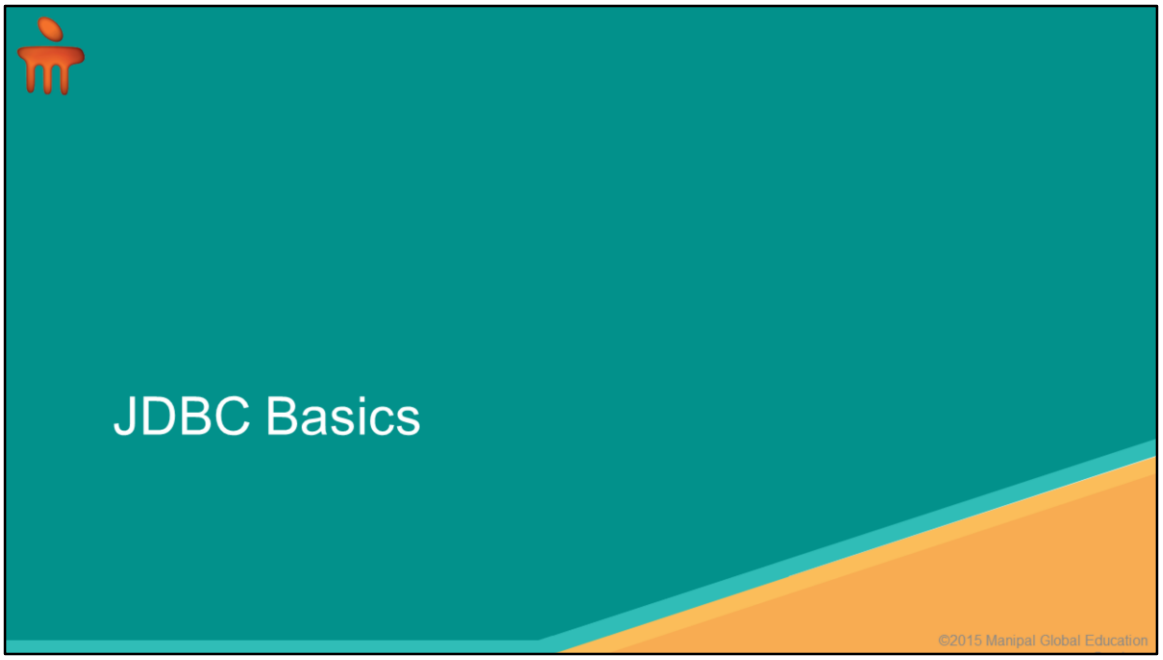
JDBC Basics
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INTRODUCTION
JDBC Basics
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LEARNING OBJECTIVES

At the end of this lesson, you will be able to:

- Identify the classes/Interface in JDBC API
- Demonstrate the steps involved in connecting to Database
- Distinguish the types of drivers
- Identify and Use the classes/interfaces during each Step
- Map SQL and Java Data types

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Refer package **com.mgait.jdbc** in the provided code base for demo programs on the topics covered in this presentation

The demo programs use the 'hr' schema of Oracle Express Edition

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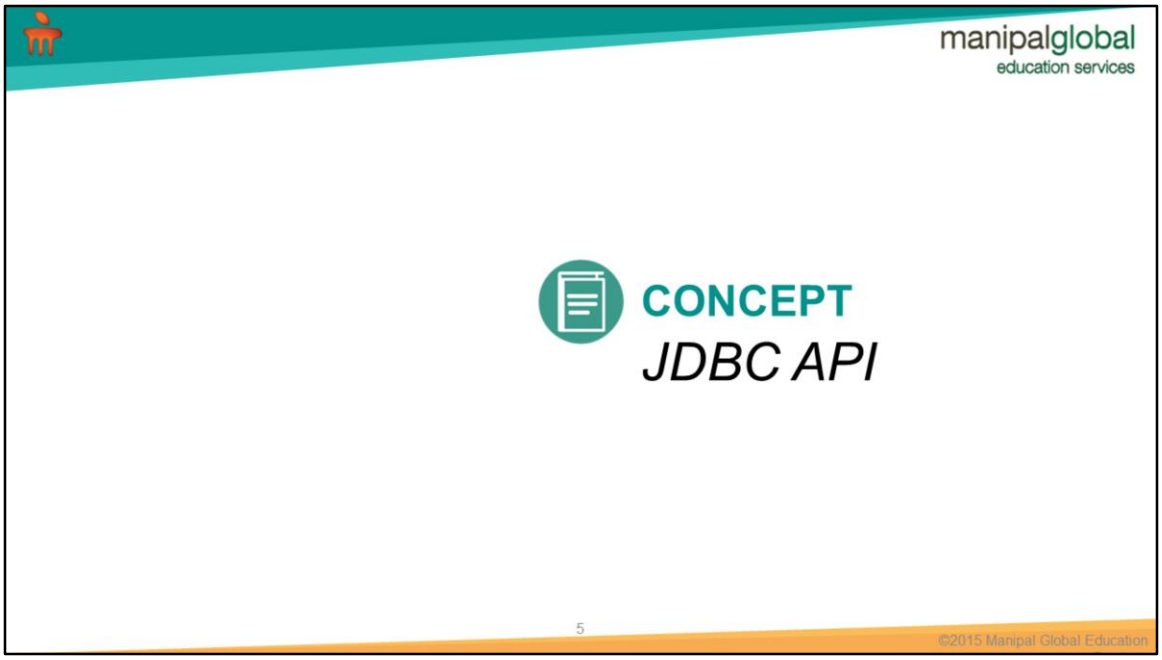
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CONCEPT
JDBC API
5
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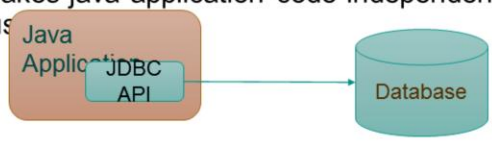
Introduction to JDBC

- JDBC stands for Java Database Connectivity
- Standard API which enables java applications to interact with relational databases
- JDBC API makes java application code independent of the database the application us



- JDBC API defines interfaces and classes which standardize the way in which java application
  - Connect to Database
  - Execute queries

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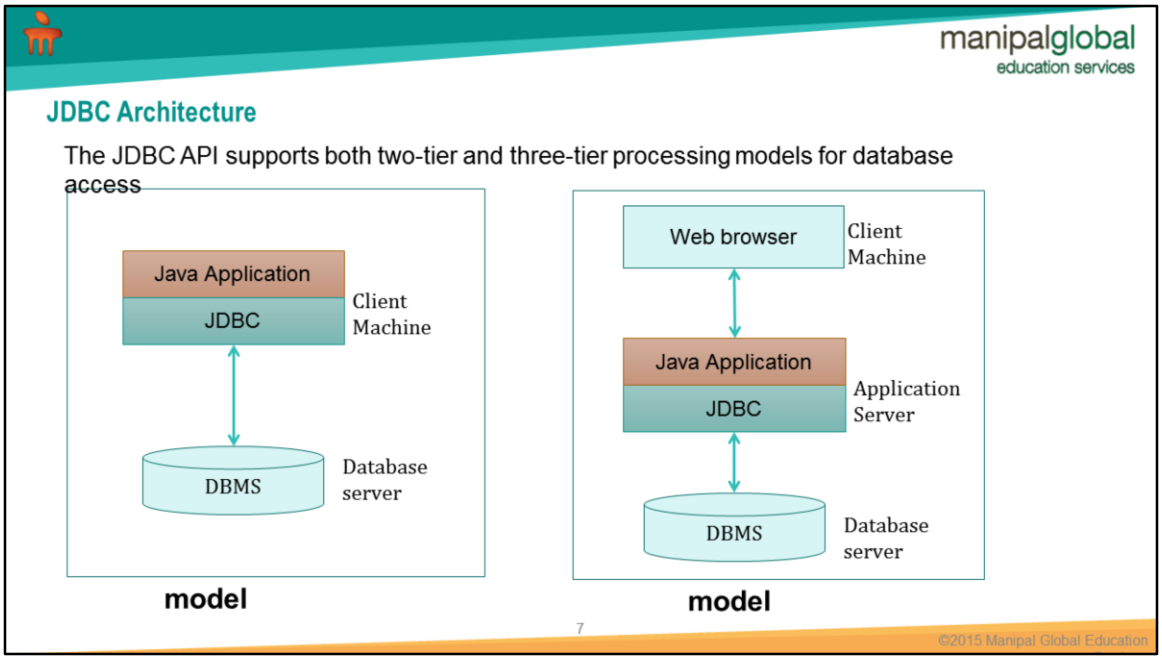
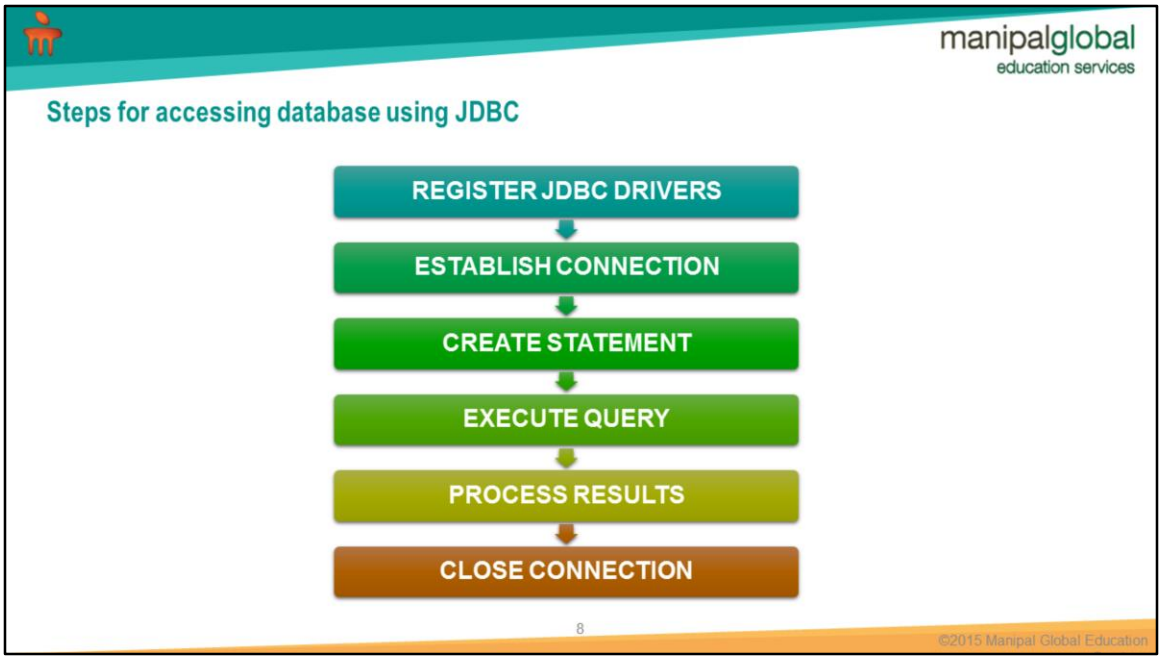


In the two-tier model, a Java application talks directly to the data source. The database may be located on another machine to which the user is connected via a network. It is based on client server architecture. The client contains all the code to interact with the database.

In the three-tier model, commands are sent to a "middle tier" , which then sends the commands to the data source. The data source processes the commands and sends the results back to the middle tier, which then sends them to the user.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Steps for accessing database using JDBC
REGISTER JDBC DRIVERS
ESTABLISH CONNECTION
CREATE STATEMENT
EXECUTE QUERY
PROCESS RESULTS
CLOSE CONNECTION
8
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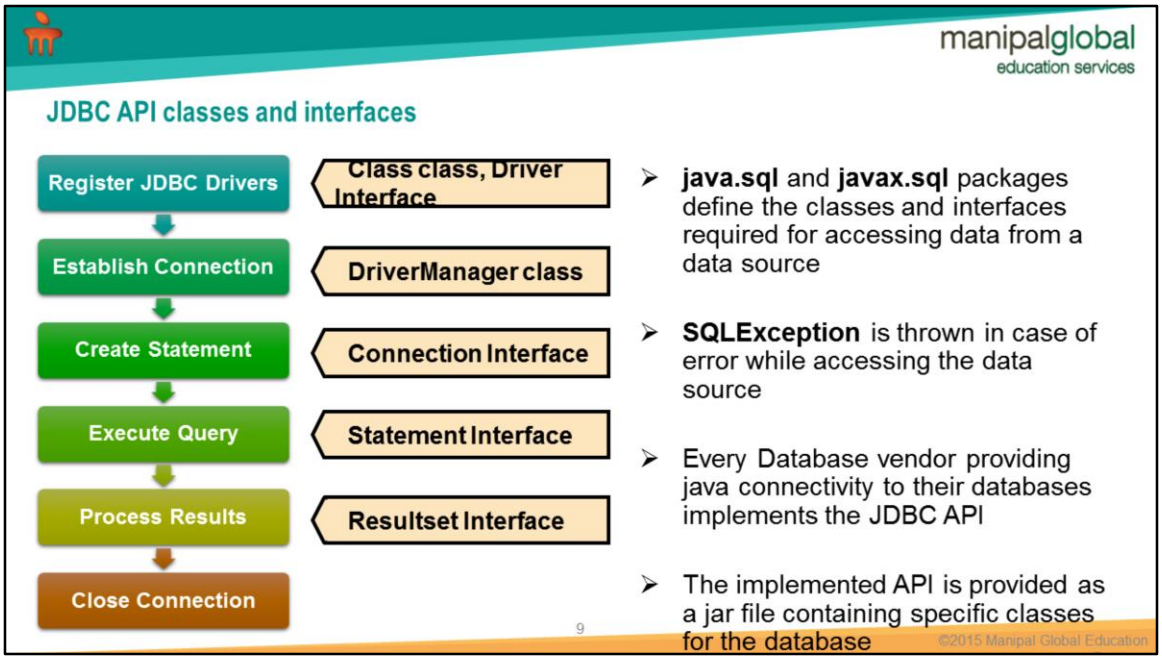
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JDBC API classes and interfaces
Register JDBC Drivers
Class class, Driver Interface
Establish Connection
DriverManager class
Create Statement
Connection Interface
Execute Query
Statement Interface
Process Results
Resultset Interface
Close Connection
java.sql and javax.sql packages define the classes and interfaces required for accessing data from a data source
SQLException is thrown in case of error while accessing the data source
Every Database vendor providing java connectivity to their databases implements the JDBC API
The implemented API is provided as a jar file containing specific classes for the database
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REGISTER JDBC DRIVERS
ESTABLISH CONNECTION
CREATE STATEMENT
EXECUTE QUERY
PROCESS RESULTS
CLOSE CONNECTION
10
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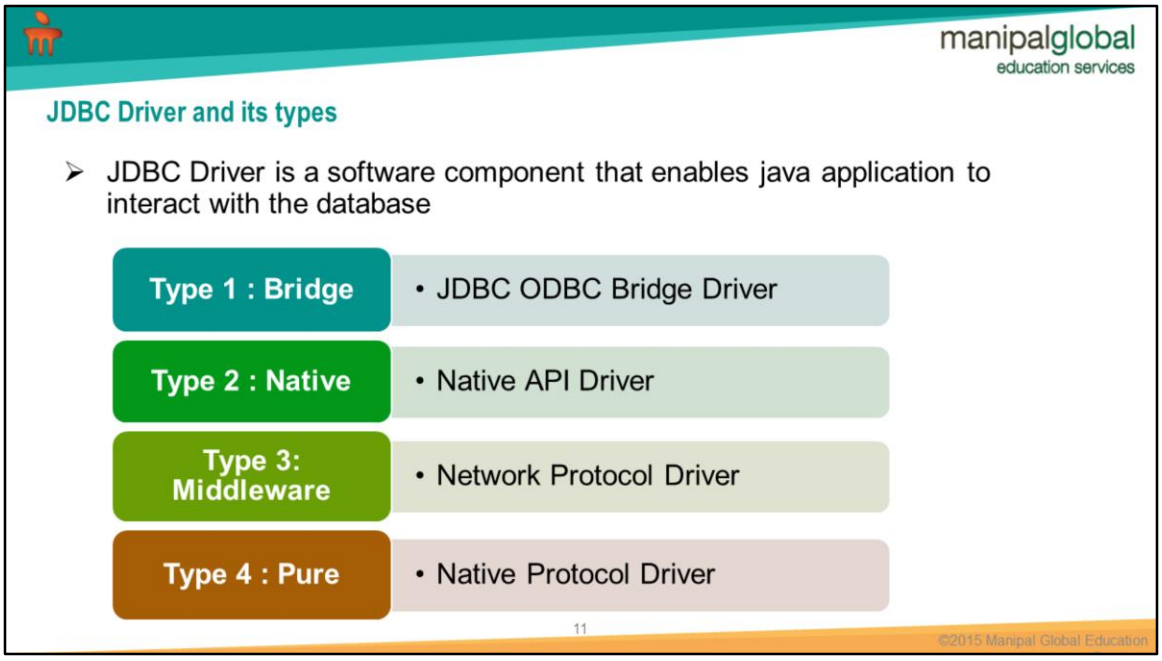
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JDBC Driver and its types
JDBC Driver is a software component that enables java application to interact with the database
Type 1 : Bridge
• JDBC ODBC Bridge Driver
Type 2 : Native
• Native API Driver
Type 3: Middleware
• Network Protocol Driver
Type 4 : Pure
• Native Protocol Driver
11
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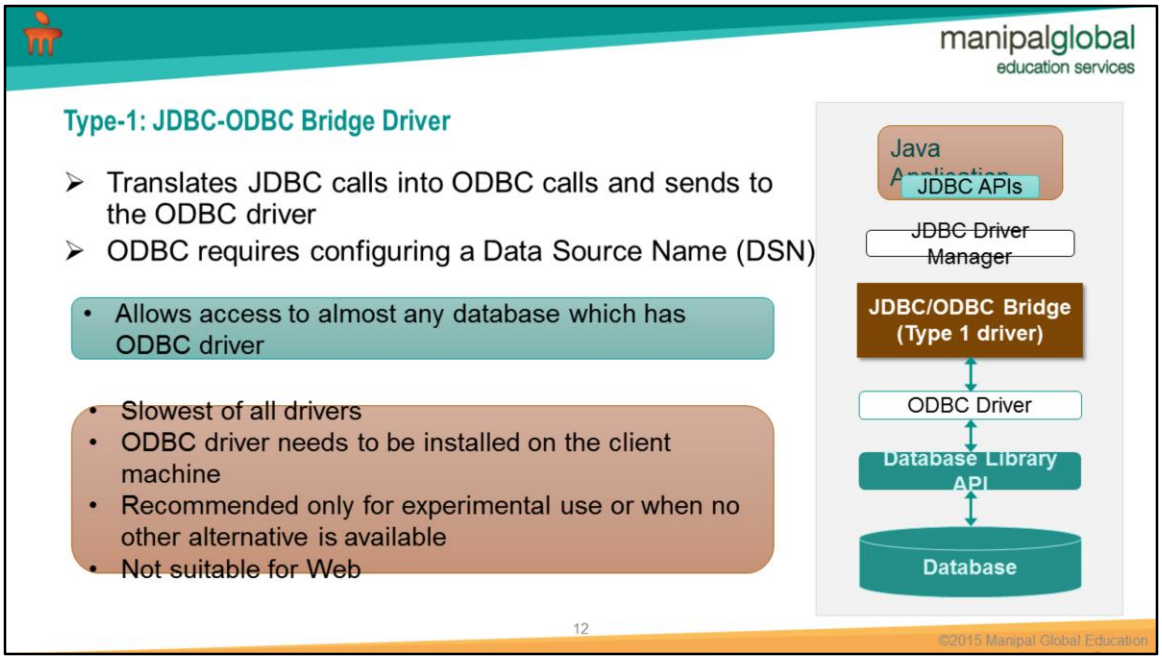
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Type-1: JDBC-ODBC Bridge Driver
Translates JDBC calls into ODBC calls and sends to the ODBC driver
ODBC requires configuring a Data Source Name (DSN)
Allows access to almost any database which has ODBC driver
Slowest of all drivers
ODBC driver needs to be installed on the client machine
Recommended only for experimental use or when no other alternative is available
Not suitable for Web
Java
JDBC APIs
JDBC Driver Manager
JDBC/ODBC Bridge (Type 1 driver)
ODBC Driver
Database Library API
Database
12
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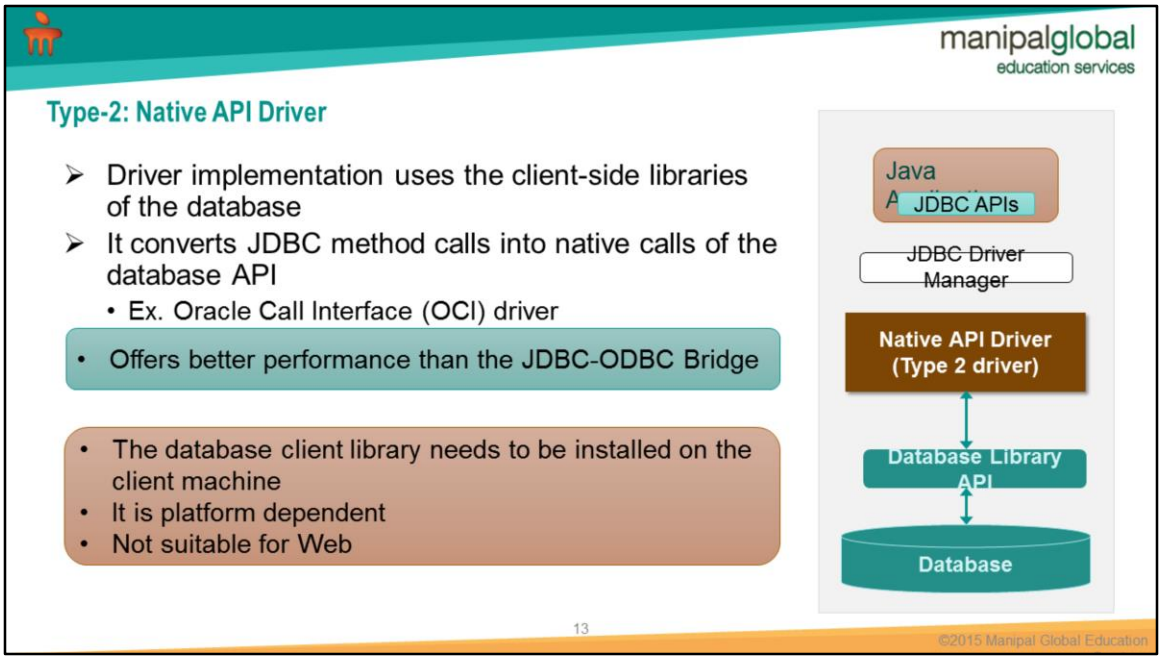
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Type-2: Native API Driver
Driver implementation uses the client-side libraries of the database
It converts JDBC method calls into native calls of the database API
Ex. Oracle Call Interface (OCI) driver
Offers better performance than the JDBC-ODBC Bridge
The database client library needs to be installed on the client machine
It is platform dependent
Not suitable for Web
Java
JDBC APIs
JDBC Driver Manager
Native API Driver (Type 2 driver)
Database Library API
Database
13
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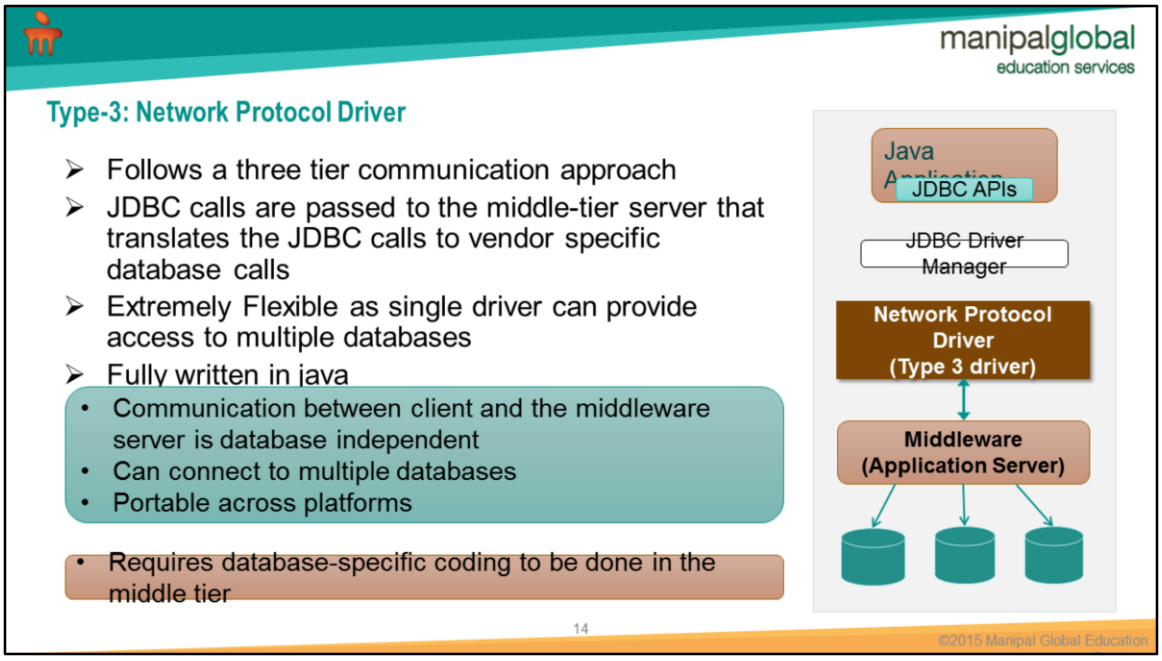
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Type-3: Network Protocol Driver
Follows a three tier communication approach
JDBC calls are passed to the middle-tier server that translates the JDBC calls to vendor specific database calls
Extremely Flexible as single driver can provide access to multiple databases
Fully written in java
Communication between client and the middleware server is database independent
Can connect to multiple databases
Portable across platforms
Requires database-specific coding to be done in the middle tier
Java
JDBC APIs
JDBC Driver Manager
Network Protocol Driver (Type 3 driver)
Middleware (Application Server)
14
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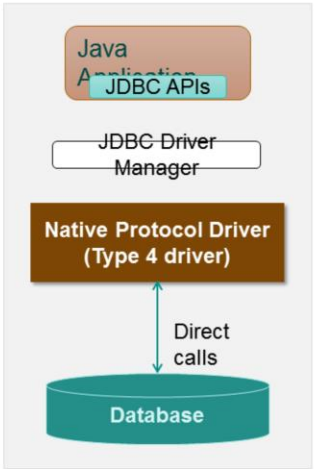
Type-4 : Native Protocol Driver

- Also known as the Direct to Database Pure Java Driver
- Uses java networking libraries to directly communicate with the database server
- Converts JDBC calls directly into a vendor-specific

- Highest performance driver available for the database
- Completely written in java to achieve platform independence

- Drivers are database dependent, hence separate driver is required for each database



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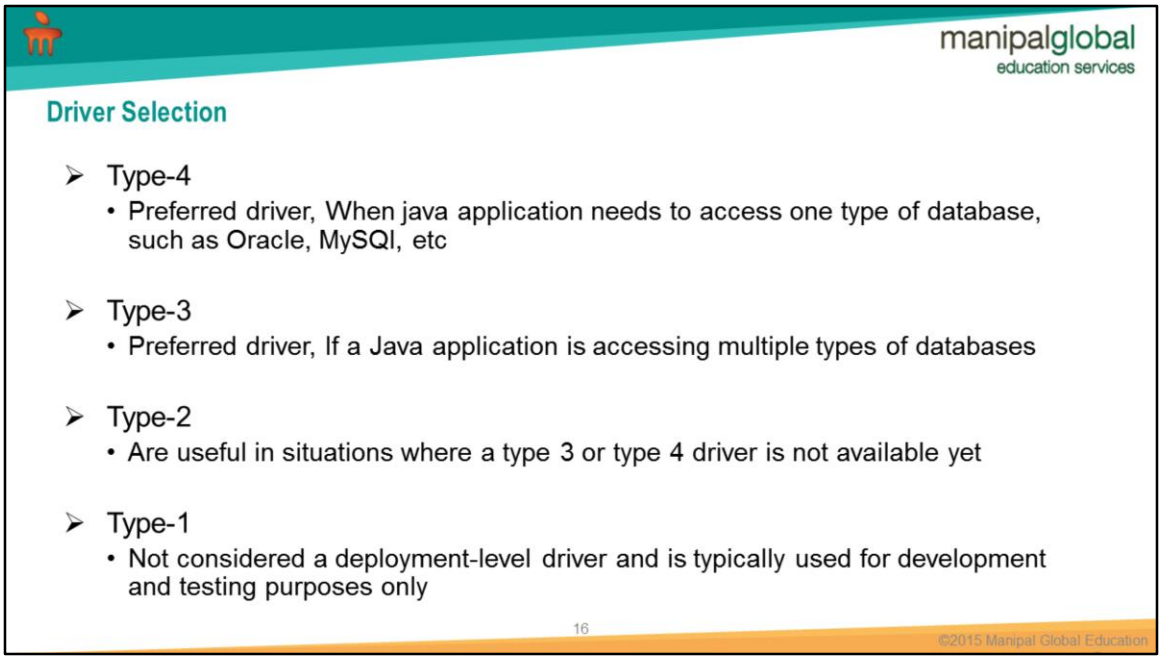
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Driver Selection
Type-4
Preferred driver, When java application needs to access one type of database, such as Oracle, MySQl, etc
Type-3
Preferred driver, If a Java application is accessing multiple types of databases
Type-2
Are useful in situations where a type 3 or type 4 driver is not available yet
Type-1
Not considered a deployment-level driver and is typically used for development and testing purposes only
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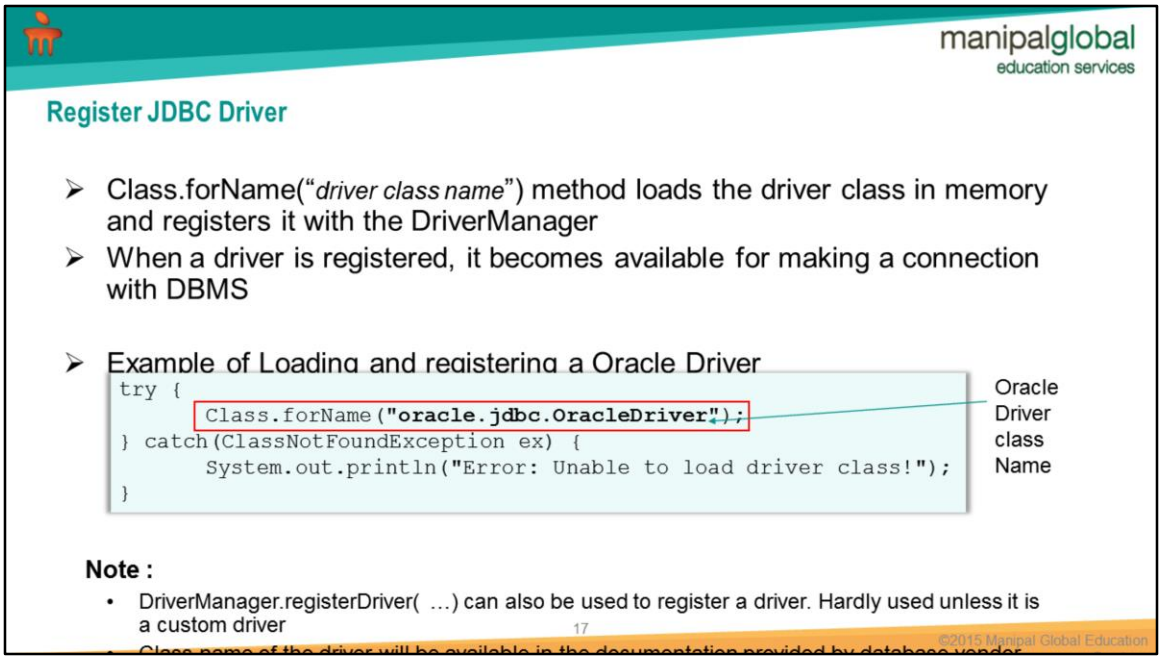
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Register JDBC Driver
Class.forName("driver class name") method loads the driver class in memory and registers it with the DriverManager
When a driver is registered, it becomes available for making a connection with DBMS
Example of Loading and registering a Oracle Driver
try {
Class.forName("oracle.jdbc.OracleDriver");
} catch(ClassNotFoundException ex) {
System.out.println("Error: Unable to load driver class!");
}
Oracle Driver class Name
Note :
DriverManager.registerDriver(…) can also be used to register a driver. Hardly used unless it is a custom driver
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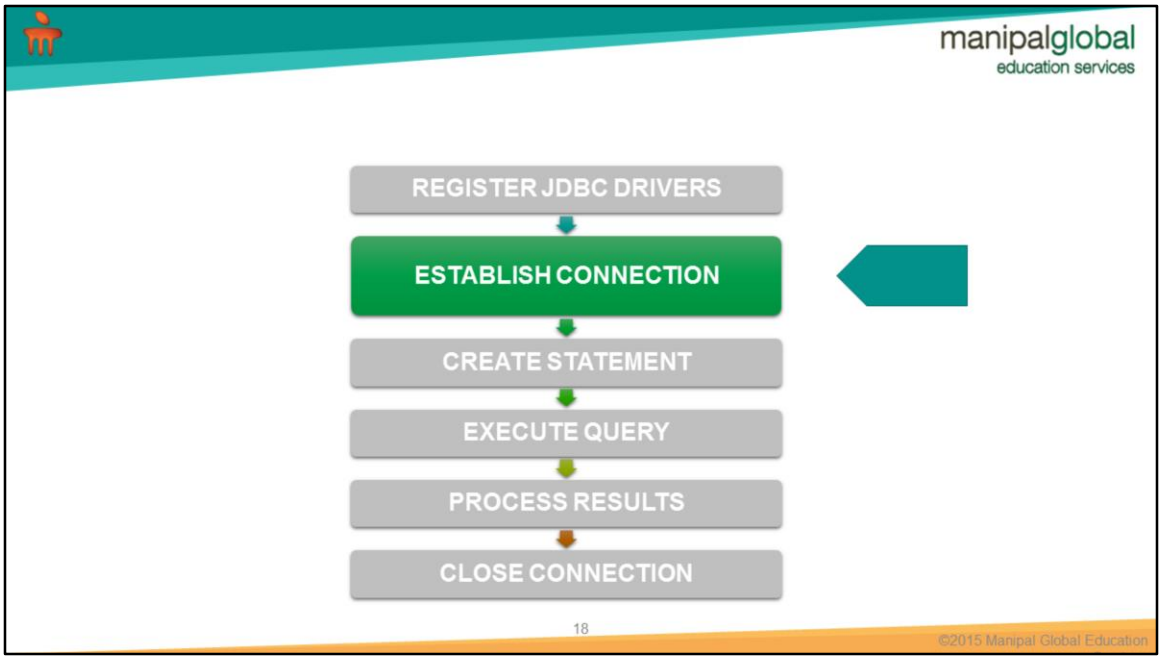
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REGISTER JDBC DRIVERS
ESTABLISH CONNECTION
CREATE STATEMENT
EXECUTE QUERY
PROCESS RESULTS
CLOSE CONNECTION
18
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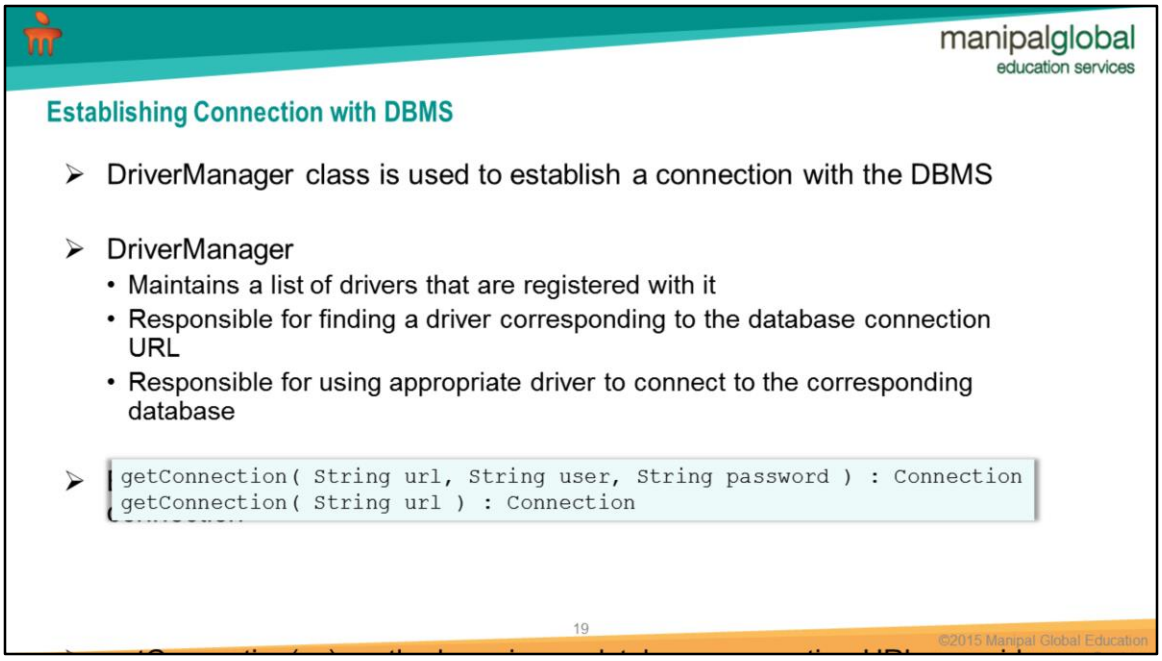
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Establishing Connection with DBMS
DriverManager class is used to establish a connection with the DBMS
DriverManager
Maintains a list of drivers that are registered with it
Responsible for finding a driver corresponding to the database connection URL
Responsible for using appropriate driver to connect to the corresponding database
getConnection(String url, String user, String password) : Connection
getConnection(String url) : Connection
19
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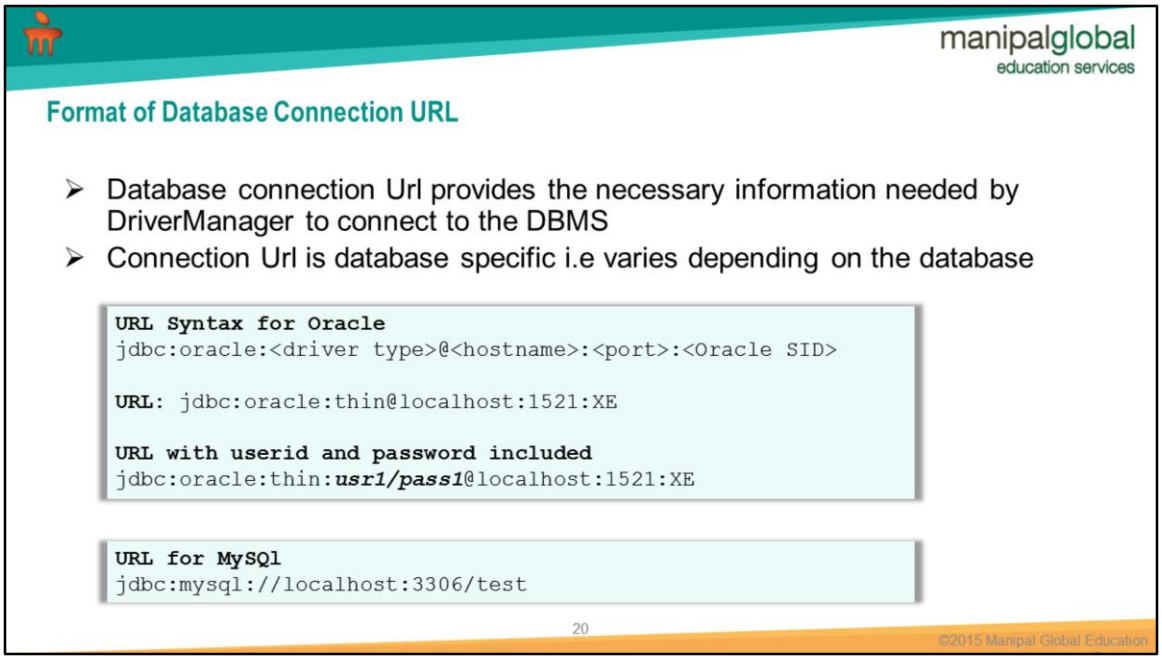
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Format of Database Connection URL
Database connection Url provides the necessary information needed by DriverManager to connect to the DBMS
Connection Url is database specific i.e varies depending on the database
URL Syntax for Oracle
jdbc:oracle:<driver type>@<hostname>:<port>:<Oracle SID>
URL: jdbc:oracle:thin@localhost:1521:XE
URL with userid and password included
jdbc:oracle:thin:usr1/pass1@localhost:1521:XE
URL for MySQl
jdbc:mysql://localhost:3306/test
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Opening a Connection using DriverManager

```
static final String DB_URL = "jdbc:oracle:thin:@localhost:1521:XE";
static final String USERID = "hr";
static final String PASSWORD = "hr";
try{
   Connection conn = DriverManager.getConnection(DB_URL, USERID, PASSWORD);
} catch(SQLException ex) {
       System.out.println("Error: Unable to open connection");
}
```

- getConnection(…) method returns a Object of type Connection
- The object returned is assigned to the Connection Interface

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Connection Interface

- Connection Interface provides methods for
  - Creating Statement Objects
  - Transaction Management
  - Getting meta data of Database
  - Ending the Connection
- Connection object represents a connection session with a database
- Java Application can have connections to multiple database or multiple connections to a single database
- Connection has to be closed once all the data access is complete for the session

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REGISTER JDBC DRIVERS
ESTABLISH CONNECTION
CREATE STATEMENT
EXECUTE QUERY
PROCESS RESULTS
CLOSE CONNECTION
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Create Statement

- createStatement() method of Connection Interface is used to create a Statement object
- Statement object is used to send SQL statements to the database.

```
try{
   Connection conn = DriverManager.getConnection(DB_URL, USERID, PASSWORD);

   Statement statement = conn.createStatement();

catch(SQLException ex) {
   System.out.println("Error: Unable to open connection");
}
```


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REGISTER JDBC DRIVERS
ESTABLISH CONNECTION
CREATE STATEMENT
EXECUTE QUERY
PROCESS RESULTS
CLOSE CONNECTION
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Executing Query

- Statement object is used to execute a static SQL query and return the results of the query
- **Statement Interface** provides methods for execution of static SQL queries

```
String sql = "Select COUNTRY_ID, COUNTRY_NAME from COUNTRIES";
try{
   Connection conn = ...
   Statement statement = conn.createStatement();

   ResultSet result = statement.executeQuery(sql);

catch(SQLException ex) {
   System.out.println("Error: Unable to open connection");
}
```


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ESTABLISH CONNECTION
CREATE STATEMENT
EXECUTE QUERY
PROCESS RESULTS
CLOSE CONNECTION
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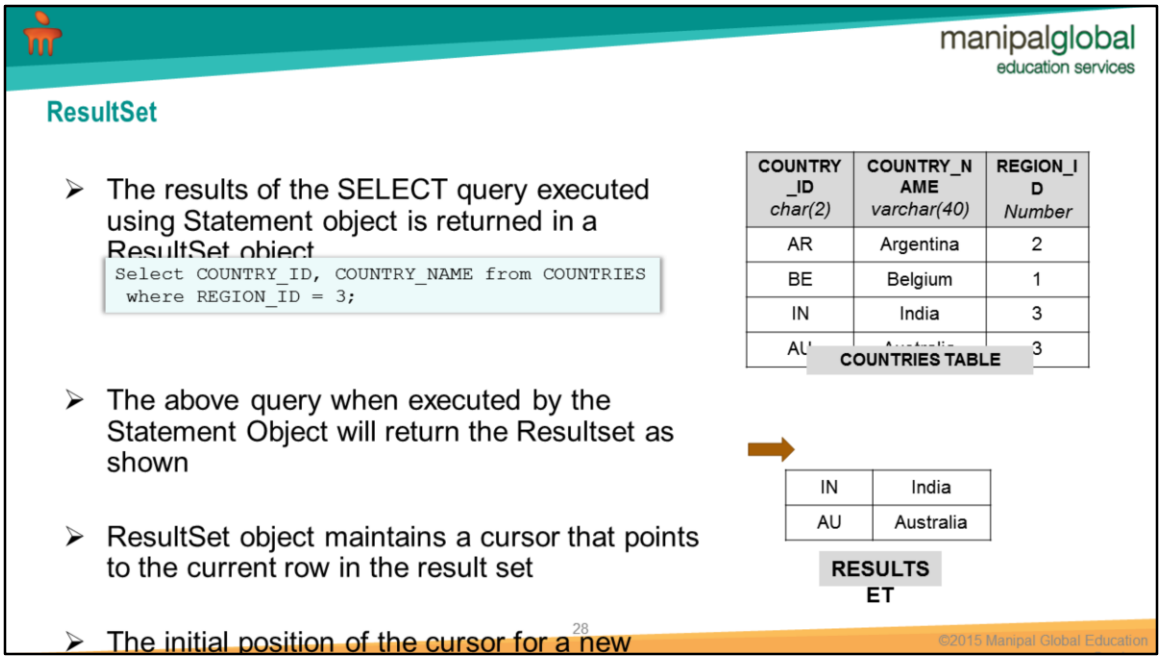
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ResultSet
The results of the SELECT query executed using Statement object is returned in a ResultSet object
Select COUNTRY_ID, COUNTRY_NAME from COUNTRIES
where REGION_ID = 3;
COUNTRY_ID char(2)
COUNTRY_NAME varchar(40)
REGION_ID Number
AR
Argentina
2
BE
Belgium
1
IN
India
3
AU
3
COUNTRIES TABLE
The above query when executed by the Statement Object will return the Resultset as shown
IN
India
AU
Australia
RESULTSET
ResultSet object maintains a cursor that points to the current row in the result set
The initial position of the cursor for a new
28
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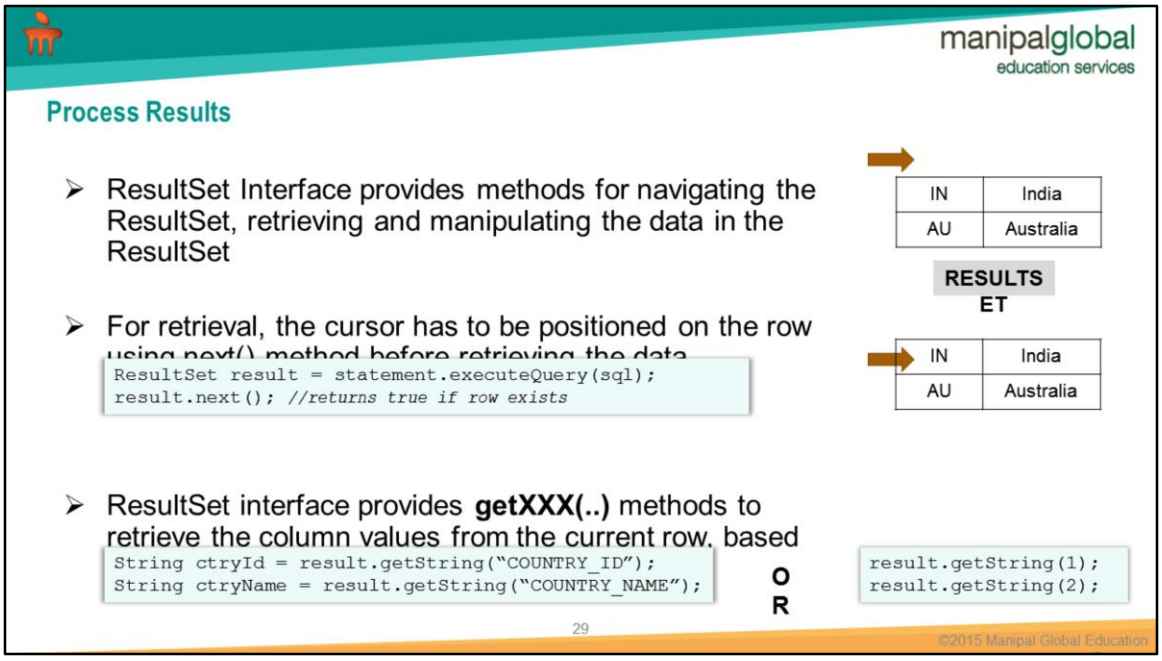
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Process Results
ResultSet Interface provides methods for navigating the ResultSet, retrieving and manipulating the data in the ResultSet
For retrieval, the cursor has to be positioned on the row using next() method before retrieving the data
ResultSet result = statement.executeQuery(sql);
result.next(); //returns true if row exists
IN India
AU Australia
RESULTS ET
IN India
AU Australia
ResultSet interface provides getXXX(..) methods to retrieve the column values from the current row, based
String ctryId = result.getString("COUNTRY_ID");
String ctryName = result.getString("COUNTRY_NAME");
OR
result.getString(1);
result.getString(2);
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REGISTER JDBC DRIVERS
ESTABLISH CONNECTION
CREATE STATEMENT
EXECUTE QUERY
PROCESS RESULTS
CLOSE CONNECTION
30
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CLOSE CONNECTION

- After retrieving the data from the Resultset, the Statement object has to be closed to release the resources held
- close() method releases the database and JDBC resources immediately
- Closing a statement object automatically closes the ResultSet object that was generated by the Statement

```
statement.close();
```

- If the Connection to Database is no more needed, It should be closed as below to release JDBC and database resources

```
connection.close();
```


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SQLException

- SQLException is thrown, If any errors occur while accessing the database using jdbc
- SQLException is defined in java.sql package

- Methods for getting details about the Exception
  - getErrorCode( )
    - Returns an error code that is specific to each vendor. Normally this will be the actual error code returned by the underlying database.
  - getMessage( )
    - Returns a string describing the error
  - getSQLState( )
    - Returns a string with the SQLState of the database error
  - getNextException( )
    - Gets the next Exception object in the exception chain

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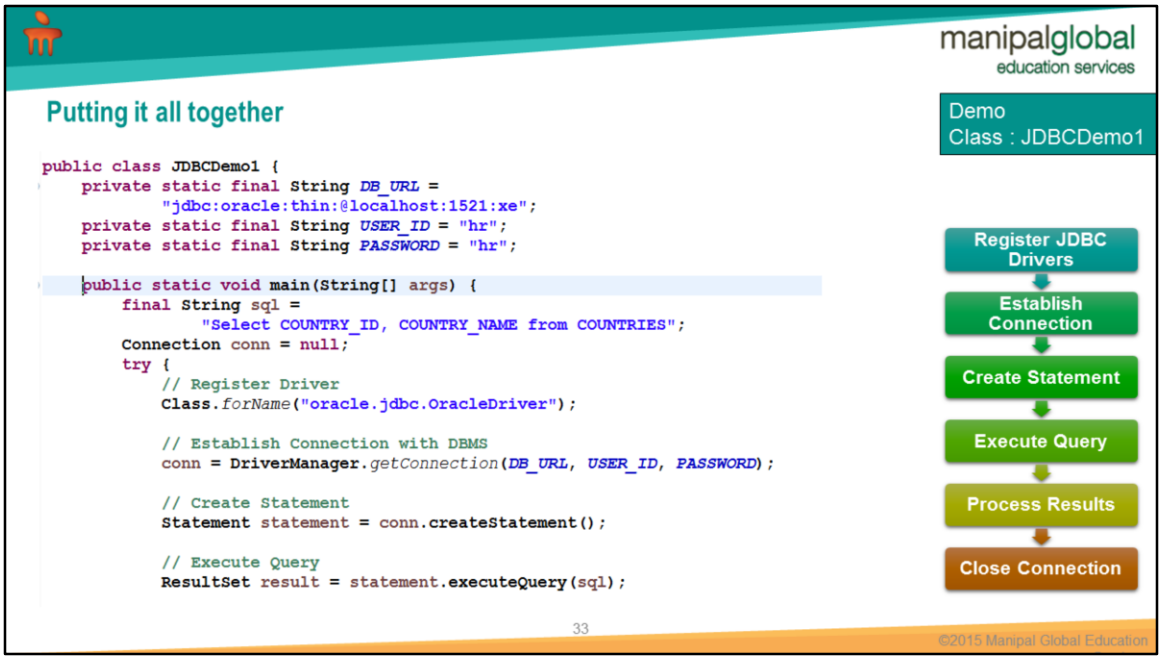
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Putting it all together
Demo
Class : JDBCDemo1
public class JDBCDemo1 {
private static final String DB_URL =
"jdbc:oracle:thin:@localhost:1521:xe";
private static final String USER_ID = "hr";
private static final String PASSWORD = "hr";
public static void main(String[] args) {
final String sql =
"Select COUNTRY_ID, COUNTRY_NAME from COUNTRIES";
Connection conn = null;
try {
// Register Driver
Class.forName("oracle.jdbc.OracleDriver");
// Establish Connection with DBMS
conn = DriverManager.getConnection(DB_URL, USER_ID, PASSWORD);
// Create Statement
Statement statement = conn.createStatement();
// Execute Query
ResultSet result = statement.executeQuery(sql);
Register JDBC Drivers
Establish Connection
Create Statement
Execute Query
Process Results
Close Connection
33
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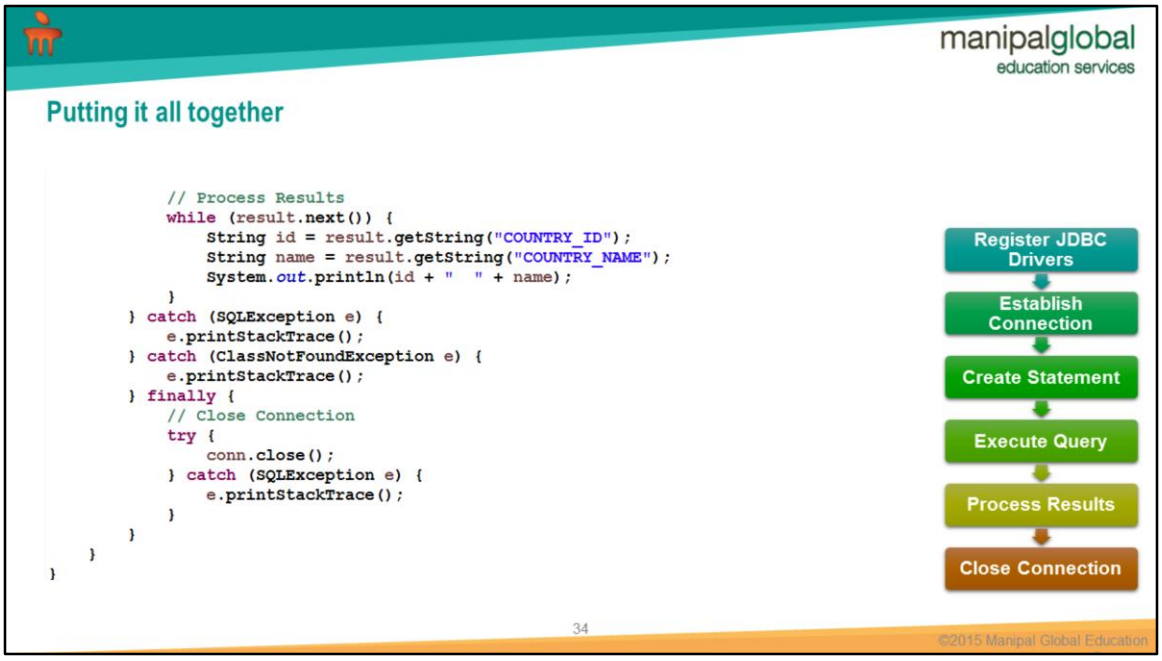
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Putting it all together
// Process Results
while (result.next()) {
String id = result.getString("COUNTRY_ID");
String name = result.getString("COUNTRY_NAME");
System.out.println(id + " " + name);
}
} catch (SQLException e) {
e.printStackTrace();
} catch (ClassNotFoundException e) {
e.printStackTrace();
} finally {
// Close Connection
try {
conn.close();
} catch (SQLException e) {
e.printStackTrace();
}
}
}
}
Register JDBC Drivers
Establish Connection
Create Statement
Execute Query
Process Results
Close Connection
34
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DATA TYPE MAPPING

- The following tables shows the mapping between Java types and SQL Data types
- The JDBC driver does the data type conversion implicitly

SQL	JAVA
VARCHAR, CHAR, LONGVARCHAR	java.lang.String
TINYINT	byte
SMALLINT	short
INTEGER	int
BIGINT	long
REAL, FLOAT	float
DOUBLE	double

SQL	JAVA
DATE	java.sql.Date
TIME	java.sql.Time
TIMESTAMP	java.sql.Timestamp
ARRAY	java.sql.Array
BINARY	byte[ ]
VARBINARY	byte[ ]
NUMERIC	java.math.BigDecimal

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SQLWarning

- SQLWarning objects are a subclass of SQLException that deal with database access warnings.
- Warnings do not stop the execution of an application, as exceptions do; they simply alert the user that something did not happen as planned
- A warning can be reported on a Connection object, a Statement object or a ResultSet object
- Each of these classes has a getWarnings method, which must be invoked

```
SQLWarning warning = stmt.getWarnings();
if (warning != null) {
        System.out.println("Warnings");
        while (warning != null) {
                System.out.println("Message: " + warning.getMessage());
                System.out.println("SQLState: " + warning.getSQLState());
                warning = warning.getNextWarning();
} }
```


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Which JDBC driver is portable and provides the highest performance?

- ❑ JDBC ODBC Bridge Driver
- ❑ Native API Driver
- ❑ Network Protocol Driver
- ❑ Native Protocol Driver

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Which of the following is not a part of Database Connection URL?

- ❑ Server IP address
- ❑ Port No
- ❑ Driver Class Name
- ❑ UserId/Password

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Which Exception should be replaced by "?" In the below code?

```
try {
        Class.forName("oracle.jdbc.OracleDriver");
} catch(? ex) {
        System.out.println("Error: Unable to load driver class!");
}
```

- SQLException
- ClassNotFoundException
- ClassCastException
- ClassFormatError
- Try-catch not required as no

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Consider result as an object of type ResultSet. Which of the following statements is/are true, when the below code is executed?

```
result.next();
```

- It returns the next resultset, if query returns multiple resultsets
- It returns false, if there are no rows in the Resultset
- It returns false, When the cursor is on the last row in the Resultset
- It returns true, when the cursor successfully moves to the next row

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References

- Refer following demo videos on EduNxt
  - Introduction To Jdbc
  - Jdbc Driver And Different Types
  - Jdbc Url
  - Overview Of Jdbc Api
  - Connection
  - Inserting A Record Using Statement

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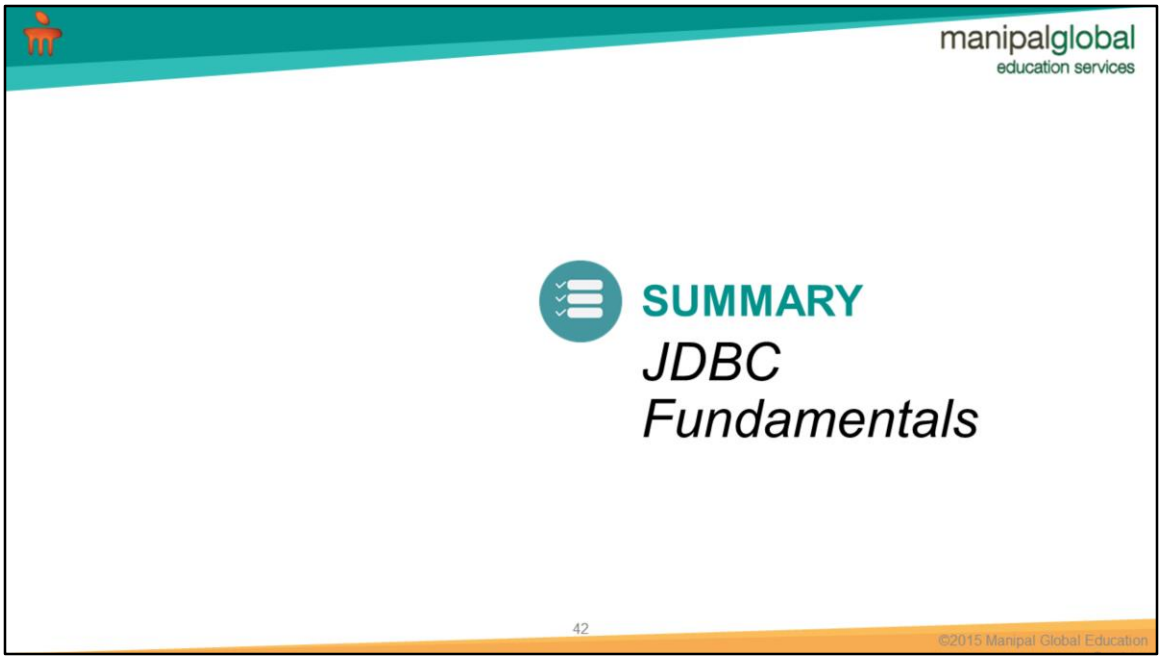
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SUMMARY
JDBC
Fundamentals
42
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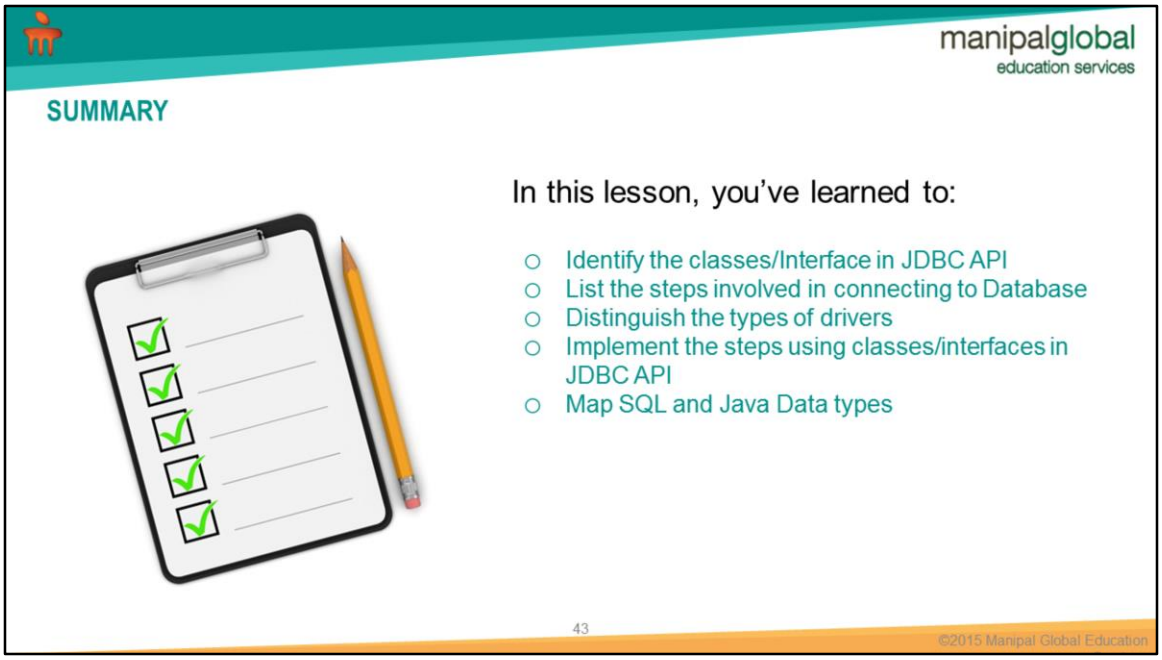
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SUMMARY
In this lesson, you've learned to:
Identify the classes/Interface in JDBC API
List the steps involved in connecting to Database
Distinguish the types of drivers
Implement the steps using classes/interfaces in JDBC API
Map SQL and Java Data types
43
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