Introduction to JDBC

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SWE 642
Software Engineering for the World Wide Web

sources: ***Java for the Web with Servlets, JSP and EJB*****, Kurniawan, New Riders**
Professional Java Server Programming**, Patzer, Wrox**

JDBC

- JDBC API allows Java programs to connect to DBs
- Provides cross-vendor connectivity and data access across relational databases from different vendors
- Classes and interfaces allow users to access the database in a standard way
- The JVM uses the JDBC driver to translate generalized JDBC calls into vendor specific database calls

JDBC=Java Data Base Connectivity ?

- Most people believe that JDBC stands for ***J**ava **D**ata **B**ase **C**onnectivity*
- But not quite—it used to be, but now is a trademarked name
- Excerpt :
  - *"JDBC (TM) is a Java (TM) API for executing SQL statements. (As a point of interest, JDBC is a trademarked name and is not an acronym; nevertheless, JDBC is often thought of as standing for `Java Database Connectivity'.) "*

JDBC Drivers

1. JDBC-ODBC bridge
2. Part Java, Part Native Driver
3. Intermediate DAccess Server
4. Pure Java Drivers

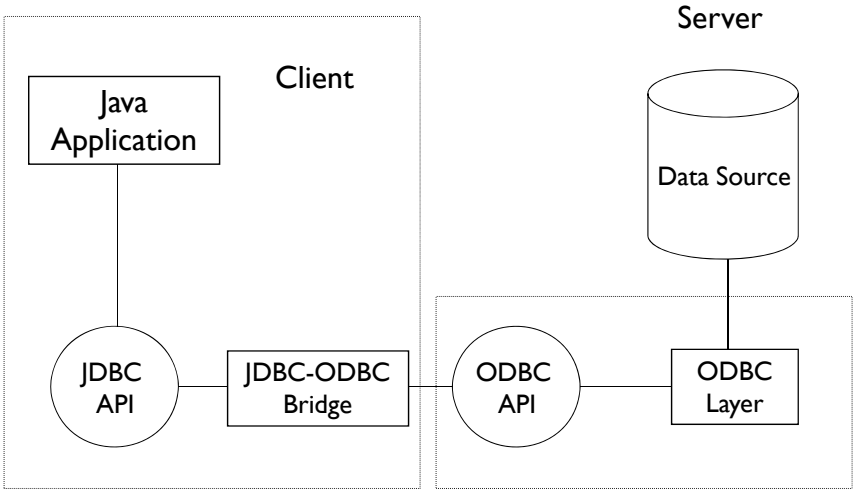
1. JDBC-ODBC Bridge

- ODBC (***O***pen ***D***ata***B***ase ***C***onnectivity)

  A set of APIs for database access

  Originally only for windows platforms, later extended to non-windows platforms
- Originally C interfaces
- Hard to learn
- The standard JDK includes classes for the JDBC-ODBC bridge (sun.jdbc.odbc.JdbcOdbcDriver)
- There is no need for additional installation, apart from having to configure the ODBC driver by creating data source names

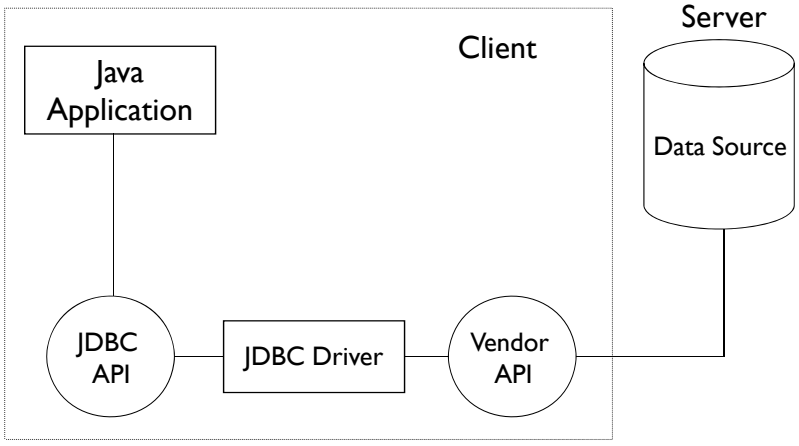
1. JDBC-ODBC Bridge (2)



2. Part Java, Part Native Driver

- A mixture of Java implementation and vendor-specific native APIs for data access
- This is similar to type 1 except that these have one less layer to go through and so is faster
- The native JDBC driver (part Java, part native code) must be installed on each client along with the vendor-specific native language API

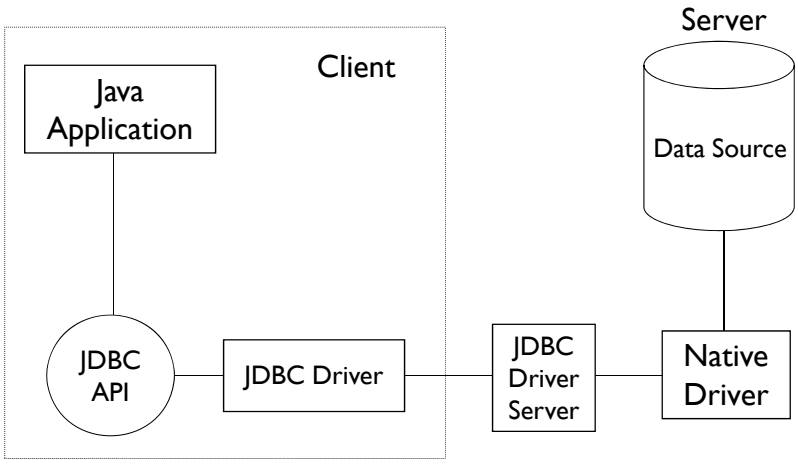
2. Part Java, Part Native Driver (2)



3. Intermediate Database Access Server

- Based on intermediate (middleware) database servers
- Connect to various database servers via an intermediate server that acts like a gateway for multiple database servers
- The intermediate server can abstract details to connections to database servers

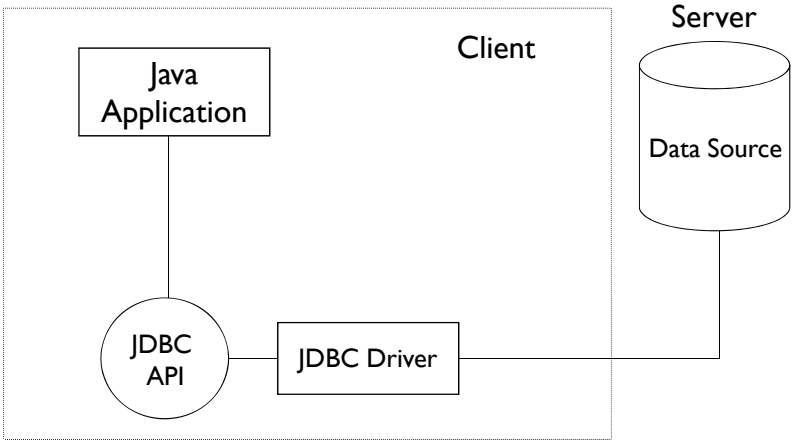
3. Intermediate Database Access Server (2)



4. Pure Java Driver

- Convert the JDBC API calls to direct network calls
  - Using vendor-specific networking protocols
  - Making direct socket connections with the database
- It is the most efficient method to access database, both in performance and development time
- It is the simplest to deploy
- All major database vendors provide Type 4 JDBC drivers for their databases
  - Also available from third party vendors
- A list of JDBC drivers:
  - http://www.java2s.com/Tutorial/Java/0340__Database/AListofJDBCDriversconnectionstringdrivername.htm

4. Pure Java Driver (2)



Typical JDBC Programming Procedure

1. Load the database driver
2. Obtain a connection
3. Create and execute statements
4. Use result sets to navigate through the results
5. Close the connection

Driver Manager

- The purpose of the java.sql.DriverManger class in JDBC is to provide a common access layer on top of different database drivers used in an application
- DriverManager requires that each driver required by the application must be registered before use
- Load the database driver using ClassLoader :
  - Class.forName ("oracle.jdbc.driver.OracleDriver");

Connecting to a Database

- Type 4 JDBC Driver
  - Oracle Server

```
Class.forName ("oracle.jdbc.driver.OracleDriver");
con = DriverManager.getConnection (
    "jdbc:oracle:thin:@apollo.vse.gmu.edu:1521:ite10g",
     "your_username", "your_oracle_password");
```

  - "your_username" is the same as your Mason ID
  - "your_oracle_password" is created when you activate your Oracle account at https://access.vse.gmu.edu/

  - MySQL Server

```
Class.forName ("org.gjt.mm.mysql.Driver");
con = DriverManager.getConnection
   ("jdbc:mysql://localhost/databasename", uid, passwd);
```


Creating and Executing SQL Statements

- Statement object
  - Statement statement = con.createStatement();
  - statement.executeUpdate ("CREATE TABLE STUDENT");
  - statement.executeQuery ("SELECT * FROM STUDENT");

SQL Statements

- Create Tables

  CREATE TABLE table (field type [(size)] [NOT NULL] [index1], …, [CONSTRAINT multifieldindex …)

- Create Index

  Create [UNIQUE] INDEX index ON table (field [ASC|DESC],….) [WITTH {PRIMARY|DISALLOW NULL|IGNORE NULL}]

- Drop

  Drop TABLE table

  Drop INDEX index ON table

SQL Statements (2)

- Alter Table

  ALTER TABLE table {ADD {COLUMN field type…} | DROP {COLUMN field|CONSTRAINT indexname}}

- DELETE

  DELETE FROM table WHERE criteria

- Insert

  INSERT INTO target [(field1, …)] VALUES (value1,…)

- Update

  UPDATE table SET newvalue WHERE criteria

SQL Statements (3)

- Select

  SELECT {*|table.*|[table].field} FROM tableexpression WHERE {criteria| [NOT] [IN] (value1…)} [GROUP BY] [HAVING] [ORDER BY] ….

- Select into

  SELECT fields INTO newtable FROM SOURCE

- Select subquery

  SELECT selectstatement
  (SELECT selectstatement (SELECT selectatement))

Creating Tables Examples

- Creating a Coffee table

  CREATE TABLE COFFEES (COF_NAME VARCHAR(32), SUP_ID INTEGER, PRICE FLOAT, SALES INTEGER, TOTAL INTEGER)

- Creating JDBC statements

  Statement stmt = con.createStatement ();

- Execute a statement

  stmt.executeUpdate ("CREATE TABLE COFFEES " +
  "(COF_NAME VARCHAR(32), SUP_ID INTEGER, PRICE FLOAT," +
  "SALES INTEGER, TOTAL INTEGER)");

SQL query

Checking to See if a Table Exists

Use *meta* data about the table

```
DatabaseMetaData dmd  = con.getMetaData();
ResultSet rs = dmd.getTables (null, null,
  "COFFEES", null);
if (rs == null)
{
      // table does not exist, create it.
}
```


Execute Statements

- This uses executeUpdate because the SQL statement contained in createTableCoffees is a data definition language (DDL) statement
- DDL statements are executed with executeUpdate
  - Create a table
  - Alter a table
  - Drop a table
- executeUpdate is also used to execute SQL statements that update a table

Execute Statements

- executeUpdate is used far more often to update tables than to create them
  - We create a table once but update it many times
- The method used most often for executing SQL statements is executeQuery
- executeQuery is used to execute SELECT statements
  - SELECT statements are the most common SQL statements

Entering Data to a Table

```
Statement stmt = con.createStatement();
stmt.executeUpdate ( "INSERT INTO COFFEES " +
   "VALUES ('Colombian', 101, 7.99, 0, 0)");
stmt.executeUpdate ("INSERT INTO COFFEES " +
   "VALUES ('French_Roast', 49, 8.99, 0, 0)");
stmt.executeUpdate ("INSERT INTO COFFEES " +
   "VALUES ('Espresso', 150, 9.99, 0, 0)");
stmt.executeUpdate ("INSERT INTO COFFEES " +
   "VALUES ('Colombian_Decaf', 101, 8.99, 0, 0)");
stmt.executeUpdate ("INSERT INTO COFFEES " +
   "VALUES ('French_Roast_Decaf', 49, 9.99, 0, 0)");
```

Prepared Statement

- A PreparedStatement object can hold precompiled SQL statements
- If the same SQL statement is executed many times with different parameters, it is more efficient to use a PreparedStatement object
- Examples:

```
PreparedStatement pstat = connection.prepareStatement
   ("Insert into" student (title, ...) values (?, ?, ..) );
pstat.setString (1, name);
pstat.executeUpdate();
```


Getting and Using Data From Tables

```
ResultSet rs = stmt.executeQuery  ("SELECT
  COF_NAME, PRICE FROM COFFEES");
while (rs.next())
{
   String s = rs.getString ("COF_NAME");
   float n = rs.getFloat ("PRICE");
   System.out.println (s + " " + n);
}
```

Navigating Result Sets

JDBC Types Mapped to Java Types				
JDBC Types	**Java Types**		**JDBC Types**	**Java Types**
CHAR	String		DATE	Java.sql.Date
VARCHAR	String		TIME	Java.sql.Time
LONGVARCHAR	String		TIMESTAMP	Java.sql.Timestamp
TINYINT	short			
INTEGER	Int		JAVAOBJECT	Object
BIGINT	Long		BLOB	Java.sql.Blob interface
REAL	Float		CLOB	Java.sql.Clob interface
FLOAT	Double		ARRAY	Java.sql.Array interface
DOUBLE	Double		STRUCT	
BIT	boolean		REF	

Navigating Result Sets

```
ResultSet
ResultSet rs = statement.exeuteQuery ("select * from student");
while (rs.netxt())
{
    System.out.print (rs.getString ("name") + …
}

ResultSetMetaData metaData = rs.getMetaData();
metaData.getColumnCount();
metaData.getColumnName (I);
metaData.getColumnType (I);
```

Navigating Result Sets

- A default ResultSet object is read-only (not updateable) and has a cursor that moves forward only (next()).
- Scrollable result sets have more operations

  First, last, absolute, relative, next, previous, beforeFirst, afterLast, isFirst isBeforeFirst, isLast, isAfterLast

Batch Update

- What is batch update?
  - Send multiple update statement in a single request to the database
- Why batch update?
  - Better performance
- How do we perform batch update?
  - Statement.addBatch (sqlString);
  - Statement.executeBatch();

Transaction Support

- A database transaction is a work unit treated in a coherent and reliable way independent of other transactions
- If a transaction starts, all pieces must complete
- Two main purposes :
  - Allow recovery from errors when operations do not complete
  - Provide concurrency control
- A database transaction must be ACID :
  - Atomic
  - Consistent
  - Isolated
  - Durable

Transaction Support (2)

- By default, a connection is in auto-commit mode
  - Each individual SQL statement is treated as a transaction
- To turn off auto-commit mode :
  - `connection.setAutoCommit (false);`
- Commit and Rollback
  - Commit – a call to `commit()` will commit everything that was done since the last commit was issued
  - Rollback – a call to `rollback()` will undo any changes since the last commit

Exception Handling

- Objectives
  - Handle exceptions gracefully
  - Maintain the integrity of the database
- Exception handling with a rollback :

```
try {
  con.setAutoCommit (false);
  statement.executeUpdate ("....");
  statement.executeUpdate ("....");
   commit(); con.setAutoCommit (true);
}
catch (SQLException ex)
{ con.rollback(); }
```

- SQL warnings

```
ResultSet rs = statement.executeQuery ("Select * from student");
SQLWarning warn = statement.getWarnings();
if (warn != null)
  System.out.println (warn.getMessage());
```


JDBC Summary

- Most web applications use databases to store data in a persistent way
- The techniques for accessing databases from Java programs are identical in web applications and in stand-alone Java programs
- This lecture does not teach how to set up or use a database or the details of constructing SQL queries
  - INFS 614, Database Management
  - INFS 740, Database Programming for the World Wide Web