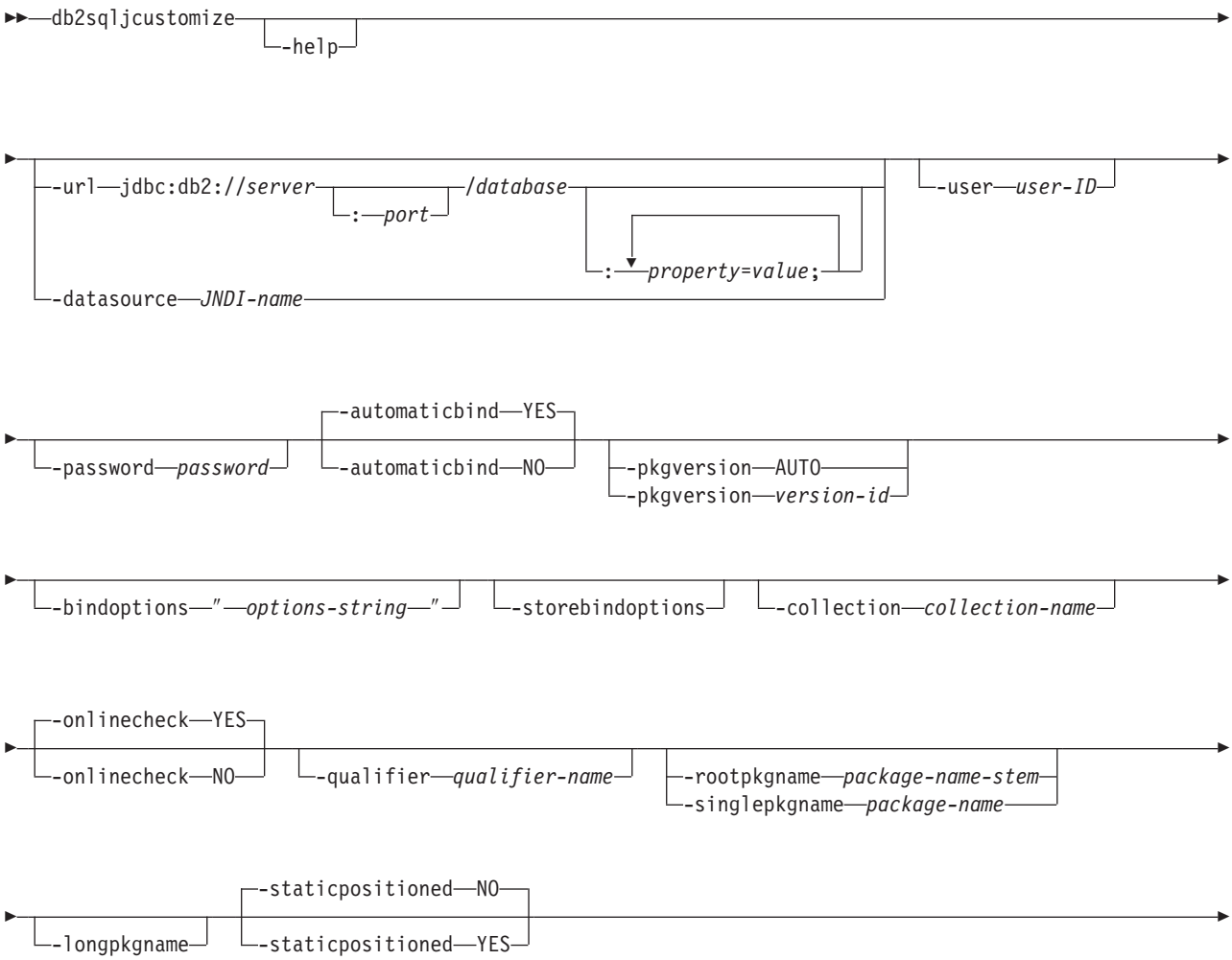
Authorization

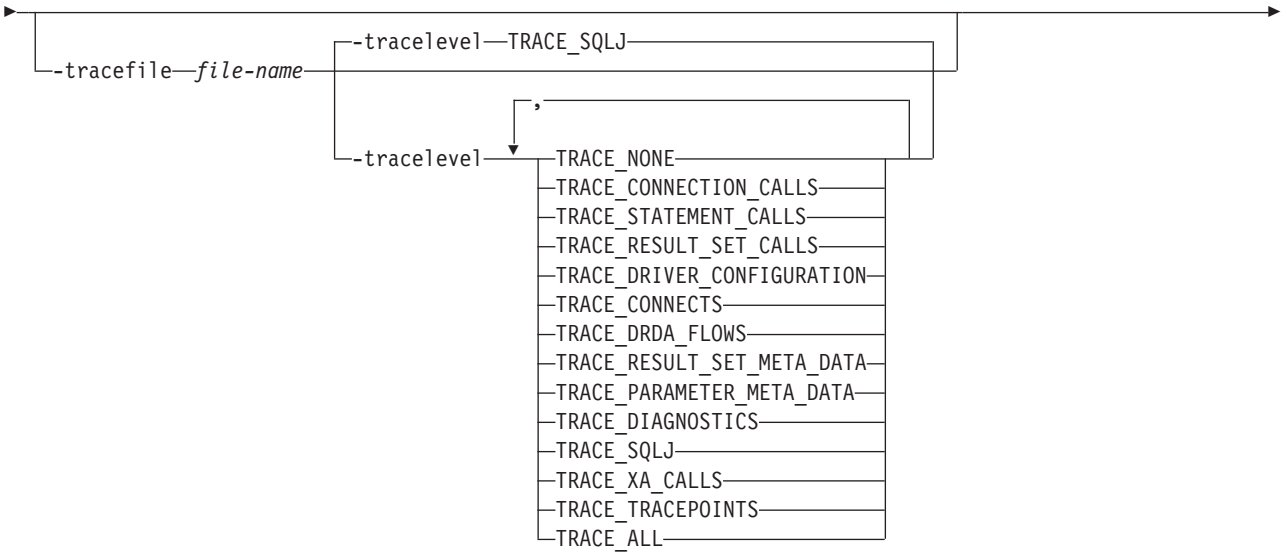
The privilege set of the process must include one of the following authorities:

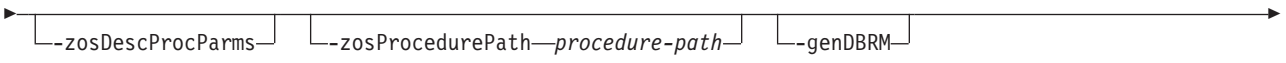
- SYSADM authority
- DBADM authority
- If the package does not exist, the BINDADD privilege, and one of the following privileges:
  - CREATEIN privilege
  - IMPLICIT_SCHEMA authority on the database if the schema name of the package does not exist
- If the package exists:
  - ALTERIN privilege on the schema
  - BIND privilege on the package

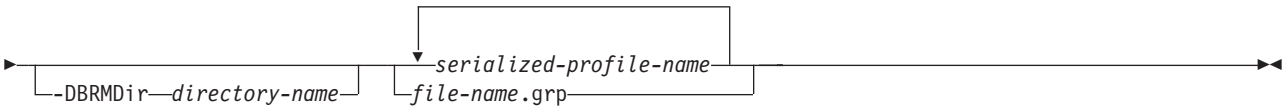
The user also needs all privileges that are required to compile any static SQL statements in the application. Privileges that are granted to groups are not used for authorization checking of static statements. If the user has SYSADM authority, but no explicit privileges to complete the bind, the DB2 database manager grants explicit DBADM authority automatically.

Command syntax

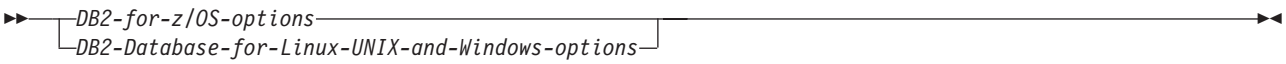




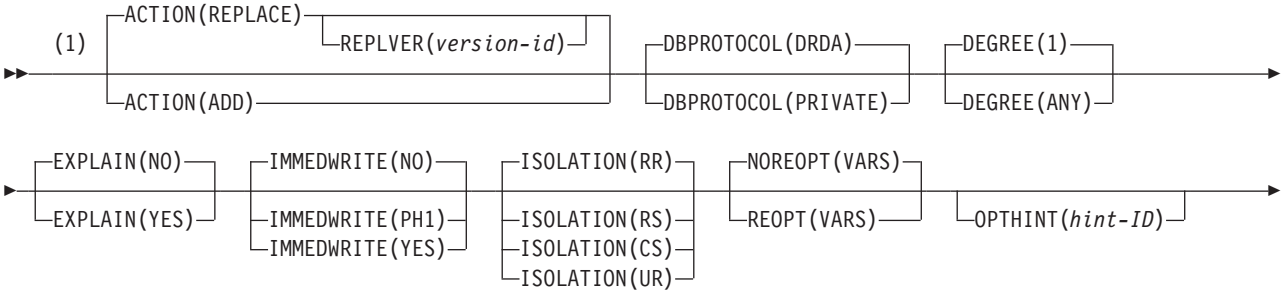


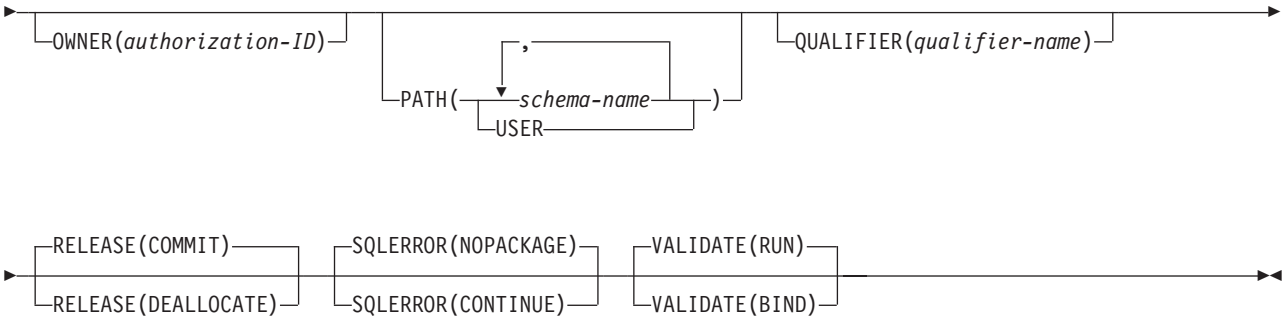


options-string:



DB2 for z/OS options:

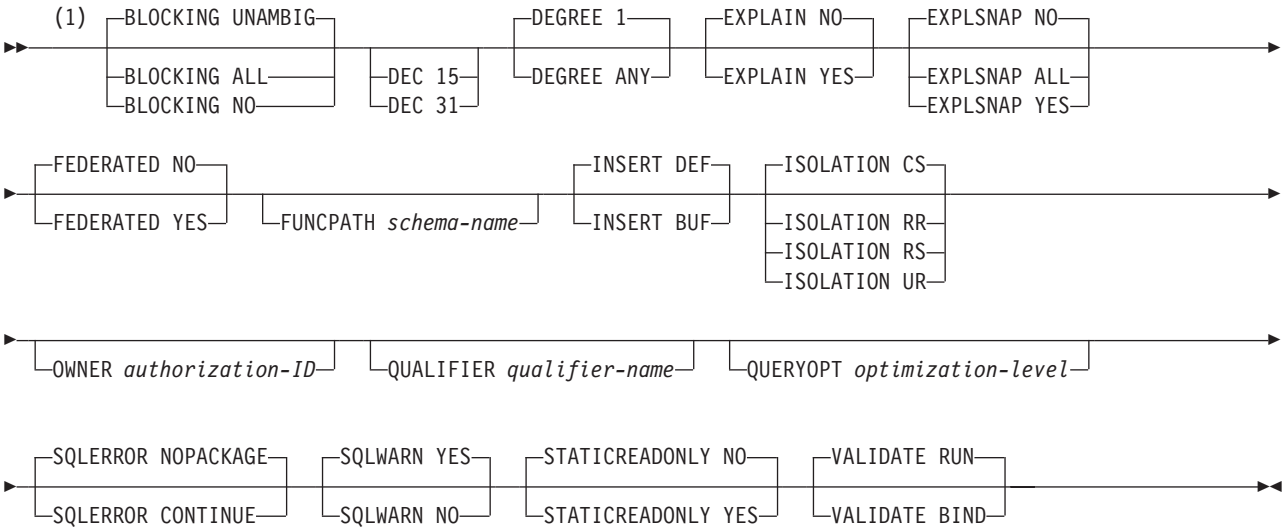




Notes:

1 These options can be specified in any order.

DB2 Database for Linux, UNIX, and Windows options



Notes:

1 These options can be specified in any order.

Command parameters

-help
Specifies that the SQLJ customizer describes each of the options that the customizer supports. If any other options are specified with -help, they are ignored.

-url
Specifies the URL for the data source for which the profile is to be customized. A connection is established to the data source that this URL represents if the -automaticbind or -onlinecheck option is specified as YES or defaults to YES. The variable parts of the `-url` value are:

server
The domain name or IP address of the z/OS system on which the DB2 subsystem resides.

port
The TCP/IP server port number that is assigned to the DB2 subsystem. The default is 446.

-url
Specifies the URL for the data source for which the profile is to be customized. A connection is established to the data source that this URL represents if the -automaticbind or -onlinecheck option is specified as YES or defaults to YES. The variable parts of the `-url` value are:

server
The domain name or IP address of the operating system on which the database server resides.

port
The TCP/IP server port number that is assigned to the database server. The default is 446.

database
A name for the database server for which the profile is to be customized.

If the connection is to a DB2 for z/OS server, *database* is the DB2 location name that is defined during installation. All characters in this value must be uppercase characters. You can determine the location name by executing the following SQL statement on the server:

```
SELECT CURRENT SERVER FROM SYSIBM.SYSDUMMY1;
```

If the connection is to a DB2 Database for Linux, UNIX, and Windows server, *database* is the database name that is defined during installation.

If the connection is to an IBM Cloudscape server, the *database* is the fully-qualified name of the file that contains the database. This name must be enclosed in double quotation marks (″). For example:

```
"c:/databases/testdb"
```

property=value;
A property for the JDBC connection.

property=value;
A property for the JDBC connection.

-datasource *JNDI-name*
Specifies the logical name of a DataSource object that was registered with JNDI. The DataSource object represents the data source for which the profile is to be customized. A connection is established to the data source if the -automaticbind or -onlinecheck option is specified as YES or defaults to YES. Specifying -datasource is an alternative to specifying -url. The DataSource object must represent a connection that uses IBM Data Server Driver for JDBC and SQLJ type 4 connectivity.

-user *user-ID*
Specifies the user ID to be used to connect to the data source for online checking or binding a package. You must specify -user if you specify -url. You must specify -user if you specify -datasource, and the DataSource object that *JNDI-name* represents does not contain a user ID.

-password *password*
Specifies the password to be used to connect to the data source for online checking or binding a package. You must specify -password if you specify -url.

You must specify -password if you specify -datasource, and the DataSource object that *JNDI-name* represents does not contain a password.

-automaticbind YES | NO
Specifies whether the customizer binds DB2 packages at the data source that is specified by the -url parameter.

The default is YES.

The number of packages and the isolation levels of those packages are controlled by the -rootpkgname and -singlepkgname options.

Before the bind operation can work, the following conditions need to be met:

- TCP/IP and DRDA must be installed at the target data source.
- Valid -url, -username, and -password values must be specified.
- The -username value must have authorization to bind a package at the target data source.

-pkgversion AUTO | *version-id*
Specifies the package version that is to be used when packages are bound at the server for the serialized profile that is being customized. db2sqljcustomize stores the version ID in the serialized profile and in the DB2 package. Run-time version verification is based on the consistency token, not the version name. To automatically generate a version name that is based on the consistency token, specify -pkgversion AUTO.

The default is that there is no version.

-bindoptions *options-string*
Specifies a list of options, separated by spaces. These options have the same function as DB2 precompile and bind options with the same names. If you are preparing your program to run on a DB2 for z/OS system, specify DB2 for z/OS options. If you are preparing your program to run on a DB2 Database for Linux, UNIX, and Windows system, specify DB2 Database for Linux, UNIX, and Windows options.

Notes on bind options:

- Specify ISOLATION only if you also specify the -singlepkgname option.
- The value for STATICREADONLY is YES for servers that support STATICREADONLY, and NO for other servers. When you specify STATICREADONLY YES, DB2 processes ambiguous cursors as if they were read-only cursors. For troubleshooting iterator declaration errors, you need to explicitly specify STATICREADONLY NO, or declare iterators so that they are unambiguous. For example, if you want an iterator to be unambiguously updatable, declare the iterator to implement sqlj.runtime.ForUpdate. If you want an iterator to be read-only, include the FOR READ ONLY clause in SELECT statements that use the iterator.

Important: Specify only those program preparation options that are appropriate for the data source at which you are binding a package. Some values and defaults for the IBM Data Server Driver for JDBC and SQLJ are different from the values and defaults for DB2.

-storebindoptions
Specifies that values for the -bindoptions and -staticpositioned parameters are stored in the serialized profile. If db2sqljbind is invoked without the -bindoptions or -staticpositioned parameter, the values that are stored in the serialized profile are used during the bind operation. When multiple serialized

profiles are specified for one invocation of db2sqljcustomize, the parameter values are stored in each serialized profile. The stored values are displayed in the output from the db2sqljprint utility.

-collection *collection-name*
The qualifier for the packages that `db2sqljcustomize` binds. `db2sqljcustomize` stores this value in the customized serialied profile, and it is used when the associated packages are bound. If you do not specify this parameter, `db2sqljcustomize` uses a collection ID of NULLID.

-onlinecheck YES|NO
Specifies whether online checking of data types in the SQLJ program is to be performed. The -url or -datasource option determines the data source that is to be used for online checking. The default is YES if the -url or -datasource parameter is specified. Otherwise, the default is NO.

-qualifier *qualifier-name*
Specifies the qualifier that is to be used for unqualified objects in the SQLJ program during online checking. This value is not used as the qualifier when the packages are bound.

-rootpkgname|-singlepkgname
Specifies the names for the packages that are associated with the program. If -automaticbind is NO, these package names are used when `db2sqljbind` runs. The meanings of the parameters are:

-rootpkgname *package-name-stem*
Specifies that the customizer creates four packages, one for each of the four DB2 isolation levels. The names for the four packages are:

*package-name-stem***1**
For isolation level UR

*package-name-stem***2**
For isolation level CS

*package-name-stem***3**
For isolation level RS

*package-name-stem***4**
For isolation level RR

If -longpkgname is not specified, *package-name-stem* must be an alphanumeric string of seven or fewer bytes.

If -longpkgname is specified, *package-name-stem* must be an alphanumeric string of 127 or fewer bytes.

-singlepkgname *package-name*
Specifies that the customizer creates one package, with the name *package-name*. If you specify this option, your program can run at only one isolation level. You specify the isolation level for the package by specifying the ISOLATION option in the -bindoptions options string.

If -longpkgname is not specified, *package-name* must be an alphanumeric string of eight or fewer bytes.

If -longpkgname is specified, *package-name* must be an alphanumeric string of 128 or fewer bytes.

Using the -singlepkgname option is not recommended.

Recommendation: If the target data source is DB2 for z/OS, use uppercase characters for the *package-name-stem* or *package-name* value. DB2 for z/OS systems that are defined with certain CCSID values cannot tolerate lowercase characters in package names or collection names.

If you do not specify -rootpkgname or -singlepkgname, `db2sqljcustomize` generates four package names that are based on the serialized profile name. A serialized profile name is of the following form:

*program-name*_SJProfile*IDNumber*.ser

The four generated package names are of the following form:

*Bytes-from-program-name**IDNumber**PkgIsolation*

Table 94 shows the parts of a generated package name and the number of bytes for each part.

The maximum length of a package name is *maxlen*. *maxlen* is 8 if -longpkgname is not specified. *maxlen* is 128 if -longpkgname is specified.

Table 94. Parts of a package name that is generated by db2sqljcustomize

Package name part	Number of bytes	Value
Bytes-from-program-name	*m*=min(Length(*program-name*), *maxlen*–1–Length(*IDNumber*))	First *m* bytes of *program-name*, in uppercase
IDNumber	Length(*IDNumber*)	*IDNumber*
PkgIsolation	1	1, 2, 3, or 4. This value represents the transaction isolation level for the package. See Table 95.

Table 95 shows the values of the *PkgIsolation* portion of a package name that is generated by db2sqljcustomize.

Table 95. PkgIsolation values and associated isolation levels

***PkgNumber* value**	**Isolation level for package**
1	Uncommitted read (UR)
2	Cursor stability (CS)
3	Read stability (RS)
4	Repeatable read (RR)

Example: Suppose that a profile name is ThisIsMyProg_SJProfile111.ser. The db2sqljcustomize option -longpkgname is not specified. Therefore, *Bytes-from-program-name* is the first four bytes of ThisIsMyProg, translated to uppercase, or THIS. *IDNumber* is 111. The four package names are:

```
THIS1111
THIS1112
THIS1113
THIS1114
```

Example: Suppose that a profile name is ThisIsMyProg_SJProfile111.ser. The db2sqljcustomize option -longpkgname is specified. Therefore, *Bytes-from-program-name* is ThisIsMyProg, translated to uppercase, or THISISMYPROG. *IDNumber* is 111. The four package names are:

```
THISISMYPROG1111
THISISMYPROG1112
THISISMYPROG1113
THISISMYPROG1114
```

Example: Suppose that a profile name is A_SJProfile0.ser. *Bytes-from-program-name* is A. *IDNumber* is 0. Therefore, the four package names are:

```
A01
A02
A03
A04
```

Letting `db2sqljcustomize` generate package names is not recommended. If any generated package names are the same as the names of existing packages, `db2sqljcustomize` overwrites the existing packages. To ensure uniqueness of package names, specify -rootpkgname.

-longpkgname
Specifies that the names of the DB2 packages that db2sqljcustomize generates can be up to 128 bytes. Use this option only if you are binding packages at a server that supports long package names. If you specify -singlepkgname or -rootpkgname, you must also specify -longpkgname under the following conditions:

- The argument of -singlepkgname is longer than eight bytes.
- The argument of -rootpkgname is longer than seven bytes.

-staticpositioned NO|YES
For iterators that are declared in the same source file as positioned UPDATE statements that use the iterators, specifies whether the positioned UPDATEs are executed as statically bound statements. The default is NO. NO means that the positioned UPDATEs are executed as dynamically prepared statements.

-zosDescProcParms
Specifies that DB2 for z/OS performs a DESCRIBE operation on stored procedure parameters.

-zosDescProcParms applies to programs that are to be run on DB2 for z/OS database servers only.

If DESCRIBE information is available, SQLJ has information about the length and precision of INOUT and OUT parameters, so it allocates only the amount of memory that is needed for those parameters. Availability of DESCRIBE information can have the biggest impact on storage usage for character INOUT parameters, LOB OUT parameters, and decimal OUT parameters.

When -zosDescProcParms is specified, the DB2 database server uses the specified or default value of -zosProcedurePath to resolve unqualified names of stored procedures for which DESCRIBE information is requested.

-zosProcedurePath *procedure-path*
Specifies a list of schema names that DB2 for z/OS uses to resolve unqualified stored procedure names during online checking of an SQLJ program.

-zosProcedurePath applies to programs that are to be run on DB2 for z/OS database servers only.

The list is a String value that is a comma-separated list of schema names that is enclosed in double quotation marks. The DB2 database server inserts that list into the SQL path for resolution of unqualified stored procedure names. The SQL path is:

`SYSIBM, SYSFUN, SYSPROC, procedure-path, qualifier-name, user-ID`

qualifier-name is the value of the -qualifier parameter, and *user-ID* is the value of the -user parameter.

The DB2 database server tries the schema names in the SQL path from left to right until it finds a match with the name of a stored procedure that exists on that database server. If the DB2 database server finds a match, it obtains the information about the parameters for that stored procedure from the DB2 catalog. If the DB2 database server does not find a match, SQLJ sets the parameter data without any DB2 catalog information.

If -zosProcedurePath is not specified, the DB2 database server uses this SQL path:

```
SYSIBM, SYSFUN, SYSPROC, qualifier-name, user-ID
```

If the -qualifier parameter is not specified, the SQL path does not include *qualifier-name*.

-genDBRM
Specifies that db2sqljcustomize generates database request modules (DBRMs). Those DBRMs can be used to create DB2 for z/OS plans and packages.

-genDBRM applies to programs that are to be run on DB2 for z/OS database servers only.

If -genDBRM and -automaticbind NO are specified, db2sqljcustomize creates the DBRMs but does not bind them into DB2 packages. If -genDBRM and -automaticbind YES are specified, db2sqljcustomize creates the DBRMs and binds them into DB2 packages.

One DBRM is created for each DB2 isolation level. The naming convention for the generated DBRM files is the same as the naming convention for packages. For example, if -rootpkgname SQLJSA0 is specified, and -genDBRM is also specified, the names of the four DBRM files are:
- SQLJSA01
- SQLJSA02
- SQLJSA03
- SQLJSA04

-DBRMDir *directory-name*
When -genDBRM is specified, -DBRMDir specifies the local directory into which db2sqljcustomize puts the generated DBRM files. The default is the current directory.

-DBRMdir applies to programs that are to be run on DB2 for z/OS database servers only.

-tracefile *file-name*
Enables tracing and identifies the output file for trace information. This option should be specified only under the direction of IBM Software Support.

-tracelevel
If -tracefile is specified, indicates what to trace while `db2sqljcustomize` runs. The default is TRACE_SQLJ. This option should be specified only under the direction of IBM Software Support.

serialized-profile-name | *file-name*.**grp**
Specifies the names of one or more serialized profiles that are to be customized. The specified serialized profile must be in a directory that is named in the CLASSPATH environment variable.

A serialized profile name is of the following form:

*program-name*_SJProfile*IDNumber*.ser

You can specify the serialized profile name with or without the .ser extension.

program-name is the name of the SQLJ source program, without the extension .sqlj. *n* is an integer between 0 and *m-1*, where *m* is the number of serialized profiles that the SQLJ translator generated from the SQLJ source program.

You can specify serialized profile names in one of the following ways:

- List the names in the db2sqljcustomize command. Multiple serialized profile names must be separated by spaces.
- Specify the serialized profile names, one on each line, in a file with the name *file-name*.grp, and specify *file-name*.grp in the db2sqljcustomize command.

If you specify more than one serialized profile name, and if you specify or use the default value of -automaticbind YES, db2sqljcustomize binds a single DB2 package from the profiles. When you use db2sqljcustomize to create a single DB2 package from multiple serialized profiles, you must also specify the -rootpkgname or -singlepkgname option.

If you specify more than one serialized profile name, and you specify -automaticbind NO, if you want to bind the serialized profiles into a single DB2 package when you run db2sqljbind, you need to specify the same list of serialized profile names, in the same order, in db2sqljcustomize and db2sqljbind.

Output

When `db2sqljcustomize` runs, it creates a customized serialized profile. It also creates DB2 packages, if the automaticbind value is YES.

Examples

```
db2sqljcustomize -user richler -password mordecai
  -url jdbc:db2:/server:50000/sample -collection duddy
  -bindoptions "EXPLAIN YES" pgmname_SJProfile0.ser
```

Usage notes

Online checking is always recommended: It is highly recommended that you use online checking when you customize your serialized profiles. Online checking determines information about the data types and lengths of DB2 host variables, and is especially important for the following items:

- Predicates with java.lang.String host variables and CHAR columns

  Unlike character variables in other host languages, Java String host variables are not declared with a length attribute. To optimize a query properly that contains character host variables, DB2 needs the length of the host variables. For example, suppose that a query has a predicate in which a String host variable is compared to a CHAR column, and an index is defined on the CHAR column. If DB2 cannot determine the length of the host variable, it might do a table space scan instead of an index scan. Online checking avoids this problem by providing the lengths of the corresponding character columns.
- Predicates with java.lang.String host variables and GRAPHIC columns

  Without online checking, DB2 might issue a bind error (SQLCODE -134) when it encounters a predicate in which a String host variable is compared to a GRAPHIC column.

- Column names in the result table of an SQLJ SELECT statement at a remote server:

  Without online checking, the driver cannot determine the column names for the result table of a remote SELECT.

Customizing multiple serialized profiles together: Multiple serialized profiles can be customized together to create a single DB2 package. If you do this, and if you specify -staticpostioned YES, any positioned UPDATE or DELETE statement that references a cursor that is declared *earlier in the package* executes statically, even if the UPDATE or DELETE statement is in a different source file from the cursor declaration. If you want -staticpositioned YES behavior when your program consists of multiple source files, you need to order the profiles in the db2sqljcustomize command to cause cursor declarations to be ahead of positioned UPDATE or DELETE statements in the package. To do that, list profiles that contain SELECT statements that assign result tables to iterators *before* profiles that contain the positioned UPDATE or DELETE statements that reference those iterators.

Using a customized serialized profile at one data source that was customized at another data source: You can run `db2sqljcustomize` to produce a customized serialized profile for an SQLJ program at one data source, and then use that profile at another data source. You do this by running `db2sqljbind` multiple times on customized serialized profiles that you created by running `db2sqljcustomize` once. When you run the programs at these data sources, the DB2 objects that the programs access must be identical at every data source. For example, tables at all data sources must have the same encoding schemes and the same columns with the same data types.

Using the -collection parameter: `db2sqljcustomize` stores the DB2 collection name in each customized serialized profile that it produces. When an SQLJ program is executed, the driver uses the collection name that is stored in the customized serialized profile to search for packages to execute. The name that is stored in the customized serialized profile is determined by the value of the -collection parameter. Only one collection ID can be stored in the serialized profile. However, you can bind the same serialized profile into multiple package collections by specifying the COLLECTION option in the -bindoptions parameter. To execute a package that is in a collection other than the collection that is specified in the serialized profile, include a SET CURRENT PACKAGESET statement in the program.

Using the VERSION parameter: Use the VERSION parameter to bind two or more versions of a package for the same SQLJ program into the same collection. You might do this if you have changed an SQLJ source program, and you want to run the old and new versions of the program.

To maintain two versions of a package, follow these steps:

1. Change the code in your source program.
2. Translate the source program to create a new serialized profile. Ensure that you do not overwrite your original serialized profile.
3. Run `db2sqljcustomize` to customize the serialized profile and create DB2 packages with the same package names and in the same collection as the original packages. Do this by using the same values for -rootpkgname and -collection when you bind the new packages that you used when you created

the original packages. Specify the VERSION option in the -bindoptions parameter to put a version ID in the new customized serialized profile and in the new packages.

It is essential that you specify the VERSION option when you perfom this step. If you do not, you overwrite your original packages.

When you run the old version of the program, DB2 loads the old versions of the packages. When you run the new version of the program, DB2 loads the new versions of the packages.

Binding packages and plans on DB2 for z/OS: You can use the db2sqljcustomize -genDBRM parameter to create DBRMs on your local system. You can then transfer those DBRMs to a DB2 for z/OS system, and bind them into packages or plans there. If you plan to use this technique, you need to transfer the DBRM files to the z/OS system as **binary** files, to a partitioned data set with record format FB and record length 80. When you bind the packages or plans, you need to specify the following bind option values:

ENCODING(EBCDIC)
The IBM Data Server Driver for JDBC and SQLJ on DB2 for z/OS requires EBCDIC encoding for your packages and plans.

DYNAMICRULES(BIND)
This option ensures consistent authorization rules when SQLJ uses dynamic SQL. SQLJ uses dynamic SQL for positioned UPDATE or DELETE operations that involve multiple SQLJ programs.

DBPROTOCOL(DRDA)
Private protocol is deprecated, so you should use DBPROTOCOL(DRDA) for all applications. However, for SQLJ applications that use remote three-part table names, you must use DBPROTOCOL(DRDA). Otherwise, those applications might fail.

db2sqljbind - SQLJ profile binder

db2sqljbind binds DB2 packages for a serialized profile that was previously customized with the db2sqljcustomize command.

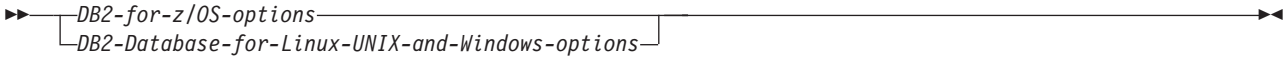
Authorization

The privilege set of the process must include one of the following authorities:
- SYSADM authority
- DBADM authority
- If the package does not exist, the BINDADD privilege, and one of the following privileges:
  - CREATEIN privilege
  - IMPLICIT_SCHEMA authority on the database if the schema name of the package does not exist
- If the package exists:
  - ALTERIN privilege on the schema
  - BIND privilege on the package

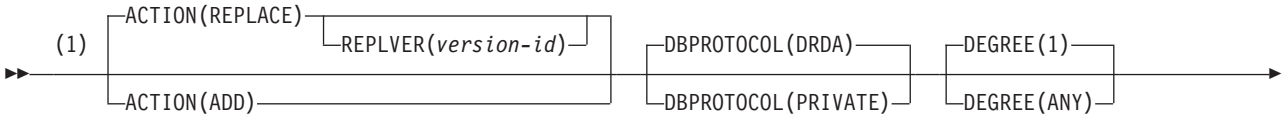
The user also needs all privileges that are required to compile any static SQL statements in the application. Privileges that are granted to groups are not used for authorization checking of static statements. If the user has SYSADM authority, but no explicit privileges to complete the bind, the DB2 database manager grants explicit DBADM authority automatically.

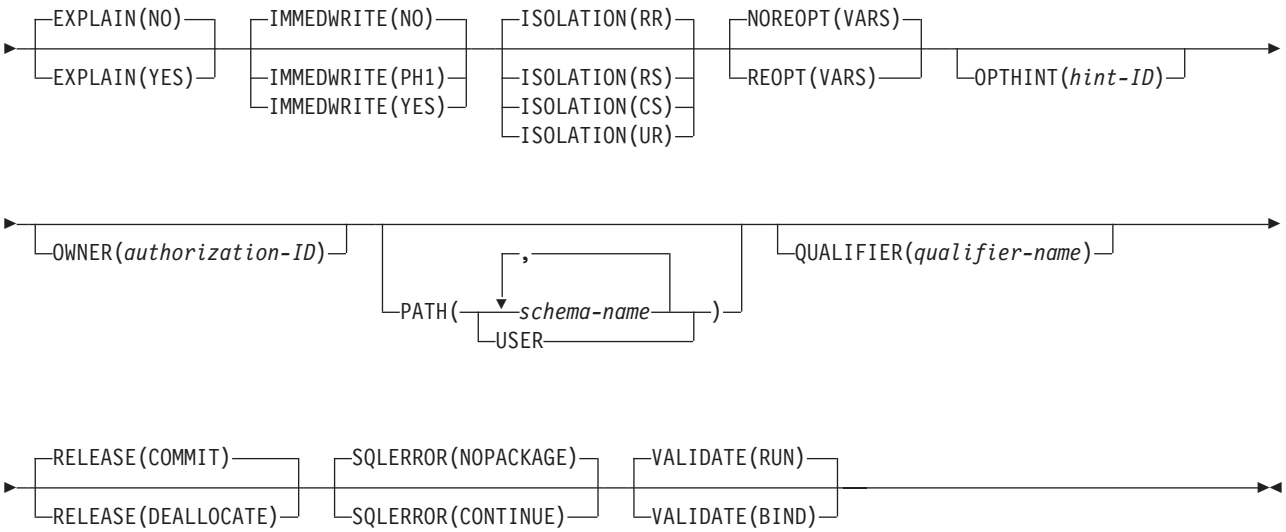
Command syntax

options-string:



DB2 for z/OS options:

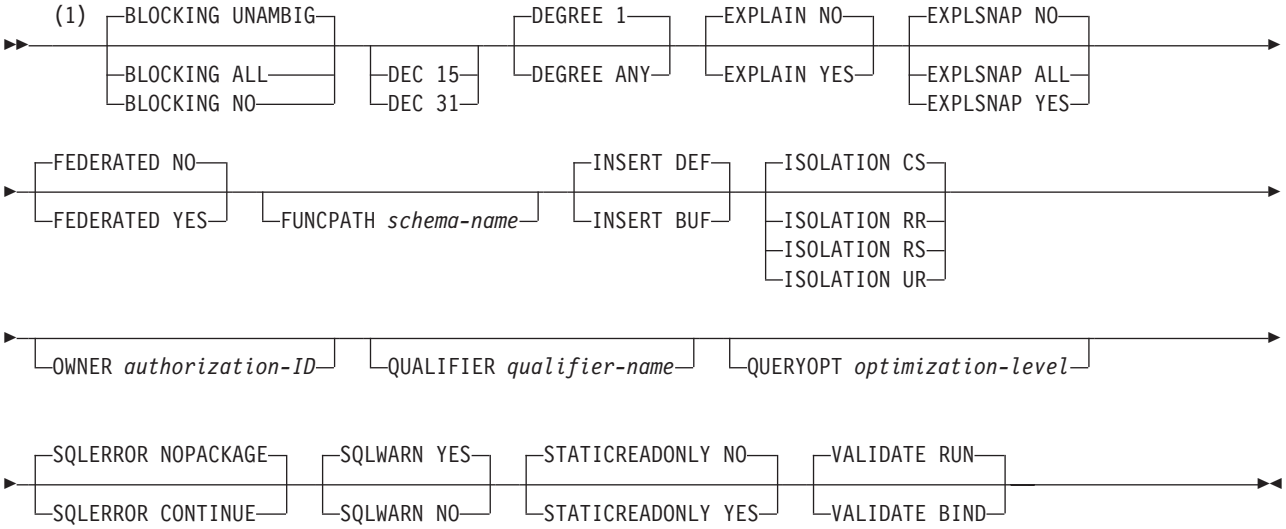




Notes:

1 These options can be specified in any order.

DB2 Database for Linux, UNIX, and Windows options



Notes:

1 These options can be specified in any order.

Command parameters

-help
Specifies that `db2sqljbind` describes each of the options that it supports. If any other options are specified with -help, they are ignored.

-url
Specifies the URL for the data source for which the profile is to be customized. A connection is established to the data source that this URL represents if the -automaticbind or -onlinecheck option is specified as YES or defaults to YES. The variable parts of the `-url` value are:

server
The domain name or IP address of the operating system on which the database server resides.

port
The TCP/IP server port number that is assigned to the database server. The default is 446.

database
A name for the database server for which the profile is to be customized.

If the connection is to a DB2 for z/OS server, *database* is the DB2 location name that is defined during installation. All characters in this value must be uppercase characters. You can determine the location name by executing the following SQL statement on the server:

```
SELECT CURRENT SERVER FROM SYSIBM.SYSDUMMY1;
```

If the connection is to a DB2 Database for Linux, UNIX, and Windows server, *database* is the database name that is defined during installation.

If the connection is to an IBM Cloudscape server, the *database* is the fully-qualified name of the file that contains the database. This name must be enclosed in double quotation marks (″). For example:

```
"c:/databases/testdb"
```

property=value;
A property for the JDBC connection.

-user *user-ID*
Specifies the user ID to be used to connect to the data source for binding the package.

-password *password*
Specifies the password to be used to connect to the data source for binding the package.

-bindoptions *options-string*
Specifies a list of options, separated by spaces. These options have the same function as DB2 precompile and bind options with the same names. If you are preparing your program to run on a DB2 for z/OS system, specify DB2 for z/OS options. If you are preparing your program to run on a DB2 Database for Linux, UNIX, and Windows system, specify DB2 Database for Linux, UNIX, and Windows options.

Notes on bind options:

- Specify VERSION only if the following conditions are true:
  - If you are binding a package at a DB2 Database for Linux, UNIX, and Windows system, the system is at Version 8 or later.
  - You rerun the translator on a program before you bind the associated package with a new VERSION value.
- The value for STATICREADONLY is YES for servers that support STATICREADONLY, and NO for other servers. When you specify STATICREADONLY YES, DB2 processes ambiguous cursors as if they were read-only cursors. For troubleshooting iterator declaration errors, you need to explicitly specify STATICREADONLY NO, or declare iterators so that they are unambiguous. For example, if you want an iterator to be unambiguously updatable, declare the iterator to implement sqlj.runtime.ForUpdate. If you want an iterator to be read-only, include the FOR READ ONLY clause in SELECT statements that use the iterator.

Important: Specify only those program preparation options that are appropriate for the data source at which you are binding a package. Some values and defaults for the IBM Data Server Driver for JDBC and SQLJ are different from the values and defaults for DB2.

-staticpositioned NO | YES
For iterators that are declared in the same source file as positioned UPDATE statements that use the iterators, specifies whether the positioned UPDATEs are executed as statically bound statements. The default is NO. NO means that the positioned UPDATEs are executed as dynamically prepared statements. This value must be the same as the -staticpositioned value for the previous db2sqljcustomize invocation for the serialized profile.

-genDBRM
Specifies that db2sqljbind generates database request modules (DBRMs) from the serialized profile, and that db2sqljbind does not perform remote bind operations.

-genDBRM applies to programs that are to be run on DB2 for z/OS database servers only.

-DBRMDir *directory-name*
When -genDBRM is specified, -DBRMDir specifies the local directory into which db2sqljbind puts the generated DBRM files. The default is the current directory.

-DBRMdir applies to programs that are to be run on DB2 for z/OS database servers only.

-tracefile *file-name*
Enables tracing and identifies the output file for trace information. This option should be specified only under the direction of IBM Software Support.

-tracelevel
If -tracefile is specified, indicates what to trace while `db2sqljcustomize` runs. The default is TRACE_SQLJ. This option should be specified only under the direction of IBM Software Support.

serialized-profile-name
Specifies the name of one or more serialized profiles from which the package is bound. A serialized profile name is of the following form:

*program-name*_SJProfile*IDNumber*.ser

program-name is the name of the SQLJ source program, without the extension .sqlj. *n* is an integer between 0 and *m-1*, where *m* is the number of serialized profiles that the SQLJ translator generated from the SQLJ source program.

If you specify more than one serialized profile name to bind a single DB2 package from several serialized profiles, you must have specified the same serialized profile names, in the same order, when you ran db2sqljcustomize.

Examples

```
db2sqljbind -user richler -password mordecai
  -url jdbc:db2://server:50000/sample -bindoptions "EXPLAIN YES"
  pgmname_SJProfile0.ser
```

Usage notes

Package names produced by db2sqljbind: The names of the packages that are created by `db2sqljbind` are the names that you specified using the-rootpkgname or

-singlepkgname parameter when you ran db2sqljcustomize. If you did not specify -rootpkgname or -singlepkgname, the package names are the first seven bytes of the profile name, appended with the isolation level character.

DYNAMICRULES value for db2sqljbind: The DYNAMICRULES bind option determines a number of run-time attributes for the DB2 package. Two of those attributes are the authorization ID that is used to check authorization, and the qualifier that is used for unqualified objects. To ensure the correct authorization for dynamically executed positioned UPDATE and DELETE statements in SQLJ programs, db2sqljbind always binds the DB2 packages with the DYNAMICRULES(BIND) option. You cannot modify this option. The DYNAMICRULES(BIND) option causes the SET CURRENT SQLID statement and the SET CURRENT SCHEMA statement to have no impact on an SQLJ program, because those statements affect only dynamic statements that are bound with DYNAMICRULES values other than BIND.

With DYNAMICRULES(BIND), unqualified table, view, index, and alias names in dynamic SQL statements are implicitly qualified with value of the bind option QUALIFIER. If you do not specify QUALIFIER, DB2 uses the authorization ID of the package owner as the implicit qualifier. If this behavior is not suitable for your program, you can use one of the following techniques to set the correct qualifier:

- Force positioned UDPATE and DELETE statements to execute statically. You can use the -staticpositioned YES option of db2sqljcustomize or db2sqljbind to do this if the cursor (iterator) for a positioned UPDATE or DELETE statement is in the same package as the positioned UPDATE or DELETE statement.
- Fully qualify DB2 table names in positioned UPDATE and positioned DELETE statements.

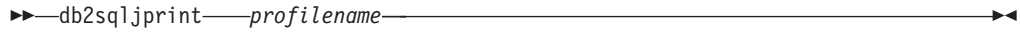
db2sqljprint - SQLJ profile printer

db2sqljprint prints the contents of the customized version of a profile as plain text.

Authorization

None

Command syntax



Command parameters

profilename

Specifies the relative or absolute name of an SQLJ profile file. When an SQLJ file is translated into a Java source file, information about the SQL operations it contains is stored in SQLJ-generated resource files called profiles. Profiles are identified by the suffix _SJProfileN (where N is an integer) following the name of the original input file. They have a .ser extension. Profile names can be specified with or without the .ser extension.

Examples

```
db2sqljprint pgmname_SJProfile0.ser
```

Appendix A. Overview of the DB2 technical information

DB2 technical information is available through the following tools and methods:

- DB2 Information Center
  - Topics (Task, concept and reference topics)
  - Help for DB2 tools
  - Sample programs
  - Tutorials
- DB2 books
  - PDF files (downloadable)
  - PDF files (from the DB2 PDF DVD)
  - printed books
- Command line help
  - Command help
  - Message help

Note: The DB2 Information Center topics are updated more frequently than either the PDF or the hard-copy books. To get the most current information, install the documentation updates as they become available, or refer to the DB2 Information Center at ibm.com®.

You can access additional DB2 technical information such as technotes, white papers, and IBM Redbooks® publications online at ibm.com. Access the DB2 Information Management software library site at http://www.ibm.com/software/data/sw-library/.

Documentation feedback

We value your feedback on the DB2 documentation. If you have suggestions for how to improve the DB2 documentation, send an email to db2docs@ca.ibm.com. The DB2 documentation team reads all of your feedback, but cannot respond to you directly. Provide specific examples wherever possible so that we can better understand your concerns. If you are providing feedback on a specific topic or help file, include the topic title and URL.

Do not use this email address to contact DB2 Customer Support. If you have a DB2 technical issue that the documentation does not resolve, contact your local IBM service center for assistance.

DB2 technical library in hardcopy or PDF format

The following tables describe the DB2 library available from the IBM Publications Center at www.ibm.com/shop/publications/order. English DB2 Version 9.5 manuals in PDF format and translated versions can be downloaded from www.ibm.com/support/docview.wss?rs=71&uid=swg2700947.

Although the tables identify books available in print, the books might not be available in your country or region.

Table 96. DB2 technical information

Name	Form Number	Available in print
Administrative API Reference	SC23-5842-00	Yes
Administrative Routines and Views	SC23-5843-00	No
Call Level Interface Guide and Reference, Volume 1	SC23-5844-00	Yes
Call Level Interface Guide and Reference, Volume 2	SC23-5845-00	Yes
Command Reference	SC23-5846-00	Yes
Data Movement Utilities Guide and Reference	SC23-5847-00	Yes
Data Recovery and High Availability Guide and Reference	SC23-5848-00	Yes
Data Servers, Databases, and Database Objects Guide	SC23-5849-00	Yes
Database Security Guide	SC23-5850-00	Yes
Developing ADO.NET and OLE DB Applications	SC23-5851-00	Yes
Developing Embedded SQL Applications	SC23-5852-00	Yes
Developing Java Applications	SC23-5853-00	Yes
Developing Perl and PHP Applications	SC23-5854-00	No
Developing User-defined Routines (SQL and External)	SC23-5855-00	Yes
Getting Started with Database Application Development	GC23-5856-00	Yes
Getting Started with DB2 installation and administration on Linux and Windows	GC23-5857-00	Yes
Internationalization Guide	SC23-5858-00	Yes
Message Reference, Volume 1	GI11-7855-00	No
Message Reference, Volume 2	GI11-7856-00	No
Migration Guide	GC23-5859-00	Yes
Net Search Extender Administration and User's Guide **Note:** The content of this document is not included in the DB2 Information Center	SC23-8509-00	Yes
Partitioning and Clustering Guide	SC23-5860-00	Yes
Query Patroller Administration and User's Guide	SC23-8507-00	Yes
Quick Beginnings for IBM Data Server Clients	GC23-5863-00	No
Quick Beginnings for DB2 Servers	GC23-5864-00	Yes

Table 96. DB2 technical information (continued)

Name	Form Number	Available in print
Spatial Extender and Geodetic Data Management Feature User's Guide and Reference	SC23-8508-00	Yes
SQL Reference, Volume 1	SC23-5861-00	Yes
SQL Reference, Volume 2	SC23-5862-00	Yes
System Monitor Guide and Reference	SC23-5865-00	Yes
Text Search Guide	SC23-5866-00	Yes
Troubleshooting Guide	GI11-7857-00	No
Tuning Database Performance	SC23-5867-00	Yes
Visual Explain Tutorial	SC23-5868-00	No
What's New	SC23-5869-00	Yes
Workload Manager Guide and Reference	SC23-5870-00	Yes
pureXML Guide	SC23-5871-00	Yes
XQuery Reference	SC23-5872-00	No

Table 97. DB2 Connect-specific technical information

Name	Form Number	Available in print
Quick Beginnings for DB2 Connect Personal Edition	GC23-5839-00	Yes
Quick Beginnings for DB2 Connect Servers	GC23-5840-00	Yes
DB2 Connect User's Guide	SC23-5841-00	Yes

Table 98. Information Integration technical information

Name	Form Number	Available in print
Information Integration: Administration Guide for Federated Systems	SC19-1020-01	Yes
Information Integration: ASNCLP Program Reference for Replication and Event Publishing	SC19-1018-02	Yes
Information Integration: Configuration Guide for Federated Data Sources	SC19-1034-01	No
Information Integration: SQL Replication Guide and Reference	SC19-1030-01	Yes
Information Integration: Introduction to Replication and Event Publishing	SC19-1028-01	Yes

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Note: The most up-to-date and complete DB2 documentation is maintained in the DB2 Information Center at http://publib.boulder.ibm.com/infocenter/db2luw/v9r5.

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  3. Provide your representative with the titles and form numbers of the books that you want to order. For titles and form numbers, see "DB2 technical library in hardcopy or PDF format" on page 407.

Displaying SQL state help from the command line processor

DB2 returns an SQLSTATE value for conditions that could be the result of an SQL statement. SQLSTATE help explains the meanings of SQL states and SQL state class codes.

To invoke SQL state help, open the command line processor and enter:

```
? sqlstate or ? class code
```

where *sqlstate* represents a valid five-digit SQL state and *class code* represents the first two digits of the SQL state.

For example, `? 08003` displays help for the 08003 SQL state, and `? 08` displays help for the 08 class code.

Accessing different versions of the DB2 Information Center

For DB2 Version 9.5 topics, the DB2 Information Center URL is http://publib.boulder.ibm.com/infocenter/db2luw/v9r5/

For DB2 Version 9 topics, the DB2 Information Center URL is http://publib.boulder.ibm.com/infocenter/db2luw/v9/

For DB2 Version 8 topics, go to the Version 8 Information Center URL at: http://publib.boulder.ibm.com/infocenter/db2luw/v8/

Displaying topics in your preferred language in the DB2 Information Center

The DB2 Information Center attempts to display topics in the language specified in your browser preferences. If a topic has not been translated into your preferred language, the DB2 Information Center displays the topic in English.

- To display topics in your preferred language in the Internet Explorer browser:
  1. In Internet Explorer, click the **Tools** —> **Internet Options** —> **Languages...** button. The Language Preferences window opens.
  2. Ensure your preferred language is specified as the first entry in the list of languages.
     - To add a new language to the list, click the **Add...** button.

       Note: Adding a language does not guarantee that the computer has the fonts required to display the topics in the preferred language.
     - To move a language to the top of the list, select the language and click the **Move Up** button until the language is first in the list of languages.
  3. Clear the browser cache and then refresh the page to display the DB2 Information Center in your preferred language.
- To display topics in your preferred language in a Firefox or Mozilla browser:
  1. Select the button in the **Languages** section of the **Tools** —> **Options** —> **Advanced** dialog. The Languages panel is displayed in the Preferences window.
  2. Ensure your preferred language is specified as the first entry in the list of languages.
     - To add a new language to the list, click the **Add...** button to select a language from the Add Languages window.
     - To move a language to the top of the list, select the language and click the **Move Up** button until the language is first in the list of languages.
  3. Clear the browser cache and then refresh the page to display the DB2 Information Center in your preferred language.

On some browser and operating system combinations, you might have to also change the regional settings of your operating system to the locale and language of your choice.

Updating the DB2 Information Center installed on your computer or intranet server

If you have installed the DB2 Information Center locally, you can download and install updates that IBM might make available.

Updating your locally-installed DB2 Information Center requires that you:

1. Stop the DB2 Information Center on your computer, and restart the Information Center in stand-alone mode. Running the Information Center in stand-alone mode prevents other users on your network from accessing the Information Center, and allows you to download and apply updates.
2. Use the Update feature to see what updates are available. If there are updates that you would like to install, you can use the Update feature to download and install them

   Note: If your environment requires installing the DB2 Information Center updates on a machine that is not connected to the internet, you have to mirror the update site to a local file system using a machine that is connected to the internet and has the DB2 Information Center installed. If many users on your network will be installing the documentation updates, you can reduce the time required for individuals to perform the updates by also mirroring the update site locally and creating a proxy for the update site.
   If update packages are available, use the Update feature to download the packages. However, the Update feature is only available in stand-alone mode.
3. Stop the stand-alone Information Center, and restart the DB2 Information Center on your computer.

Note: On Windows Vista, the commands listed below must be run as an administrator. To launch a command prompt or graphical tool with full administrator privileges, right-click on the shortcut and then select **Run as administrator**.

To update the DB2 Information Center installed on your computer or intranet server:

1. Stop the DB2 Information Center.
   - On Windows, click **Start → Control Panel → Administrative Tools → Services**. Then right-click on **DB2 Information Center** service and select **Stop**.
   - On Linux, enter the following command:
     ```
     /etc/init.d/db2icdv95 stop
     ```
2. Start the Information Center in stand-alone mode.
   - On Windows:
     a. Open a command window.
     b. Navigate to the path where the Information Center is installed. By default, the DB2 Information Center is installed in the <Program Files>\IBM\DB2 Information Center\Version 9.5 directory, where <Program Files> represents the location of the Program Files directory.
     c. Navigate from the installation directory to the doc\bin directory.
     d. Run the help_start.bat file:
        ```
        help_start.bat
        ```
   - On Linux:

a. Navigate to the path where the Information Center is installed. By default, the DB2 Information Center is installed in the /opt/ibm/db2ic/V9.5 directory.
b. Navigate from the installation directory to the doc/bin directory.
c. Run the help_start script:

```
help_start
```

The systems default Web browser launches to display the stand-alone Information Center.

3. Click the Update button (). On the right hand panel of the Information Center, click Find Updates. A list of updates for existing documentation displays.
4. To initiate the download process, check the selections you want to download, then click Install Updates.
5. After the download and installation process has completed, click Finish.
6. Stop the stand-alone Information Center.
   - On Windows, navigate to the installation directory's doc\bin directory, and run the help_end.bat file:

     ```
     help_end.bat
     ```

     Note: The help_end batch file contains the commands required to safely terminate the processes that were started with the help_start batch file. Do not use `Ctrl-C` or any other method to terminate help_start.bat.
   - On Linux, navigate to the installation directory's doc/bin directory, and run the help_end script:

     ```
     help_end
     ```

     Note: The help_end script contains the commands required to safely terminate the processes that were started with the help_start script. Do not use any other method to terminate the help_start script.
7. Restart the DB2 Information Center.
   - On Windows, click **Start → Control Panel → Administrative Tools → Services**. Then right-click on **DB2 Information Center** service and select **Start**.
   - On Linux, enter the following command:

     ```
     /etc/init.d/db2icdv95 start
     ```

The updated DB2 Information Center displays the new and updated topics.

DB2 tutorials

The DB2 tutorials help you learn about various aspects of DB2 products. Lessons provide step-by-step instructions.

Before you begin

You can view the XHTML version of the tutorial from the Information Center at http://publib.boulder.ibm.com/infocenter/db2help/.

Some lessons use sample data or code. See the tutorial for a description of any prerequisites for its specific tasks.

DB2 tutorials

To view the tutorial, click on the title.

"pureXML™" in *pureXML Guide*
Set up a DB2 database to store XML data and to perform basic operations with the native XML data store.

"Visual Explain" in *Visual Explain Tutorial*
Analyze, optimize, and tune SQL statements for better performance using Visual Explain.

DB2 troubleshooting information

A wide variety of troubleshooting and problem determination information is available to assist you in using DB2 products.

DB2 documentation
Troubleshooting information can be found in the DB2 Troubleshooting Guide or the Support and Troubleshooting section of the DB2 Information Center. There you will find information on how to isolate and identify problems using DB2 diagnostic tools and utilities, solutions to some of the most common problems, and other advice on how to solve problems you might encounter with your DB2 products.

DB2 Technical Support Web site
Refer to the DB2 Technical Support Web site if you are experiencing problems and want help finding possible causes and solutions. The Technical Support site has links to the latest DB2 publications, TechNotes, Authorized Program Analysis Reports (APARs or bug fixes), fix packs, and other resources. You can search through this knowledge base to find possible solutions to your problems.

Access the DB2 Technical Support Web site at http://www.ibm.com/software/data/db2/udb/support.html

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