JDBC – Java DB Connectivity

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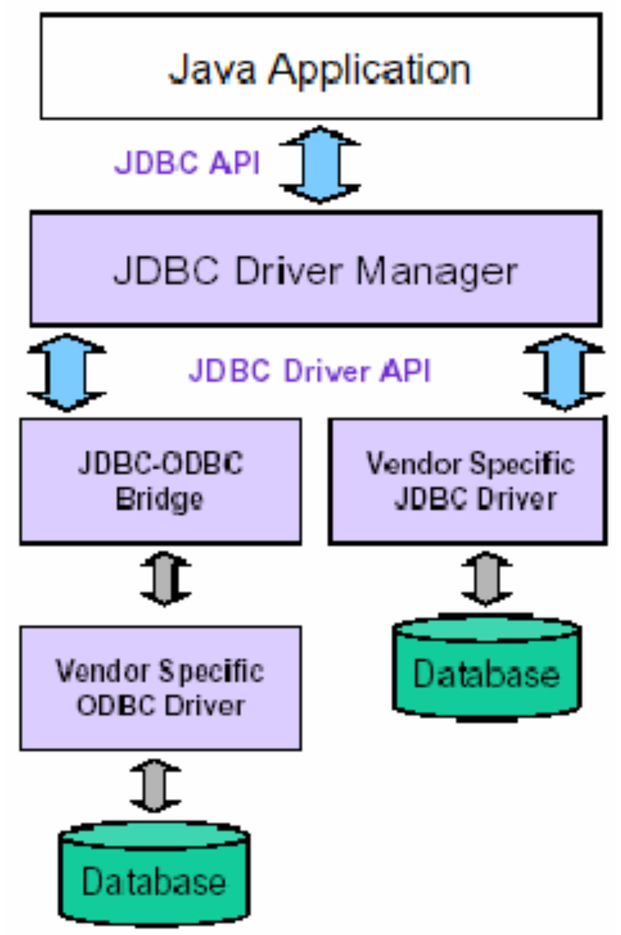
What is JDBC?

- "An API that lets you access virtually any tabular data source from the Java programming language"
    - JDBC Data Access API – JDBC Technology Homepage
  - What's an API?
    - See J2SE documentation
  - What's a tabular data source?
- "... access virtually any data source, from relational databases to spreadsheets and flat files."
  - JDBC Documentation
- We'll focus on accessing relational databases

General Architecture



- What design pattern is implied in this architecture?
- What does it buy for us?
- Why is this architecture also multi-tiered?

Basic steps

- 1.Establish a **connection**
- 2.Create JDBC **Statements**
- 3.Execute **SQL** Statements
- 4.Get **ResultSet**
- 5.**Close** connections

1. Establish a connection

- **import java.sql.*;**
- **Load the vendor specific driver**
  - Class.forName("org.postgresql.Driver");
    - What do you think this statement does, and how?
    - Dynamically loads a driver class, for Oracle database
- **Make the connection**
  - Connection con = DriverManager.getConnection(“jdbc:postgresql:///dbname", "username", "password");
    - What do you think this statement does?
    - Establishes connection to database by obtaining a *Connection* object

2. Create JDBC statement(s)

- Statement stmt = con.createStatement() ;
  - Creates a Statement object for sending SQL statements to the database

3. Executing SQL Statements

- String createLehigh = "Create table Lehigh " +
  "(SSN Integer not null, Name VARCHAR(32), " +
  "Marks Integer)";
  stmt.**executeUpdate**(createLehigh);
  //What does this statement do?

- String insertLehigh = "Insert into Lehigh values“
  +   "(123456789,abc,100)";
  stmt.**executeUpdate**(insertLehigh);

4. Get ResultSet

```
String queryLehigh = "select * from Lehigh";

ResultSet rs = Stmt.executeQuery(queryLehigh);
//What does this statement do?

while (rs.next()) {
    int ssn = rs.getInt("SSN");
    String name = rs.getString("NAME");
    int marks = rs.getInt("MARKS");
}
```

5. Close connection

- stmt.close();
- con.close();

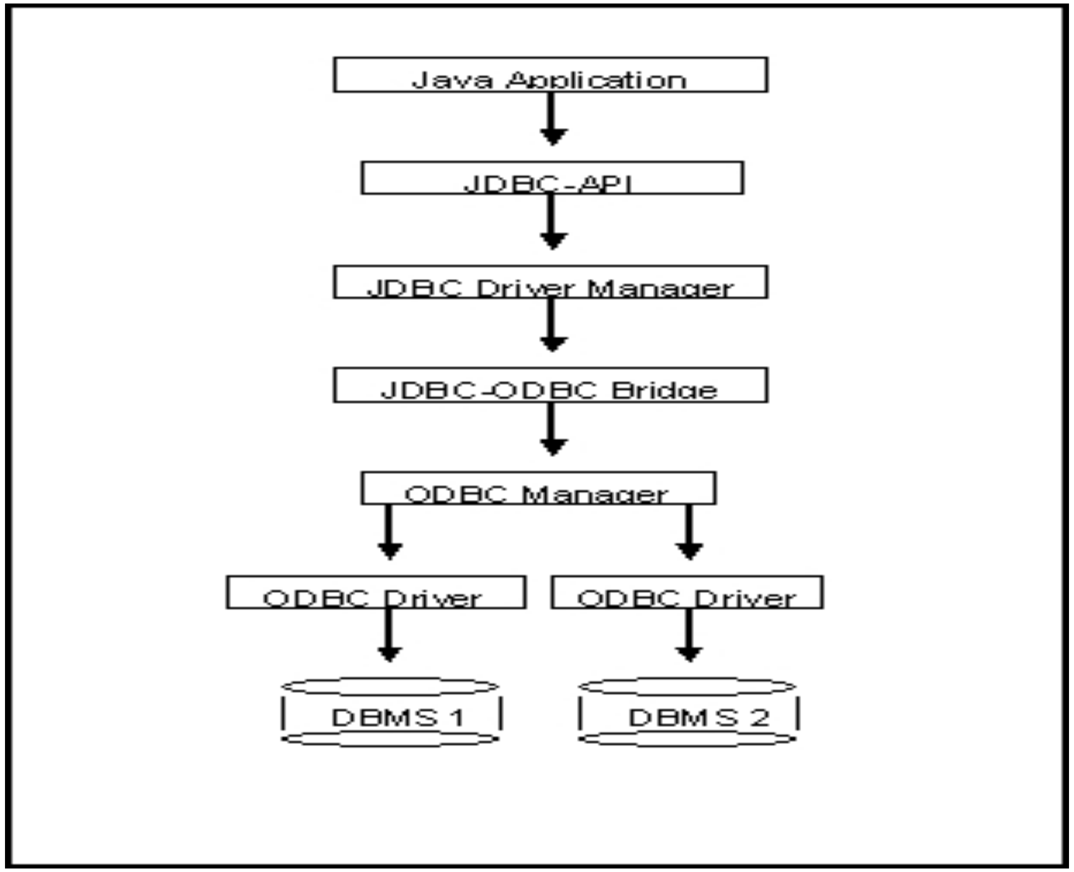
Transactions and JDBC

- JDBC allows SQL statements to be grouped together into a single transaction
- Transaction control is performed by the Connection object, default mode is auto-commit, I.e., each sql statement is treated as a transaction
- We can turn off the auto-commit mode with con.setAutoCommit(false);
- And turn it back on with con.setAutoCommit(true);
- Once auto-commit is off, no SQL statement will be committed until an explicit is invoked con.commit();
- At this point all changes done by the SQL statements will be made permanent in the database.

Handling Errors with Exceptions

- Programs should recover and leave the database in a consistent state.
- If a statement in the try block throws an exception or warning, it can be caught in one of the corresponding catch statements
- How might a finally {…} block be helpful here?
- E.g., you could rollback your transaction in a catch { …} block or close database connection and free database related resources in finally {…} block

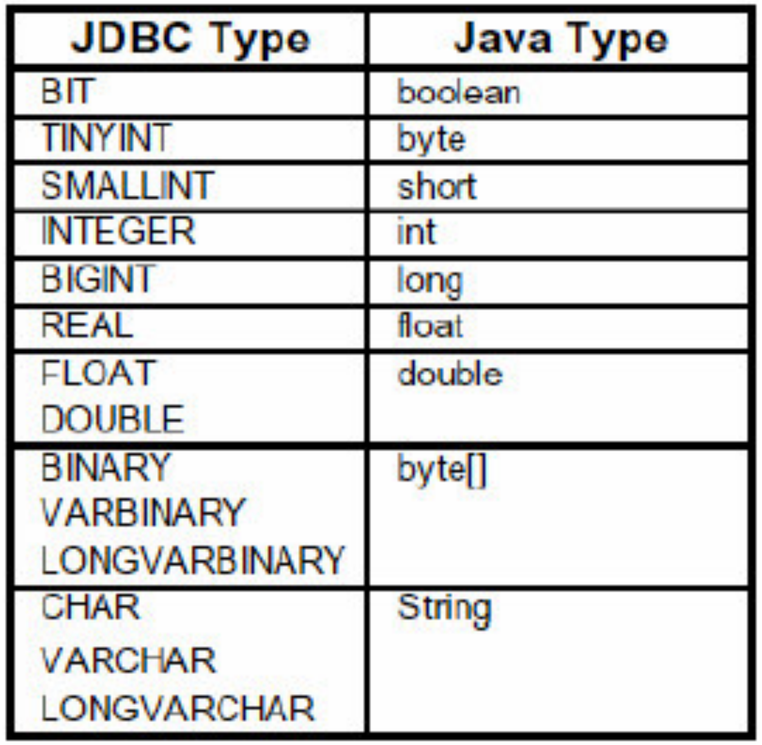
JDBC-ODBC



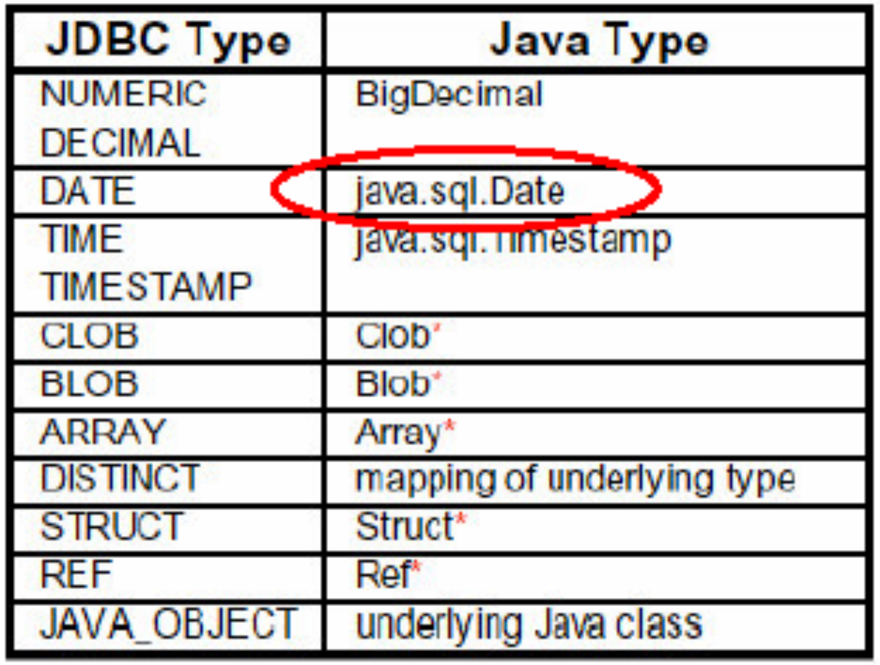
What's a bit different about this architecture?

Why add yet another layer?

Mapping types JDBC - Java



JDBC Type	Java Type
BIT	boolean
TINYINT	byte
SMALLINT	short
INTEGER	int
BIGINT	long
REAL	float
FLOAT DOUBLE	double
BINARY VARBINARY LONGVARBINARY	byte[]
CHAR VARCHAR LONGVARCHAR	String



JDBC Type	Java Type
NUMERIC DECIMAL	BigDecimal
DATE	java.sql.Date
TIME TIMESTAMP	java.sql.Timestamp
CLOB	Clob*
BLOB	Blob*
ARRAY	Array*
DISTINCT	mapping of underlying type
STRUCT	Struct*
REF	Ref*
JAVA_OBJECT	underlying Java class

*SQL3 data type supported in JDBC 2.0

JDBC – Scrollable Result Set

```
…
Statement stmt =
con.createStatement(ResultSet.TYPE_SCROLL_INSENSITIVE,
                    ResultSet.CONCUR_READ_ONLY);

String query = “select students from class where type= ‘not sleeping’ “;
ResultSet rs = stmt.executeQuery( query );

rs.previous();  / / go back in the RS (not possible in JDBC 1…)
rs.relative(-5); / / go 5 records back
rs.relative(7); / / go 7 records forward
rs.absolute(100); / / go to 100th record
…
```

JDBC – Updateable ResultSet

```
…
Statement stmt =
con.createStatement(ResultSet.TYPE_FORWARD_ONLY,
                ResultSet.CONCUR_UPDATABLE);
String query = " select students, grade from class
           where type= ‘really listening this presentation’ “;
ResultSet rs = stmt.executeQuery( query );
…
while ( rs.next() )
{
    int grade = rs.getInt(“grade”);
    rs.updateInt(“grade”, grade + 1);
    rs.updateRow();
}
```

Metadata from DB

- A Connection's database is able to provide schema information describing its tables, its supported SQL grammar, its stored procedures the capabilities of this connection, and so on
  - What is a stored procedure?
  - Group of SQL statements that form a logical unit and perform a particular task
- This information is made available through a DatabaseMetaData object.

Metadata from DB - example

```
…
Connection con = …. ;

DatabaseMetaData dbmd = con.getMetaData();

String catalog = null;
String schema = null;
String table = "sys%";
String[ ] types = null;

ResultSet rs =
    dbmd.getTables(catalog , schema , table , types );
…
```

JDBC – Metadata from RS

```
public static void printRS(ResultSet rs) throws SQLException {
    ResultSetMetaData md = rs.getMetaData();
    // get number of columns
    int nCols = md.getColumnCount();
    // print column names
    for(int i=1; i < nCols; ++i)
     System.out.print( md.getColumnName( i)+",");
}
```

JDBC and beyond

- (JNDI) Java Naming and Directory Interface
  - API for network-wide sharing of information about users, machines, networks, services, and applications
  - Preserves Java's object model
- (JDO) Java Data Object
  - Models persistence of objects, using RDBMS as repository
  - Save, load objects from RDBMS
- (SQLJ) Embedded SQL in Java
  - Standardized and optimized by Sybase, Oracle and IBM
  - Java extended with directives: # sql
  - SQL routines can invoke Java methods
  - Maps SQL types to Java classes

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JDBC references

- JDBC Data Access API – JDBC Technology Homepage
  - http://java.sun.com/products/jdbc/index.html
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  - http://java.sun.com/j2se/1.4.2/docs/guide/jdbc/getstart/GettingStartedTOC.fm.html
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