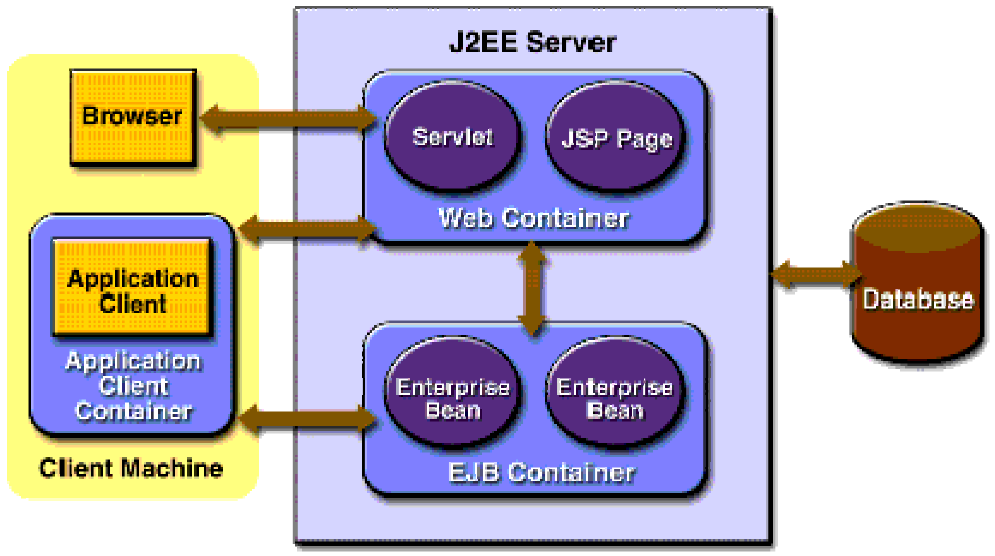
Java DataBase Connectivity (JDBC)

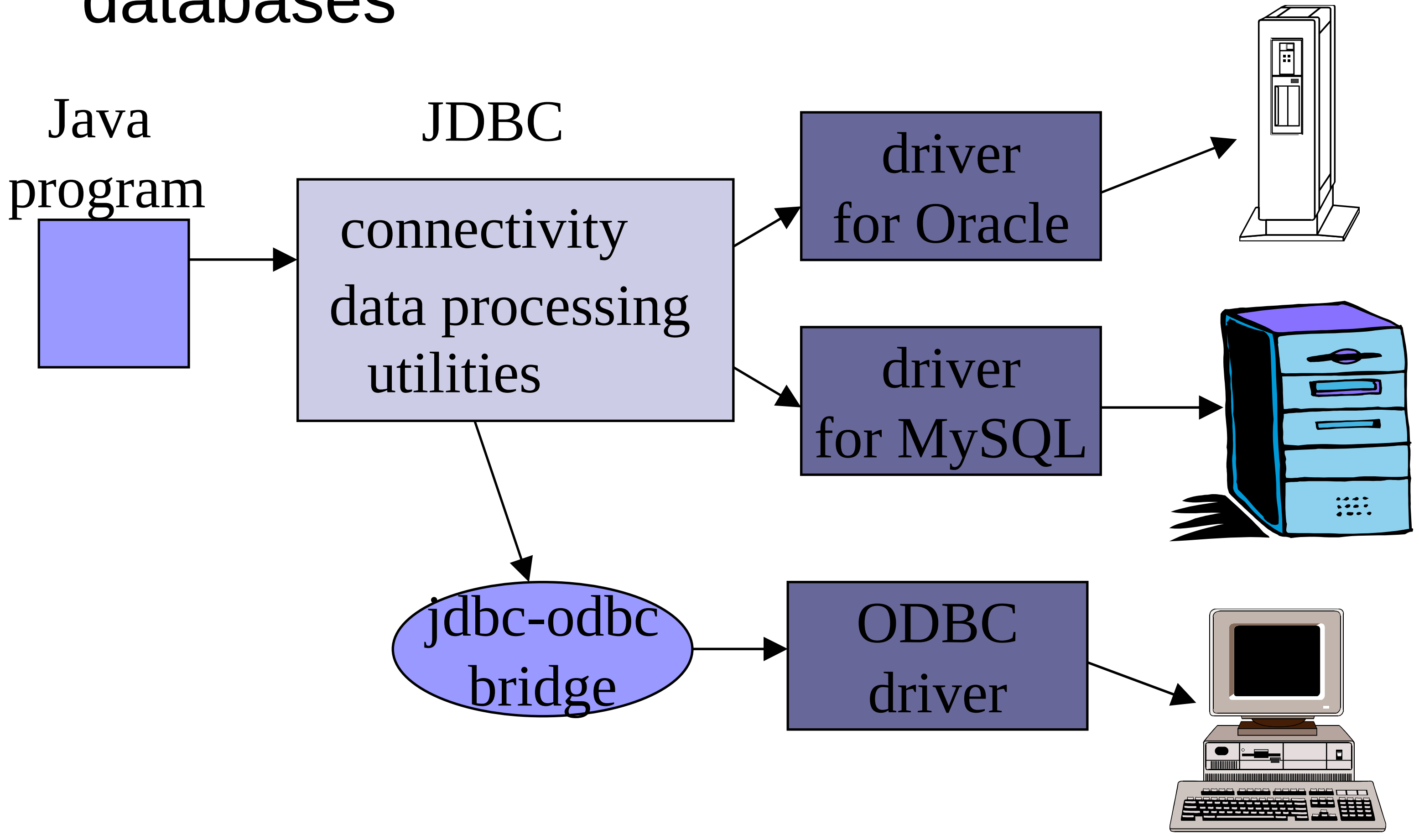
J2EE application model

- J2EE is a multitiered distributed application model
  - client machines
  - the J2EE server machine
  - the database or legacy machines at the back end



JDBC API

- JDBC is an interface which allows Java code to execute SQL statements inside relational databases



The JDBC-ODBC Bridge

- ODBC (Open Database Connectivity) is a Microsoft standard from the mid 1990’s.
- It is an API that allows C/C++ programs to execute SQL inside databases
- ODBC is supported by many products.

The JDBC-ODBC Bridge (Contd.)

- The JDBC-ODBC bridge allows Java code to use the C/C++ interface of ODBC
  - it means that JDBC can access many different database products
- The layers of translation (Java --> C --> SQL) can slow down execution.

The JDBC-ODBC Bridge (Contd.)

- The JDBC-ODBC bridge comes *free* with the J2SE:
  - called `sun.jdbc.odbc.JdbcOdbcDriver`
- The ODBC driver for Microsoft Access comes with MS Office
  - so it is easy to connect Java and Access

JDBC Pseudo Code

- All JDBC programs do the following:
- Step 1) load the JDBC driver
- Step 2) Specify the name and location of the database being used
- Step 3) Connect to the database with a `Connection` object
- Step 4) Execute a SQL query using a `Statement` object
- Step 5) Get the results in a `ResultSet` object
- Step 6) Finish by closing the `ResultSet`, `Statement` and `Connection` objects

JDBC API in J2SE

- Set up a database server (Oracle , MySQL, pointbase)
- Get a JDBC driver
  - set CLASSPATH for driver lib
    - Set classpath in windows, control panel->system->advanced->environment variable
    - Set classpath in Solaris, set CLASSPATH to driver jar file
- Import the library
  - import java.sql.*;
- Specify the URL to database server
  - String **url = "jdbc:pointbase://127.0.0.1/test“**
- Load the JDBC driver
  - Class.forName("**com.pointbase.jdbc.jdbcUniversalDriver**");
- Connect to database server
  - Connection con = DriverManager.getConnection(url, “dbUser", “dbPass");
- Create SQL Statement
  - stmt = con.createStatement();
- Execute SQL
  - stmt.executeUpdate("insert into COFFEES " + "values('Colombian', 00101, 7.99, 0, 0)");
  - ResultSet rs = stmt.executeQuery(query);

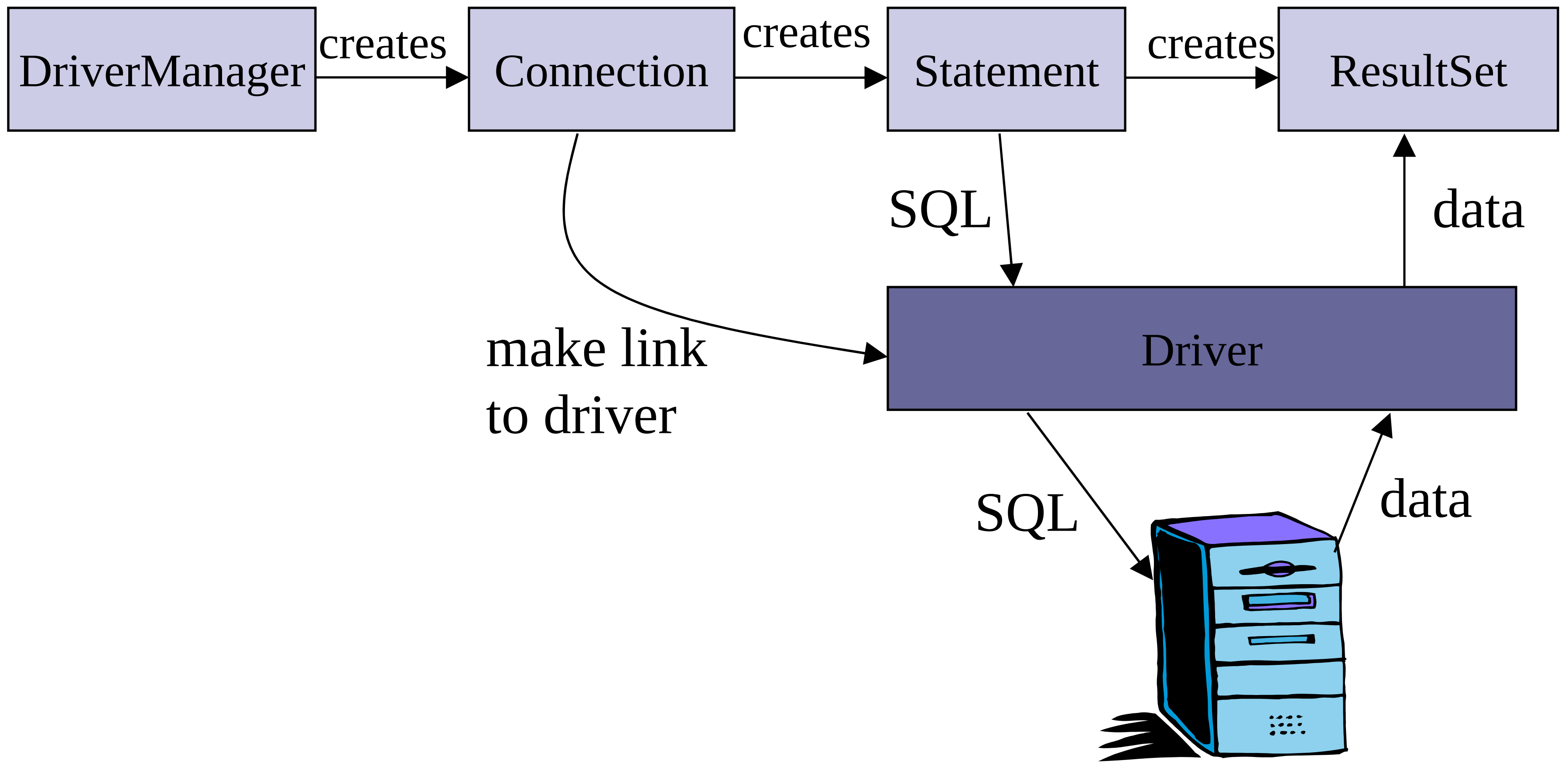
JDBC Example

```
import java.sql.*;

public class SqlTest
{
        public static void main(String[] args)
        {
                try
                {

                // Step 1: Make a connection

                // Load the driver
                Class.forName("com.pointbase.jdbc.jdbcUniversalDriver");

                // Get a connection using this driver
                String url = "jdbc:pointbase://localhost/cs595";
                String dbUser = "PBPUBLIC";
                String dbPassword = "PBPUBLIC";

                Connection con = DriverManager.getConnection(url, dbUser, dbPassword);
```

JDBC Example (Contd.)

```
                Statement stmt = con.createStatement();
                String sql= "select * from Traps";

                ResultSet rs = stmt.executeQuery(sql);

                String name;
                double val;
                java.sql.Date date;

                while (rs.next())
                {
                                name = rs.getString("TrapName");
                                val = rs.getDouble("TrapValue");
                                date = rs.getDate("TrapDate");
                                System.out.println("name = " + name + " Value = " + val + " Date = " + date);
                }


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

                }
                catch(ClassNotFoundException ex1)
                {
                                System.out.println(ex1);
                }
                catch(SQLException ex2)
                {
                                System.out.println(ex2);
                }
        }
}
```

JDBC Diagram



Load Driver

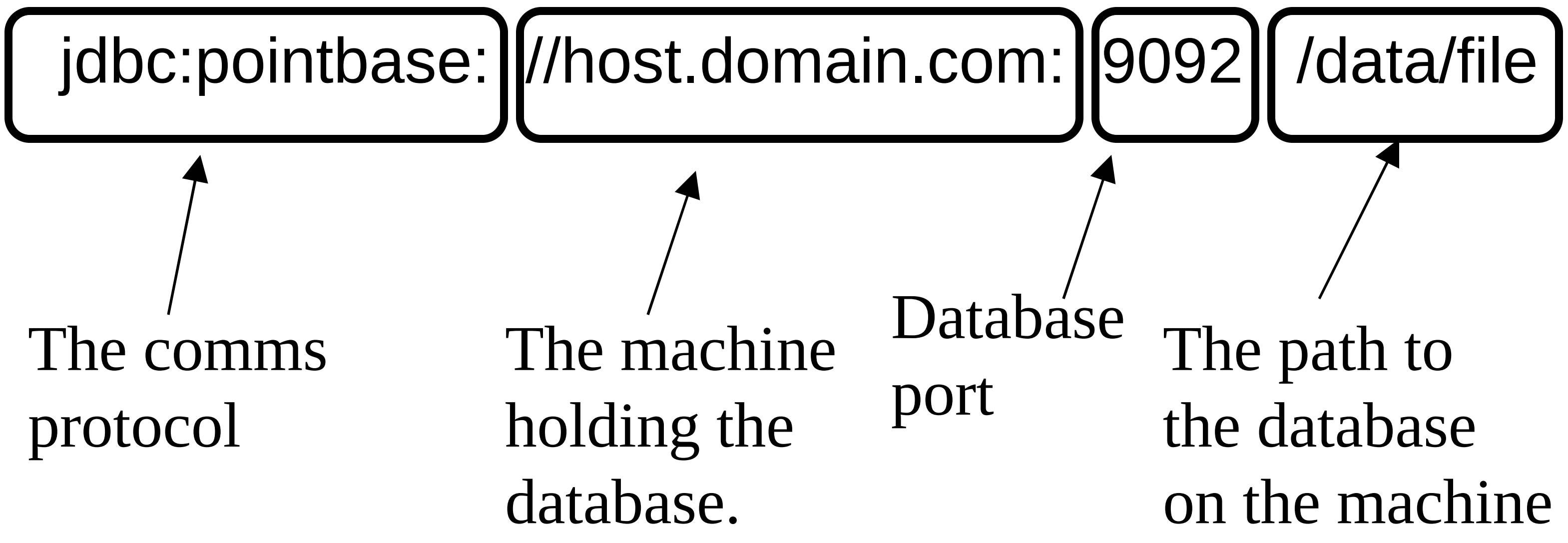
- DriverManager is responsible for establishing the connection to the database through the driver.
- e.g.

```
Class.forName(
      "sun.jdbc.odbc.JdbcOdbcDriver");
Connection conn =
      DriverManager.getConnection(url);
```

Specify the URL to database server

- The name and location of the database is given as a URL
  - the details of the URL vary depending on the type of database that is being used

Database URL



e.g. `jdbc:pointbase://localhost/myDB`

Statement Object

- The `Statement` object provides a workspace where SQL queries can be created, executed, and results collected.
- e.g.

```
Statement st =
           conn.createStatement():
ResultSet rs = st.executeQuery(
      “ select * from Authors” );
      :
st.close();
```

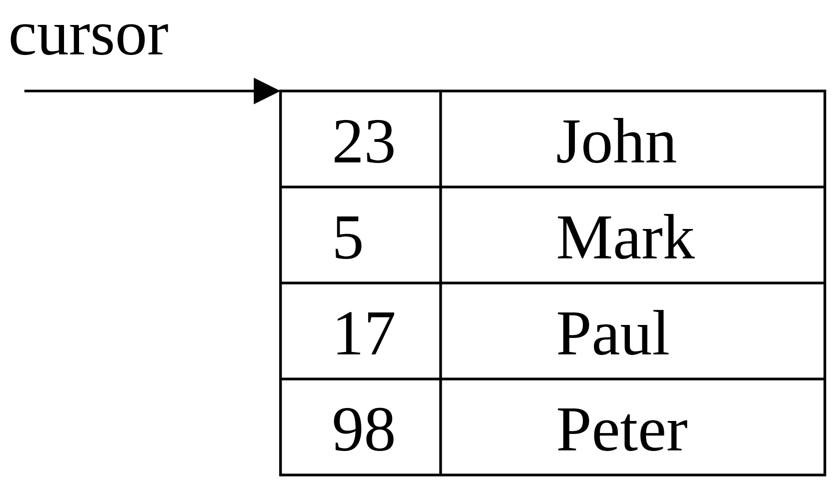
ResultSet Object

- Stores the results of a SQL query.
- A `ResultSet` object is similar to a ‘table’ of answers, which can be examined by moving a ‘pointer’ (cursor).

Accessing a ResultSet

- Cursor operations:
  - `first()`, `last()`, `next()`, `previous()`, etc.
- Typical code:

```
while( rs.next() ) {
  // process the row;
}
```



23	John
5	Mark
17	Paul
98	Peter

Accessing a ResultSet (Contd.)

- The `ResultSet` class contains many methods for accessing the value of a column of the current row
  - can use the column name or position
  - e.g. get the value in the lastName column:

    ```
    rs.getString("lastName")
    or rs.getString(2)
    ```

Accessing a ResultSet (Contd.)

- The ‘tricky’ aspect is that the values are SQL data, and so must be converted to Java types/objects.
- There are many methods for accessing/converting the data, e.g.
  - `getString(), getDate(), getInt(), getFloat(), getObject()`

Meta Data

- Meta data is the information *about* the database:
  - e.g. the number of columns, the types of the columns
  - meta data is the *schema* information

ID	Name	Course	Mark
007	James Bond	Shooting	99
008	Aj. Andrew	Kung Fu	1

$\xleftarrow{\text{meta data}}$

Accessing Meta Data

- The `getMetaData()` method can be used on a `ResultSet` object to create its meta data object.
- e.g.

```
ResultSetMetaData md =
                     rs.getMetaData();
```

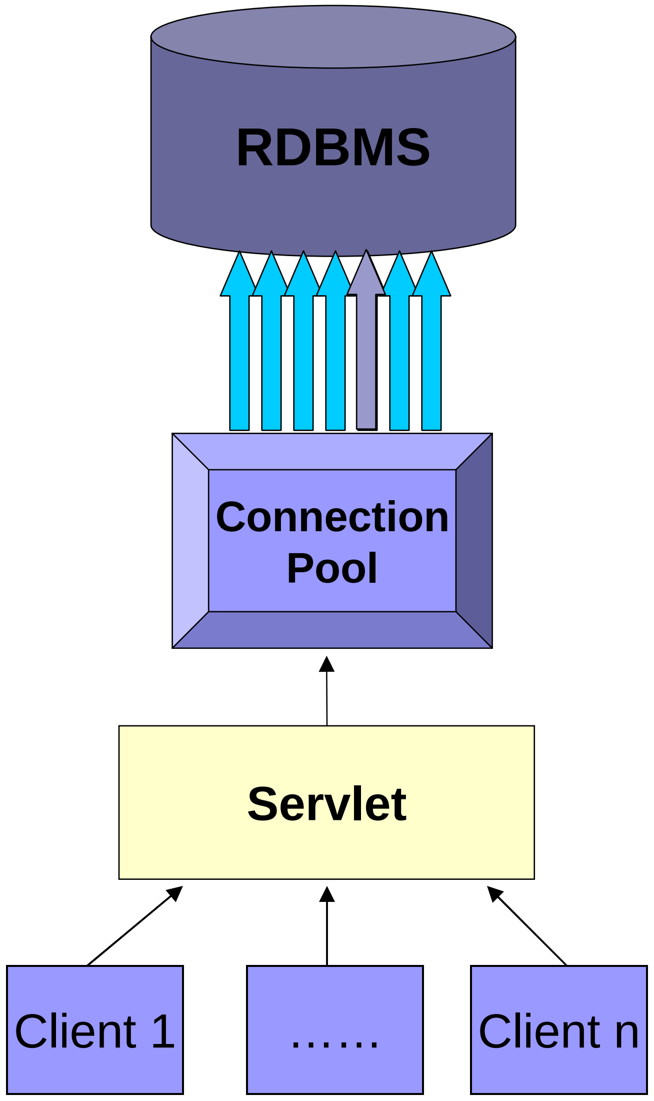
Using Meta Data

```
int numCols = md.getColumnCount();

for (int i = 0; i <= numCols; i++) {
  if (md.getColumnType(i) ==
                       Types.CHAR)
    System.out.println(
             md.getColumnName(i) )
}
```

Database Connection Pooling

- **Connection pooling is a technique that was pioneered by database vendors to allow multiple clients to share a cached set of connection objects that provide access to a database resource**

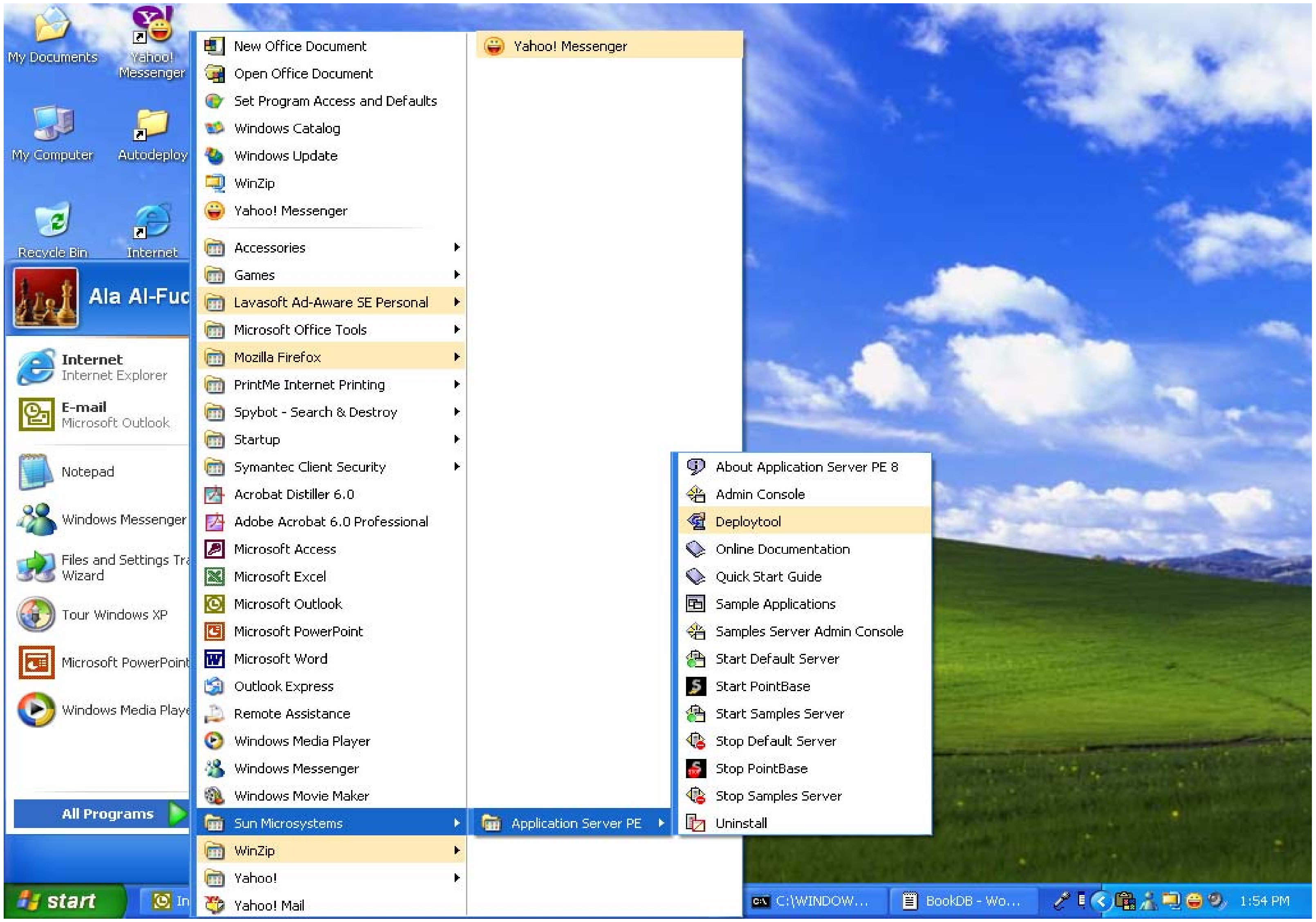
- **Connection pools minimize the opening and closing of connections**



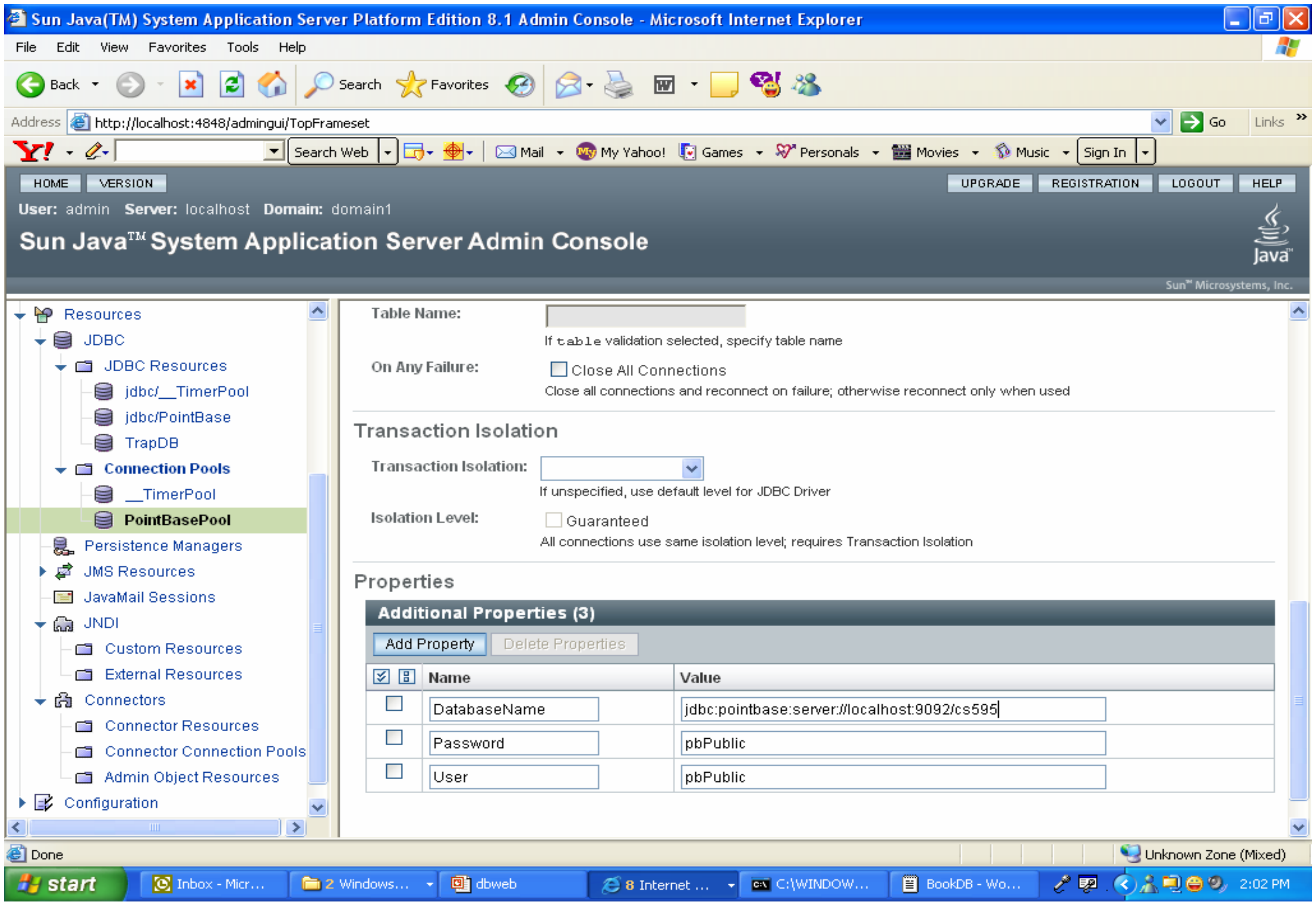
JDBC in J2EE

- Step 1: Start Sun Application Server PE 8
- Step 2: Start PointBase
- Step 3: Use J2EE admin to create connection pool
- Step 4: Use J2EE admin to create JDBC data source
- Step 5: import java.sql.*;
- Step 6: get Context
- Step 7: look up data source with JNDI
- Step 8: Execute SQL and process result

Start Application Server & PointBase



Create Connection Pool Using Admin GUI



Address: http://localhost:4848/admingui/TopFrameset

User: admin Server: localhost Domain: domain1

Table Name:

If table validation selected, specify table name

On Any Failure: ☐ Close All Connections

Close all connections and reconnect on failure; otherwise reconnect only when used

Transaction Isolation

Transaction Isolation:

If unspecified, use default level for JDBC Driver

Isolation Level: ☐ Guaranteed

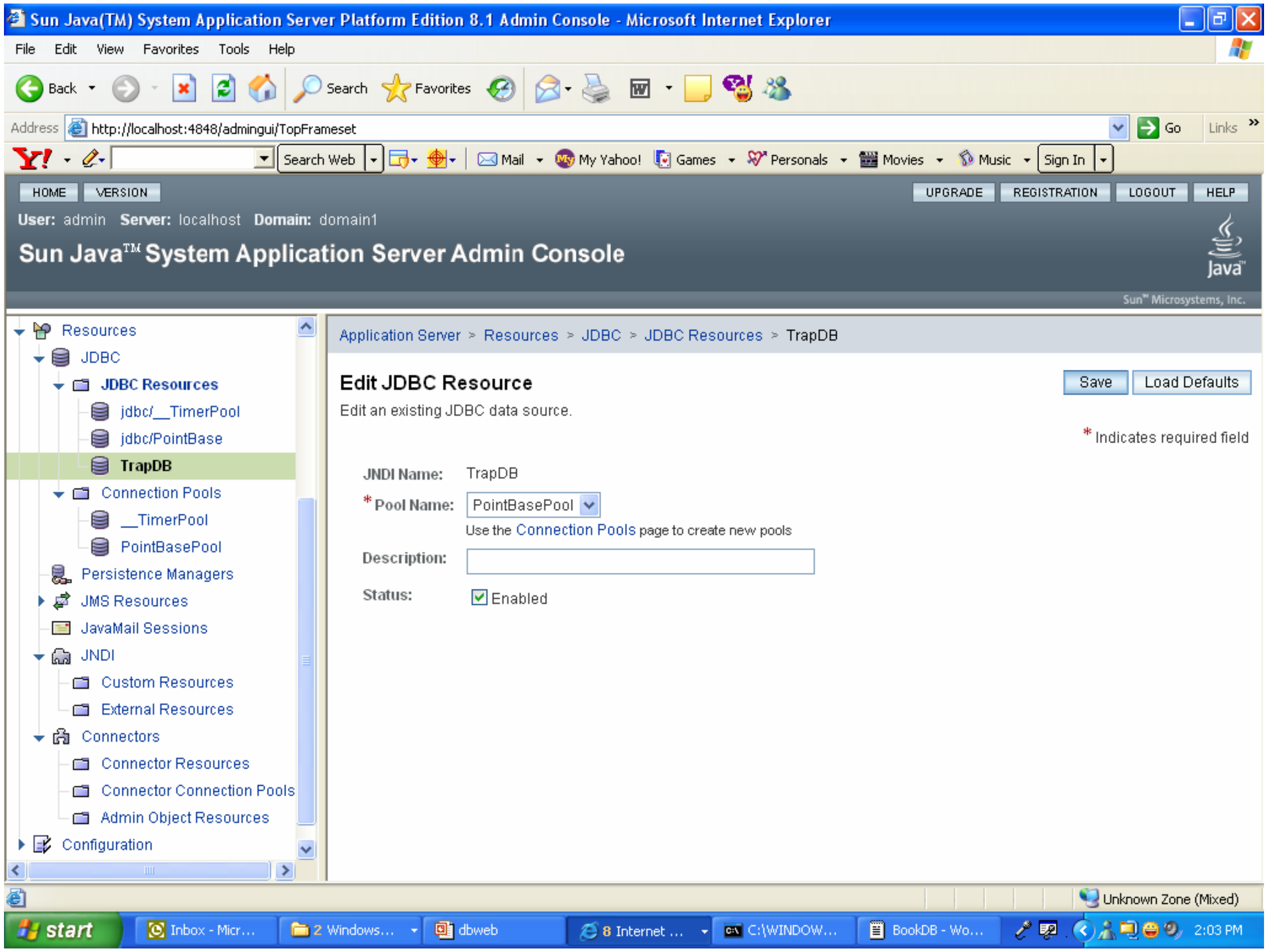
All connections use same isolation level; requires Transaction Isolation

Properties

Additional Properties (3)

	Name	Value
☐	DatabaseName	jdbc:pointbase:server://localhost:9092/cs595
☐	Password	pbPublic
☐	User	pbPublic

Create Data Source Using Admin GUI


Sun Java(TM) System Application Server Platform Edition 8.1 Admin Console - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://localhost:4848/admingui/TopFrameset
HOME VERSION UPGRADE REGISTRATION LOGOUT HELP
Sun Java™ System Application Server Admin Console
Resources
JDBC
JDBC Resources
jdbc/__TimerPool
jdbc/PointBase
TrapDB
Connection Pools
__TimerPool
PointBasePool
Persistence Managers
JMS Resources
JavaMail Sessions
JNDI
Custom Resources
External Resources
Connectors
Connector Resources
Connector Connection Pools
Admin Object Resources
Configuration
Save
Load Defaults

User: admin Server: localhost Domain: domain1

Application Server > Resources > JDBC > JDBC Resources > TrapDB

Edit JDBC Resource

Edit an existing JDBC data source.

* Indicates required field

JNDI Name:	TrapDB
* Pool Name:	PointBasePool
	Use the Connection Pools page to create new pools
Description:	
Status:	✓ Enabled

Example: JDBC Using JNDI & Connection Pools

```
import javax.servlet.*;
import javax.servlet.http.*;
import java.sql.*;
import javax.sql.*;
import javax.naming.*;
import java.io.*;
import java.util.*;

public class SqlServlet extends HttpServlet
{
    public void doGet(HttpServletRequest req, HttpServletResponse res) throws
    ServletException
    {
        res.setContentType("text/plain");
```

Example: JDBC Using JNDI & Connection Pools (Contd.)

```
try
{

PrintWriter pw = res.getWriter();

String dbName = "java:comp/env/jdbc/TrapDB";

InitialContext ic = new InitialContext();
DataSource ds = (DataSource) ic.lookup(dbName);
Connection con = ds.getConnection();

Statement stmt = con.createStatement();
String sql= "select * from Traps";

ResultSet rs = stmt.executeQuery(sql);

String name;
double val;
java.sql.Date date;

while (rs.next())
{
            name = rs.getString("TrapName");
            val = rs.getDouble("TrapValue");
            date = rs.getDate("TrapDate");
            pw.println("name = " + name + " Value = " + val + " Date = " + date);
}
```

Example: JDBC Using JNDI & Connection Pools (Contd.)

```
                stmt.close();

                }
                catch(SQLException ex2)
                {
                        System.out.println(ex2);
                }
                catch(IOException ex3)
                {
                        System.out.println(ex3);
                }
                catch(Exception ex4)
                {
                        System.out.println(ex4);
                }
           }
        }
```

Reference

- Database and Enterprise Web Application Development in J2EE, Xiachuan Yi, Computer Science Department, University of Georgia.