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CMP514
Advance
Java

Advance JAVA

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Production

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Books and References:

Sr. No.	Title	Author/s	Publisher
1.	Jdbc, Servlets, and Jsp Black Book (New Edition)	Kogent Solutions Inc. Santosh Kumar K.	Dreamtech Press
2.	Head First Servlets and JSP, 2nd Edition	Bert Bates, Bryan Basham, Kathy Sierra	O'Reilly
3	Just Hibernate	Madhusudhan Konda	O'Reilly
4	Getting Started with Spring Framework	J Sharma, Ashish Sarin	

Note: This Study material is still under development and editing process. This draft is being made available for the sole purpose of reference. Final edited copies will be made available once ready.

Introduction:

Java a powerful OOP language is used for developing numerous types of client side applications and web applications.

Core Java covers the Standard J2SE concepts.

Advance Java topics cover Database Connectivity, Servlets, JSP and the different types of Java Frameworks which make development of domain specific software much easier.

Diminished Time-to-Market, Network –Centric applications are the advantages of Advance Java.

Unit 1 – JDBC

1.1 Learning Objectives

After completing this topic you will be able to create database connected Java applications.

1.2 JDBC Introduction

UNIT 1 - JDBC

A **database** is an organized collection of related data. There are many different ways for organizing data to make it easy to access and manipulate. A **database management system(DBMS)** provides mechanisms for **storing, organizing, retrieving and modifying data** from any user. **Database management systems allow for the access and storage of data without concern for the internal representation of data.**

Today's most popular database systems are **relational databases**.A language called **SQL**—is the international standard query language used almost universally with relational databases to perform **queries** and to manipulate data.

Some popular **relational database management systems (RDBMSs)** are **Microsoft SQL Server, Oracle, Sybase, MySQL,etc.** The JDK now comes with a pure-Java RDBMS called **Java DB**—Oracles's version of Apache Derby.

Java programs communicate with databases and manipulate their data using the **Java Database Connectivity (JDBC) API**.

A **JDBC driver** enables Java applications to connect to a database in a particular DBMS and allows you to manipulate that database using the JDBC API.

JDBC Introduction

The **JDBC API** is a Java API that can access any kind of tabular data, especially data stored in a Relational Database.

JDBC helps to write Java applications that manage these three programming activities:

- Connect to a data source, like a database
- Send queries

- update or modify the database
- delete records
- Retrieve and process the results received from the database in answer to your query

JDBC includes four components:

The JDBC API — The JDBC API provides programmatic access to relational data from the Java programming language. Using the JDBC API, applications can execute SQL statements, retrieve results, and transmit changes back to the underlying data source. The JDBC API can also interact with multiple data sources in a distributed, heterogeneous environment.The JDBC API is part of the Java platform, which includes the Java Standard Edition (Java SE) and the Java Enterprise Edition (Java2EE). The **JDBC 4.0 API** is divided into **two packages**: **java.sql and javax.sql**. Both packages are included in the Java SE and Java EE platforms.

JDBC Driver Manager — The JDBC DriverManager class defines objects which can connect Java applications to a JDBC driver. DriverManager has traditionally been the backbone of the JDBC architecture. It is quite small and simple.

JDBC Test Suite — The JDBC driver test suite helps you to determine that JDBC drivers will run your program. These tests are not comprehensive or exhaustive, but they do exercise many of the important features in the JDBC API.

JDBC-ODBC Bridge — The Java Software Bridge provides JDBC access via ODBC drivers. Note that you need to load ODBC binary code onto each client machine that uses this driver. As a result, the ODBC driver is most appropriate on a corporate network where client installations are not a major problem, or for application server code written in Java in three-tier architecture.

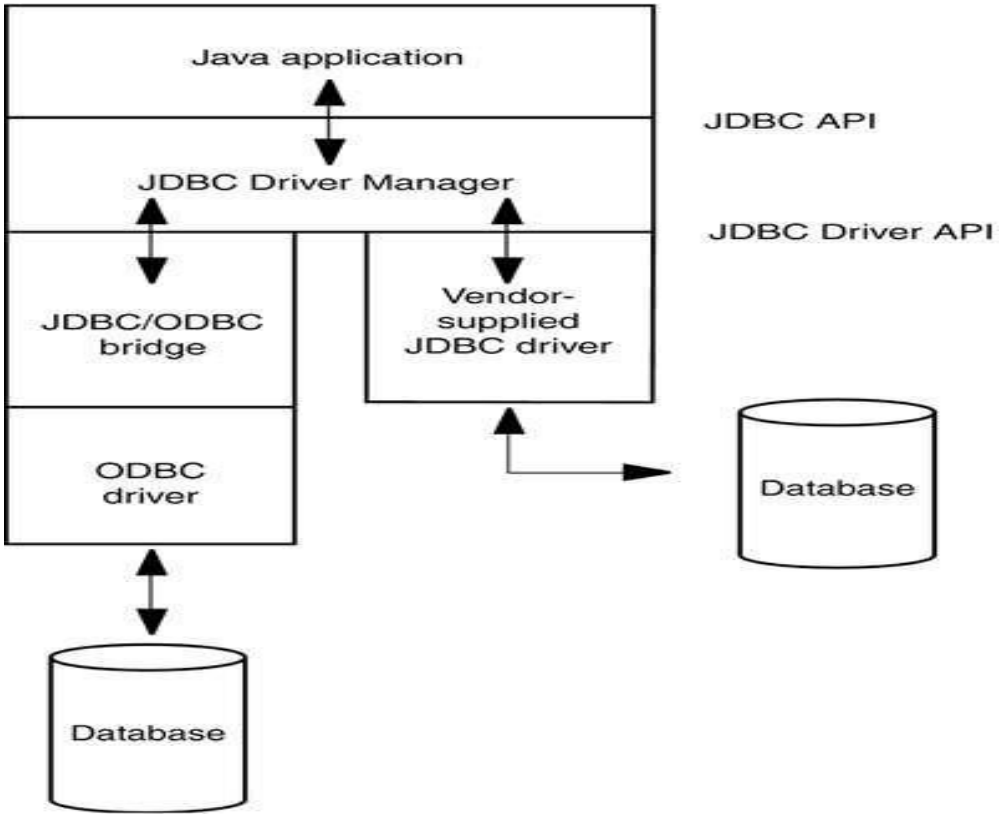


fig.JDBC-to-database communication path

JDBC Driver Types

JDBC drivers are classified into the following types:

- A **type 1 driver** translates JDBC to ODBC and relies on an ODBC driver to communicate with the database. Sun includes one such driver, the JDBC/ODBC bridge, with the JDK. However, the bridge requires deployment and proper configuration of an ODBC driver.

- A **type 2 driver** is written partly in Java and partly in native code; it communicates with the client API of a database. When you use such a driver, you must install some platform-specific code in addition to a Java library.

- A **type 3 driver** is a pure Java client library that uses a database-independent protocol to communicate database requests to a server component, which then translates the requests into a database-specific protocol. This can simplify deployment since the database-dependent code is located only on the server.

- A **type 4 driver** is a pure Java library that translates JDBC requests directly to a database-specific protocol.

Most database vendors supply either a type 3 or type 4 driver with their database. Furthermore, a number of third-party companies specialize in producing drivers with better standards conformance, support for more platforms, better performance, or, in some cases, simply better reliability than the drivers that are provided by the database vendors.

JDBC is used to for the following:

Programmers can write applications in the Java programming language to access any database, using standard SQL statements or even specialized extensions of SQLwhile still following Java language conventions.

Database vendors and database tool vendors can supply the low-level drivers. Thus, they can optimize their drivers for their specific products.

Typical Uses of JDBC

The traditional **client/server** model has a rich **GUI on the client** and **a database on the server (**figure below). In this model, a JDBC driver is deployed on the client.

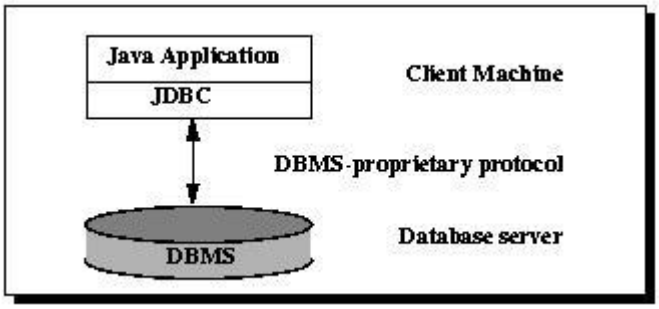
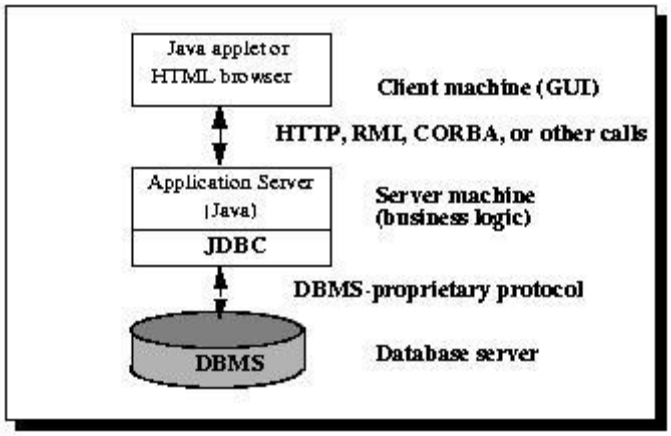


fig. Two-tier Architecture for Data Access.

However, the world is moving away from client/server and toward a **"three-tier model"** or even more advanced "n-tier models." In the three-tier model, the client does not make database calls. Instead, it calls on a middleware layer on the server that in turn makes the database queries. The three-tier model has a couple of advantages. It separates **visual presentation (on the client)** from the **business logic (in the middle tier)** and the **raw data (in the database).** Therefore, it becomes possible to access the same data and the same business rules from multiple clients, such as a Java application or applet or a web form.

Communication between the client and middle tier can occur through HTTP (when you use a web browser as the client), RMI (when you use an application), or another mechanism. JDBC manages the communication between the middle tier and the back-end database. Figure below shows the basic three tier architecture.

fig.Three-tier Architecture for Data Access



Database connections in Java using JDBC

Basic steps to use a database in Java are:

1.Establish a connection

2.Create JDBC Statements

3.Execute SQL Statements

4.GET ResultSet

5.Close connections

Establishing a connection - An object that implements **interface Connection** manages the connection between the Java program and the database. Connection objects enable programs to create SQL statements that manipulate databases. The program initializes connection with the result of a call to **static method getConnection of class DriverManager (package java.sql),** which attempts to connect to the database specified by itsURL.

Method get-Connection takes three arguments—a String that specifies the database URL, **a String that specifies the username and a String that specifies the password**.

e.g.

```
import java.sql.*;

Class.forName("sun.jdbc.odbc.JdbcOdbcDriver");

Connection conn = null;

conn = DriverManager.getConnection("jdbc:odbc:mydata","","");

// conn now has a live connection to the database
```

2. Create JDBC Statements

JDBC API provides 3 different interfaces to execute the different types of SQL queries.

They are:

1) Statement – Used to execute normal SQL queries. Parameters cannot be passed to SQL query at runtime. This interface is preferred if you are executing a particular SQL query only once. Most of the times it is used with DDL statements like CREATE,ALTER,DROP etc.

e.g.

```
//Creating The Statement Object

Statement stmt = con.createStatement();

//Executing The Statement

stmt.executeUpdate("CREATE  TABLE  STUDENT(ID NUMBER NOT NULL, NAME VARCHAR)");
```

2) PreparedStatement – PreparedStatement is used to execute dynamic or parameterized SQL queries. You can pass the parameters to SQL query at runtime using this interface. It is better to use **PreparedStatement** if you are executing a particular SQL query multiple times.

e.g

```
//Creating PreparedStatement object

PreparedStatement pstmt = con.prepareStatement("update STUDENT set NAME = ? where ID = ?");

//Setting values to place holders using setter methods of PreparedStatement object

pstmt.setString(1, "MyName");   //Assigns "MyName" to first place holder

pstmt.setInt(2, 111);     //Assigns "111" to second place holder

//Executing PreparedStatement

pstmt.executeUpdate();
```

3) CallableSatement – CallableSatement is used to execute stored procedures. Using CallableSatement you can pass 3 types of parameters to stored procedures. They are IN -
Used to pass the values to stored procedure, OUT – used to hold the result returned by stored procedure and IN OUT – acts as both IN and OUT parameter.

e.g

```
//Creating CallableStatement object

CallableStatement cstmt = con.prepareCall("{call anyProcedure(?, ?, ?)}");

Use cstmt.setter() methods to pass IN parameters

//Use cstmt.registerOutParameter() method to register OUT parameters

//Executing the CallableStatement

cstmt.execute();

//Use cstmt.getter() methods to retrieve the result returned by the stored procedur
```

Statement	PreparedStatement	CallableStatement
It is used to execute normal SQL queries.	It is used to execute parameterized or dynamic SQL queries.	It is used to call the stored procedures.
It is preferred when a particular SQL query is to be executed only once.	It is preferred when a particular query is to be executed multiple times.	It is preferred when the stored procedures are to be executed.
You cannot pass the parameters to SQL query using this interface.	You can pass the parameters to SQL query at run time using this interface.	You can pass 3 types of parameters using this interface. They are – IN, OUT and IN OUT.
This interface is mainly used for DDL statements like CREATE, ALTER, DROP etc.	It is used for any kind of SQL queries which are to be executed multiple times.	It is used to execute stored procedures and functions.
The performance of this interface is very low.	The performance of this interface is better than the Statement interface (when used for multiple execution of same query).	The performance of this interface is high.

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

Retrieving and Modifying Values from Result Sets

A ResultSet object is a table of data representing a database result set, which is usually generated by executing a statement that queries the database. A ResultSet object can be created through any object that implements the Statement interface, including PreparedStatement, CallableStatement, and RowSet.

You access the data in a ResultSet object through a cursor. Note that this cursor is not a database cursor. This cursor is a pointer that points to one row of data in the ResultSet. Initially, the cursor is positioned before the first row. The method **ResultSet.next()** moves the cursor to the next row. This method returns false if the cursor is positioned after the last row. This method repeatedly calls the ResultSet.next method with a while loop to iterate through all the data in the ResultSet.

ResultSet Interface

The ResultSet interface provides methods for retrieving and manipulating the results of executed queries, and ResultSet objects can have different functionality and characteristics. These characteristics are **type, concurrency, and cursor hold ability.**

ResultSet Types

The type of a ResultSet object determines the level of its functionality in two areas: the ways in which the cursor can be manipulated, and how concurrent changes made to the underlying data source are reflected by the ResultSet object.

The sensitivity of a ResultSet object is determined by one of three different ResultSet types:

(a)TYPE_FORWARD_ONLY: The result set cannot be scrolled; its cursor moves forward only, from before the first row to after the last row. The rows contained in the result set depend on how the underlying database generates the results. That is, it contains the rows that satisfy the query at either the time the query is executed or as the rows are retrieved.

(b)TYPE_SCROLL_INSENSITIVE: The result can be scrolled; its cursor can move both forward and backward relative to the current position, and it can move to an absolute position. The result set is insensitive to changes made to the underlying data source while it is open. It contains the rows that satisfy the query at either the time the query is executed or as the rows are retrieved.

(c)TYPE_SCROLL_SENSITIVE: The result can be scrolled; its cursor can move both forward and backward relative to the current position, and it can move to an absolute position. The result set reflects changes made to the underlying data source while the result set remains open.

The default ResultSet type is TYPE_FORWARD_ONLY.

Note: Not all databases and JDBC drivers support all ResultSet types. The method DatabaseMetaData.supportsResultSetType returns true if the specified ResultSet type is supported and false otherwise.

ResultSet Concurrency

The concurrency of a ResultSet object determines what level of update functionality is supported.

There are two concurrency levels:

CONCUR_READ_ONLY: The ResultSet object cannot be updated using the ResultSet interface.
CONCUR_UPDATABLE: The ResultSet object can be updated using the ResultSet interface.

The default ResultSet concurrency is CONCUR_READ_ONLY.

Note: Not all JDBC drivers and databases support concurrency. The method DatabaseMetaData.supportsResultSetConcurrency returns true if the specified concurrency level is supported by the driver and false otherwise.

Cursor Holdability

Calling the method Connection.commit can close the ResultSet objects that have been created during the current transaction. In some cases, however, this may not be the desired behavior. The ResultSet property holdability gives the application control over whether ResultSet objects (cursors) are closed when commit is called.

The following ResultSet constants may be supplied to the Connection methods createStatement, prepareStatement, and prepareCall:

HOLD_CURSORS_OVER_COMMIT: ResultSet cursors are not closed; they are holdable: they are held open when the method commit is called. Holdable cursors might be ideal if your application uses mostly read-only ResultSet objects.

CLOSE_CURSORS_AT_COMMIT: ResultSet objects (cursors) are closed when the commit method is called. Closing cursors when this method is called can result in better performance for some applications.

The default cursor hold ability varies depending on your DBMS.

Retrieving Column Values from Rows

The ResultSet interface declares **getter methods** (for example, **getBoolean and getLong**) for retrieving column values from the current row. You can retrieve values using either the index number of the column or the alias or name of the column. The column index is usually more efficient. Columns are numbered from 1. For maximum portability, result set columns within each row should be read in left-to-right order, and each column should be read only once.

```
try
{

    // create Statement for querying database
       statement =
       connection.createStatement();


    // query database

  resultSet = statement.executeQuery(
    "SELECT AuthorID, FirstName, LastName FROM authors" );
```

```
// process query results
ResultSetMetaData metaData = resultSet.getMetaData(); int
    numberOfColumns = metaData.getColumnCount();
    System.out.println( "Authors Table of Books Database:\n"
    );

for ( int i = 1; i <= numberOfColumns; i++ )
      System.out.printf( "%-8s\t", metaData.getColumnName( i ) );
    System.out.println();

while ( resultSet.next() )
{
    int id = rs.getInt("AuthorID");
    String firstName = rs.getString("FirstName");
    String lastName = rs.getString("LastName");
    System.out.println(id+ "\t" + firstName+
            "\t" + lastName );
    }   //   end
  while } // end
  try
catch ( SQLException sqlException )
{
  sqlException.printStackTrace();
} // end catch
```

Cursors

As mentioned previously, you access the data in a **ResultSet object through a cursor**, which points to one row in the ResultSet object. However, when a ResultSet object is first created, the cursor is positioned before the first row.There are other methods available to move the cursor:

next: Moves the cursor forward one row. Returns true if the cursor is now positioned on a row and false if the cursor is positioned after the last row.

previous: Moves the cursor backward one row. Returns true if the cursor is now positioned on a row and false if the cursor is positioned before the first row.

first: Moves the cursor to the first row in the ResultSet object. Returns true if the cursor is now positioned on the first row and false if the ResultSet object does not contain any rows.

last: Moves the cursor to the last row in the ResultSet object. Returns true if the cursor is now positioned on the last row and false if the ResultSet object does not contain any rows.

beforeFirst: Positions the cursor at the start of the ResultSet object, before the first row. If the ResultSet object does not contain any rows, this method has no effect.

afterLast: Positions the cursor at the end of the ResultSet object, after the last row. If the ResultSet object does not contain any rows, this method has no effect. **relative(int rows):** Moves the cursor relative to its current position.

absolute(int row): Positions the cursor on the row specified by the parameter row.

Note that the default sensitivity of a ResultSet is TYPE_FORWARD_ONLY, which means that it cannot be scrolled; you cannot call any of these methods that move the cursor, except next, if your ResultSet cannot be scrolled.

Updating Rows in ResultSet Objects

You cannot update a default ResultSet object, and you can only move its cursor forward. However, you can create ResultSet objects that can be scrolled (the cursor can move backwards or move to an absolute position) and updated.

```
try {
    // establish connection to database
        connection =
        DriverManager.getConnection(
        DATABASE_URL, "root", "" );

     statement                                                    =
          connection.createStatement(ResultSet.TYPE_SCROLL_SENSITIVE,
          ResultSet.CONCUR_UPDATABLE);
 ResultSet uprs= statement.executeQuery("SELECT * FROM authors");

  while (uprs.next()) {
    uprs.updateString( "LastName","Sharma");
    uprs.updateRow();
  }
 }
catch ( SQLException sqlException )
 {
   sqlException.printStackTrace();
 } // end catch
```

The field **ResultSet.TYPE_SCROLL_SENSITIVE** creates a ResultSet object whose cursor can move both forward and backward relative to the current position and to an absolute position. The field **ResultSet.CONCUR_UPDATABLE** creates a ResultSet object that can be updated. See the ResultSet Javadoc for other fields you can specify to modify the behavior of ResultSet objects.

The method **ResultSet.updateString** updates the specified column (in this example, LastName with the specified float value in the row where the cursor is positioned. ResultSet contains various updater methods that enable you to update column values of various data types. However, none of these

updater methods modifies the database; you must call the method **ResultSet.updateRow to update the database**.

Inserting Rows in ResultSet Objects

Note: Not all JDBC drivers support inserting new rows with the ResultSet interface. If you attempt to insert a new row and your JDBC driver database does not support this feature, a SQLFeatureNotSupportedException exception is thrown.

```
try {
     statement                                                    =
       connection.createStatement(ResultSet.TYPE_SCROLL_SENSITIVE,
       ResultSet.CONCUR_UPDATABLE);

 ResultSet uprs = statement.executeQuery(
    "SELECT * FROM authors");

 uprs.moveToInsertRow();
 uprs.updateInt("AuthorID",9);
 uprs.updateString("FirstName","Subash");
 uprs.updateString("LastName","Pakhrin");
 uprs.insertRow();
 uprs.beforeFirst();
}
 catch ( SQLException sqlException )
{
  sqlException.printStackTrace();
} // end catch
```

This example calls the Connection.createStatement method with two arguments, **ResultSet.TYPE_SCROLL_SENSITIVE and ResultSet.CONCUR_UPDATABLE**. The first value enables the cursor of the ResultSet object to be moved both forward and backward. The second value, ResultSet.CONCUR_UPDATABLE, is required if you want to insert rows into a ResultSet object; it specifies that it can be updatable.

The same stipulations for using strings in getter methods also apply to updater methods.

The method **ResultSet.moveToInsertRow** moves the cursor to the insert row. The insert row is a special row associated with an updatable result set. It is essentially **a buffer** where a new row can be constructed by calling the updater methods prior to inserting the row into the result set. For example, this method calls the method ResultSet.updateString to update the insert row's COF_NAME column to Kona.

The method ResultSet.insertRow inserts the contents of the insert row into the ResultSet object and into the database.

Note: After inserting a row with the ResultSet.insertRow, you should move the cursor to a row other than the insert row. For example, this example moves it to before the first row in the result set with the method **ResultSet.beforeFirst**. Unexpected results can occur if another part of your application uses the same result set and the cursor is still pointing to the insert row.

Using Statement Objects for Batch Updates

Statement, PreparedStatement and CallableStatement objects have a list of commands that is associated with them. This list may contain statements for updating, inserting, or deleting a row; and it may also contain DDL statements such as CREATE TABLE and DROP TABLE. It cannot, however, contain a statement that would produce a ResultSet object, such as a SELECT statement. In other words, the list can contain only statements that produce an update count.

The list, which is associated with a Statement object at its creation, is initially empty. You can add SQL commands to this list with the method addBatch and empty it with the method clearBatch. When you have finished adding statements to the list, call the method **executeBatch** to send them all to the database to be executed as a unit, or batch.

```
try {
   connection = DriverManager.getConnection(
     DATABASE_URL, "root", "" );
 connection.setAutoCommit(false);
 statement = connection.createStatement();

statement.addBatch(
    "INSERT INTO authors " +
    "VALUES('15','Hari','Shrestha')");

 statement.addBatch(
    "INSERT INTO authors " +
    "VALUES('16','Ram','Acharya')");

 statement.addBatch(
    "INSERT INTO authors " +
    "VALUES('17','Shyam','Gautam')");

statement.addBatch(
    "INSERT INTO authors " +
    "VALUES('18','Govinda','Paudel')");

 int [] updateCounts = statement.executeBatch();
connection.commit();
```

```
    } catch(BatchUpdateException  b)
      { b.printStackTrace();
    } catch(SQLException  ex)
      { ex.printStackTrace();
}
```

The following line disables auto-commit mode for the Connection object con so that the **transaction** will not be automatically committed or rolled back when the method executeBatch is called. **connection.setAutoCommit(false);**

To allow for correct error handling, you should always disable auto-commit mode before beginning a batch update.

The method **Statement.addBatch** adds a command to the list of commands associated with the Statement object statement. In this example, these commands are all INSERT INTO statements, each one adding a row consisting of three column values.

The following line sends the four SQL commands that were added to its list of commands to the database to be executed as a batch:

int [] updateCounts = statement.executeBatch();

Note that **statement** uses the method **executeBatch** to send the batch of insertions, **not the method executeUpdate**, **which sends only one command and returns a single update count.** The DBMS executes the commands in the order in which they were added to the list of commands, so it will first add the row of values for "Hari" , then add the row for "Ram", then "Shyam" , and finally "Govinda". If all four commands execute successfully, the DBMS will return an update count for each command in the order in which it was executed. The update counts that indicate how many rows were affected by each command are stored in the array updateCounts.

If all four of the commands in the batch are executed successfully, updateCounts will contain four values, all of which are 1 because an insertion affects one row. The list of commands associated with stmt will now be empty because the four commands added previously were sent to the database when stmt called the method executeBatch. You can at any time explicitly empty this list of commands with the method clearBatch.

The Connection.commit method makes the batch of updates to the "authors" table permanent. This method needs to be called explicitly because the auto-commit mode for this connection was disabled previously.

The following line enables auto-commit mode for the current Connection object.

connection.setAutoCommit(true);

Now each statement in the example will automatically be committed after it is executed, and it no longer needs to invoke the method commit.

Transaction Processing

Many database applications require guarantees that a series of database insertions, updates and deletions executes properly before the application continues processing the next database operation. For example, when you transfer money electronically between bank accounts, several factors determine if the transaction is successful. You begin by specifying the source account and the amount you wish to transfer from that account to a destination account. Next, you specify the destination account. The bank checks the source account to determine whether its funds are sufficient to complete the transfer. If so, the bank withdraws the specified amount and, if all goes well, deposits it into the destination account to complete the transfer. What happens if the transfer fails after the bank withdraws the money from the source account? In a proper banking system, the bank redeposits the money in the source account.The way to be sure that either both actions occur or neither action occurs is to use a **transaction. A transaction is a set of one or more statements that is executed as a unit, so either all of the statements are executed, or none of the statements is executed.**

The way to allow two or more statements to be **grouped into a transaction** is to **disable the auto-commit mode.**

Disabling Auto-Commit Mode

When a connection is created, it is in auto-commit mode. This means that each individual SQL statement is treated as a transaction and is automatically committed right after it is executed.

The way to allow two or more statements to be **grouped into a transaction** is to **disable the auto-commit mode.**

con.setAutoCommit(false);

Committing Transactions

After the auto-commit mode is disabled, no SQL statements are committed until you call the **method commit explicitly**. All statements executed after the previous call to the method commit are included in the **current transaction and committed together as a unit**. **con.commit();**

Rollback

If you group update statements to a transaction, then the transaction either succeeds in its entirety and it can be committed, or it fails somewhere in the middle. In that case, you can carry out a **rollback** and **the database automatically undoes the effect of all updates that occurred since the last committed transaction**.

You turn off autocommit mode with the command

conn.setAutoCommit(false);

Now you create a statement object in the normal way:

Statement stat = conn.createStatement();

Call executeUpdate any number of times:

stat.executeUpdate(command1);

stat.executeUpdate(command2);

stat.executeUpdate(command3);

. . .

When all commands have been executed, call the commit method:

conn.commit();

However, if an error occurred, call

conn.rollback();

Then, all commands until the last commit are automatically reversed. You typically issue a rollback when your transaction was interrupted by a SQLException.

RowSet Interface

A JDBC RowSet object holds tabular data in a way that makes it more flexible and easier to use than a result set.The RowSet interface configures the database connection and prepares query statements automatically.It provides several **set methods** that allow you to specify the properties needed to establish a connection (such as the database URL, user name and password of the database) and create a Statement (such as a query). RowSet also provides several **get methods** that return these properties.

Connected and Disconnected RowSets

There are **two types of RowSet objects—connected and disconnected**. A **connected RowSet** object connects to the database once and remains connected while the object is in use. A **disconnected RowSet** object connects to the database, executes a query to retrieve the data from the database and then closes the connection. A program may change the data in a disconnected RowSet while it's disconnected. Modified data can be updated in the database

after a disconnected RowSet reestablishes the connection with the database.

Package javax.sql.rowset contains two subinterfaces of RowSet—**JdbcRowSet** and **CachedRowSet**. JdbcRowSet, a connected RowSet, acts as a wrapper around a ResultSet object and allows you to scroll through and update the rows in the ResultSet. By default, a ResultSet object is nonscrollable and read only—you must explicitly set the result set type constant to TYPE_SCROLL_INSENSITIVE and set the result set concurrency constant to CONCUR_UPDATABLE to make a ResultSet object scrollable and updatable.

A JdbcRowSet object is scrollable and updatable by default. CachedRowSet, a disconnected

RowSet, caches the data of a ResultSet in memory and disconnects from the database.Like JdbcRowSet, a CachedRowSet object is scrollable and updatable by default. A Cached-RowSet object is also serializable, so it can be passed between Java applications through a network, such as the Internet. However, CachedRowSet has a limitation—the amount of data that can be stored in memory is limited. Package javax.sql.rowset contains three other subinterfaces of RowSet:**WebRowSet,JoinRowSet and FilteredRowSet.**

JdbcRowSet

Navigating JdbcRowSet Objects

```
JdbcRowSet jdbcRs = new JdbcRowSetImpl();
jdbcRs.absolute(4);
jdbcRs.previous();
```

Updating Column Values

```
jdbcRs.absolute(3);
jdbcRs.updateString("lastName", "Sharma");
jdbcRs.updateRow();
```

Inserting Rows

```
jdbcRs.moveToInsertRow();
jdbcRs.updateInt("Author_ID", 10);
jdbcRs.updateString("FirstName", "Navin");
jdbcRs.updateString("LastName", "Sharma");
jdbcRs.insertRow();
```

Deleting Rows

```
jdbcRs.last();
jdbcRs.deleteRow();
```

References:

https://docs.oracle.com
https://www.javatpoint.com

UNIT 2 SERVLETS

Structure **Page Nos.**

2.0 INTRODUCTION

Till now we have learned how to connect a Java Application to a Database. In this Unit we will learn a Server side technology known as Servlet that extends the capability of a Web server.

2.1 OBJECTIVE

After going through this unit you will be able to explain.

- What is a Servlet?
- The various Servlet API
- What is the Life-cycle of a Servlet?
- How to run a servlet in Apache Tomcat Server?
- Types of servlets. Generic and HTTP
- What is a session?
- How to bind a Session?
- Session tracking.
- How servlets of a web application communicate with each other?

2.2 What is a Java Servlet?

Servlets are Java programs that can be run dynamically from a Web Server. They are a Server side technology.A Servlet is an intermediating layer between an HTTP request of a client and the Web server.

For example, a Servlet might be responsible for taking data in an HTML order-entry form and applying the business logic used to update a company's order database

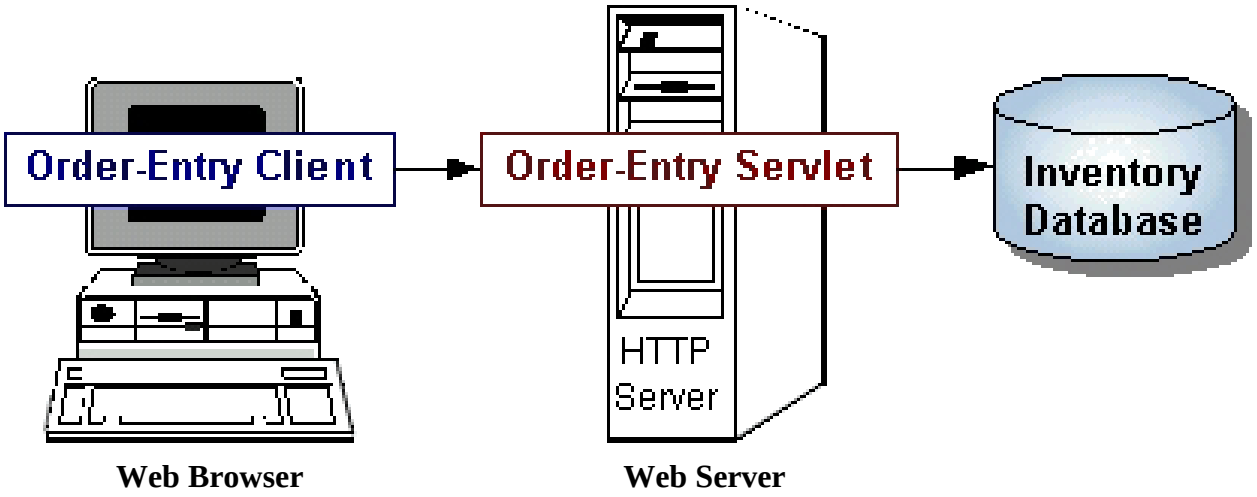


Figure 2.1

2.3 Servlet API

The Servlet API is made up of two packages. These packages contains the classes and interfaces required to build servlets.They are **javax.servlet** and **javax.servlet.http.** These packages are not part of the Java core packages. Instead, they are standard extensions. Therefore, they are not included in the Java Software Development Kit. You must download Tomcat or Glass Fish server to obtain their functionality.

The javax.servlet Package

The **javax.servlet package** contains a number of interfaces and classes that establish the framework in which servlets operate.

The following table lists the **core interfaces** that are provided in this package. The most important is **Servlet**. All servlets you create must implement this interface or extend to a class that implements this interface.

The **ServletRequest** and **ServletResponse** interfaces are also very important.

Interface	**Description**
Servlet	Declares life cycle methods for a servlet.
ServletConfig	Allows servlets to get initialization parameters.
ServletContext	Enables servlets to log events and access information about their environment.
ServletRequest	Used to read data from a client request.
ServletResponse	Used to write data to a client response.
SingleThreadModel	Indicates that the servlet is thread safe.

The following table summarizes the **core classes** that are provided in the javax.servlet package.

Class	**Description**
GenericServlet	Implements the Servlet and ServletConfig interfaces.
ServletInputStream	Provides an input stream for reading requests from a client.
ServletOutputStream	Provides an output stream for writing responses to a client.
ServletException	Indicates a servlet error occurred.
UnavailableException	Indicates a servlet is unavailable.

The Servlet Interface

All servlets must implement the **Servlet interface**. It declares the **init( ), service( ), and destroy( ) methods** that are called by the server during the life cycle of a servlet. The methods defined by Servlet are shown below:

Method Summary	
void	**destroy**() Called by the servlet container to indicate to a servlet that the servlet is being taken out of service.
ServletConfig	**getServletConfig**() Returns a ServletConfig object, which contains initialization and startup parameters for this servlet.
java.lang.String	**getServletInfo**() Returns information about the servlet, such as author, version, and copyright.
void	**init**(ServletConfig config) Called by the servlet container to indicate to a servlet that the servlet is being placed into service.
void	**service**(ServletRequest req, ServletResponse res) Called by the servlet container to allow the servlet to respond to a request.

Table 2.1

The ServletRequest Interface

The ServletRequest interface is implemented by the server. It enables a servlet to obtain information about a client request. Several of its methods are summarized in Table below.

Method	Description
Object getAttribute(String *attr*)	Returns the value of the attribute named *attr*.
String getCharacterEncoding( )	Returns the character encoding of the request.
int getContentLength( )	Returns the size of the request. The value –1 is returned if the size is unavailable.
String getContentType( )	Returns the type of the request. A **null** value is returned if the type cannot be determined.
ServletInputStream getInputStream( ) throws IOException	Returns a **ServletInputStream** that can be used to read binary data from the request. An **IllegalStateException** is thrown if **getReader( )** has already been invoked for this request.
String getParameter(String *pname*)	Returns the value of the parameter named *pname*.
Enumeration getParameterNames( )	Returns an enumeration of the parameter names for this request.
String[ ] getParameterValues(String *name*)	Returns an array containing values associated with the parameter specified by *name*.
String getProtocol( )	Returns a description of the protocol.
BufferedReader getReader( ) throws IOException	Returns a buffered reader that can be used to read text from the request. An **IllegalStateException** is thrown if **getInputStream( )** has already been invoked for this request.
String getRemoteAddr( )	Returns the string equivalent of the client IP address.
String getRemoteHost( )	Returns the string equivalent of the client host name.
String getScheme( )	Returns the transmission scheme of the URL used for the request (for example, "http", "ftp").
String getServerName( )	Returns the name of the server.
int getServerPort( )	Returns the port number.

Table 2.2

The ServletResponse Interface

The ServletResponse interface is implemented by the server. It enables a servlet to formulate a response for a client. Several of its methods are summarized in Table below.

Method	Description
String getCharacterEncoding( )	Returns the character encoding for the response.
ServletOutputStream getOutputStream( ) throws IOException	Returns a **ServletOutputStream** that can be used to write binary data to the response. An **IllegalStateException** is thrown if **getWriter( )** has already been invoked for this request.
PrintWriter getWriter( ) throws IOException	Returns a **PrintWriter** that can be used to write character data to the response. An **IllegalStateException** is thrown if **getOutputStream( )** has already been invoked for this request.
void setContentLength(int *size*)	Sets the content length for the response to *size*.
void setContentType(String *type*)	Sets the content type for the response to *type*.

Table 2.3

2.4 Servlet Life-Cycle

The life-cycle of a servlet is the entire process or steps from its creation till its destruction. The entire process is maintained by the Servlet Container.

A servlet's life cycle is managed via the init(), service() and destroy() methods.

The following figure shows the Servlet Life-Cycle.

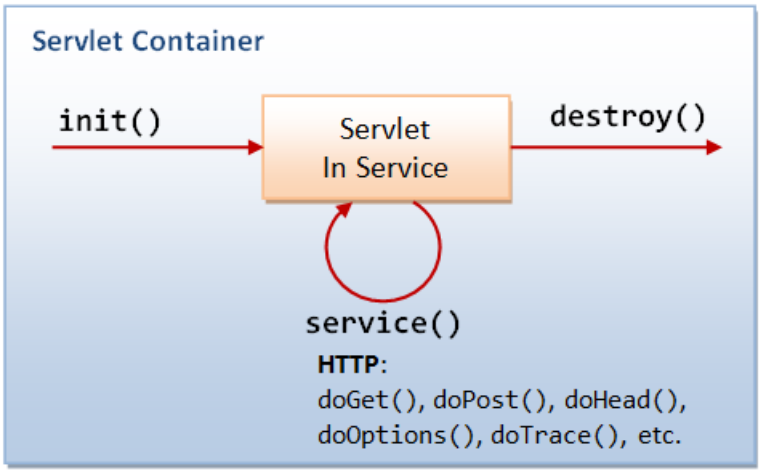


Figure 2.2

The steps of the life cycle of the servlet are:

1. The server loads the Servlet class and initializes one instance of it
2. Servlet instance is created. Each client request is handled by the Serlvet instance in a separate thread
3. init() method is invoked.
4. service() method is invoked.
5. destroy () method is invoked.

Step 1-3: Loading and Initialization

Servlet container (e.g., Tomcat or Glassfish) is responsible for loading and instantiating servlets. It may load and instantiate servlets when it is started, or delay until it determines that the servlet is needed to service a request (usually at the first request to the servlet).

The servlet container invokes the init(ServletConfig) method of the servlet, providing a ServletConfig object as an argument. init() runs only once. It is usually used to read persistent configuration data and initialize costly resource.

This ServletConfig object allows the servlet to access *initialization parameters* for this particular servlet.

These parameters are defined in the *web application deployment descriptor file* (i.e., "web.xml"), under the servlet's name, as follows:

```
<servlet>
  <servlet-name>ServletName</servlet-name>
  <servlet-class>ServletClassFile</servlet-class>
  <init-param>
    <param-name>initParam1</param-name>
    <param-value>initParam1Value</param-value>
  </init-param>
  <init-param>
    <param-name>initParam2</param-name>
    <param-value>initParam2Value</param-value>
  </init-param>
</servlet>
```

The ServletConfig interface defines these methods to retrieve the initialization parameters for this servlet.

String **getInitParameter**(String name)
java.util.Enumeration **getInitParameterNames**()

The ServletConfig interface is implemented by HTTPServlet and GenericServlet. Hence, the getInitParameter() and getInitParameterNames() method can be called directly within init() or service().
The ServletConfig also gives servlet access to a ServletContext object that provides information about this web context (aka web application). ServletContext will be discussed later.

Step 4: In Service

Once a servlet is initialized, the servlet container invokes its service() method to handle client requests. This method is called once for each request. Generally, the servlet container handle concurrent request to the same servlet by running service() on different threads (unless SingleThreadModel interface is declared).
For HttpServlet, service() dispatches doGet(), doPost(), doHead(), doOptions(), doTrace(), etc, to handle HTTP GET, POST, HEAD, OPTIONS, TRACE, etc, request respectively.
The service() method of an HttpServlet takes two arguments, an HttpServletRequest object and an HttpServletResponse object that corresponds to the HTTP request and response messages respectively.

Step 5: End of Service

When the servlet container decides that a Servlet should be removed from the container (e.g., shutting down the container or time-out, which is implementation-dependent), it calls the destroy() method to release any resource it is using and save any persistent state. Before the servlet container calls the destroy(), it must allow all service() threads to complete or time-out.

2.5 Working with Apache Tomcat HTTP Server

Apache Tomcat is a Java-capable HTTP server, which can execute special Java web programs known as "Java Servlets" and "Java Server Pages (JSP)". Tomcat is an open-source project, under the "Apache Software Foundation" The mother site for Tomcat is http://tomcat.apache.org. Tomcat was originally written by James Duncan Davison (then working in Sun) in 1998, based on an earlier Sun's server called Java Web Server (JWS). Sun subsequently made Tomcat open-source and gave it to Apache.
Tomcat Server is a container for Java Servlets. To run a Servlet the Apache Tomcat web server has to be downloaded from http://tomcat.apache.org.

Steps to run a Servlet in Apache Tomcat

1. Download Apache tomcat and save folder in C drive.

2. Right click on Computer from properties select advance tab and select environment variable.

3. Select new button and set variable CATALINA_HOME to C:\mywebproject\tomcat

4. Select new button and set variable JAVA_HOME to C:\Program Files\Java\jdk1.7.0_04

5. Click on OK and close property dialog.

6. Write servlet program in notepad and save it in the following path
C:\ mywebproject\tomcat \webapps\examples\WEB-INF\classes

7. Goto command prompt change directory to the above path

8. Set CLASSPATH=C:\Program Files\Java\jdk1.7.0_04\bin;C:\ mywebproject\tomcat \bin;
C:\ mywebproject\tomcat\lib\servlet-api.jar;

9. set PATH=C:\Program Files\Java\jdk1.7.0_04\bin

10. Compile the servlet program by running javac.

e.g:
C:\ mywebproject\tomcat \webapps\examples\WEB-INF\classes>javac Login.java

11. Make changes to web.config file which is in the following path of Tomcat
C:\ mywebproject\tomcat \webapps\examples\WEB-INF

12. e.g

```
<servlet>
    <servlet-name>Login</servlet-name>
    <servlet-class>Login</servlet-class>
</servlet>

<servlet-mapping>
    <servlet-name>Login</servlet-name>
    <url-pattern>/servlets/servlet/Login</url-pattern>
</servlet-mapping>
```

13. Start Tomcat server by selecting startup.exe from the following path
C:\mywebproject\ tomcat\bin

14. Start Internet Explorer and in the URL type
http://localhost:9999/

15. To view your servlet in the URL type
http://localhost:9999/examples/servlets/servlet/Login

2.6 GenericServlets

Generic Servlets make writing a Servlet easier. Simple versions of the init and destroy are provided, it also provides simple version ServletConfig interface methods. A log method, from the ServletContext interface is also provided. The written servlet should override only the service abstract method.
The following diagram shows the hierarchy of the Servlet interface and classes.

Hierarchy of Servlet , GenericServlet , HttpServlet

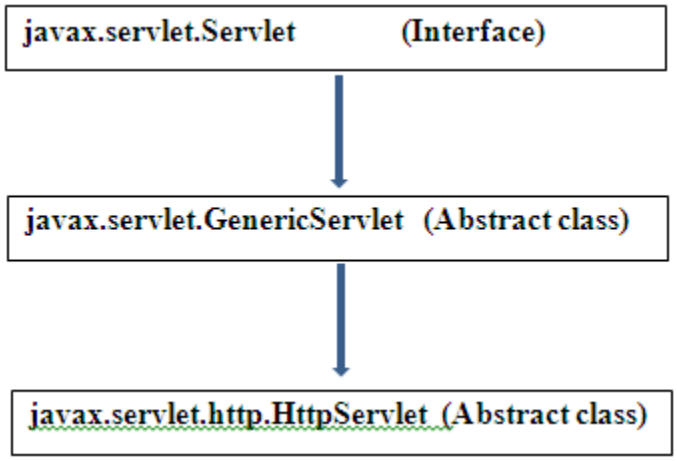


Figure 2.3

We can write a Servlet in three ways.
1. By implementing the Servlet interface.
2. By extending GenericServlet abstract class for protocol independent Servlet.
3. By extending HttpServlet abstract class.

Writing a Generic Servlets
As discussed a Generic servlet is a protocol-independent servlet that should always override the service() method to handle the client request. The service() method accepts two arguments, *ServletRequest object, and ServletResponse object.* The request object tells the servlet about the request made by the client while the response object is used to return a response back to the client. GenericServlet is an *abstract class* and it has only one abstract method, which is *service().* In the following example we see how to create and invoke a Generic servlet.

We have to create 3 files :
1. HTML file
First we create an HTML file that will call the servlet once we click on the link on the web page.

```
<html>
        <title>Generic Servlet Demo</title>
</head>
<body>
<a href="welcome">Click here for call to Generic Servlet</a>
</body>
```

</html>

2. **Java Class file**

Second we create a Java file MyGeneric by extending GenericServlet class. When creating a GenericServlet, you must override the service() method

```
import java.io.*;
import javax.servlet.*;

public class MyGeneric extends GenericServlet{
public void service(ServletRequest req,ServletResponse res)
throws IOException,ServletException
{
res.setContentType("text/html");
PrintWriter out=res.getWriter();
out.print("<html>");
out.print("<body>");
out.print("<h1>Generic Servlet Example</h1>");
out.print("Welcome to Advance Java Servlets programming");
out.print("</body>");
out.print("</html>");
}
}
```

3. Change web.xml file

We make changes to the web.xml file to map to the Servlet with the specific URL.

web.xml

```
<web-app>
<servlet>
  <servlet-name> MyGeneric </servlet-name>
  <servlet-class> MyGeneric </servlet-class>
</servlet>
<servlet-mapping>
  <servlet-name> MyGeneric </servlet-name>
  <url-pattern>/l MyGeneric </url-pattern>
</servlet-mapping>
</web-app>
```

2.7 HttpServlets

As shown in Figure 2.2 the HttpServlet class extends the GenericServlet class. It is an http protocol based servlet which implements the Serializable interface. It provides http specific methods such as doGet, doPost, doHead, doTrace etc.

To write the HttpServlet we have to override either the doGet or doPost method. The doGet method is overridden if the Servlet supports the HTTP Get request and doPost for HTTP POST request.

In the following example we see how to create and invoke an HttpServlet.

We have to create 3 files :

1. HTML file

First we create an HTML file that will call the servlet once we click on the link on the web page.

```
<html>
        <title>Http Servlet Demo</title>
</head>
<body>
<a href="welcome">Click here for calling Http Servlet</a>
</body>
</html>
```

2. **Java Class file**

Second we create a Java file MyHttpServlet by extending HttpServlet class. When creating a HttpServlet, we will override the doGet() method

```
import java.io.*;
import javax.servlet.*;

public class MyHttpServlet extends HttpServlet{
  public void doGet(HttpServletRequest request, HttpServletResponse response)
{
res.setContentType("text/html");
PrintWriter out=res.getWriter();
out.print("<html>");
out.print("<body>");
out.print("<h1>Generic Servlet Example</h1>");
out.print("Welcome to Advance Java Servlets programming");
out.print("</body>");
out.print("</html>");
}
}
```

3. Change web.xml file

We make changes to the web.xml file to map to the Servlet with the specific URL.

web.xml

```
<web-app>
<servlet>
  <servlet-name> MyHttpServlet </servlet-name>
  <servlet-class> MyHttpServlet </servlet-class>
</servlet>
<servlet-mapping>
  <servlet-name> MyHttpServlet </servlet-name>
  <url-pattern>/l MyHttpServlet </url-pattern>
</servlet-mapping>
</web-app>
```

2.8 HttpSession

Session in Servlets

The **interactive time** between client and server on a single connection is known as a session or the **period of time** between connection establishment and connection closing between client and server is known as a session. A Session begins when the client **logs in** to a Web site and ends when the user **logs out**.
A connection is **well maintained** by the Servlet container while the client and server are conversing back and forth in a session.

HttpSession

The HttpSession object is used for session management. A session contains information specific to a particular user across the whole application. When a user enters into a website (or an online application) for the first time HttpSession is obtained via request.getSession(), the user is given a unique ID to identify his session. This unique ID can be stored into a cookie or in a request parameter.
The HttpSession stays alive until it has not been used for more than the timeout value specified in tag in deployment descriptor file(web.xml). The default timeout value is 30 minutes, this is used if you don't specify the value in tag. This means that when the user doesn't visit web application time specified, the session is destroyed by servlet container. The subsequent request will not be served from this session anymore; the servlet container will create a new session.

HttpSession methods

public void setAttribute(String name, Object value): This method binds the object with a name and stores the name/value pair as an attribute of the HttpSession object. If an attribute already exists, then this method replaces the existing attributes.

public Object getAttribute(String name): This method returns the String object specified in the parameter, from the session object. If no object is found for the specified attribute, then the getAttribute() method returns null.

public Enumeration getAttributeNames():This method returns an Enumeration that contains the name of all the objects that are bound as attributes to the session object.

public void removeAttribute(String name): This method removes the given attribute from session.

setMaxInactiveInterval(int interval): This method sets the session inactivity time in seconds. This is the time in seconds that specifies how long a sessions remains active since last request received from client.

2.9 Session Binding/Tracking

Session Tracking or Session Management
A session includes a **lot of interactions**, where data will be exchanged, between client and server, on a single connection. Once the server accepts the client connection, the client and server talk together and keep with them lot of data exchanged that includes commits, questions, answers etc. Preserving the data of a session so that the data can be reused later is known as session tracking or session management.

A session can temporarily store information related to the activities of the user while logged in. A servlet should be capable to store temporary information pertaining to the activities of the user in a session.

Session tracking is required many a times in Web communication, especially in e-commerce or online shopping (shopping cart). In online shopping, a client logs into an e-commerce web site and clicks many times the items he would like to buy. In between he may ask the server the details of a product, its price and any schemes available etc. The server duly responses and make a note of the items the buyer orders. Preserving the item names and quantity all over the session is a must to make a final bill before the client transfers money online. All this requires session tracking.
In the following session example 3 files are created – index.html, MyServlet1.java, MyServlet2.java and changes are made to the web.xml file for servlet mapping.

Session Example
index.html

```
<form action="login">
  User Name:<input type="text" name="userNm"/><br/>
  Password:<input type="password" name="userPsw"/><br/>
  <input type="submit" value="Submit"/>
</form>
```

MyServlet1.java

```
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;

public class MyServlet1 extends HttpServlet {
   public void doGet(HttpServletRequest request, HttpServletResponse response){
     try{
      response.setContentType("text/html");
      PrintWriter outr = response.getWriter();

      String name = request.getParameter("userNm");
      String password = request.getParameter("userPsw");
      out.print("Hello "+name);
      out.print("Your Password is: "+password);
      HttpSession session=request.getSession();
```

```
      session.setAttribute("uname",name);
      session.setAttribute("upass",password);
      out.print("<a href='welcome'>view details</a>");
      out.close();
    }catch(Exception ex){
       System.out.println(ex);
     }
  }
}
```

MyServlet2.java

```
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;
public class MyServlet2 extends HttpServlet {
  public void doGet(HttpServletRequest request, HttpServletResponse response){
  try{
      response.setContentType("text/html");
      PrintWriter out = response.getWriter();
      HttpSession session=request.getSession(false);
      String myName=(String)session.getAttribute("uname");
      String myPass=(String)session.getAttribute("upass");
      out.print("Name: "+myName+" Pass: "+myPass);
out.close();
  }catch(Exception ex){
      System.out.println(ex);
   }
  }
}
```

web.xml

```
<web-app>
<servlet>
   <servlet-name>Servlet1</servlet-name>
   <servlet-class>MyServlet1</servlet-class>
</servlet>
<servlet-mapping>
   <servlet-name>Servlet1</servlet-name>
   <url-pattern>/login</url-pattern>
</servlet-mapping>
<servlet>
   <servlet-name>Servlet2</servlet-name>
   <servlet-class>MyServlet2</servlet-class>
</servlet>
<servlet-mapping>
   <servlet-name>Servlet2</servlet-name>
   <url-pattern>/welcome</url-pattern>
</servlet-mapping>
</web-app>
```

2.10 Inter Servlet Communication

The communication between the servlets of a web application is known as Inter Servlet Communication. The uses of Inter Servlet communication are direct servlet manipulation, reusing servlets and servlet collaboration. There are various ways through which servlets communicate with each other; we are going to discuss Request Dispatcher method and Redirect methods.

Inter-servlet communication using Request Dispatcher
The RequestDispatcher object can **forward** a client's request to a resource or **include** the resource itself in the response back to the client. The resource can be another servlet, an HTML file, or a JSP file, etc.

There are two ways to delegate a request:- 1) Forward and 2) Include

Request Dispatcher:
An object of the javax.servlet.RequestDispatcher interface that allows inter-servlet communication.
Object is used to include or forward the content of another servlet.
To get RequestDispatcher Object:

```
//for relative path
ServletContext.getRequestDispatcher(String resource)

//for context path
ServletRequest.getRequestDispatcher(String resource)
```

RequestDispatcher interface provides two methods:

public void forward(ServletRequest req,ServletResponse res)throws ServletException,java.io.IOException:

Forwards a request from a servlet to another resource on the server.

public void include(ServletRequest req,ServletResponse res)throws ServletException,java.io.IOException:

Includes the content of a resource in the response.

Examples:

```
RequestDispatcher rd;
rd = request.getRequestDispatcher("xyz.jsp?user=fred");
rd.include(request, response);
Or
RequestDispatcher dispatcher =  req.getRequestDispatcher("/index.html");
dispatcher.forward(req, res);
```

Inter-servlet communication using Send Redirect

Send Redirect can be used to communicate between two servlet present in different servers, the output will be same as request dispatcher forward example but the url of the page will be changed to redirected page
Example:

```
response.sendRedirect
                ("http://localhost:9999/Test/ServletTwo");
```

_____

2.11 Summary

In this Unit what is a Servlet was explained. The different types of Servlets, the Servlet APIs were discussed. How to create a Generic and Http servlet was explained with example. What is session, session management was explained. The topic inter servlet communication was also discussed.

2.12 Important Questions

1. What is a servlet?
2. Can we use the constructor, instead of Init(), to initialize Servlet?
3. What is Servlet Context?
4. What Is A Servlet Filter? Explain life cycle.
5. What Is A War File? Describe the structure in brief.
6. What Is Genericservlet Class?
7. How Can The Session In Servlet Be Destroyed?
8. What Are The Mechanisms Used By A Servlet Container For Maintaining Session Information?
9. What Is The Procedure For Initializing A Servlet?
10. What Is The Web Container?
11. What Are The Uses Of Servletrequest?
12. What Are The Uses Of Servletresponse Interface?
13. How Http Servlet Handles Client Requests?
14. What Is Pre Initialization Of A Servlet?
15. How Do You Communicate Between The Servlets?
16. What Are The Differences Between A Session And A Cookie?
17. Why Should We Go For Inter Servlet Communication?
18. What's The Servlet Interface?
19. What Is The Difference Between Servletcontext And Servletconfig?
20. What is different between web server and application server?
21. What is the difference between GET and POST method?
22. What is MIME Type?
23. What is a web application and what is it’s directory structure?
24. What are common tasks performed by Servlet Container?
25. What is ServletConfig object?
26. What is difference between GenericServlet and HttpServlet?
27. What is servlet attributes and their scope?
28. How can we invoke another servlet in a different application?
29. What are the phases of servlet life cycle?
30. What are life cycle methods of a servlet?

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UNIT 3 JSP

Structure **Page Nos.**

3.0 INTRODUCTION

In the previous chapter, we learned how to generate dynamic Web pages with servlets.
In the Servlet examples most of the code generated output consisted of the HTML elements. Only a small part of the code dealt with the business logic. Servlet writers have to be Java programmers. However, Web application developers and Web site designers, may not know Java. It is difficult for people who are not Java programmers to implement, maintain and extend a Web application that consists of primarily of servlets. The answer to this problem is Java Server Pages (JSP) an extension of servlet technology that separates the presentation from the business logic.

3.1 OBJECTIVE

After going through this unit you will be able to explain.

- What is JSP?
- The keywords and Syntax of JSP
- What are the different Page directives?
- Use of Include Directive.
- How to declare data in JSP ?
- How methods are defined?
- What is a Scriplet?
- Implicit Objects.

- What are Custom Tags?
- Session Tracking process.
- What is a Page Context object?
- JSP Exceptions.

3.2 Java Server Pages- JSP

Java Server Pages or JSP simplify dynamic Web content delivery. They enable Web application programmers to create dynamic content by reusing predefined components and by interacting with components using server-side scripting. JSP contain Custom-tag libraries that allows Java developers to hide complex code for database access and other useful services for dynamic Web pages.

The classes and interfaces that are specific to JavaServer Pages programming are located in various packages.packages.
JavaServer Page (JSP) like Microsoft's *Active Server Pages* (ASP) allows you to mix *static* HTML with *dynamically generated* HTML - in the way that the *business logic* and the *presentation* are well separated.
The advantages of JSP are:

1. **Separation of static and dynamic contents**: JSP enables the separation of *static* contents from *dynamic* contents. The dynamic contents are generated via programming logic and inserted into the *static template*. This greatly simplifies the creation and maintenance of web contents.
2. **Reuse of components and tag libraries:** The dynamic contents can be provided by reusable components such as JavaBean, Enterprise JavaBean (EJB) and tag libraries.
3. **Java's power and portability**

JSPs are Internally Compiled into Java Servlets
What can done in JSP can also be done using Java servlets. Servlets and JSPs are complementary technologies. Servlet can be viewed as "***HTML inside Java***", which is better for implementing business logic - as it is mainly written in Java. Whereas JSP is "***Java inside HTML***", which is better for creating presentation - as it mainly contains HTML. In a typical *Model-View-Control* (MVC) application, servlets are often used for the Controller (C), which involves complex programming logic. JSPs are often used for the View (V), which mainly deals with presentation. The Model (M) is usually implemented using JavaBean or EJB.

Apache Tomcat Server
JSPs, like servlets, are server-side programs run inside a HTTP server. To support JSP/servlet, a Java-capable HTTP server is required. Tomcat Server (@ http://tomcat.apache.org) is the official *reference implementation* (RI) for Java servlet and JSP, provided *free* by Apache (@ http://www.apache.org) - an *open-source* software foundation.

3.2 JSP SYNTAX

There are **four key components** to JSP page -**directives, actions, scripting elements and tag libraries**. **Directives** are messages to the JSP container-the server component that executes JSPs-that enable the programmer to specify page settings, to include content from other resources and to specify custom tag libraries for use in a JSP. **Actions** encapsulate functionality in predefined tags that programmers can embed in a JSP. Actions often are performed based on the information sent to the server as part of a particular client request. They also can create Java objects for use in JSP scriptlets. **Scripting elements** enable programmers to insert Java code that interacts with components in a JSP (and possibly other Web application components) to perform request processing. **Scriptlets**, one kind of scripting element, contain code fragments that describe the action to be performed in response to a user request**. Tag libraries** are part of the tag extension mechanism that enables programmers to create custom tags. Such tags enable Web page designers to manipulate JSP content without prior Java knowledge.

In some ways, JavaServer Pages look like standard XHTML or XML documents. In fact, JSPs normally include XHTML or XML markup. Such markup is known as **fixed-template data or fixed-template text.** Fixed-template data often helps a programmer decide whether to use a servlet or a JSP. Programmers tend to use JSPs when most of the content sent to the client is fixed-template data and little or none of the content is generated dynamically with Java code. Programmers typically use servlets when only a small portion of the content sent to the client is fixed-template data. In fact, some servlets do not produce content. Rather, they perform a task on behalf of the client, then invoke other servlets or JSPs to provide a response. Note that in most cases servlet and JSP technologies are interchangeable. As with servlets, JSPs normally execute as part of a Web server.

When a JSP-enabled server receives the first request for a JSP, the JSP container translates the JSP into a Java servlet that handles the current request and future requests to the JSP. Literal text in a JSP becomes string literals in the servlet that represents the translated JSP. Any errors that occur in compiling the new servlet result in translation-time errors. The JSP container places the Java statements that implement the JSP's response in method _jspService at translation time. If the new servlet compiles properly, the JSP container invokes method _jspService to process the request. The JSP may respond directly or may invoke other Web application components to assist in processing the request. Any errors that occur during request processing are known as request-time errors.

Overall, the request-response mechanism and the JSP life cycle are the same as those of a servlet. JSPs can override methods **jspInit** and **jspDestroy** (similar to servlet methods init and destroy), which the JSP container invokes when initializing and terminating a JSP, respectively. JSP programmers can define these methods using JSP declarations--part of the JSP scripting mechanism.

A Simple JSP Example

JSP expression inserting the date and time into a Web page.

//test.jsp

```
<html>
<head>
<meta http-equiv = "refresh" content = "60" />
<title>A Simple JSP Example</title>
<style type = "text/css">
.big { font-family: helvetica, arial, sans-serif;
font-weight: bold;
font-size: 2em; }
</style>
</head>
<body>
<p class = "big">Simple JSP Example</p>
<table style = "border: 6px outset;">
<tr>
    <td style = "background-color: black;">
     <p class = "big" style = "color: cyan;">
<!-- JSP expression to insert date/time -->
<%= new java.util.Date() %>
</p>
</td>
</tr>
</table>
</body
</html>
```

As you can see, most of test.jsp consists of XHTML markup.In cases like this, JSPs are easier to implement than servlets. In a servlet that performs the same task as this JSP, each line of XHTML markup typically is a separate Java statement that outputs the string representing the markup as part of the response to the client. Writing code to output markup can often lead to errors.That's why in such scenarios JSP is preferred than Servlets.The key line in the above program is the expression

<%= new java.util.Date() %>

JSP expressions are delimited by <%= and %>. The preceding expression creates a new instance of class Date (package java.util). By default, a Date object is initialized with the current date and time. When the client requests this JSP, the preceding expression inserts the String representation of the date and time in the response to the client. [Note: **Because the client of a JSP could be anywhere in the world, the JSP should return the date in the client locale's format**. However, the JSP executes on the server, so the server's locale determines the String representation of the Date.

We use the XHTML meta element in line 9 to set a refresh interval of 60 seconds for the document. This causes the browser to request test.jsp every 60 seconds. For each request to test.jsp, the JSP container reevaluates the expression in line 24, creating a new Date object with the server's current date and time.

When you first invoke the JSP, you may notice a brief delay as GlassFish Server translates the JSP into a servlet and invokes the servlet to respond to your request

3.4 Page Directives

A page directive provides attributes that get applied to entire JSP page. It defines page dependent attributes, such as scripting language, error page, and buffering requirements.
It is also used to provide instructions to a container that pertains to current JSP page.
Syntax of Page Directive:

<%@ page… %>

Example:

```
<%@ page language="java" contentType="text/html; charset=ISO-8859-1"
   import="java.util.Date" pageEncoding="ISO-8859-1"%>
```

In the above example the attribute **language** defines the programming language used in the page, **contentType** defines the character coding scheme, **charset** defines the character set used, **import** indicates the classes which have been imported, **pageEncoding** defines the character encoding for JSP page.

1. Besides these there are many other attributes like session, extends, info, autoflush, isErrorPage etc.

3.5 Include Directives

An include directive instructs the JSP container to include an external file in the JSP page.This directive can be used anywhere in the JSP page.

General Syntax:
<%@ include file = "relative url" >

XML syntax:
<jsp:directive.include file = "relative url" />

If the file is in the same directory only file name is mentioned.

Example:
<%@ include file = "first.jspl" >

3.6 Data Declaration

A declaration statement declares variables or methods that you will use in Java code inyour JSP page. It is compulsory to declare all the variables and methods before its use.

General Syntax for JSP Declarations:

<%! declaration; [declaration;]+ ... %>

XML equivalent of the above syntax:

```
<jsp:declaration>
  Java code fragment
</jsp:declaration>
```

Example:

```
<%! int j = 0; %>
<%! int a, b, c; %>
<%! Rectangle r = new Rectangle(25.0,30.5); %>
```

3.7 Method Definition

A function or method is used to perform a specific process.

Syntax;

```
<%!
access_specifier returndatatype  function_name(list of arguments)
  {
java code fragment
return expression
  }
%>
```

The following example shows a method square which returns the square of the number passed to it.

```
<%!
  public int square(int num)
  {
    return num*num;
  }
%>
```

3.8 Scriplets

JavaServer Pages often present dynamically generated content as part of an XHTML document that is sent to the client in response to a request.
JSP programmers can insert Java code and logic in a JSP using scripting.

Scripting Components
The JSP scripting components include **scriptlets, comments, expressions, declarations and escape sequences.**

Scriptlets are blocks of code delimited by **<% and %>.** They contain Java statements that the container places in method _jspService at translation time.

JSPs support three **comment** styles: **JSP comments, XHTML comments and scripting-language comments. JSP comments** are delimited by **<%-- and --%>.** These can be placed throughout a JSP, but not inside scriptlets.
XHTML comments are delimited with **<!-- and -->.** These, too, can be placed throughout a JSP, but not inside scriptlets.
Scripting language comments are currently **Java comments**, because Java currently is the only JSP scripting language.
Scriptlets can use Java's **end-of-line //** comments and traditional comments (delimited by **/* and */).**
JSP comments and scripting-language comments are ignored and do not appear in the response to a client. When clients view the source code of a JSP response, they will see only the XHTML comments in the source code.

JSP expressions are delimited by **<%= and %>** and contain a Java expression that is evaluated when a client requests the JSP containing the expression. The container converts the result of a JSP expression to a String object, then outputs the String as part of the response to the client.

As already discussed **Declarations** are delimited by **<%! and %>,** enable a JSP programmer to define variables and methods for use in a JSP. Variables become instance variables of the servlet class that represents the translated JSP. Similarly, methods become members of the class that represents the translated JSP. Declarations of variables and methods in a JSP use Java syntax. Thus, a variable declaration must end with a semicolon, as in

<%! int counter = 0; %>

Special characters or character sequences that the JSP container normally uses to delimit JSP code can be included in a JSP as literal characters in scripting elements, fixed template data and attribute values using **escape sequences**. The escape sequences used are:

Literal	Escape sequence	Description
<%	<\%	The character sequence <% normally indicates the beginning of a scriptlet. The <\% escape sequence places the literal characters <% in the response to the client.
%>	%\>	The character sequence %> normally indicates the end of a scriptlet. The %\> escape sequence places the literal characters %> in the response to the client.
'	\'	As with string literals in a Java program, the escape sequences for characters ', " and \ allow these characters to appear in attribute values. Remember that the literal text in a JSP becomes string literals in the servlet that represents the translated JSP.
"	\"	
\	\\	

Figure 2.1

Scriplet Example

//welcome.jsp

```
<!DOCTYPE html>
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=UTF-
8"> <title>Processing "get" requests with data</title>
</head>
<!-- body section of document -->
<body>
<% // begin scriptlet
String name = request.getParameter( "firstName" );

if ( name != null )
{
%> <%-- end scriptlet to insert fixed template data --%>

<h1>
Hello <%= name %>, <br />
Welcome to JavaServer Pages!
</h1>

<% // continue scriptlet

} // end if
else {

%> <%-- end scriptlet to insert fixed template data --%>
```

```
<form action = "welcome.jsp" method = "get">
<p>Type your first name and press Submit</p>

<p><input type = "text" name = "firstName" />
<input type = "submit" value = "Submit" />
</p>
</form>

<% // continue scriptlet

} // end else

%> <%-- end scriptlet --%>
</body>
</html>
```

3.9 Implicit Objects

Implicit objects provide access to many servlet capabilities in the context of a JavaServer Page. Implicit objects have **four scopes: application, page, request and session**. The JSP container owns objects with application scope. Any JSP can manipulate such objects. Objects with page scope exist only in the page that defines them. Each page has its own instances of the page-scope implicit objects. Objects with request scope exist for the duration of the request. For example, a JSP can partially process a request, and then forward it to a servlet or another JSP for further processing. Request-scope objects go out of scope when request processing completes with a response to the client. Objects with session scope exist for the client's entire browsing session. The following list describes the JSP implicit objects and their scopes.

Implicit object	Description
Application Scope	
`application`	A `javax.servlet.ServletContext` object that represents the container in which the JSP executes.
Page Scope	
`config`	A `javax.servlet.ServletConfig` object that represents the JSP configuration options. As with servlets, configuration options can be specified in a Web application descriptor.
`exception`	A `java.lang.Throwable` object that represents an exception that is passed to a JSP error page. This object is available only in a JSP error page.
`out`	A `javax.servlet.jsp.JspWriter` object that writes text as part of the response to a request. This object is used implicitly with JSP expressions and actions that insert string content in a response.
`page`	An `Object` that represents the `this` reference for the current JSP instance.
`pageContext`	A `javax.servlet.jsp.PageContext` object that provides JSP programmers with access to the implicit objects discussed in this table.
`response`	An object that represents the response to the client and is normally an instance of a class that implements `HttpServletResponse` (package `javax.servlet.http`). If a protocol other than HTTP is used, this object is an instance of a class that implements `javax.servlet.ServletResponse`.
Request Scope	
`request`	An object that represents the client request and is normally an instance of a class that implements `HttpServletRequest` (package `javax.servlet.http`). If a protocol other than HTTP is used, this object is an instance of a subclass of `javax.servlet.Servlet-Request`.
Session Scope	
`session`	A `javax.servlet.http.HttpSession` object that represents the client session information if such a session has been created. This object is available only in pages that participate in a session.

3.10 Custom Tags

User-defined tags are known as **custom tags**.

To create a custom tag we need three things:
1) Tag handler class: In this class we specify what our custom tag will do when it is used in a JSP page.

2) TLD file: Tag descriptor file where we will specify our tag name, tag handler class and tag attributes.

3) JSP page: A JSP page where we will be using our custom tag.

Example:
In the below example we are creating a custom tag MyTag which will display the message "This is a custom tag" when used in a JSP page.

Tag handler class:

A tag handler class should implement Tag/IterationTag/ BodyTag interface or it can also extend TagSupport/BodyTagSupport/SimpleTagSupport class. All the classes that support custom tags are present inside javax.servlet.jsp.tagext. In the below we are extending the class SimpleTagSupport.

Details.java

```
import javax.servlet.jsp.tagext.*;
import javax.servlet.jsp.*;
import java.io.*;
public class Details extends SimpleTagSupport {
  public void doTag() throws JspException, IOException {

    JspWriter out = getJspContext().getOut();
    out.println("This is a custom tag");
  }
}
```

TLD File
This file should present at the location: Project Name/WebContent/WEB-INF/ and it should have a **.tld** extension.

Note:
<name> tag: custom tag name. In this example we have given it as MyTag
<tag-class> tag: Fully qualified class name. The package in which the tag handler class Details.java is present has to be written .
message.tld

```
<taglib>
 <tlib-version>1.0</tlib-version>
 <jsp-version>2.0</jsp-version>
 <short-name>My Custom Tag</short-name>
 <tag>
 <name>MyMsg</name>
 <tag-class>mypackage.Details</tag-class>
 <body-content>empty</body-content>
 </tag>
</taglib>
```

Using custom tag in JSP:
Above we have created a custom tag named Tag Here we will be using it.
Note: taglib directive should have the TLD file path in uri field. Above we have created the message.tld file so we have given the path of that file.
Choose any prefix and specify it in taglib directive's prefix field. Here we have specified it as myprefix.
Custom tag is called like this: <prefix:tagName/>. Our prefix is myprefix and tag name is MyTag so we have called it as <myprefix:MyTag/> in the below JSP page.

```
<%@ taglib prefix="myprefix" uri="WEB-INF/message.tld"%>
<html>
 <head>
   <title>JSP Custom Tag Example</title>
 </head>
 <body>
   <myprefix:MyTag/>
 </body>
</html>
```

3.11 Session Tracking in JSP

Sessions are mechanism for storing client data across multiple HTTP requests. From one request to another user the HTTP server does not maintain a reference or keep any record of client previous request.

HttpSession Methods

- **getAttribute** : it returns stored value from session object. It returns null if no value is associated with name.
- **setAttribute** : It associates a value with name.
- **removeAttribute** : It removes all the values associated with name.
- **getAttributeNames** : It returns all attributes names in the session.
- **getId** : it returns unique id in the session.
- **isNew** : It determine if session is new to client.
- **getcreationTime** : It returns time at which session was created.
- **getlastAccessedTime** : It returns time at which session was accessed last by client.
- **getMaxInactiveInterval** : It gets maximum amount of time session in seconds that access session before being invalidated.

- **setMaxInaxctiveInterval** : It sets maximum amount of time session in seconds between client requests before session being invalidated.

Following ways are used to maintain session between client and web server:

Cookies
A cookie, also known as an HTTP cookie, web cookie, or browser cookie, is a small piece of data sent from a website and stored in a user's web browser while the user is browsing that website.
A cookie's value can uniquely identify a client, so cookies are commonly used for session management. Browser stores each message in a small file, called cookie.txt. When you request another page from the server, your browser sends the cookie back to the server. Cookies have lifespan and are flushed by the client browser at the end of lifespan.

Cookie objects have following methods.
1. **getComment ()** : Returns comment describing the purpose of the cookie.
2. **getMaxAge ()** : Returns maximum specified age of the cookie.
3. **getName()** : Returns name of the cookie.
4. **getPath()** : Returns URL for which cookie is targeted.
5. **getValue()** :Returns value of the cookie.
6. **setComment(String)** : Cookie's purpose will be described using this comment.
7. **setMaxAge(int)** : Sets maximum age of the cookie. A zero value causes the cookie to be deleted.
8. **setPath(String)** : It determines Cookie should begin with this URL .
9. **setValue(String)** : Sets the value of the cookie. Values with special characters such as white space, brackets, equal sign, comma, double quote, slashes , "at" sign, colon and semicolon should be avoided.

Hidden Form Fields

It is hidden (invisible) text field used for maintaining the state of user. We store the information in the hidden field and get it from another servlet.
Following shows how to store value in hidden field.

<input type="hidden" name="uname" value="prodigy">
Here, *name* is hidden field name and *prodigy* is hidden field value. When the form is submitted, the specified name and value are automatically included in the GET or POST data.

URL Rewriting

A static HTML page or form must be dynamically generated to encode every URL. If you cannot verify that every user of web application uses cookies, then you must consider web container need to use URL-rewriting. If the browser does not support cookies, or if cookies are disabled, you can still enable session tracking using URL rewriting.
A web container attempts to use cookies to store the session ID. If that fails then web container tries to use URL-rewriting. URL rewriting essentially includes the session ID within the link itself as a name/value.

Adding the session ID to a link contain following methods:

- **response.encodeURL ():** Associates a session ID with a given URL.
- **response.encodeRedirectURL () :** If you are using redirection, this method can be used.

3.12 Page Context

JSP Page Context Object is used to store and retrieve the page-related information and sharing objects. PageContext is an instance of javax.servlet.jsp.PageContext. PageContext is used to **findAttribute**, **setAttribute**, **getAttribute** and **removeAttribute** and it has the following scope.

- Page_Context scope
- Request_Context scope
- Session_Context scope
- Application_Context scope

findAttribute(String AttributeName): This method is used to search the attributes like the page, session, request, application. Return type is an object. If there is no attribute it returns null.

Syntax
pageContext.findAttribute("name of attribute");

getAttribute(String AttributeName, int scope): This method is used to get the attribute with specified scope. This is same as findAttribute() method but getAttribute look for specific scope. It returns the object, if there is no attribute, it returns null.

Syntax
Object object = pageContext.getAttribute("Attribute name", PageContext.SESSION_CONTEXT);

removeAttribute(String AttributeName, int scope): This method is used to remove the attribute from given scope and there is no return type of this method.

Syntax
pageContext.removeAttribute("Attribute Name",PageContext.REQUEST_CONTEXT);

setAttribute(String AttributeName, Object AttributeValue, int scope): This method is used to set the name of the attribute, attribute value and scope of that object. This method has no return type.

Syntax
pageContext.setAttribute("AttributeName","AttributeValue", PageContext. APPLICATION_CONTEXT);

Example of JSP Page Context Object.

pagecontext.html

```
<html>
  <body>
<form action="pageContext.jsp">
          Name:    <input type="text" name="Name"/></br>
          FullName:<input type="text" name="fullName"/></br></br>
                <input type="submit" value="submit"/>
 </form>
</body>
</html>
```

Here the developer just created two text boxes such as **Name** and **fullName** and also created submit button.

pageContext.jsp

```
<html>
<body>
<form action="getPageContext.jsp">
<%
String Name = request.getParameter("Name");
String fullName = request.getParameter("fullName");
 out.println("Hello "+ Name+" ");
pageContext.setAttribute("Name", Name, PageContext.SESSION_SCOPE);
pageContext.setAttribute("fullName", fullName, PageContext.SESSION_SCOPE);
 %>
<input type="submit" value="Click Here"/>
</form>
</body>
</html>
```

request.getParameter() method is used to retrieve the details which are placed in HTML page. **pageContext.setAttribute()** method is used to set the name of the attribute, attribute value and scope of that object. This method has no return type.

getPageContext.jsp

```
<html>
<body>
<%
String Name = (String) pageContext.getAttribute("Name", PageContext.SESSION_SCOPE);
String fullName = (String) pageContext.getAttribute("fullName", PageContext.SESSION_SCOPE);
out.println("Hi "+ Name+" ");
out.println("This is your fullname :"+fullName);
%>
</body>
</html>
```

getAttribute(String AttributeName, int scope) method is used to get the attribute with specified scope.

3.13 Exceptions

The exception is normally an object that is thrown at runtime. Exception Handling is the process to handle the runtime errors. There may occur exception any time in your web application. So handling exceptions is a safer side for the web developer. In JSP, there are two ways to perform exception handling:

1. By **errorPage** and **isErrorPage** attributes of page directive
2. By **<error-page>** element in web.xml file

Example of exception handling in jsp by the elements of page directive

In this case, you must define and create a page to handle the exceptions, as in the error.jsp page. The pages where may occur exception, define the errorPage attribute of page directive, as in the process.jsp page.

There are 3 files:

- index.jsp for input values
- arithmetic.jsp for dividing the two numbers and displaying the result
- error.jsp for handling the exception

index.jsp

```
<form action="arithmetic.jsp">
Enter first Number : <input type="text" name="num1" /><br/><br/>
Enter second Number : <input type="text" name="num2" /><br/><br/>
<input type="submit" value="Divide"/>
</form>
```

arithmetic.jsp

```
<%@ page errorPage="error.jsp" %>
<%
String n1=request.getParameter("num1");
String n2=request.getParameter("num2");

int a=Integer.parseInt(n1);
int b=Integer.parseInt(n2);
int c=a/b;
out.print("division of numbers is: "+c);
 %>
```

error.jsp

```
<%@ page isErrorPage="true" %>

<h2>Sorry something has gone wrong!</h2>
  Exception message is: <%= exception %>
```

Example of exception handling in jsp by specifying the error-page element in web.xml file

This approach is better because you don't need to specify the errorPage attribute in each jsp page. Specifying the single entry in the web.xml file will handle the exception. In this case, either specify exception-type or error-code with the location element. If you want to handle all the exception, you will have to specify the java.lang.Exception in the exception-type element. Let's see the simple example:

There are 4 files:

- web.xml file for specifying the error-page element
- index.jsp for input values
- arithmetic.jsp for dividing the two numbers and displaying the result
- error.jsp for displaying the exception

1) web.xml file if you want to handle any exception

```
<web-app>

 <error-page>
<exception-type>java.lang.Exception</exception-type>
  <location>/error.jsp</location>
  </error-page>

</web-app>
```

This approach is better if you want to handle any exception. If you know any specific error code and you want to handle that exception, specify the error-code element instead of exception-type as given below:

1) web.xml file if you want to handle the exception for a specific error code

```
<web-app>

<error-page>
<error-code>500</error-code>
  <location>/error.jsp</location>
 </error-page>

</web-app>
```

2) index.jsp file is same as in the above example

3) arithmetic.jsp

Now, you don't need to specify the errorPage attribute of page directive in the jsp page.

```
<%@ page errorPage="error.jsp" %>
<%
String n1=request.getParameter("num1");
String n2=request.getParameter("num2");
 int a=Integer.parseInt(n1);
int b=Integer.parseInt(n2);
int c=a/b;
out.print("division of numbers is: "+c);
%>
```

4) error.jsp file is same as in the above example

3.14 Summary

In this Unit we learned how to create a JSP page. The syntax of JSP both general and XML equivalent.
The different types of directives- Page directive and Include directive.
How data is declared and methods are defined. What is meant by JSP Scriplet?
Making a custom tag with example. Session Tracking methods of JSP. We also learned Exception handling with example.

3.15 Important Questions

1. Explain JSP and tell its uses.
2. Explain JSP Technology.
3. Explain Implicit objects in JSP.
4. How can multiple submits due to refresh button clicks be prevented?
5. How to restrict page errors display in a JSP page?
6. What are JSP Actions?
7. Explain JSP lifecycle methods.
8. Explain handling of runtime exceptions.
9. Explain the various scope values for tag.
10. Explain page Directives.
11. Explain in brief attributes of page directives.
12. What are standard actions in JSP?
13. Explain the jsp:setProperty action.
14. Explain client and server side validation.
15. How can Automatic creation of session be prevented in a JSP page?
16. Explain the jspDestroy() method.
17. How is JSP better than Servlet technology?
18. Explain in brief session maintaining between client and server.
19. What do you mean by custom tag explain it with suitable example.
20. What Is Jsp Page?
21. How Is Jsp Include Directive Different From Jsp Include Action. ?
22. What Is The Difference Between Directive Include And Jsp Include?
23. What Are The Different Ways For Session Tracking?
24. What Is Session?
25. How Method Is Declared Within Jsp Page?
26. State The Difference Between The Expression And Scriptlet?
27. What are the various exception handling methods?
28. List out any five exception handling methods in JSP.

Unit 4
Hibernate

Why Hibernate?

Hibernate (framework)

Hibernate ORM (Hibernate in short) is an object-relational mapping tool for the Java programming language. It provides a framework for mapping an object-oriented domain model to a relational database. Hibernate handles object-relational impedance mismatch problems by replacing direct, persistent database accesses with high-level object handling functions.
Hibernate is an open software that is distributed under the GNU Lesser General Public License 2.1.
Hibernate's primary feature is mapping from Java classes to database tables, and mapping from Java data types to SQL data types. Hibernate also provides data query and retrieval facilities. It generates SQL calls and relieves the developer from the manual handling and object conversion of the result set.

Why Hibernate and not JDBC?

- JDBC maps Java classes to database tables (and from Java data types to SQL data types)
- Hibernate automatically generates the SQL queries.
- Hibernate provides data query and retrieval facilities and can significantly reduce development time as more time is required to manually handle data in SQL and JDBC.
- It makes an application portable to all SQL databases.
- Hibernate provides HQL for performing selective search
- Hibernate also supports SQL Queries (Native Query)
- Hibernate provides primary and secondary level caching support
- Can be used in both console and web based applications
- Developers can use the components from the Hibernate framework selectively.
- Hibernate can be used with JPA (Java Persistence API)
- It supports both xml file and annotations as metadata.

What is ORM?
ORM stands for **O**bject-**R**elational **M**apping (ORM) is a programming technique for converting data between relational databases and object oriented programming languages such as Java, C#, etc.
An ORM system has the following advantages over plain JDBC –

1. Lets the business logic code access objects rather than DB tables.
2. Hides details of SQL queries from OO logic.
3. No need to deal with the database implementation.
4. Entities based on business concepts rather than database structure.
5. Transaction management and automatic key generation.

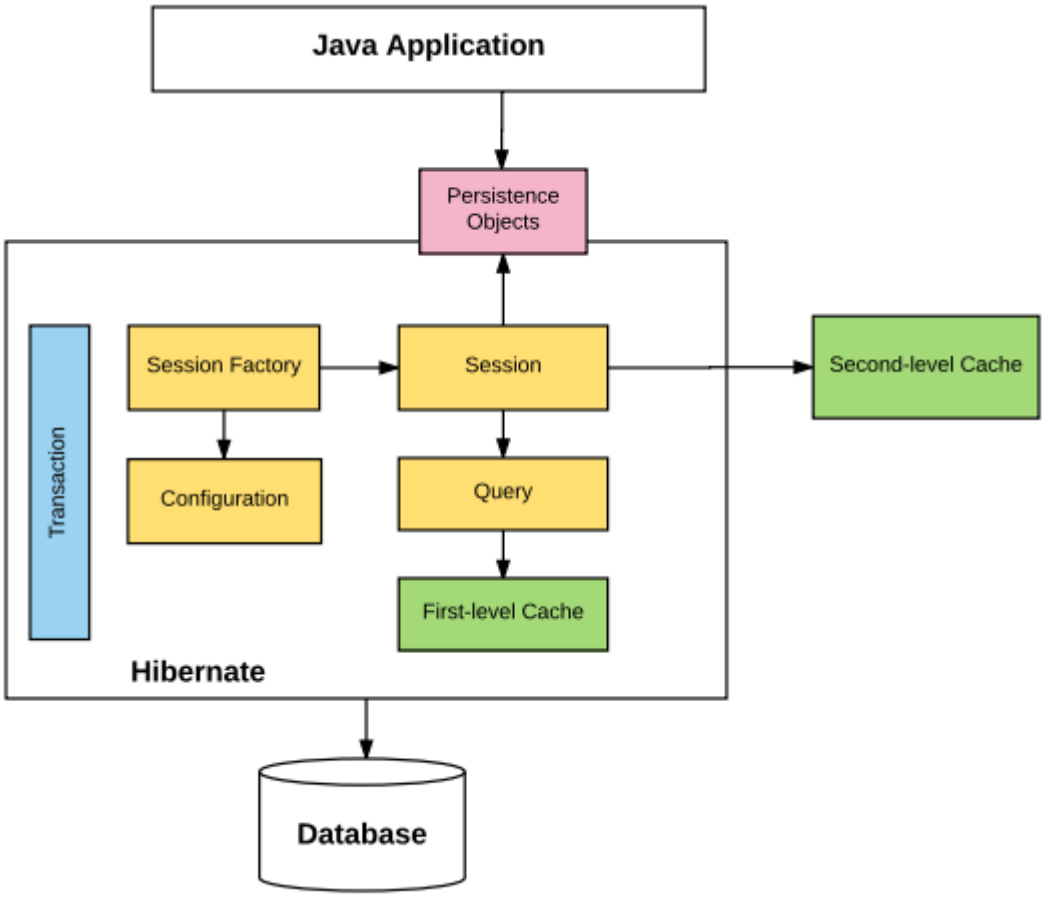
An ORM solution consists of the following advantages :–

- Transparent Persistence (POJO/JavaBeans)
- Persistent/transient instances
- Automatic Dirty Checking
- Transitive Persistence
- Lazy Fetching
- Outer Join Fetching
- Runtime SQL Generation
- Three Basic Inheritance Mapping Strategies

Hibernate is a great tool for **ORM mappings** in Java. It can cut down a lot of complexity and is specially a boon for Java developers with limited knowledge of SQL.

Hibernate Architecture

The following diagram shows the main building blocks in hibernate architecture.



Explanation of each block:

1. **Configuration**: Generally written in hibernate.properties or hibernate.cfg.xml files. For Java configuration, you may find class annotated with @Configuration. It is used by Session Factory to work with Java Application and the Database. It represents an entire set of mappings of an application Java Types to an SQL database.
2. **Session Factory** : Any user application requests Session Factory for a session object. Session Factory uses configuration information from above listed files, to instantiates the session object appropriately.
3. **Session** : This represents the interaction between the application and the database at any point of time. This is represented by the org.hibernate.Session class. The instance of a session can be retrieved from the SessionFactory bean.
4. **Query** : It allows applications to query the database for one or more stored objects. Hibernate provides different techniques to query database,
   including NamedQuery and Criteria API.
5. **First-level cache** : It represents the default cache used by Hibernate Session object while interacting with the database. It is also called as session cache and caches objects within the current session. All requests from the Session object to the database must pass through the first-level cache or session cache. One must note that the first-level cache is available with the session object until the Session object is live.
6. **Transaction** : enables you to achieve data consistency, and rollback incase something goes unexpected.
7. **Persistent objects** : These are plain old Java objects (POJOs), which get persisted as one of the rows in the related table in the database by hibernate.They can be configured in configurations files (hibernate.cfg.xml or hibernate.properties) or annotated with @Entity annotation.
8. **Second-level cache** : It is used to store objects across sessions. This needs to be explicitly enabled and one would be required to provide the cache provider for a second-level cache. One of the common second-level cache providers is *EhCache*.

Steps to Create a Hibernate Application

1. Create POJO (Plain Old Java Object) Classes

The first step in creating an application is to build the Java POJO class or classes, depending on the application that will be persisted to the database. Let us consider our Employee class with getXXX and setXXX methods to make it JavaBeans compliant class.
A POJO is a Java object that doesn't extend or implement some specialized classes and interfaces respectively required by the EJB framework. All normal Java objects are POJO. When you design a class to be persisted by Hibernate, it is important to provide JavaBeans compliant code as well as one attribute, which would work as index like id attribute in the Employee class.

```
public class Employee {
private int id;
private String fullName;
private int salary;
public Employee() {}
public Employee(String fullName, int salary) {
this.fullName = fname;
this.salary = salary;
}
public int getId() {
return id;
}
public void setId( int id ) {
this.id = id;
}
public String getFullName() {
return fullName;
}
public void setFullName( String fullName ) {
this.fullName = fullName;
}
public int getSalary() {
return salary;
}
public void setSalary( int salary ) {
this.salary = salary;
}

}
```

2. Create Database Tables

Second step would be creating tables in your database. There would be one table corresponding to each object, to provide persistence. Consider above objects need to be stored and retrieved into the following RDBMS table –

```
create table EMPLOYEE (
id INT NOT NULL auto_increment,
full_name VARCHAR(100) default NULL,
salary INT default NULL,
PRIMARY KEY (id)
);
```

3. Create Mapping Configuration File

This step is to create a mapping file that instructs Hibernate how to map the defined class or classes to the database tables.

```
<?xml version = "1.0" encoding = "utf-8"?>
<!DOCTYPE hibernate-mapping PUBLIC "-//Hibernate/Hibernate Mapping DTD//EN"
"http://www.hibernate.org/dtd/hibernate-mapping-3.0.dtd">
<hibernate-mapping>
<class name = "Employee" table = "EMPLOYEE">
<meta attribute = "class-description">
This class contains the employee detail.
</meta>
<id name = "id" type = "int" column = "id">
<generator class="native"/>
</id>
<property name = "fullName" column = "full_name" type = "string"/>
<property name = "salary" column = "salary" type = "int"/>
</class>
</hibernate-mapping>
```

You should save the mapping document in a file with the format <classname>.hbm.xml. example Employee.hbm.xml. Let us see little detail about the mapping document −

- The mapping document is an XML document having <hibernate-mapping> as the root element which contains all the <class> elements.
- The <class> elements are used to define specific mappings from a Java classes to the database tables. TheJava class name is specified using the name attribute of the class element and the database table name isspecified using the table attribute.
- The <meta> element is optional element and can be used to create the class description.
- The <id> element maps the unique ID attribute in class to the primary key of the database table. The name attribute of the id element refers to the property in the class and the column attribute refers to the column in the database table. The type attribute holds the hibernate mapping type, this mapping types will convert from Java to SQL data type.
- The <generator> element within the id element is used to generate the primary key values automatically. The class attribute of the generator element is set to native to let hibernate pick up either identity, sequence or hilo algorithm to create primary key depending upon the capabilities of the underlying database.

- The <property> element is used to map a Java class property to a column in the database table. The name attribute of the element refers to the property in the class and the column attribute refers to the column in the database table. The type attribute holds the hibernate mapping type, this mapping types will convert from Java to SQL data type.

4. Create Application Class

Finally, we will create our application class with the main method to run the application. We will use this application to save few Employee's records and then we will apply CRUD operations on those records.

```
import java.util.List;
import java.util.Date;
import java.util.Iterator;
import org.hibernate.HibernateException;
import org.hibernate.Session;
import org.hibernate.Transaction;
import org.hibernate.SessionFactory;
import org.hibernate.cfg.Configuration;

public class ManageEmployee {
private static SessionFactory factory;
public static void main(String[] args) {
try {
factory = new Configuration().configure().buildSessionFactory();
} catch (Throwable ex) {
System.err.println("Failed to create sessionFactory object." + ex);
throw new ExceptionInInitializerError(ex);
}
ManageEmployee ME = new ManageEmployee();
/* Add few employee records in database */
Integer empID1 = ME.addEmployee("Fred Flintstone", 10000);
Integer empID2 = ME.addEmployee("Mickey Mouse", 15000);
Integer empID3 = ME.addEmployee("John Brown", 20000);
/* List down all the employees */
ME.listEmployees();
/* Update employee's records */
ME.updateEmployee(empID1, 5000);
/* Delete an employee from the database */
ME.deleteEmployee(empID2);
/* List down new list of the employees */
ME.listEmployees();
}
/* Method to CREATE an employee in the database */
public Integer addEmployee(String fname, int salary){
Session session = factory.openSession();
Transaction tx = null;
Integer employeeID = null;
try {
tx = session.beginTransaction();
Employee employee = new Employee(fname, salary);
```

```
employeeID = (Integer) session.save(employee);
tx.commit();
} catch (HibernateException e) {
if (tx!=null) tx.rollback();
e.printStackTrace();
} finally {
session.close();
}
return employeeID;
}
/* Method to READ all the employees */
public void listEmployees( ){
Session session = factory.openSession();
Transaction tx = null;
try {
tx = session.beginTransaction();
List employees = session.createQuery("FROM Employee").list();
for (Iterator iterator = employees.iterator(); iterator.hasNext();){
Employee employee = (Employee) iterator.next();
System.out.print("Name: " + employee.getFullName());
System.out.println(" Salary: " + employee.getSalary());
}
tx.commit();
} catch (HibernateException e) {
if (tx!=null) tx.rollback();
finally {
session.close();
}
}
/* Method to UPDATE salary for an employee */
public void updateEmployee(Integer EmployeeID, int salary ){
Session session = factory.openSession();
Transaction tx = null;
try {
tx = session.beginTransaction();
Employee employee = (Employee)session.get(Employee.class, EmployeeID);
employee.setSalary( salary );
session.update(employee);
tx.commit();
} catch (HibernateException e) {
if (tx!=null) tx.rollback();
e.printStackTrace();
} finally {
session.close();
}
}
/* Method to DELETE an employee from the records */
public void deleteEmployee(Integer EmployeeID){
Session session = factory.openSession();
Transaction tx = null;
```

```
try {
tx = session.beginTransaction();
Employee employee = (Employee)session.get(Employee.class, EmployeeID);
session.delete(employee);
tx.commit();
} catch (HibernateException e) {
if (tx!=null) tx.rollback();
e.printStackTrace();
} finally {
session.close();
}
}
}
```

5. Compilation and Execution

Here are the steps to compile and run the above mentioned application. Make sure, you have set PATH and CLASSPATH appropriately before proceeding for the compilation and execution.

- Create hibernate.cfg.xml configuration file as explained in configuration chapter.
- Create Employee.hbm.xml mapping file as shown above.
- Create Employee.java source file as shown above and compile it.
- Create ManageEmployee.java source file as shown above and compile it.
- Execute ManageEmployee binary to run the program.

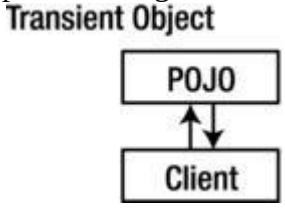
Persistent Object Life Cycle

As you know that **Hibernate** works with normal Java objects that your application creates with the new operator. In raw form (without annotations), hibernate will not be able to identify your java classes; but when they are properly annotated with required annotations then hibernate will be able to identify them and then work with them e.g. store in DB, update them etc. These objects can be said to mapped with hibernate.

Given an instance of an object that is mapped to Hibernate, it can be in any one of four different states: **transient, persistent, detached, or removed**.

Transient Object

Transient objects exist in heap memory. Hibernate does not manage transient objects or persist changes to transient objects.

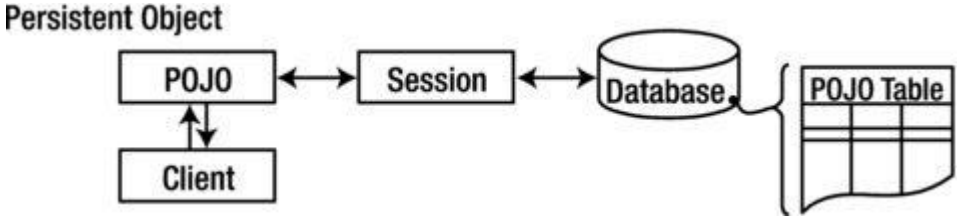


Transient objects are independent of Hibernate

To persist the changes to a transient object, you would have to ask the session to save the transient object to the database, at which point Hibernate assigns the object an identifier and marks the object as being in persistent state.

Persistent Object

Persistent objects exist in the database, and Hibernate manages the persistence for persistent objects.

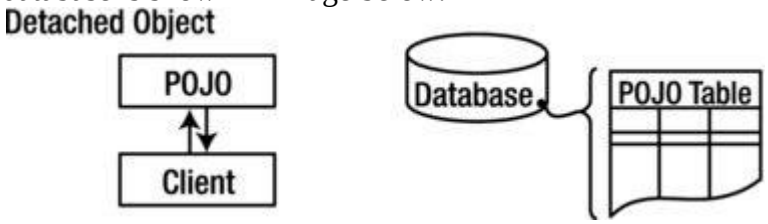


Persistent objects are maintained by Hibernate

If fields or properties change on a persistent object, Hibernate will keep the database representation up to date when the application marks the changes as to be committed.

Detached Object

Detached objects have a representation in the database, but changes to the object will not be reflected in the database, and vice-versa. This temporary separation of the object and the database is shown in image below.



Detached objects exist in the database but are not maintained by Hibernate

A detached object can be created by closing the session that it was associated with, or by evicting it from the session with a call to the session's evict() method.

One reason you might consider doing this would be to read an object out of the database, modify the properties of the object in memory, and then store the results some place other than your database. This would be an alternative to doing a deep copy of the object.

In order to persist changes made to a detached object, the application must reattach it to a valid Hibernate session. A detached instance can be associated with a new Hibernate session when your application calls one of the load, refresh, merge, update(), or save() methods on the new session with a reference to the detached object. After the call, the detached object would be a persistent object managed by the new Hibernate session.

Removed Object

Removed objects are objects that are being managed by Hibernate (persistent objects, in other words) that have been passed to the session's remove() method. When the application marks the changes held in the session as to be committed, the entries in the database that correspond to removed objects are deleted.

Now let's not note down the take-aways from this tutorial.

Bullet Points

1. Newly created POJO object will be in the transient state. Transient object doesn't represent any row of the database i.e. not associated with any session object. It's plain simple java object.
2. Persistent object represent one row of the database and always associated with some unique hibernate session. Changes to persistent objects are tracked by hibernate and are saved into database when commit call happen.
3. Detached objects are those who were once persistent in past, and now they are no longer persistent. To persist changes done in detached objects, you must reattach them to hibernate session.

4. Removed objects are persistent objects that have been passed to the session's remove() method and soon will be deleted as soon as changes held in the session will be committed to database.

Hibernate with Servlets

Hibernate Servlet Integration

Introduction

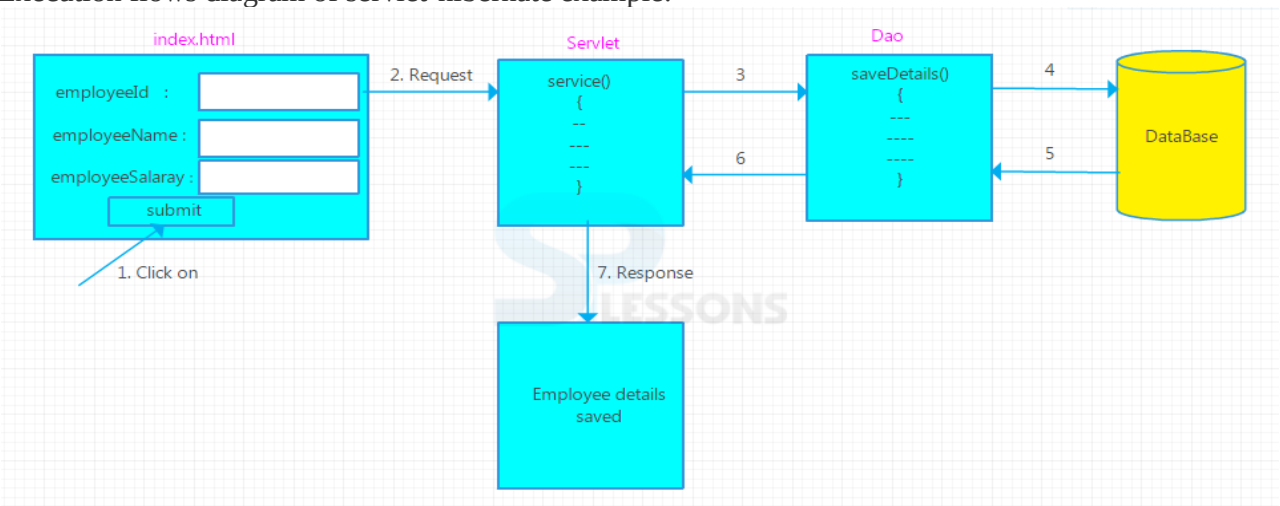
Hibernate Servlet Integration, Developing an application using hibernate is a very simple task if developer has knowledge in flow of code why because every hibernate application will have two minimum files they are configuration file and hibernate mapping file, remaining files are regarding required java files , as earlier discussed the main advantage of hibernate is tables will be created automatically after the execution of a program.Here input values are sent from the **Html page** to **Servlet** which calls **Dao class of Hibernate** and it will pass input values to **Database**.

Example

If an example is taken such that, employee details are given to Html page, it will store the details in the Database.If details are saved into Database, then Servlet gives the response as '**Employee details successfully saved'**. If not the response will be **'Employee details already saved'**.

Conceptual figure

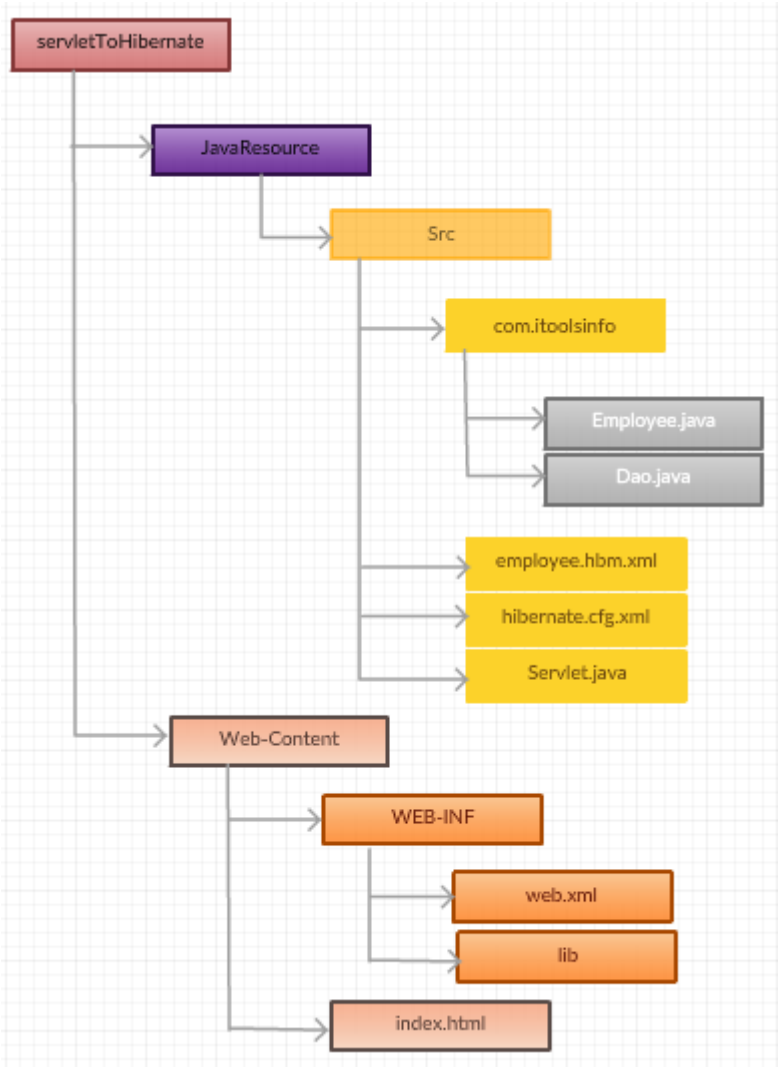
Execution flows diagram of servlet-hibernate example.



- Add all the **hibernate jar files**, **ojdbc14.jar** and **servlet-api.jar** in **lib** folder.

Example

- Create the project directory structure.



- Create the HTML file and forward the request to Servlet.

index.html

```
<!DOCTYPE html>
<html>
<head>
</head>
<body>
   <form action="ServletDemo">
       Employee Id     : <input type="text" name="id">
       Employee Name   : <input type="text" name="name">
       Employee Salary :<input type="text" name="salary">
      <input type="submit" value="submit">

   </form>
</body>
</html>
```

ServletDemo.java

```
import java.io.IOException;
import java.io.PrintWriter;

import javax.servlet.ServletException;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;

import com.iquickinfo.Dao;

 public class ServletDemo extends HttpServlet {
private static final long serialVersionUID = 1L;



protected void doGet(HttpServletRequest request, HttpServletResponse response)
throws ServletException, IOException
{
     System.out.println("this is servlet");

      int employeeId=Integer.parseInt(request.getParameter("id").trim());
      String employeeName=request.getParameter("name").trim();
      int salary=Integer.parseInt(request.getParameter("salary").trim());

      Dao dao=new Dao();
      boolean b=dao.saveDetails(employeeId, employeeName, salary);
      response.setContentType("text/html");
      PrintWriter out=response.getWriter();
     if(b==true)
     {
       out.println("<h1>Employee details sucessfully saved.</h1>");

     }
      else
     {
         out.println("<h1>Employee details already existed.</h1>");

     }
     out.println("");
     out.close();
}
```

```
}
```

In **doGet()**, the parameters are appended to the URL and sent along with the header information. The **serialVersionUID** is used as a version control in a Serializable class. If you do not explicitly declare a **serialVersionUID**, JVM will do it for you automatically, based on various aspects of your Serializable class, as described in the Java(TM) Object Serialization Specification. Sets the **content type** of the response being sent to the client, if the response has not been committed yet.The given content type may include a character encoding specification.

- Set URL Pattern in web.xml file.

web.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<web-app xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns="http://java.sun.com/xml/ns/javaee"
 xsi:schemaLocation="http://java.sun.com/xml/ns/javaee
http://java.sun.com/xml/ns/javaee/web-app_2_5.xsd" id="WebApp_ID" version="2.5">
  <display-name>ServletToHibernate</display-name>

 <servlet>
    <servlet-name>ServletDemo</servlet-name>
    <servlet-class>ServletDemo</servlet-class>
  </servlet>
  <servlet-mapping>
    <servlet-name>ServletDemo</servlet-name>
    <url-pattern>/servlet</url-pattern>
  </servlet-mapping>
</web-app>
```

- Create the persistence class.

Employee.java

```
package com.itoolsinfo;

public class Employee
{
    private int employeeId;
    private String employeeName;
    private int salary;
    public int getEmployeeId() {
        return employeeId;
    }
    public void setEmployeeId(int employeeId) {
        this.employeeId = employeeId;
    }
    public String getEmployeeName() {
        return employeeName;
    }
    public void setEmployeeName(String employeeName) {
        this.employeeName = employeeName;
    }
    public int getSalary() {
        return salary;
    }
    public void setSalary(int salary) {
        this.salary = salary;
    }
```

```
}
```

Set and **Get** methods are a pattern of data encapsulation. Instead of accessing class member variables directly, one can define get methods to access these variables, and set methods to modify them.

- Map the persistence class in mapping file.

employee.hbm.xml

```
<?xml version='1.0' encoding='UTF-8'?>
<!DOCTYPE hibernate-mapping PUBLIC "-//Hibernate/Hibernate Mapping DTD 3.0//EN"
 "http://hibernate.sourceforge.net/hibernate-mapping-3.0.dtd">

           <hibernate-mapping>
          <class name="com.itoolsinfo.Employee" table="employee">
          <id name="employeeId">
          <generator class="assigned"></generator>
          </id>
          <property name="employeeName"></property>
          <property name="salary"></property>
       </class>
     </hibernate-mapping>
```

The **generator class** subelement of id utilized to produce the unique identifier for the objects of persistence class. There are numerous generator classes characterized in the Hibernate Framework. All the generator classes actualizes the **org.hibernate.id.IdentifierGenerator interface**.

- Configure the mapping file in Configuration file.

hibernate.cfg.xml

```
<?xml version='1.0' encoding='UTF-8'?>
<!DOCTYPE hibernate-configuration PUBLIC
"-//Hibernate/Hibernate Configuration DTD 3.0//EN"
 "http://hibernate.sourceforge.net/hibernate-configuration-3.0.dtd">

<hibernate-configuration>

    <session-factory>

       <property name="connection.driver_class">oracle.jdbc.driver.OracleDriver</propert
        <property name="connection.url">jdbc:oracle:thin:@localhost:1521:XE</property>
        <property name="connection.username">system</property>
        <property name="connection.password">system</property>

         <property name="dialect">org.hibernate.dialect.Oracle10gDialect</property>
         <property name="hibernate.hbm2ddl.auto">create</property>
         <property name="show sql">true</property>

         <mapping resource="employee.hbm.xml"/>

    </session-factory>

</hibernate-configuration>
```

- Create the Dao class and store the POJO class object details which will be sent to the servlet class.

Dao.java

```
package com.itoolsinfo;

import org.hibernate.Session;
import org.hibernate.SessionFactory;
import org.hibernate.Transaction;
import org.hibernate.cfg.Configuration;

public class Dao
{
  public boolean saveDetails(int employeeId, String employeeName, int salary)
{
    boolean flag=true;
    SessionFactory factory=new Configuration().configure("hibernate.cfg.xml").buildSessi
      Session session=factory.openSession();

      Employee employee=new Employee();
        employee.setEmployeeId(employeeId);
        employee.setEmployeeName(employeeName);
        employee.setSalary(salary);
      Transaction transaction=session.beginTransaction();
      try
      {
          session.save(employee);
          transaction.commit();
      }catch(Exception e)
      {
          transaction.rollback();
          flag=false;

      }
      session.close();
      return flag;
      }
}
```

HQL: Hibernate Query Language.

HQL is an object-oriented query language, similar to SQL, but instead of operating on tables and columns, HQL works with persistent objects and their properties. This is main difference between hql vs sql. HQL is a superset of the JPQL, the Java Persistence Query Language. A JPQL query is a valid HQL query, but not all HQL queries are valid JPQL queries.
HQL is a language with its own syntax and grammar.
It is written as strings, like "*from Product p*". HQL queries are translated by Hibernate into conventional SQL queries. Hibernate also provides an API that allows us to directly issue SQL queries as well.

1. HQL Syntax
HQL syntax is defined as an **ANTLR** (ANother Tool for Language Recognition) grammar. The grammar files are included in the grammar directory of the Hibernate core download. (*ANTLR is a tool for building language parsers*). Lets outline the syntax for the four fundamental CRUD operations here:

1.1. HQL Update Statement
UPDATE alters the details of existing objects in the database. In-memory entities, managed or not, will not be updated to reflect changes resulting from issuing UPDATE statements. Here's the syntax of the UPDATE statement:

hql update statement syntax

```
UPDATE [VERSIONED]
  [FROM] path [[AS] alias] [, ...]
  SET property = value [, ...]
  [WHERE logicalExpression]
```

- path – fully qualified name of the entity or entities
- alias – used to abbreviate references to specific entities or their properties, and must be used when property names in the query would otherwise be ambiguous.
- VERSIONED – means that the update will update time stamps, if any, that are part of the entity being updated.
- property – names of properties of entities listed in the FROM path.
- logicalExpression – a where clause.
-

An example of the update in action might look like this. In this example, we are updating employee data with **hql update query multiple columns**.

hql update statement example

```
Query query=session.createQuery("update Employee set age=:age where name=:name");
query.setInteger("age", 32);
query.setString("name", "Freddy Flint");
int modifications=query.executeUpdate();
```

1.2. HQL Delete Statement

DELETE removes the details of existing objects from the database. In-memory entities will not be updated to reflect changes resulting from DELETE statements. This also means that Hibernate's cascade rules will not be followed for deletions carried out using HQL. However, if you have specified cascading deletes at the database level (either directly or through Hibernate, using the @OnDeleteannotation), the database will still remove the child rows.

Here's the syntax of the DELETE statement:

hql delete statement syntax

```
DELETE
  [FROM] path [[AS] alias]
  [WHERE logicalExpression]
```

In practice, deletes might look like this:

hql delete statement example

```
Query query=session.createQuery("delete from Account where accountstatus=:status");
query.setString("status", "purged");
int rowsDeleted=query.executeUpdate();
```

1.3. HQL Insert Statement

An HQL INSERT **cannot be used to directly insert arbitrary entities**—it can only be used to insert entities constructed from information obtained from SELECT queries (unlike ordinary SQL, in which an INSERT command can be used to insert arbitrary data into a table, as well as insert values selected from other tables).

Here's the syntax of the INSERT statement:

hql insert statement example

```
INSERT
  INTO path ( property [, ...])
  Select
```

The name of an entity is path. The property names are the names of properties of entities listed in the FROM path of the incorporated SELECT query. The select query is an HQL SELECT query (as described in the next section).
As this HQL statement can only use data provided by an HQL select, its application can be limited. An example of copying users to a purged table before actually purging them might look like this:

hql insert statement example

```
Query query=session.createQuery("insert into purged_accounts(id, code, status) "+
   "select id, code, status from account where status=:status");
query.setString("status", "purged");
```

```
int rowsCopied=query.executeUpdate();
```

1.4. HQL Select Statement

An HQL SELECT is used to query the database for classes and their properties. Here's the syntax of the SELECT statement:

hql select statement example

```
[SELECT [DISTINCT] property [, ...]]
  FROM path [[AS] alias] [, ...] [FETCH ALL PROPERTIES]
  WHERE logicalExpression
  GROUP BY property [, ...]
  HAVING logicalExpression
  ORDER BY property [ASC | DESC] [, ...]
```

The fully qualified name of an entity is path. The alias names may be used to abbreviate references to specific entities or their properties, and must be used when property names used in the query would otherwise be ambiguous.
The property names are the names of properties of entities listed in the ***FROM*** path.

If ***FETCH ALL PROPERTIES*** is used, then lazy loading semantics will be ignored, and all the immediate properties of the retrieved object(s) will be actively loaded (this does not apply recursively).
WHERE is used to create **hql select query with where clause**.

Unit 5

Java Spring Core

Introduction

The movement of Plain Old Java Object (POJO) was started in the beginning of the current century and became main stream in the enterprise Java world. This quick popularity is certainly closely related with the open source movement during that time. Many projects appeared, and most of them helped this programming model become mature with the time. This unit will tell how a thing were before this programming model existed in the enterprise Java community and discusses the problems of the old Enterprise JavaBeans (EJB) programming model. It's important that you understand the characteristics of the POJO programming model and what it provides to developers. The second half of the unit focuses on containers as well as the inversion of control patterns that are at the heart of the lightweight containers which are used today. We will learn what is a container? Which services are offered? And how a container is made lightweight? We will also learn about the inversion of control patterns, its close relationship with dependency injection terminology.

The POJO means Plain Old Java Objects. The name was coined by Martin Fowler, Rebecca Parsons, and Josh MacKenzie to provide some different name. It represents a programming trend that aims to simplify the coding, testing, and deployment phases of enterprise Java applications. We will have a better understanding of what problems the POJO model solves after understanding the problems caused by EJB Programming model.

5.1 The Spring Framework

The spring is a lightweight framework. It can be considered as a framework of frameworks because it provides support to various other Java frameworks such as Struts, Hibernate, EJB, JSF etc. The framework can be defined as a structure where we can find solution of the various technical problems occurred in programming. The spring is most popular application development framework used for programming in enterprise Java. Many of developers around the world use Spring Framework to create high performing, reusable code, and easily testable.

Spring framework is an open source Java platform. The first version was written by Rod Johnson, who released the framework with the publication of his book Expert One-on-One J2EE Design and Development in October 2002. The framework was first released under the Apache 2.0 license in June 2003. The first milestone release, 1.0, was released in March 2004 with further milestone releases in September 2004 and March 2005.

Advantages of using Spring Framework

- The spring enables developers to develop enterprise class applications using POJO programming model. The advantage of using only POJO is that we don't require an EJB

container product such as an application server but we have the option of using only robust Servlet container such as Apache Tomcat.

- Spring is organized in a modular fashion. Even though the number of packages and classes are significant, we have to worry only about the ones we need and dismiss the rest.

- Spring does not recreate anything; instead it makes use of some of the existing technologies like several ORM frameworks, logging frameworks, JEE, Quartz and JDK timers, and many other view technologies.

- Testing an application coded in Spring is very simple because environment-dependent code is moved into this framework. By using JavaBeanstyle POJO, it becomes easier to use dependency injection for injecting test data in the program.

- It's web framework is a well-designed web MVC framework, which provides a good option to web frameworks such as Struts or remaining over-engineered or less popular web frameworks.

- It provides a convenient API to translate technology-specific exceptions (thrown by JDBC, JDO or Hibernate) into consistent unchecked exceptions.

- The lightweight IoC containers lean to be lightweight, particularly when compared to Enterprise Java Beans containers. This is advantageous for developing and deploying applications on computers with small memory as well as CPU resources.

- It provides a consistent transaction management interface that can reduce to a local transaction and increase to global transactions.

The spring framework comprises several modules such as IOC, AOP, DAO, Context, ORM, WEB MVC etc. Let's understand the IOC and Dependency Injection first.

5.2 Inversion of Control

The prime aim of Inversion of control and Dependency Injection is to remove dependencies of an application. This makes the system more decoupled and rectifiable. Inversion of control is used to increase modularity of the program and make it extensible, and has applications in object-oriented programming and other programming paradigms. The term was used by Michael Mattsson in a thesis, taken from there by Stefano Mazzocchi and popularized by him in 1999 in a defunct Apache Software Foundation project, Avalon, then further popularized in 2004 by Robert C. Martin and Martin Fowler.

First let’s try to understand IOC (Inversion of control). If we go back to old computer programming days, program flow used to run in its own control. For instance let’s consider a simple chat application flow as shown in the below flow chart.

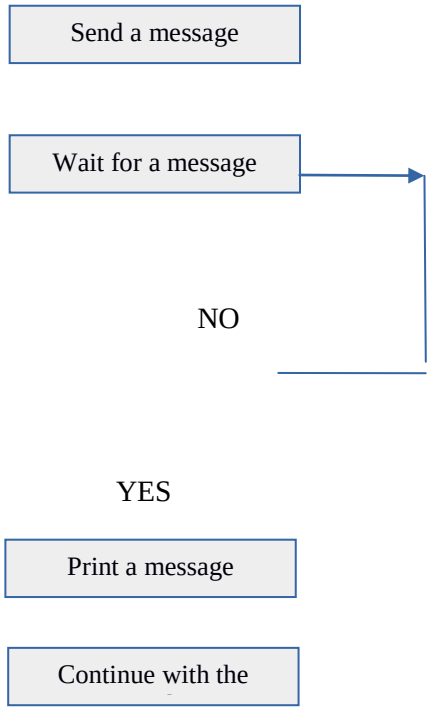


Fig. 5.1 Simple Message Communication

The communication here will be taken place in the following manner.

1. The user sends a message.
2. Our application waits for the message from the other end.
3. If no message is found it goes to Step 2 else moves to Step 4.
4. Prints the message.
5. User continues with his work after it.

Now if you examine the program flow, it is direct sequential. The program is in control of itself. Inversion of control means the program delegates control to someone else who will drive this flow. For instance if we make the chatting application event based then the flow of the program will go something as below:-

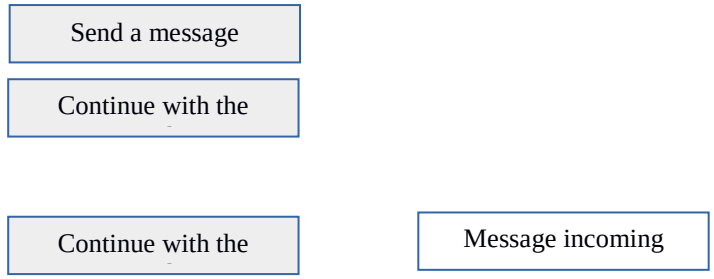


Fig. 5.2 Event based chatting application

- The user sends chat message.
- User continues with his work ahead.

- Application listens to the events. If a message arrives, event is activated, message is received and displayed.

You can see that the program flow is not sequential, its event based. So now the control is altered. It means that the internal program controlling the flow, events drive the program flow. Event flow approach is more flexible as their no direct invocation which leads to more flexibility.

We can say that IOC are implemented by only events. You can delegate the control flow by callback delegates, observer pattern, events, DI (Dependency injection) and lot of other ways.

IOC (Inversion of control) is a general parent term whereas DI (Dependency injection) is a subset of IOC. IOC is a concept where the flow of application is inverted. So for example rather than the caller calling the method.

SomeObject.Call();

Will get replaced with an event based approach as shown below.

SomeObject.WhenEvent += Call();

In this code the caller is exposing an event and when that event occurs he is taking action. It's based on the principle "Don't call us, we will call you". For example, in Hollywood when artists used to give auditions the judges would say them "Don't call us, we will call you".

This conceptualization makes code more flexible as the caller is not aware of the object methods and the object is not aware of caller's program flow.

Inversion of Control is a principle in software engineering by which the control of objects or portions of a program is transferred to a container or framework. It's most often used in the context of object-oriented programming.

By contrast with traditional programming, in which our custom code calls to a library, IoC enables a framework to take control of the program flow and make calls to our custom code. In order to enable this, frameworks use abstractions with additional behavior built-in. If we want to add our own behavior, we need to extend the classes of the framework or plug-in our own classes.

The advantages

- The decoupling the execution of a task from its implementation
- Making it easier to switch between different implementations
- Program modularization
- Ease in testing a program by isolating a component or mocking its dependencies and allowing components to communicate through contracts

5.3 IoC Container

The Spring container is at the center of the Spring Framework. It create the objects, wire them together, configure them, and manage their complete life cycle from creation till destruction. The Spring container uses DI to manage the components that make up an application. These objects are called Spring Beans.

The container gets its instructions on what objects to instantiate, configure, and assemble by reading the configuration meta-data provided. The configuration meta-data can be represented either by XML, Java annotations, or Java code. The following diagram represents a high-level view of how Spring works. The Spring IoC container makes use of Java POJO classes and configuration metadata to produce a fully configured and executable system or application.

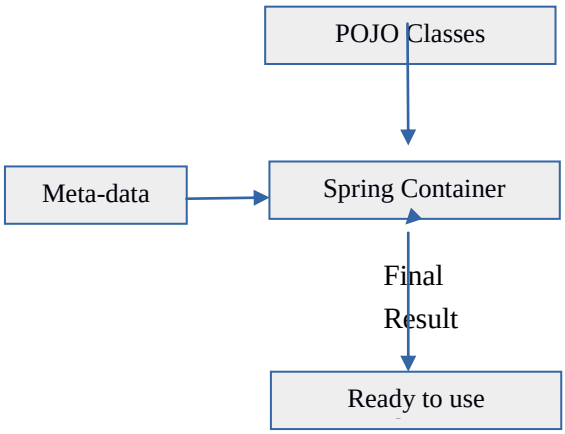


Fig. 5.3 Working of IOC Container

The IoC container is responsible to instantiate, configure and assemble the objects. The IoC container gets informations from the XML file and works with it accordingly. The main operations performed by IoC container are:

- Instantiate the application class
- Configure the object
- Assemble the dependencies between the objects

There are two types of IoC containers. They are:

1. BeanFactory
2. ApplicationContext

BeanFactory

This is the simplest container providing the basic support for DI and is defined by the org.springframework.beans.factory.BeanFactory interface. The BeanFactory and related interfaces, such as BeanFactoryAware, InitializingBean, DisposableBean, are still present in

Spring for the purpose of backward compatibility with a large number of third-party frameworks that integrate with Spring.

Spring has objects of the BeanFactory type that behave like the Factory object. We specify the blueprints object in a configuration file, which is an XML file, and then supply it to BeanFactory . Afterwards, if we need the instance of any object, we can ask BeanFactory for the same, which then refers to the XML file and constructs the bean as given. This bean is now a Spring bean as it has been created by Spring Container and is returned to us. This is how it is done.

1. Spring has BeanFactory , which creates new objects for us. So, the XYZ object will call BeanFactory .
2. BeanFactory would read from Spring XML, which contains all the bean definitions. Bean definitions are the blueprints. BeanFactory will then create beans from this blueprint and then make a new Spring bean.
3. Finally, this new Spring bean is handed back to XYZ , as shown here:

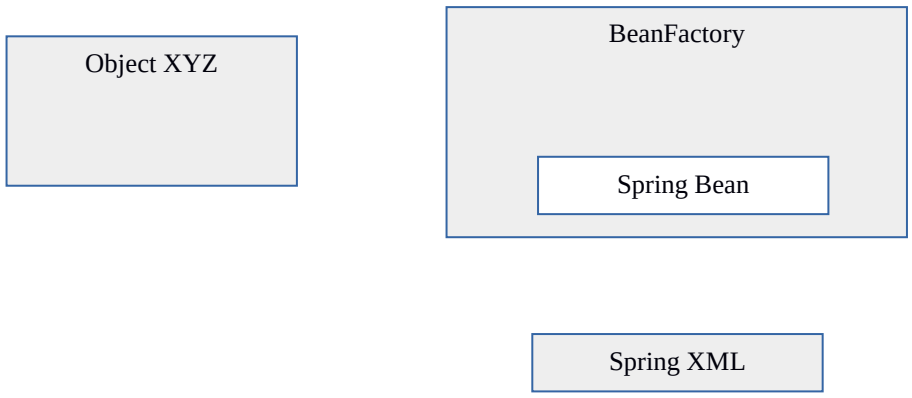


Fig. 5.4 BeanFactory Architecture

The advantage here is that this new bean has been created in this BeanFactory, which is known by Spring. Spring handles the creation and the entire life cycle of this bean. So, for this case, Spring acts as container for this newly created Spring bean. BeanFactory is defined by the org.springframework.beans.factory.BeanFactory interface. The BeanFactory interface is the central IoC container interface in Spring and provides the basic end point for Spring Core Container towards the application to access the core container service. It is responsible for containing and managing the beans. It is a factory class that contains a collection of beans. It holds multiple bean definitions within itself and then instantiates that bean as per the client's demands. BeanFactory creates associations between collaborating objects as they're instantiated. This removes the burden of configuration from the bean itself along with the bean's client. It also takes part in the life cycle of a bean and makes calls to custom initialization and destruction methods.

ApplicationContext

This container adds more enterprise-specific functionality such as the ability to resolve textual messages from a properties file and the ability to publish application events to interested event listeners. This container is defined by the org.springframework.context.ApplicationContext interface.

The ApplicationContext container includes all kinds functionality of the BeanFactoryContainer, so it is generally suggested over BeanFactory. BeanFactory can still be used for lightweight applications like mobile devices or applet-based Java applications where data volume and speed is momentous.

Like BeanFactory, ApplicationContext is also used to represent Spring Container, built upon the BeanFactory interface. ApplicationContext is suitable for Java Enterprise Edition applications, and it is always preferred over BeanFactory. All functionality of BeanFactory is included in ApplicationContext.

The org.springframework.context.ApplicationContext interface defines ApplicationContext. ApplicationContext provides advanced features to our Spring applications that make them enterprise-level applications, whereas BeanFactory provides a few basic functionalities. These are given as below.

- Except providing a means of resolving text messages, ApplicationContext also includes support for i18n of those messages.
- A generic way to load file resources, such as images, is provided by ApplicationContext.
- The events to beans that are registered as listeners can also be published using ApplicationContext.
- ApplicationContext handles certain operations on the container or beans in the container declaratively, which have to be handled with BeanFactory in a programmatic way.
- It provides ResourceLoader support. This is used to handle low-level system resources, Spring's Resource interface, and a flexible generic abstraction. ApplicationContext itself is ResourceLoader. Hence, access to deployment-specific Resource instances is provided to an application.
- It provides MessageSource support. MessageSource, an interface used to obtain localized messages with the actual implementation being pluggable, is implemented by ApplicationContext.

Creating a JavaBean

A bean in Java context is a simple Java class which has some properties (also called fields) and their getter and setter methods. These properties can be regarded as instance variables of the bean. The name of the properties and their getter/setter methods should adhere to the JavaBeans specifications that follow general conventions for a Java class.

How to create ?

There are many ways to create a bean in Spring.. All of the methods involve creating a class which will be regarded as a bean. So first let’s create a class called User.

```
package com.mitu;

public class Manager {
private String name;

private String address;

public String getName() {
    return name;
}

public void setName(String name) {
    this.name = name;
}

public String getAddress() {
    return address;
}

public void setAddress(String address) {
    this.address = address;
}
}
```

In this Java program, we are creating an instance of this class using new keyword but in Spring, there are different ways to create an instance of a bean class without using new. Although, using new keyword is permitted but is not recommended since injection of properties and Auto-wiring does not work if you create a bean using new.

Following are the ways to create a bean in Spring.

Method 1 : Declaring a bean in XML configuration file

This is the most primitive approach of creating a bean. The bean is declared in Spring's XML configuration file. Upon startup, Spring container reads this configuration file and creates and initializes all the beans defined in this file which can be used anytime during application execution. Here is how we define a bean in configuration XML.

```
<bean id= "user" class="com.mitu.Manager"></bean>
```

This method assumes that you are familiar with Spring XML configuration and how it is configured.

Details

A bean in Spring XML configuration file is defined by using element declaration. The id attribute is identifier of the bean and get its reference during execution. The class attribute should contain the fully qualified class name, including top level packages. This bean can be retrieved and used in the application in the following way.

```
public class Appl {

    @SuppressWarnings("resource")
    public static void main(String[] args) {

        ApplicationContext context = new AnnotationConfigApplicationContext(Manager.class);
        Manager man = (Manager)context.getBean("manager");
        System.out.println(man.getName());
        System.out.println(man.getAddress());
    }
}
```

Lets get in to this code. The id attribute is not mandatory and is only required when you want to access this bean in application or provide this bean as a dependency to some other bean.

The id of a bean should be unique otherwise we will get an error at start up like org.springframework.beans.factory.parsing.BeanDefinitionParsingException: Configuration problem: Bean name ‘test’ is already used in this <beans> element.

The scope of bean will be singleton by default, which means every time the bean is referred, same instance will be given. The scope of the bean can be changed by adding a scopeattribute in bean declaration.

Bean properties referred in the propertyelement should have valid setter methods otherwise following error will be received.

Bean property ‘name’ is not writable or has an invalid setter method.

Spring automatically performs the string to number conversion when the type of a class property is numeric while the values provided in XML configuration file are there in string format. But , we will get a java.lang.NumberFormatException if the property is not possible to get converted to number.

Method 2 : Using @Component annotation

@Component annotation above a class indicates that this class is a component and should be automatically detected and instantiated. Thus a Spring component bean will be created in this way.

```
package com.mitu;

@Component
```

```
public class Manager {
private String name;

private String address;

public String getName() {
    return name;
}

public void setName(String name) {
    this.name = name;
}

public String getAddress() {
    return address;
}

public void setAddress(String address) {
    this.address = address;
}
}
```

Explanation:

We need to instruct Spring container to find our beans and tell it about the package where it should find the beans, in order for a bean to be auto-discoverable and instantiated. Hence, for instantiating annotated beans, we require to add below declaration in our Spring XML configuration file :

<context:component-scan base-package= “com.mitu” />

If the bean annotated with @Componentannotation is outside of the package given in base-package attribute of this above element, then it will not be scanned and instantiated and thus won’t be found. This bean can also be used in the same way as the bean in the previous method. Thus, only bean declaration methods differs while the method of using them remains the same as of the first.

@Component annotation can only be applied at the class level. Applying it to some other location such as above a field will result it in a compiler error. The annotation @Component is not allowed for this location.

If a bean is referred and it has not been annotated with @Component or declared in XML configuration then we will get an exception as show below.

org.springframework.beans.factory.NoSuchBeanDefinitionException: No qualifying bean of type [com.mitu.Manager] is defined

Automatic instantiating a bean using @Component annotation needs that there must be a default constructor present in the class. As we know that, default constructor is a constructor without any arguments. If there is no constructor present in a class, then a default constructor is automatically created and used. If there is a constructor in your bean class which accepts some arguments then you have to create a default constructor yourself. If default constructor is not available, then following error will be generated.

org.springframework.beans.BeanInstantiationException: Failed to instantiate [com.mitu.User]: No default constructor found

5.4 Dependency Injection

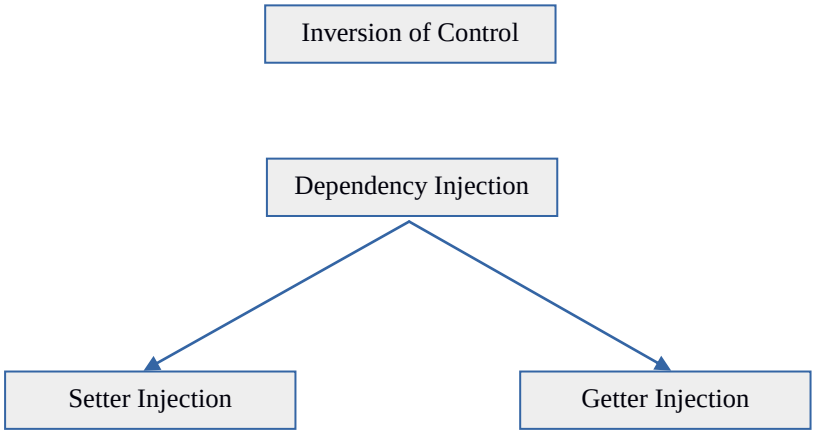


Fig. 5.6 Dependency Injection in Spring

Dependency Injection (DI) is a design pattern that is used to remove the dependency from the programming code so that it can be easy to manage and test our application. Dependency Injection makes our programming code loosely coupled.

It solves problems such as-

How can an application or class be independent of how its objects are created?

How can the way objects are created be specified in separate configuration files?

How can an application support different configurations?

Creating objects directly within the class that requires the objects is inflexible because it commits the class to particular objects and makes it impossible to change the instantiation later independently from the class. It stops the class from being reusable if other objects are required, and it makes the class hard to test because real objects can't be replaced with mock objects.

A class is no longer responsible for creating the objects it needs, and it doesn't have to delegate instantiation to a factory object as in the Abstract Factory design pattern.

In order to learn the DI, let's understand the Dependency Lookup (DL).

Dependency Lookup

The Dependency Lookup is an approach where we get the resource after demand. There can be various ways to get the resource for example:

```
X obj = new Ximpl();
```

In such way, we get the resource (instance of X class) directly by using new keyword. Another way is to use factory method:

```
X obj = X.getX();
```

Using this way, we get the resource (instance of X class) by calling the static factory method getX().

Alternatively, we can get the resource by JNDI (Java Naming Directory Interface) such as:

```
1. Context con = new InitialContext();
2. Context environmentCon = (Context) con.lookup("java:comp/env");
3. X obj = (X) environmentCon.lookup("X");
```

There can be various ways to to obtain the resource. But there are several problems in this approach.

Problems of Dependency Lookup

There are mainly two difficulties of dependency lookup approach.

Tight coupling - The dependency lookup approach makes the code tightly coupled. If resource is changed, we have to perform a lot many changes in the code.

Not easy for testing - This approach creates many problems while testing the application especially while performing black box testing.

Constructor-based Dependency Injection

Using constructor-based dependency injection, the container will raise a constructor with arguments each representing a dependency that we want to fix.

The Spring resolves each argument primarily by type, followed by name of the attribute and index for clarity. See the below example of the configuration of a bean and its dependencies using annotations:

```
@Configuration
public class Application {

@Bean
public Item item1() {
return new ItemImpl1();
}

@Bean
public Store store() {
return new Store(item1());
}
}
```

The @Configuration annotation indicates that the class is a source of bean definitions. Also, it is possible to add it to multiple configuration classes.

The @Bean annotation is used on a method for a bean definition. If we don’t specify a custom name, the bean name will default to the method name.

For a bean with the default singleton scope, Spring first checks if a cached instance of the bean already exists and only creates a new one if it is not existing. If we're using the prototype scope, the container returns a new bean instance for each of the method call.

Following is one more way to create the configuration of the beans is through XML configuration:

```
<bean id="item1" class="org.baeldung.store.ItemImpl1" />
<bean id="store" class="org.baeldung.store.Store">
<constructor-arg type="ItemImpl1" index="0" name="item" ref="item1" />
</bean>
```

Constructor Injection is the process of injecting the dependencies of an object through its constructor argument at the time of instantiating it. In other words, we can say that dependencies are supplied as an object through the object's own constructor. The bean definition can use a constructor with any number of arguments to initiate the bean, as shown here:

```
public class EmplServiceImpl implements EmplService
{
    private EmplDao emplDao = null;
    public EmplServiceImpl(EmplDao emplDao)
    {
        this.emplDao = emplDao;
    }
}
```

In the preceding code, the object of the EmplDao emplDao type is injected as a constructor argument to the EmplServiceImpl class. We need to configure bean definition in the configuration file that will do Constructor Injection. The Spring bean XML configuration tag <constructor-arg> is used for Constructor Injection:

```
...
<bean id="emplService"
    class="org.mitu.Spring.second.dependencyinjection.EmplServiceImpl">
    <constructor-arg ref="emplDao" />
</bean>
<bean id="emplDao"
    class="org.mitu.Spring.second.dependencyinjection.EmplDaoImpl">
</bean>
...
```

In the above pseudo-code, there is a Has-A relationship between the classes, which is EmplServiceImpl HAS-A EmplDao . Here, we inject a user-defined object as the source bean into

a target bean using Constructor Injection. Once we have the emplDao bean to inject it into the target emplService bean, we need another attribute called ref —its value is the name of the ID attribute of the source bean, which in our case is "emplDao" .

The <constructor-arg> element

The <constructor-arg> sub-element of the <bean> element is used for creating the Constructor Injection. This tag element supports four attributes. They are explained in the following table:

Attributes	Description	Occurrence
index	It takes the exact in the constructor argument list. It avoids the ambiguities like when two arguments are having same type.	Optional
type	This takes the type of this constructor argument	Optional
value	It describes the content in a simpe string representation, which is then converted to the type using PropertyEditors JavaBeans	Optional
ref	It refers to another bean in this factory	Optional

Table 5.1 The property attributes

Constructor Injection – injecting simple Java types

We inject simple Java types into a target bean using the Constructor Injection. The Empl class has emplName as String , emplAge as int , and married as boolean. The constructor initializes all these three fields. Following is the Empl.java file:

```
package org.mitu.Spring.second.constructioninjection.simplejavatype;
public class Empl
{
    private String emplName;
    private int emplAge;
    private boolean married;
    public Empl(String emplName, int emplAge, boolean married)
    {
        this.emplName = emplName;
        this.emplAge = emplAge;
        this.married = married;
    }
    @Override
```

```
    public String toString()
    {
        return "Empl Name: " + this.emplName + " , Age:" + this.emplAge          + ",
        IsMarried: " + married;
    }
}
```

Following is beans.xml file:

```
...
<bean id="empl" class="org.mitu.Spring.second.constructioninjection.simplejavatype.Empl">
    <constructor-arg value="Rashmi Thorave" />
    <constructor-arg value="28" />
    <constructor-arg value="True" />
</bean>
…
```

Constructor Injection with resolving ambiguity

In the Spring Framework, whenever we create a Spring bean definition file and provide values to the constructor, Spring decides implicitly and assigns the bean's value in the constructor by means of following main factors:

- Matching the number of parameters
- Matching the argument's data type
- Matching the argument's sequence

Whenever Spring tries to create bean using Construction Injection by following the mentioned rules, it tries to resolve the constructor to be chosen while creating Spring bean and hence results in the following circumstances.

No ambiguity

When Spring tries to create a Spring bean using the preceding rule if no matching constructor is found, it throws BeanCreationException exception with the message: Could not resolve matching constructor .

We will understand this scenario in more detail by taking the Empl class from earlier, which has three instance variables and a constructor to set the value of this instance variable.

The Empl class has a constructor in the order of String, int, and boolean to be passed while defining the bean in the definition file. In the beans.xml file, you'll have the following code:

```
...
```

```
<bean id="empl" class= "org.mitu.Spring.second.constructioninjection.simplejavatype.Empl">
<constructor-arg value="Rashmi Thorave" />
<constructor-arg value="True" />
<constructor-arg value="28" />
</bean>
…
```

If the orders in which constructor-arg is defined are not matching, then we will receive the following exception:

```
Exception in thread "main" org.springframework.beans.factory.
UnsatisfiedDependencyException:
Error creating bean with name empl defined in the classpath resource [beans.xml]: Unsatisfied dependency expressed through constructor argument with index 1 of type [int]: Could not convert constructor argument value of type [java.lang.String] to required type [int]: Failed to convert value of type 'java.lang.String' to required type 'int'; nested exception is java.lang.NumberFormatException: For input string: "True"
```

Solution

The solution to this problem is to fix the order of elements sent. Either we modify the constructor-arg order of the bean definition file or we use the index attribute of constructor-arg as follows:

```
...
<bean id="empl"
class="org.mitu.Spring.second.constructioninjection.simplejavatype.Empl">
<constructor-arg value="Rashmi Thorave" index="0" />
<constructor-arg value="True" index="2" />
<constructor-arg value="28" index="1" />
</bean>
…
```

Remember that the index attribute in all collection elements always starts with 0.

Parameter ambiguity

Sometimes, there is no problem in resolution of the constructor, but the constructor chosen is leading to in-convertible data. In this case, org.springframework.beans. factory.UnsatisfiedDependencyException is thrown just before the data is converted to the actual data type.

We will understand this scenario in more detail; the Empl class contains two constructor methods and both accept three arguments with different data types.

The following code snippet is also present in Empl.java :

```
package org.mitu.Spring.second.constructioninjection.simplejavatype;
public class Empl
{
    private String emplName;
    private int emplAge;
    private String emplId;
    Empl(String emplName, int emplAge, String emplId)
    {
        this.emplName = emplName;
        this.emplAge = emplAge;
        this.emplId = emplId;
    }
    Empl(String emplName, String emplId, int emplAge)
    {
        this.emplName = emplName;
        this.emplId = emplId;
        this.emplAge = emplAge;
    }
    @Override
    public String toString()
    {
        return "Empl Name: " + emplName + ", EmplAge: " + emplAge + ",
        Empl Id: " + emplId;
    }
}
```

The beans.xml file, will be like this:

```
...
<bean id="empl" class="org.mitu.Spring.second.constructioninjection.simplejavatype.Empl">
<constructor-arg value="Rashmi Thorave" />
<constructor-arg value="534" />
<constructor-arg value="28" />
</bean>
…
```

Spring chooses the wrong constructor to create the bean. The preceding bean definition has been written in the hope that Spring will choose the second constructor as Rashmi Thorave for emplName , 534 for emplId , and 28 for emplAge . But the actual output will be:

```
Empl Name: Rashmi Thorave, Empl Age: 534, Empl Id: 28
```

The preceding result is not the expected result; the first constructor is run instead of the second constructor. In Spring, the argument type 534 is converted to int, so Spring converts it and takes the first constructor even though we assume it should be a string.

In addition, if Spring can't resolve which constructor to use, it will prompt the following error message:

constructor arguments specified but no matching constructor found in bean 'CustomerBean' (hint: specify index and/or type arguments for simple parameters to avoid type ambiguities)

Solution

The solution to this problem uses the type attribute to specify the exact data type for the constructor:

```
...
<bean id="empl"
class="org.mitu.Spring.second.constructioninjection.simplejavatype.Empl">
<constructor-arg value="Rashmi Thorave" type="java.lang.String"/>
<constructor-arg value="534" type="java.lang.String"/>
<constructor-arg value="28" type="int"/>
</bean>
…
```

The output will be printed as:

Empl Name: Rashmi Thorave, Empl Age: 28, Empl Id: 534

The setter-based Dependency Injection

Setter Injection in Spring is a type of dependency injection in which the framework injects the dependent objects into the client by the setter method. The container first calls the default argument constructor and then calls the setters. The setter based injection can work even If some dependencies have been injected using the constructor.

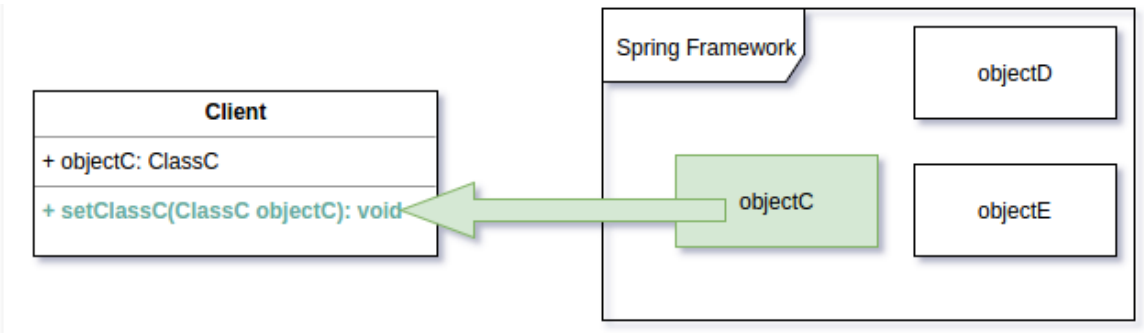


Fig. 5.7 Setter Injection

For setter-based dependency injection, the container will call setter methods of the class, after invoking a default constructor or no-argument static factory method to instantiate the bean. We will create this configuration using annotations:

```
@Bean
public Store store()
{
Store store = new Store();
store.set(item1());
return store;
}
```

We can also use XML for the same configuration of the beans:

```
<bean id="store" class="org.baeldung.store.Store">
<property name="item" ref="item1" />
</bean>
```

Constructor-based and setter-based types of injection can be combined together for the same bean. The Spring documentation recommends using constructor-based injection for compulsory dependencies, and setter-based injection for optional ones.

The setter-based D.I. is the method of injecting the dependencies of an object using the setter method. In setter injection, the Spring container uses set() of the Spring bean class to assign a dependent variable to the bean property from the bean configuration file. The setter method is more convenient to inject more dependencies since a large number of constructor arguments makes it clumsy.

In the EmplServiceImpl.java class, you'll ind the following code:

```
public class EmplServiceImpl implements EmplService
{
    private EmplDao emplDao;
    public void setEmplDao(EmplDao emplDao)
    {
        this.emplDao = emplDao;
    }
}
```

In the EmplDaoImpl.java class, we will find the following code:

```
public class EmplDaoImpl implements EmplDao
{
    // …
```

}

In the given pseudo-code, the EmplServiceImpl class defined the setEmplDao() method as the setter method where EmplDao is the property of this class. This method injects values of the emplDao bean from the bean configuration file before making the emplService bean available to the application.

The Spring bean XML configuration tag <property> is used to configure properties. The ref attribute of property elements is used to specify the reference of another bean.

In the beans.xml file, will have the following code:

```
...
<bean id="emplService" class="org.mitu.Spring.second.dependencyinjection.EmplServiceImpl">
<property name="emplDao" ref="emplDao" />
</bean>
<bean id="emplDao" class="org.mitu.Spring.second.dependencyinjection.EmplDaoImpl">
</bean>
…
```

The <property> element

The <property> element invokes the setter method. The bean definition can be describing the zero or more properties to inject before making the bean object gettable in the application. The <property> element tallies to JavaBeans' setter methods, which are exposed by bean classes. The <property> element supports the following three attributes:

Attributes	Description	Occurrence
name	It takes the name of JavaBean based property	Optional
value	The value describes the content in a simple string representation, which will be converted into the argument type using Java Bean PropertyEditors	Optional
ref	It store reference to a bean	Optional

Table 5.2 The property element attributes

Setter Injection with simple Java type

Here, we inject string-based values using the setter method. The Empl class contains the emplName ield with its setter method.

In the Empl.java class, we will have the following code:

```
package org.mitu.Spring.second.setterinjection;
public class Empl
{
    String emplName;
    public void setEmplName(String emplName)
    {
        this.emplName = emplName;
    }
    @Override
    public String toString()
    {
        return "Empl Name: " + emplName;
    }
}
```

In the beans.xml file, we will have the following code:

```
...
<bean id="empl" class="org.mitu.Spring.second.setterinjection.Empl">
<property name="emplName" value="Rashmi Thorave" />
</bean>
…
```

In this pseudo-code, the bean configuration file set the property value. In the Payroll.java class, lets have the following code.

```
package org.mitu.Spring.second.setterinjection;
import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXml.ApplicationContext;
public class Payroll
{
    public static void main(String[] args)
    {
        ApplicationContext context = new
        ClassPathXmlApplicationContext("beans.xml");
        Empl empl = (Empl)
        context.getBean("empl");
        System.out.println(empl);
    }
}
```

The output after running the Payroll class will be as follows:

INFO: Refreshing org.springframework.context.support.ClassPathXmlApplicationContext
@1ba94d: startup date [Sun Jun 28 10:11:36 IST 2019]; root of context hierarchy
Jan 25, 2015 10:11:36 AM org.springframework.beans.factory.xml.XmlBeanDefinitionReader
loadBeanDefinitions
INFO: Loading XML bean definitions from class path resource [beans.xml]
Empl Name: Rashmi Thorave

Setter Injection for injecting collections

In the Spring IoC container, beans can also access collections of the objects. Spring allows us to inject a collection of objects in a bean using Java's collection framework. Setter Injection can be used to inject collection of values into the Spring Framework. If we have a dependent object in the collection, we can inject this information using the ref element in the list, set, or map. See the below elements.

- **<list> :** It describes a java.util.List type. A list can contain multiple bean , ref , value , null , another list , set , and map elements. The required conversion is automatically performed by BeanFactory.
- **<set> :** It describes a java.util.Set type. A set will have multiple bean , ref , value , null , another set , list , and map elements.
- **<map> :** It describes a java.util.Map type. A map can contain zero or more <entry> elements, which describes a key and value.

The Empl class is a class with an injecting collection. In the Empl.java class, we will have the following code:

```
package org.mitu.Spring.second.setterinjection;
import java.util.List;
import java.util.Map;
import java.util.Set;
public class Empl
{
    private List<Object> lists;
    private Set<Object> sets;
    private Map<Object, Object> maps;

    public void setLists(List<Object> lists)
    {
        this.lists = lists;
    }
    public void setSets(Set<Object> sets)
    {
        this.sets = sets;
```

```
    }
    public void setMaps(Map<Object, Object> maps)
    {
        this.maps = maps;
    }
}
```

The bean configuration file of this code is the one that injects each and every property of the Empl class.

In the beans.xml file, we will have the following code:

```
...
<bean id="empl" class="org.mitu.Spring.second.setterinjection.Empl">
<property name="lists">
<list>
    <value>Rashmi Thorave</value>
    <value>Aniket Thorave</value>
    <value>Rahul Thorave</value>
</list>
</property>
<property name="sets">
<set>
    <value>Vihaan Thorave</value>
    <value>Pravina Thorave</value>
</set>
</property>
<property name="maps">
    <map>
    <entry key="Key 1" value="Shiroli Bk"/>
    <entry key="Key 2" value="Maharashtra"/>
    </map>
</property>
</bean>
...
```

In this pseudo code, we have injected values of all three setter methods of the Empl class. The List and Set instances are injected with the <list> and <set> tags. For the map property of the Empl class, we injected a Map instance using the <map> tag. Each entry of the <map> tag is specified with the <entry> tag that contains a key-value pair of the Map instance.

Difference betweenConstructor Injection and setter injection -

There are many differences between constructor injection and setter injection. Some prime differences are as listed below.

Partial dependency: can be injected using setter injection but it is not affirmative by constructor. Suppose there are three properties in a class, having three argument constructor and setters methods. In such case, if we want to pass information for only one property, it is possible by setter method only.

Overriding: Setter injection overrides the constructor injection. If we use both constructor and setter injection, IOC container will use the setter injection.

Changes: We can easily change the value by setter injection. It doesn't create a new bean instance always like constructor. So setter injection is flexible than constructor injection.

Unit 6

Spring Web MVC Framework

Introduction

The presentation layer in an enterprise application is the front door to your application created in Java. It provides users a interactive view of the information, allowing them to perform business functions provided and managed by the application. The development of the presentation layer is a difficult task these days because of the rise of cloud computing and different kinds of devices that people are using on regular basis. Many technologies and frameworks are now getting used to develop enterprise web applications, such as Spring Web MVC, Java Server Faces (JSF), Struts, Google Web Toolkit (GWT), as well as as jQuery. These provide rich component libraries that can help develop the interactive web front-ends. Many frameworks also provide widget libraries and tools targeting mobile devices, including tables and smart-phones.

6.1 The Spring Web Model View Controller (MVC)

The Spring Web Model View Controller (MVC) framework supports web application development by providing broadas well as intensive support for the Java application. The framework is flexible, robust, and well-designed and is used to develop web applications. It is designed in such a way that development of a web application is highly configurable into Model, View, and Controller. In the MVC design pattern, Model represents the information or data of a web application; View represents the User Interface (UI) components by which user interacts with it, such as checkbox, textbox, radio buttons and so forth that are used to display web pages; and Controller processes as per the user request. The Spring MVC framework helps in integrating other frameworks, such as Struts and WebWork, with a Spring application. This framework also supports the integration of other view technologies such as Java Server Pages (JSP), FreeMarker, Tiles, and Velocity in a Spring web application.

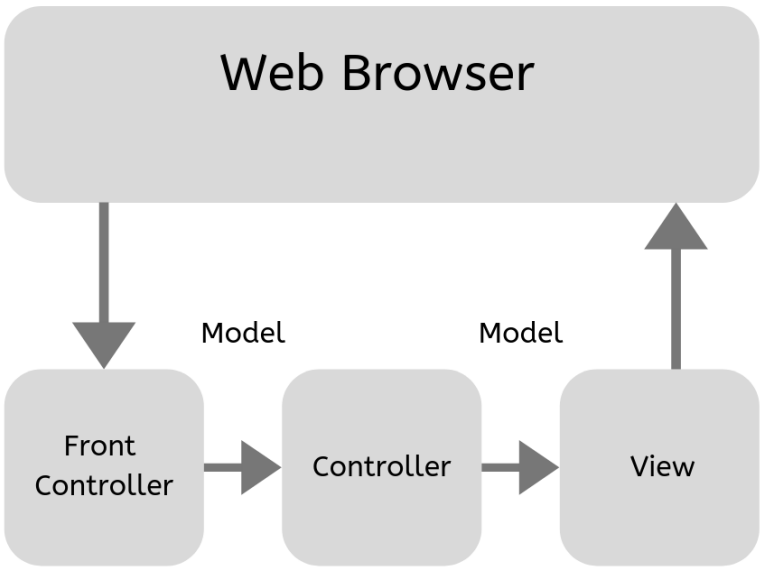


Fig. 6.1 Spring MVC Architecture

Model – It contains the data of the application. A data can be a single object or a collection of objects.

Controller –It contains the business logic of an application. Here, the @Controller annotation is used to mark the class as the controller.

View –It represents the provided information in a particular format. Generally, JSP+JSTL is used to create a view page. Although spring also supports other view technologies such as Apache Velocity, Thymeleaf and FreeMarker.

Front Controller – In Spring Web MVC, the DispatcherServlet class works as the front controller. It is responsible to manage the flow of the Spring MVC application.

Flow of Spring MVC

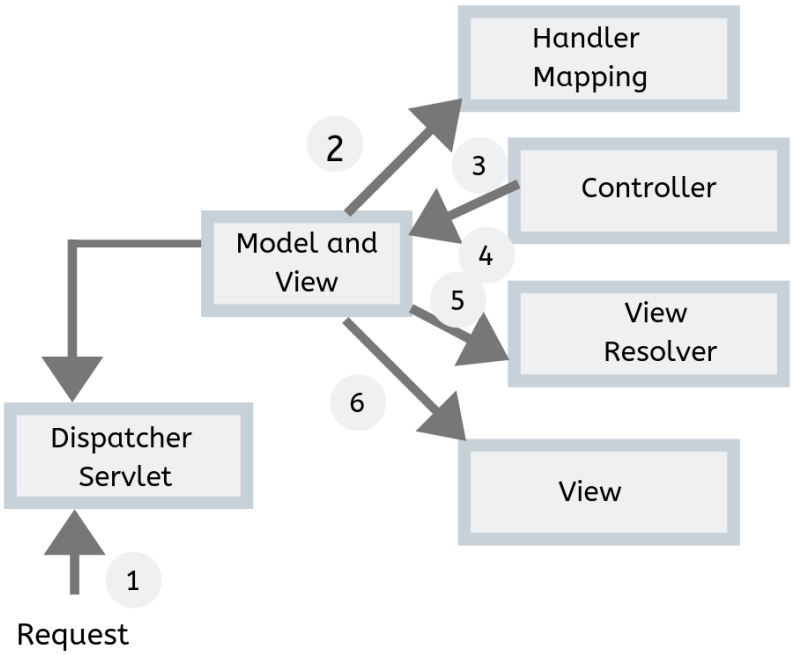


Fig. 6.2 Flow of Spring MVC

As displayed in the figure above, all the incoming request is intercepted by the Dispatcher Servlet that works as the front controller.

The DispatcherServlet gets an entry of handler mapping from the XML file and forwards the request to the controller.

The controller returns an object of ModelAndView.

The DispatcherServlet checks the entry of view resolver in the XML file and invokes the specified view component.

Advantages of using the Spring MVC Framework

Following are the advantages of Spring MVC Framework.

Isolated roles - The Spring MVC isolates each role, where the model object, controller, command object, view resolver, DispatcherServlet, validator, can be fulfilled by a specialized object.

Light-weight - This uses light-weight Servlet container to develop and deploy your application.

Mighty Configuration - It provides a robust configuration for both framework and application classes which includes easy referencing across contexts, such as from web controllers to business objects and validators.

Fast development - The Spring MVC facilitates rapid and parallel development.

Reusable business code - Instead of creating new objects, it allows us to use the existing business objects.

Effortless to test - In Spring, generally we create JavaBeans classes that enablesus to inject test data using the setter methods.

Flexible Mapping - It provides the specific annotation that easily redirects the page.

Spring Web MVC Framework Example

Let's see the simple example of a Spring Web MVC framework.

The steps are as follows:

- Load the spring's jar files or add dependencies in the case of Maven
- Create the controller class
- Provide the entry of controller in web.xml file
- Define the bean in the separate XML file
- Display the message in the JSP page created
- Start the server and then deploy the project

6.2 The MVC architecture

MVC is an architectural pattern used in the development of web applications; it provides separation of concern in the architecture of an application and separates it into three software modules which communicate with each other using a relatively easy interface. This model holds the business entities that can be passed to the View via Controller to have exposure them to the end user. The View is not dependent on the Model and Controller; it represents the presentation form of an application.

The Controller is independent of the Model and View with the exclusive purpose of handling requests and performing business concern logic. Thus, the model (business entities), controllers (business

logic), and views (presentment logic) lie in logical/physical layers, independent of each other. The presentation layer of an application is normally implemented using the MVC patterns. MVC offers more organized and reparable code. It is popularly known as a software design pattern used to develop the web applications.

The prime three components of MVC are as listed below.

- **Model:** The Model represents the business entity where the application's data is stored. It is the formulation of the objects that the user works with and the mapping of those concepts into data structures: the user model and data model.
- **View:** The View is obligated for preparing the presentation for the client based on the conclusion of the request processing, without considering any business logic. It renders the model data into the client's user interface type.
- **Controller:** The Controller is responsible for controlling the low request to response low in the middle-ware. It starts back-end services for businesses after receiving a request from the user, and updates the model. It also prepares models for the View to present. It is answerable for determining which view should be rendered.

The following figure illustrates Model, View, and Controller:

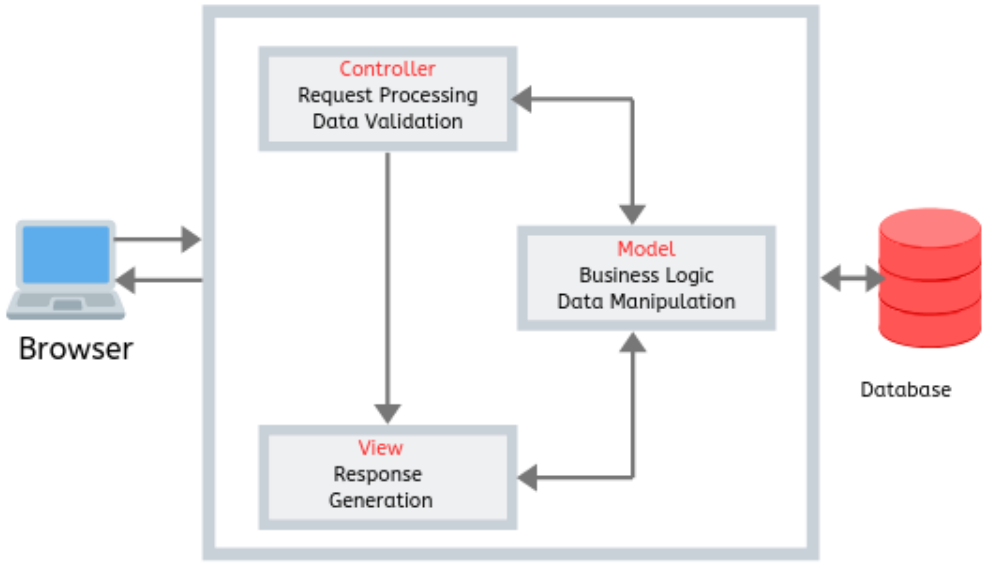


Fig 6.3 The MVC Architecture

The abovefigure shows MVC in a web application. The Controller is typically used to process requests from the client and forward requests for changes to the Model. The View code accesses the Model to render the response to the client.

6.3 Front Controller Design Pattern

A pattern represents the strategies that permit programmers to share their knowledge ragarding recurring problems and their answers. As we have seen in the previous section, the MVC pattern separates the user interface logic from the business logic of web applications. When we wish to achieve re-usability and flexibility while avoiding redundancy and decentralization, we should structure the controller for a very complex web application in the best possible manner.

The Front Controller is used at the initial point of contact to handle all Hyper Text Transfer Protocol (HTTP) requests; it enables us to centralize logic to debar duplicated code, and manages the key HTTP request-handling activities, such as navigation and routing, dispatch, and context transformation. The front controller design pattern enables centralizing the handling of all HTTP requests without limiting the number of handlers in the system.

The Front Controller does not just capture HTTP requests; it also initializes some of the very important components of the framework to run, as shown in the following igure. It helps in loading the map of URLs and the components that need to be invoked when a request lands with the URLs. It can also load some of the other components, such as views.

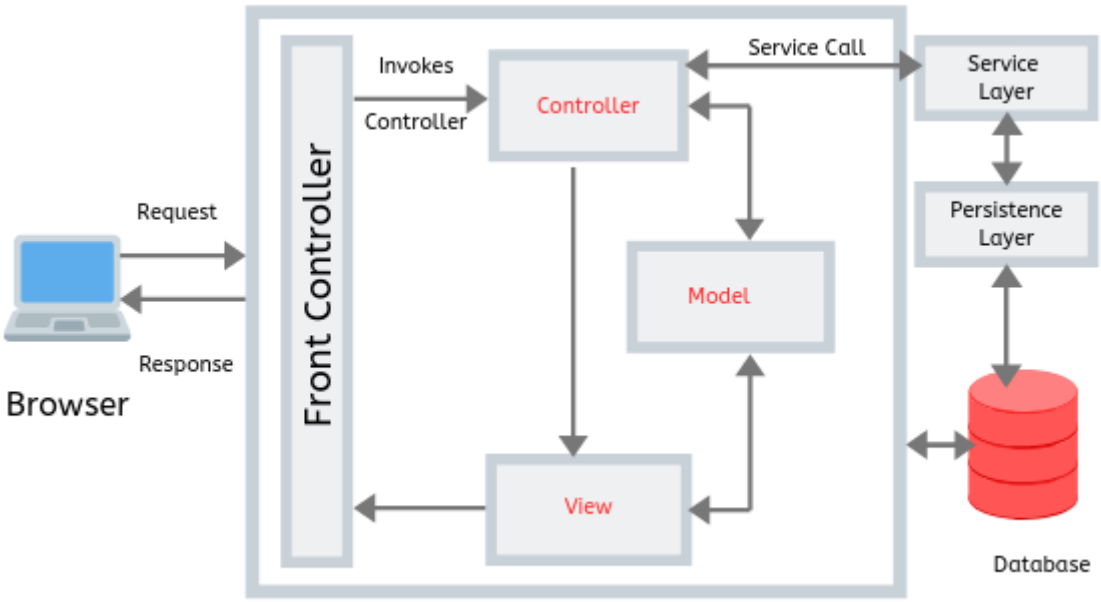


Fig. 6.4 Front controller design pattern

The abovefigure illustrates the front controller design pattern in web applications. The user/ or browser will interact with only one controller, which is front controller. The front controller intercepts the user request, does common operations, and dispatches the request to the respective controller based on web application configuration and HTTP request information. The controller then interacts with the service layer to do business logic and persistence logic. Then it updates the model, and the view renders the model data to produce presentation view and return the view to the user. The front controller responds to the client in the form of the view.

In Spring MVC, the Dispatcher Servlet does the task a front controller. As we know about the MVC and the front controller, which are the important to understand the Spring MVC framework, starting with Spring MVC framework followed by its architecture and its elements.

Spring MVC

A web application created using the Spring MVC framework is easier to develop, understand, and keep the maintenance. Spring MVC is an open source web framework; which allows us to download the source code and modify it to support user extensions as per theuser requirements. Its code is exposed to the developer and this enables rapid development and maintenance cycle. As a result, we can have a quick result from the Spring team in fixing the bugs in code and responding to new requirements in the business market.

The Spring MVC framework is implemented using standard Java technologies such as Java Servlet and JSP. Thus, we are allowed to host Spring MVC projects on any Java enterprise web server just by adding the Spring JAR files into the lib of our web application or project.

The Spring MVC module in the Spring Framework provides a big support for the MVC design for features such as i18n, theming, validation, and so on, to make easier implementation of the presentation layer.

The Spring MVC framework is configured around a DispatcherServlet. The DispatcherServlet dispatches the HTTP request to the handler, which is a very plain Controller interface. Spring MVC allows us to use any form object or command object. Struts built around needed base classes such as Action class and ActionForm class; however, the Spring MVC application doesn't need to utilize a framework-specific interface or base class.

Features of the Spring MVC framework

The Spring MVC framework provides a set of the following web support features:

- **Powerful framework configuration and application classes:** The Spring Web MVC framework provides straightforward and powerful configuration of the framework as well as of application classes such as JavaBeans.
- **Easier testing:** Most of the Spring classes are designed as JavaBeans, which allowsus to inject the test data using the setter method of these JavaBeans classes. The Spring MVC framework also provides classes to handle HTTP requests, which make the unit testing of the web application much easier.
- **Separation of roles:** Each component of a Spring MVC framework does a different role during request handling. A request is handled by components such as the Controller, Validator, Model Object, View Resolver and HandlerMapping interfaces. The whole work is dependent on these components and provides a clear isolation of roles.
- **No need for the duplication of code:** In the Spring MVC framework, we can use the existing business code in any component of the Spring MVC application. Therefore, no duplication of the code uprises in a Spring MVC application.
- **Specific validation and binding:** Validation errors are displayed when any unmatched data is entered in a form.

6.4 Flow of request handling in Spring MVC

The DispatcherServlet is the head-on controller for the Spring MVC application, which provides centralized access to the application for various requests and collaborating with various other objects to complete the request handling and present the response to the client. In Spring MVC, the DispatcherServlet gets requests and dispatches requests to the appropriate controller. There can be any number of DispatcherServlet in a Spring application to manage user interface requests or Restful Web Services requests, as shown in the following figure. Each DispatcherServlet uses its own WebApplicationContext configuration to situate the various objects registered in the Spring container, such as the controller, handler mapping, view resolving, i18n, theming, type conversion and formatting, validation, and many more.

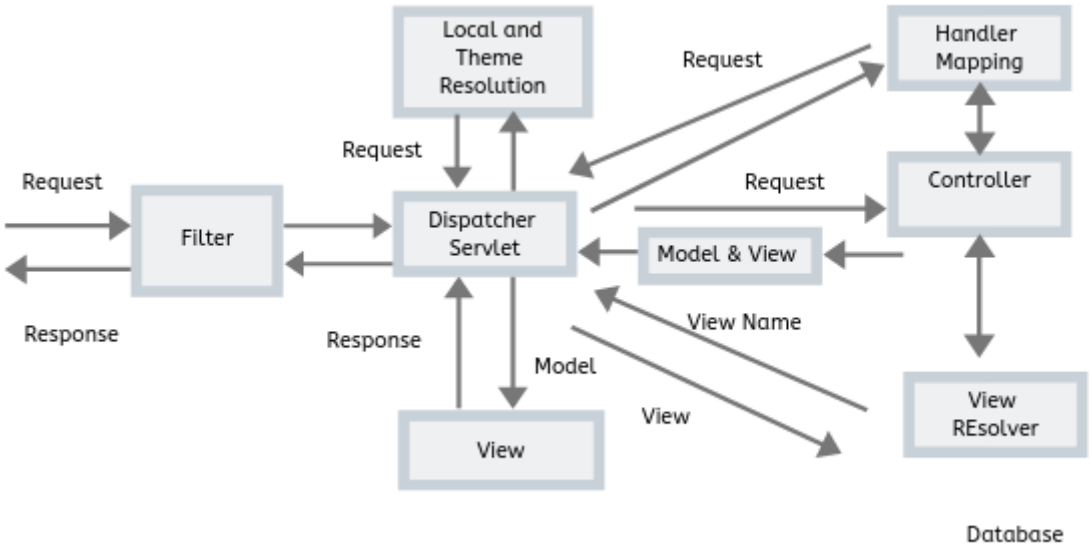


Fig. 6.5 Request handling in Spring MVC

The figure above shows the low of request handling in Spring MVC, along with its components. They are explained as below.

- **Filter:** The Filter component applies to all the HTTP requests. Various commonly used filters can be used to fulfill the HTTP requests.
- **DispatcherServlet:** The Servlet intercepts and analyzes the incoming HTTP request and dispatches them to the suitable controller to be processed. It is always configured in the web.xml file of any web application
- **Local resolution and theme resolution:** The configuration of i18n and themes is defined in DispatcherServlet file's WebApplicationContext . It provides support to all the requests.
- **Handler mapping:** This maps the HTTP request to the handler, that is, a method within a Spring MVC controller class, based on the HTTP paths declared through the @RequestMapping annotation at the method or type level inside the controller class.
- **Controller:** The Controller in Spring MVC acquires requests from the DispatcherServlet class and does some business logic in accordance with the client.
- **ViewResolver:** The ViewResolver is the interface of Spring MVC supports view resolution based on the view name returned by controller. The URLBasedViewResolver class supports the direct resolution of view name to URLs. The ContentNegotiatingViewResolver class supports the dynamic resolution of views based on the media type supported by the client, such as PDF, XML, JSON, and many more.
- **View:** In Spring MVC, the View components are user-interface elements, such as textbox items and many others, which are responsible for displaying the output of a Spring MVC application. Spring MVC provides a set of tags in the form of a tag library, which is used to construct views. Whenever an HTTP request from a browser comes to a Spring MVC application, it is irst intercepted by DispatcherServlet , which acts like the front controller for a Spring MVC application. The DispatcherServlet class intercepts the incoming HTTP request and determines which controller handles the request, and then sends the HTTP request to a Spring MVC controller.
- **The controller** implements the activity of the Spring MVC application. The controller gets the request from the DispatcherServlet class and does some business logic in agreement with the client request. A Spring MVC application may have various controllers, and to determine on the controller to send the request, DispatcherServlet takes assist from one or more handler mappings. The handler mapping makes its decision based on the URL transferred by the request. After the business logic is performed by controller, some information referred to as the model is generated, that needs to be carried back to the client and display in the browser. But it is not adequate to send raw information to the client. So the raw information required to be given to the view, which can be JSP or similar tool. The Controller also packs up the model data and identities the view name that will render the output. Then, it sends the request along with view name and model back to DispatcherServlet.
- **The DispatcherServlet** class enquires the view resolver to map the view name to a specific view implementation, which may or may not be JSP, FreeMarker, JSON, Thymeleaf, and many more. A good point here is that Spring is nescient of the view technology. So, at this point, the request job is almost over and DispatcherServlet knows about the view which will provide the

result. It delivers the model collection to the view component, and the request job is in the end done here. This model data will be used by the view to render the output, which will be carried back by the response object to the client.

Front Controller Design Pattern

The front controller design pattern refers that all requests that come for a resource in an application will be handled by a single handler and then dispatched to the suitable handler for that type of request. The main front controller may use other helpers to accomplish the dispatching mechanics.

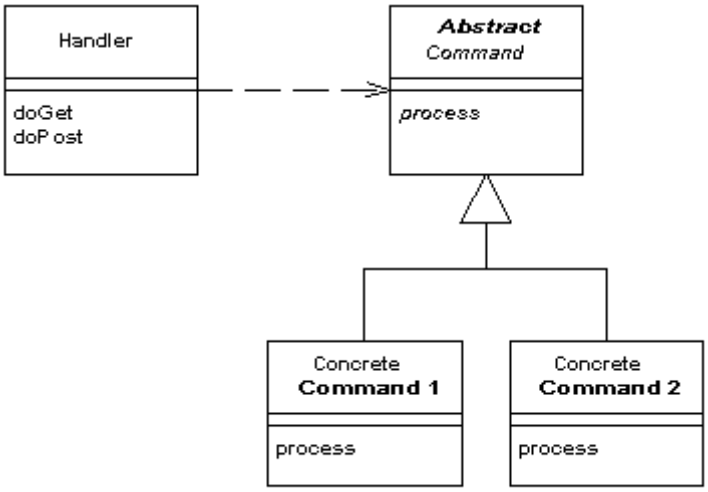


Fig. 6.6 Front Controller Design Pattern

The Design components

Controller : The controller is the first contact point for handling all requests in the system. The controller may delegate to a helper to finish authentication and authorization of a user or to negin contact retrieval.

View: A view represents and shows information to the client. The view retrieves information from a model. Helpers support views by encapsulating and adapting the underlying data model for using in the display.

Dispatcher: A dispatcher is answerable for view management and navigation, management of the choice of the next view to represent to the user, and providing the mechanics for vectoring control to that resource.

Helper : A helper is responsible for helping a view or controller complete its processing. So, helpers have many responsibilities, including gathering data needed by the view and storing this intermediate model, in which case the helper is erstwhile referred to as a value bean.

Let's see an example of Front Controller Design Pattern.

```
class TView
{
```

```
TView
public void show()
{
System.out.println("Teacher View");
}
}

class SView
{
public void show()
{
System.out.println("Student View");
}
}

class Dispatch
{
private SView SView;
private TView TView;

public Dispatch()
{
SView = new SView();
TView = new TView();
}

public void dispatch(String request)
{
if(request.equalsIgnoreCase("Student"))
{
SView.display();
}
else
```

```
{
TView.display();
}
}
}

class FrController
{
private Dispatch Dispatch;

public FrController()
{
Dispatch = new Dispatch();
}

private boolean isAuthenticUser()
{
System.out.println("Authentication is successful.");
return true;
}

private void trackRequest(String request)
{
System.out.println("Requested View: " + request);
}

public void dispatchRequest(String request)
{
trackRequest(request);

if(isAuthenticUser())
{
Dispatch.dispatch(request);
```

```
}
}
}

class FrControllerPattern
{
public static void main(String[] args)
{
FrController frController = new FrController();
frController.dispatchRequest("Teacher");
frController.dispatchRequest("Student");
}
}
```

Output is a shown below:

```
Requested View: Teacher
Authentication successful.
Teacher View
Requested View: Student
Authentication successful.
Student View
```

Benefits:

Focused control : TheFront controller handles all the requests to the Web application. This implementation of focused control that ignores using multiple controllers is desirable for imposing application-wide policies such as users tracking and safety.

Thread safety : A new command object uprises when receiving a new request and the command objects are not meant to be thread-safe. Thus, it will be safe in the command classes. Although safety is not guaranteed when threading issues are collected, codes that act with the command are still thread safe.

Drawbacks:

- It is not possible to scale an application using a front controller. The scaling up the application requires additional programming.

- It has several performance issues. Performance is better if you deal with a single request uniquely.

6.5 DispatcherServlet in Spring MVC

Spring's web MVC framework is, like many other web MVC frameworks, request-driven, designed around a centralized Servlet that dispatches requests to controllers and provides other functionality that serves the development of web applications. Spring's DispatcherServlet however, does more than just that. It is totally integrated with the Spring IoC container and as such allows us to use every other characteristic that Spring class is having.

The request processing work-flow of the Spring Web MVC DispatcherServlet is illustrated in the following diagram 6.7. The pattern-savvy reader can recognize that the DispatcherServlet is an expression of the “Front Controller” design pattern (this is a pattern that Spring Web MVC shares with many other leading web frameworks).

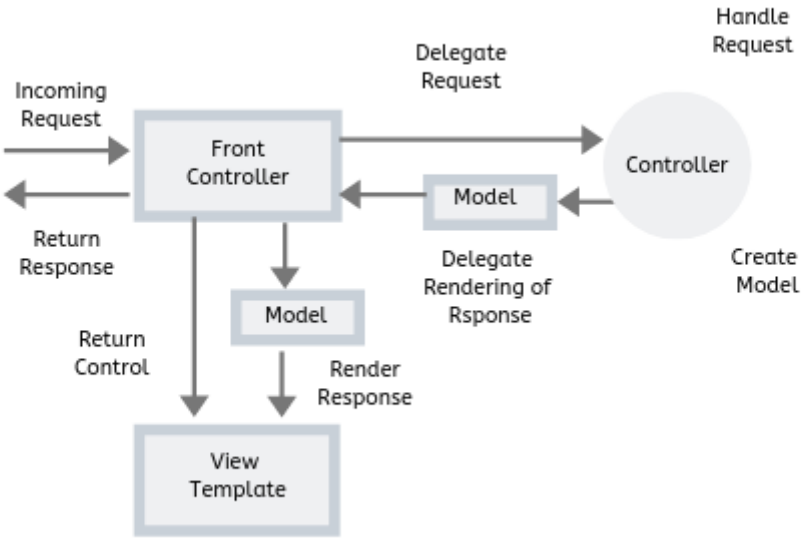


Fig. 6.7 The request processing workflow in Spring Web MVC

The DispatcherServlet is an actual Servlet (it inherits from the HttpServlet base class of servlet package), and as such is declared in the web.xml of our web application. We need to map requests that we want the DispatcherServlet to handle, by using a URL mapping in the same web.xml file. This is standard J2EE Servlet configuration; the example given below shows such a DispatcherServlet declaration and mapping:

```
<web-app>
<servlet>
<servlet-name>example</servlet-name>
<servlet-class>org.springframework.web.servlet.DispatcherServlet</servlet-class>
<load-on-startup>1</load-on-startup>
</servlet>

<servlet-mapping>
<servlet-name>example</servlet-name>
<url-pattern>/example/*</url-pattern>
</servlet-mapping>
</web-app>
```

In the given example, all requests starting with /example will be handled by the DispatcherServlet instance named example. In a Servlet 3.0 and ahead environment, we also have the option of configuring the Servlet container by programs. The code shown below is based equivalent of the above web.xml example:

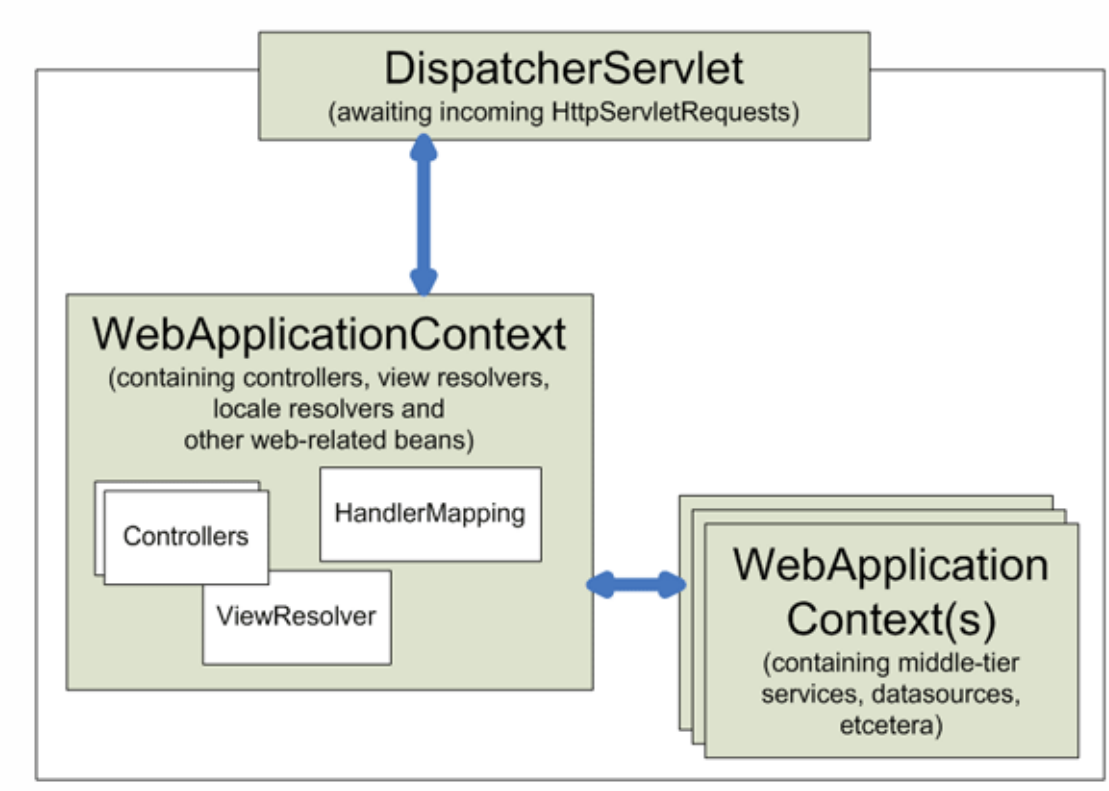
```
public class WebAppInitializer implements WebApplicationInitializer
{
@Override
public void onStartup(ServletContext container) {
ServletRegistration.Dynamic registration = container.addServlet("dispatcher", new DispatcherServlet());
registration.setLoadOnStartup(1);
registration.addMapping("/example/*");
}
```

}

WebApplicationInitializer is an interface provided by Spring MVC that ensures our code-based configuration is detected and automatically used to initialize any Servlet 3 container. An abstract base class implementation of this interface named AbstractDispatcherServletInitializer makes it even simpler to register the DispatcherServlet by just specifying its servlet mapping.

The above code is only the first step in setting up Spring Web MVC. We now need to configure the various beans used by the Spring Web MVC framework (over and above the DispatcherServlet itself).

The ApplicationContext instances in Spring can be scoped. In the Web MVC framework, each DispatcherServlet has its own WebApplicationContext, which inherits all the beans already specified in the root WebApplicationContext. These inherited beans can be overridden in the servlet-specific scope, and we can define new scope-specific beans local to a given Servlet instance.



The DispatcherServlet class of the Spring MVC framework is an implementation of front controller and is a Java Servlet component for Spring MVC applications. It is a front controller class that receives all incoming HTTP client requests for the Spring MVC application. It is also responsible for initializing framework components used to process the request at various stages.

The DispatcherServlet class is fully conigured with the Inversion of Control

Fig. 6.8 Context hierarchy in Spring web MVC (Ref. docs.spring.io)

(IoC) container that allows us to use various Spring features such as Spring context, Spring Object Relational Mapping (ORM), Spring Data Access Object (DAO), and many more. DispatcherServlet is a Servlet that handles HTTP requests and is inherited from HttpServlet base class.

Configuring DispatcherServlet in our Spring web application into the web application deployment descriptor (that is, web.xml) is essential, just like any other servlet. Using URL mapping in the configuration file, the HTTP requests to be handled by DispatcherServlet are mapped. A Spring MVC application can have any number of DispatcherServlet classes and each DispatcherServlet class will have its own WebApplicationContext .

DispatcherServlet in deployment descriptor

web.xml

For a Java web application, the web deployment descriptor web.xml is the essential configurationfile. In web.xml , we define the Servlet for our web application and how the web request should be mapped to them. In the Spring MVC application, we only have to define a single DispatcherServlet instance, which acts as the front end controller for the Spring MVC application, even though we are allowed to define more than one if necessary. The following pseudo code declares the DispatcherServlet in web.xml :

```
<servlet>
<servlet-name>SpringDispatcher</servlet-name>
<servlet-class>
org.springframework.web.DispatcherServlet
</servlet-class>
<load-on-startup>1</load-on-startup>
</servlet>
<servlet-mapping>
<servlet-name>SpringDispatcher</servlet-name>
<url-pattern>/**</url-pattern>
```

</servlet-mapping>

In the above pseudo code, SpringDispatcher is the user-defined name of the DispatcherServlet class, which is enclosed with the <servlet-name> element. When this newly created SpringDispatcher class is loaded in a web application, it loads an ApplicationContext from an XML file.

The next task to do after creating the SpringDispatcher class is to map this class with the incoming HTTP request that signals what URLs are handled by the DispatcherServlet class. To map the DispatcherServlet class, we use the <servlet-mapping> element and to handle URLs, we use the <url-pattern> tag in the web.xml file, as seen in the preceding pseudo code.

The /** (slash with **) pattern doesn't express any specific type of response and simply indicates that DispatcherServlet will serve all incoming HTTP requests, including the request for any static content.

Registering Spring MVC configuration file location

As we discussed in the previous topic, DispatcherServlet loads the [servlet-name]-servlet.xml file in the WEB-INF folder to compose WebApplicationContext. In order to define this file as a random file in a random location, or as a multi-file we use <init-param> under <servlet> to define an initialization parameter named contextConfigLocation.

<init-param>

<param-name>contextConfigLocation</param-name>

<param-value>/config/springmvc/someCommon-servlet.xml,

/config/springmvc/someUser-servlet.xml</param-value>

</init-param>

Spring configuration – SpringDispatcher, servlet.xml

By default, when the DispatcherServlet class is loaded, it loads the Spring application context from the XML file whose name is based on the name of the Servlet. In the previous code, as the name of the Servlet has been defined as SpringDispatcher, DispatcherServlet will try to load the application context from a file named SpringDispatcher-servlet.xml located in the application's WEB-INF directory.

The DispatcherServlet class will use the SpringDispatcher- servlet.xml file to create an ApplicationContext, which is a standard Spring bean configuration file, as shown below.

<beans xmlns="http://www.springframework.org/schema/beans"

xmlns:context="http://www.springframework.org/schema/context"

xmlns:mvc="http://www.springframework.org/schema/mvc"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="

http://www.springframework.org/schema/beans

http://www.springframework.org/schema/beans/spring-beans-3.0.xsd

http://www.springframework.org/schema/context

```
    http://www.springframework.org/schema/context/spring-
    context-3.0.xsd http://www.springframework.org/schema/mvc
    http://www.springframework.org/schema/mvc/spring-mvc-3.0.xsd">
    <mvc:annotation-driven />

    <context:component-scan base-package="org.mitu.Spring.third.springmvc" />
    <bean class="org.springframework.web.servlet.view.InternalResourceViewResolver">
        <property name="prefix" value="/WEB-INF/views/" />
        <property name="suffix" value=".jsp" />
    </bean>
</beans>
```

Let's take a look at some of the MVC features used in the pseudo code above.

<mvc:annotation-driven/> : This tells the Spring Framework to support annotations like @Controller , @RequestMapping , and others, all of which simplify the writing and configuration of controllers.

InternalResourceViewResolver : The Spring MVC framework supports various types of views for presentation technologies, including JSPs, HTML, PDF, JSON, and many more. When the DispatcherServlet class defined in the application's web.xml file gets a view name returned from the handler, it resolves the logical view name into a view implementation for rendering.

In the above pseudo code, we have configured the InternalResourceViewResolver bean to resolve the bean into JSP files in the /WEB-INF/views/ directory.

<context:component-scan> : This tells Spring to automatically detect annotations. It takes the value of the base package, which corresponds to the one used in the Spring MVC controller.

6.6 Controllers in Spring MVC

The DispatcherServlet class delegates the incoming HTTP client request to the controllers to execute the functionality specific to it. The controller interprets user input and converts this input into a specific model which will be represented by the view to the user.

While developing web functionality, we will develop resource-oriented controllers. Rather than each use case having one controller in the web application, we will have a single controller for each resource that the Spring web application serves. An abstract implementation method is provided by Spring for the user to develop the controller without being dependent on a specific API. We don’t need to inherit any specific interface or class while developing a controller based on Spring MVC using the @Controller annotation.

The @Controller annotation to define a controller

The @Controller annotation is used to define a class as a controller class without inheriting any interface or class. The following code snippet defines the EmplController class as a controller using the @Controller annotation:

```
package org.mitu.Spring.third.springmvc.controller;

import org.springframework.stereotype.Controller;

@Controller

public class EmplController

{

    // …

}
```

The @Controller annotation indicates the role to the annotated class. Such an annotated class is scanned by the dispatcher for mapped methods and finds the @RequestMapping annotation. This defined controller can be automatically registered in the Spring container by adding –

<context:component-scan/> in SpringDispatcher-servlet.xml ile.

```
<?xml version="1.0" encoding="UTF-8"?>

<beans xmlns="http://www.springframework.org/schema/beans"

    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

    xmlns:p="http://www.springframework.org/schema/p"

    xmlns:context="http://www.springframework.org/schema/context"

    xsi:schemaLocation="http://www.springframework.org/schema/beans

    http://www.springframework.org/schema/beans/spring-beans.xsd

    http://www.springframework.org/schema/context

    http://www.springframework.org/schema/context/spring-context.xsd">

    <context:component-scan base-package="org.mitu.Spring.third.springmvc"/>

    <!-- ... -->

</beans>
```

Unit 7

Introduction to Java API

Introduction

An e-mail plays an important role in all daily activities in this era of inter-connected networks. For example, we want to get regular updates of a particular feature on a website, by just subscribing to that feature, we will start receiving e-mails regarding these updates. E-mails also allow us to receive notifications, business related communications, or any periodical reports of a producer. Oracle JAVA provides a simple yet mighty API called as a JavaMail API for creating an application to have an e-mail support. This API is actually a set of classes and interfaces for creating the e-mail applications. Writing the program using this API in Java, we can send as well as receive the e-mails, which can be scaled up to work with different protocols associated with the mailing system like POP and SMTP. Being a very powerful API, it is complex, and using the JavaMail API directly in our application is a slightly tiresome work as it involves writing a lot of programming lines.

7.1 What is an API?

API is means Application Programming Interface which is a collection of communication protocols and subroutines used by various programs of language to convey data among them. A programmer can use various Application Programming Interface tools to make its program easy. Also, an API facilitates the programmers with an efficient way to develop their programs.

Thus in simple term, an Application Programming Interface helps two programs or applications to communicate with each other by providing them with essential tools as well as functions and methods. It receives the request from the user and transmits it to the service provider and again sends the result generated from the service provider to the desired user.

The developers use Application Programming Interfaces in their software to implement different features by using an API call without writing the complicated codes for it. We can write an API for an operating system, database systems, hardware system etc. An API is similar to a GUI (Graphical User Interface) with one prime difference.

Real life example of an API:

For example, we are looking for a hotel room on an online website. In this case, we have a huge number of options to choose from and this may include the hotel's location, the check-in time and check-out dates, cost, accommodation details and many more factors. So in order to reserve the room online, we have to interact with the hotel booking's website which will let us to know if there is a room available on that particular date or not and at what price?

Now in this example, the API is the interface that actually communicates in between programs. It takes the request of the user to the hotel booking's website and in turn returns back the most relevant data from the website to the intended user. We can see from this example how an API works and it has numerous applications in real life from switching on mobile phones to maintaining a huge amount of databases from any part of the world.

There are various kinds of API's available as per their applications and uses like the Browser API which is created for the web browsers to abstract and to return the data from environment or the Third party API's, for which we have to get the codes from other sites on the web like social networking websites.

7.2 Types of APIs

There are basically three types of APIs available as listed and explained below.

1. WEB APIs:

The Web API is also known as Web Services is an enormously used API over the web and can be easily accessed through the HTTP protocols. It is an open source interface and can be used by a huge number of clients using their mobile phones, tablets or desktop computers.

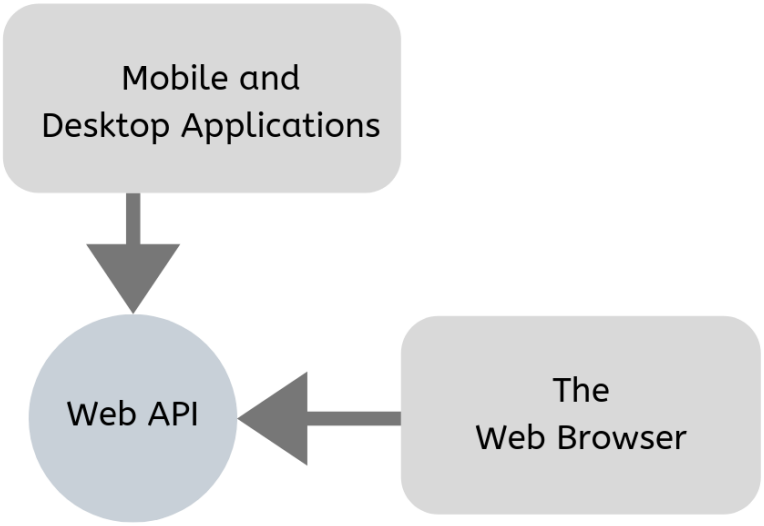


Fig. 7.1 Web APIs

2. LOCAL APIs:

Using the local API, the programmers receives the local middleware services. TAPI (Telephony Application Programming Interface), and .NET are basic examples of Local API's.

3. PROGRAM APIs:

The Program APIs make a remote program appears to be local by making use of RPC's (Remote Procedure Calls). SOAP is a example of this type of API.

Other types of APIs

REST (Representational State Transfer): It uses the HTTP to GET, POST, PUT, or DELETE data. It is basically used to take benefit of the existing data.

SOAP (Simple Object Access Protocol): It is used to define messages in XML format used by web applications to communicate with each other.

XML-RPC: It is based on XML and uses HTTP for data communication. This API is generally used to exchange information between two or among more networks.

JSON-RPC: It uses JSON for data transfer and is a light-weight remote procedural call (RPC) for defining few data structure types.

These various types and forms of API's largely used over web networks to exchange information and to raise communication among them.

Advantages of using APIs

Efficiency: The API generates efficient, quicker and more useful results than the outputs produced by human beings in an organisation.

Flexible delivery of services: The API provides rapid and flexible delivery of services according to developers necessity.

Integration: The best feature of API is that it allows movement of data between various sites and thus raises coordinated user content.

Automation: API make use of robotic computers rather than human being, it generates better and automated results.

New functionality: While using API the developers find novel tools and functionality for API exchanges.

Disadvantages of APIs

Cost: Development and implementation of the API is costly at times and needs high maintenance and support from developer.

Security: The API adds another layer of surface which is then prone to attacks, and hence the security risk problem occurs in APIs.

7.3 The JavaMail API

The JavaMail API provides platform-independent as well as protocol-independent framework to have e-mail support for a Java application. It is a collection of classes and interfaces that comprise of an e-mail system. Following are the steps performed in sending a simple e-mail using the JavaMail API:

- Send a request for connection to an e-mail server by defining the username and password. For example, if we want to send an e-mail from xyz@abc.com , then we need to connect to the e-mail server of abc.com .
- Wrire a message by specifying the receiver's addresses that can include CC and BCC email addresses also.
- Add attachments to the message if required.
- Transport the message to the e-mail server.

Sending a simple e-mail requires the use of a number of classes and interfaces that are present in the javax.mail and javax.mail.internet packages. The important classes and interfaces in the JavaMail API are as follows.

- Session: Represents an e-mail session.
- Message: This abstract class models an email message.
- Transport: This represents protocol used to sending and receiving emails.
- Authenticator: This represents authentication for email provider.
- PasswordAuthentication: It holds the username and password for Authenticator.
- MimeMessage: This represents the multimedia messages.
- InternetAddress: This represents the internet email addresses of to, cc and bcc.

The JavaMail program uses the JavaMail API to exchange e-mails, as shown in the figure below:

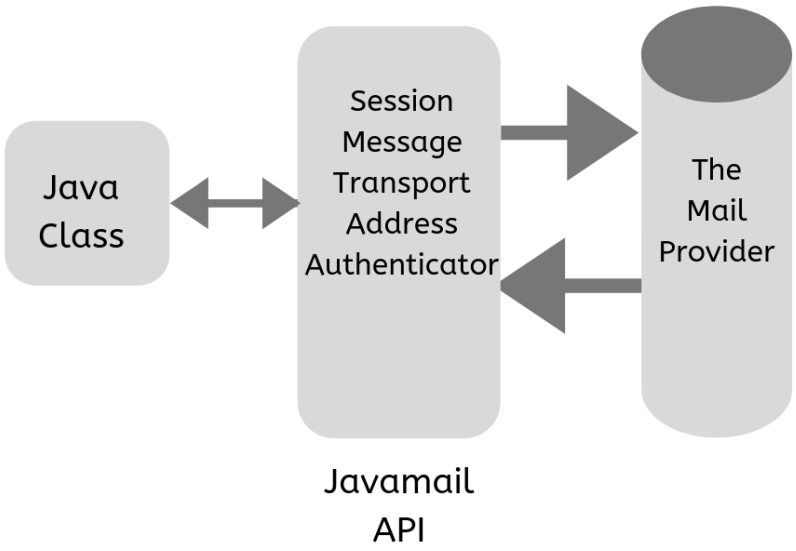


Fig. 7.2 The JavaMail API

In the above figure, the Java classes use the Spring API, which indirectly uses the JavaMail API to send and receive e-mails.

7.4 Sending a Simple E-mail

The code given below is the example to send a simple e-mail from our machine. It is assumed that our computer system is connected to the Internet and capable of sending an e-mail.

```
import java.util.*;
import javax.mail.*;
import javax.mail.internet.*;
import javax.activation.*;
public class EmailSend
{
    public static void main(String [] args)
    {
        // Senders email ID
        String to = "hello@abc.com";

        // Sender's email ID
        String from = "data@xyz.com";

        // We are sending email from localhost
        String host = "localhost";

        // Get system properties using Properties class
        Properties properties = System.getProperties();

        // Setup the mail server
        properties.setProperty("mail.smtp.host", host);

        // Get the default object of Session.
        Session session = Session.getDefaultInstance(properties);

        try
        {
                // Create a MimeMessage class object.
                MimeMessage mime = new MimeMessage(session);

                // Set From: header field of the header.
                mime.setFrom(new InternetAddress(from));
```

```
                // Set To: header field of the header.
                mime.addRecipient(Message.RecipientType.TO, new
                        InternetAddress(to));

                // Set Subject: header field
                mime.setSubject("The Subject is here.");

                // Send the message
                message.setText("Message: Hi Friend");

                // Send message
                Transport.send(message);   // This is javax.mail package
                System.out.println("The message is sent successfully!");
        }
        catch (MessagingException e)
        {
                e.printStackTrace();
        }
    }
}
```

When we compile and run this program, we will get the following output

Output

```
$ java EmailSend
The message is sent successfully!
```

If we want to send an e-mail to multiple recipients then the following methods would be used to specify multiple e-mail IDs:

```
void addRecipients(Message.RecipientType type, Address[] addresses) throws MessagingException
```

Parameters:

type − This would be set to TO, CC or BCC. Here TO represents original receiver of message, CC represents Carbon Copy and BCC represents Black Carbon Copy. Example: Message.RecipientType.TO

addresses − This is an array of e-mail IDs. We would need to use InternetAddress() method while specifying email IDs.

7.5 Developing an application for email using Spring

We develop a basic e-mail application that creates simple e-mails containing text only.

Configuration file – Spring.xml

Let's create the configuration file, Spring.xml , and configure the mailSender bean of the JavaMailSender class and define its properties:

- host
- port
- username
- password

Configuration of the bean for the MyEmailService class with the mailSender property will be like this-

```
<bean id="mailSender" class="org.springframework.mail.javamail.JavaMailSender">
    <property name="host" value="smtp.gmail.com" />
    <property name="port" value="25" />
    <property name="username" value="username" />
    <property name="password" value="password" />
    <property name="javaMailProperties">
    <properties>
    <prop key="mail.smtp.auth">true</prop>
    <prop key="mail.smtp.starttls.enable">true</prop>
    </properties>
</property>
</bean>
    <bean id="emailService" class="org.mitu.Spring.fourth.mail">
    <property name="mailSender" ref="mailSender" />
</bean>
```

This configuration file sets the host as "smtp.gmail.com" and the port as "25." The username and the password properties need to be set with reader's username and password of their own Gmail account. The username is used as the sender of the e-mail.

Spring's e-mail sender

It is the e-mail API-specific Java file. It provides the definition of the sendEmail() method, which is used to send the actual e-mail to the recipient:

```
package org.mitu.Spring.fourth.mail;

import org.springframework.mail.MailSender;

import org.springframework.mail.SimpleMailMessage;

public class MyEmailService

{

    private MailSender ms;

    public void sendEmail(String to, String subject, String message)

    {

        // creates a simple e-mail object

        SimpleMailMessage mail = new SimpleMailMessage();

        mail.setTo(to);

        mail.setSubject(subject);

        mail.setText(message);


        // sends the e-mail

        ms.send(mail);

    }

}
```

The MailerTest class

The MailerTest class has the main( ) method that will call the sendEmail() method of the MyEmailService class and send an e-mail:

```
package org.mitu.Spring.fourth.mail;

import org.springframework.context.ApplicationContext;

import org.springframework.context.support.ClassPathXml

public class MailerTest

{

    public static void main( String[ ] args )

    {

        //Create the application context

        ApplicationContext context = new
```

```
                ClassPathXmlApplicationContext("Spring.xml");
        //Get the mailer instance
        EmailService emailService = (EmailService)context.getBean("emailService ");
        //Send a composed mail
        emailService.sendEmail("****@gmail.com",
        "Email Test Subject",
        "Email Testing body");
    }
}
```

The output of this application can be checked by opening the inbox of your email.

Now check the Spring Java Messaging Service.

7.6 Spring Java Messaging Service

What is a message and messaging?

A message is nothing but just bytes of data or information exchanged between two parties. By using various specifications, a message can be described in several ways. However, it is nothing but an entity for communication. A message can be used to send a piece of information from one application to another application, which may run or may not run in the similar platform.

Messaging is the communication among different applications (in a distributed environment) or system components, which are loosely coupled unlike its peers such as TCP sockets, Remote Method Invocation (RMI), or Common Object Request Broker Architecture i.e. CORBA, which is tightly coupled. The advantage of Java messaging includes the power to integrate various platforms, and reliability of message transfer, and bring down the system bottlenecks. Using messaging, we can increase the systems and clients who are consuming and generating the message as much as we require.

We have a lot of ways by which we communicate right from the instant messenger, to the stock taker, to the mobile-based messaging system, to the age-old messaging system; they are all part of messaging. We realize that a message is a portion of data transmitted from one system to another system and it can be between humans as well, but it is mainly between systems rather than human beings when we use the messaging using Java Messaging Service.

The Java Messaging Service?

The Java Message Service (JMS) is a Java Message Oriented Middleware (MOM) API for sending messages between two or multiple clients. It is a part of the Java Enterprise edition, J2EE. It is a broker like a postman who acts as an intermediary between the message sender and the receiver. JMS is a specification that describes an ordinary way for Java programs to make up, transmit, and read distributed enterprise messages. It advocates the loosely coupled communication without worrying about the sender and the receiver. It supplies asynchronous messaging, which means

that it doesn't matter whether the sender and the receiver are present at the same time or not. The two systems that are sending or receiving messages need not be up at a time.

The JMS application

See the sample JMS application as shown in the following figure:

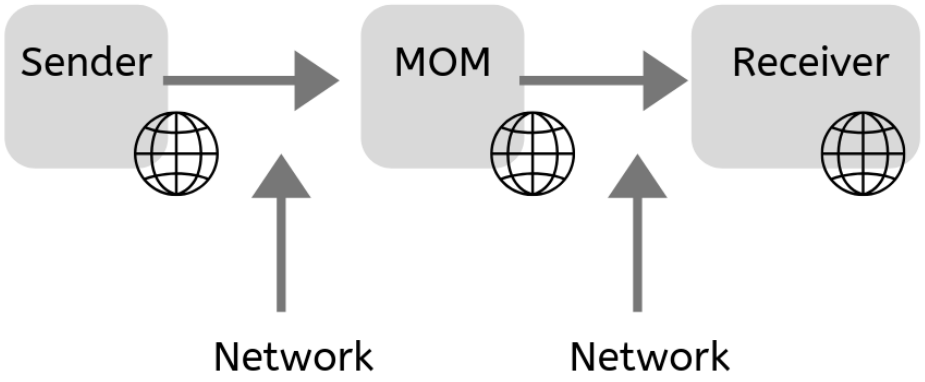


Fig. 7.3 The JMS System

We have a Sender and a Receiver. The Sender transmits a message while the Receiver gets one. We need to have a broker that is MOM between the Sender and the Receiver who takes the sender's message and passes it to the network and to the receiver. MOM is basically an MQ application such as ActiveMQ or IBM-MQ, which are two different message providers. The Sender promises the loose coupling and it can be a .NET or mainframe-based application. The Receiver can be a Java or Spring-based application, and it sends back the message to the Sender as well. This is a two-way communication that is loosely coupled.

JMS components

A JMS system contains the following components:

- JMS Client: It is a Java program used to send, produce, publish, receive, consume or subscribe messages.
- JMS Sender: It is used to send messages to the destination system. It is also known as JMS Producer or Publisher.
- JMS Receiver: It is used to receive messages from Source system, also known as JMS Consumer or Subscriber.
- JMS Provider: JMS Provider is a third-party system which is responsible to implementing the JMS API to provide messaging features to the clients. It is also known as MOM (Message Oriented Middleware) software or Message Broker. It provides some GUI components to administrate and control this MOM software.
- ConnectionFactory: ConnectionFactory’s object is used to make a connection between Java Application and JMS Provider.

- Destination: These JMS Objects used by a JMS Client to specify the destination of messages it is sending and the source of messages that it receives. There are two types of Destinations available: Queue and Topic.
- JMS Message: It is an object that contains the data being communicated between JMS clients.

Following are the most popular JMS Providers.

S.No.	JMS Provider	Software Organization
1.	TIBCO EMS	TIBCO
2.	Open MQ	Oracle Corporation
3.	WebSphere	MQ IBM
4.	Weblogic Messaging	Oracle Corporation
5.	Active MQ	Apache Foundation
6.	Rabbit MQ	Rabbit Technologies (now with Spring Source)
7.	SonicMQ	Aurea Software
8.	HornetQ	JBoss
9.	Sonic MQ	Progress Software

The JMS Communication

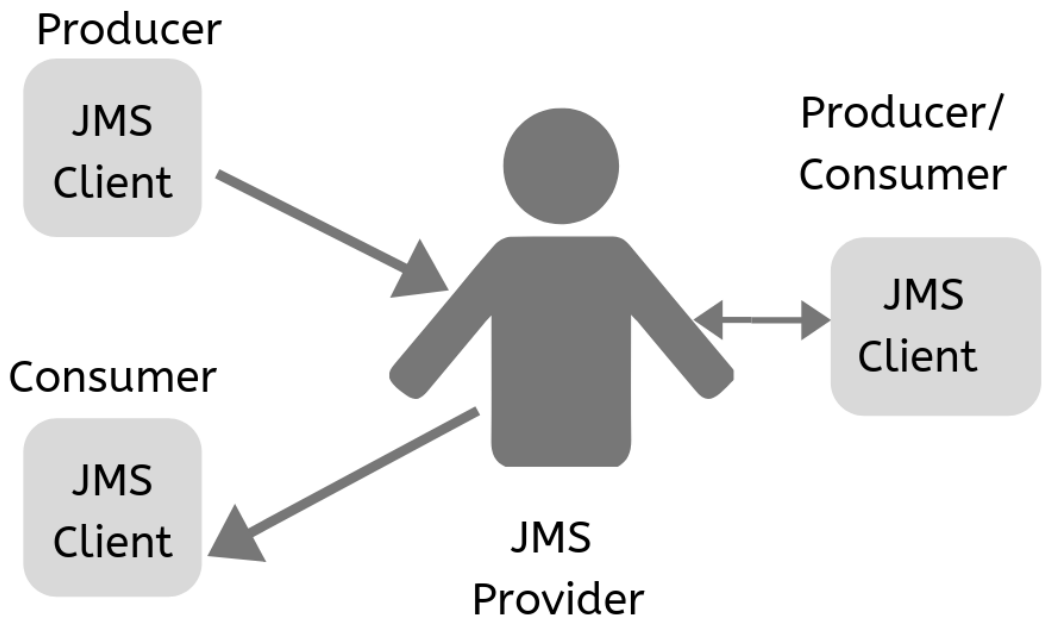


Fig. 7.4 The JMS Communication

There are three JMS clients as given inabove figure. The Producer can be assumed as it's we are going to send a message to our friend. The Consumer can be assumed to be our friend who will get this message. The Producer or Consumer could be someone else who will get as well as send a message also. The JMS Provider can be assumed as the post office or postman through which the

whole delivery things happen and which guarantee that the confirmed delivery happens only one time.

The Spring bean configuration (Spring.xml) Create the configuration file Spring.xml and define the respective bean definitions such as ActiveMQ ConnectionFactory, ActiveMQ queue destination, and JMS template as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:context="http://www.springframework.org/schema/context"
    xmlns:jms="http://www.springframework.org/schema/jms"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
    http://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/context
    http://www.springframework.org/schema/context/spring-context.xsd
    http://www.springframework.org/schema/jms
    http://www.springframework.org/schema/jms/spring-jms.xsd
    http://activemq.apache.org/schema/core
    http://activemq.apache.org/schema/core/activemq-core.xsd">
    <context:component-scan base-package="org.mitu.Spring.fourth.JMS" />
    <bean id="jt"class="org.springframework.jms.core.JmsTemplate">
    <property name="connectionFactory" ref="connectionFactory" />
    <property name="defaultDestination" ref="destination" />
</bean>
<bean id="connectionFactory" class="org.apache.activemq.ActiveMQConnectionFactory">
    <property name="brokerURL">
    <value>tcp://localhost:61616</value>
    </property>
</bean>
<bean id="destination" class="org.apache.activemq.command.ActiveMQQueue">
    <constructor-arg value="myMessageQueue" />
</bean>
</beans>
```

The Spring Framework supports JMS with the help of the classes as mentioned below:

- **ActiveMQConnectionFactory** : This class is used to create a JMS ConnectionFactory for ActiveMQ that connects to a remote broker on a specific host name and the port.
- **ActiveMQQueue**: This class will configure the ActiveMQ queue name, as in our case it is myMessageQueue.
- **JmsTemplate :**This class allows us to hide some of the lower-level JMS description while sending a message.

The MessageSender.java file – Spring JMS Template

The MessageSender class used for sending a message to the JMS queue as given in the code below:

```
package org.mitu.Spring.fourth.JMS.Message;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.jms.core.JmsTemplate;
import org.springframework.stereotype.Component;
@Component
public class MsgSender
{
    @Autowired
    private JmsTemplate jt;
    public void send(final Object Object)
    {
        jt.convertAndSend(Object);
    }
}
```

The Application.java file:

The Application class will have the main method, which calls the send() method to send a message, as shown in the following pseudo code:

```
package org.mitu.Spring.fourth.JMS.Main;
import java.util.HashMap;
import java.util.Map;
import org.mitu.Spring.mitu.JMS.Message.MessageSender;
import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;
public class Application
```

```
{
    public static void main(String[] args)
    {
        ApplicationContext context = new
                ClassPathXmlApplicationContext("Spring.xml");
        MessageSender messageSender = (MessageSender) context
                .getBean("messageSender");
        Map<String, String> message = new HashMap<String, String>();
        message.put("Hello", "India");
        message.put("city", "Nashik");
        message.put("state", "Maharashtra");
        message.put("country", "India");
        messageSender.send(message);
        System.out.println("Message Sent to JMS Queue: " + message);
    }
}
```

Start ActiveMQ

Before we run Application.java , we have to start ActiveMQ, which allows us to run a broker; it will run ActiveMQ Broker using the out-of-the-box configuration.

Output:

Run Application.java and get the output on the console as shown below:

Message Sent to JMS Queue: {state=Maharashtra, Hello=India, country=India, city=Nashik}

Exception handling running Application.java

We can get the following while connecting to broker URL exception:

tcp://localhost:61616. Reason: Java.net.ConnectException: Connection refused: connect.

This exception will come if the message broker service is not up, so we need to make sure that ActiveMQ is running, as shown here:

Exception in thread "main"

org.springframework.jms.UncategorizedJmsException: Uncategorized

exception occurred during JMS processing; nested exception is

javax.jms.JMSException: Could not connect to broker URL:

tcp://localhost:61616. Reason: java.net.ConnectException:

Connection refused: connect at

org.springframework.jms.support.JmsUtils.convertJmsAccessException (JmsUtils.java:316)

Sending an HTML E-mail

It is assumed that our computer, localhost is connected to the Internet and capable of sending an e-mail.

Here we are using setContent() method to set content whose second argument is "text/html" to specify that the HTML content is included in the message. Using this example, we can send as big as HTML content we like.

```
// File Name HtmlEmail.java

import java.util.*;

import javax.mail.*;

import javax.mail.internet.*;

import javax.activation.*;

public class HtmlEmail

{

    public static void main(String [] args)

    {

        // Email Id of receiver

        String to = "abc@xyz.com";


        // Sender's email ID

        String from = "data@xyz.com";


        // We are sending email from localhost

        String host = "localhost";


        // Get properties of system

        Properties properties = System.getProperties();


        // Setup the mail server

        properties.setProperty("mail.smtp.host", host);


        // Get the default Session object.
```

```
        Session ssn = Session.getDefaultInstance(properties);
        try
        {
                // Create a default MimeMessage object.
                MimeMessage msg = new MimeMessage(ssn);

                // From: header field of the header.
                msg.setFrom(new InternetAddress(from));

                // To: header field of the header.
                msg.addRecipient(Message.RecipientType.TO,new InternetAddress(to));

                // Subject: header field
                msg.setSubject("Hi! This is subject.");

                // Actual message
                msg.setContent("<h1>This is your message</h1>", "text/html");

                // Send message
                Transport.send(msg);
                System.out.println("Message is sent successfully!");
        }
        catch (MessagingException e)
        {
                e.printStackTrace();
        }
    }
}
```

Output:

```
$ java HtmlEmail
Message is sent successfully!
```

7.7 Sending email with attachment

JavaMail API provides some useful classes like BodyPart, MimeBodyPart etc for sending email with attachment. Let's see the steps of sending email using JavaMail API first. For sending the email using JavaMail API, we need to load the two jar files:

mail.jar

activation.jar

So wee need to download these jar files (or) go to the Oracle site to download the latest version of them.

We need to go with 7 steps for sending attachment with email.

- Create the session object
- Compose the message
- Create object of MimeBodyPart and set your message text
- Create new MimeBodyPart object and set DataHandler object to this object
- Create Multipart object and add MimeBodyPart objects to this object
- Set the multiplart object to the message object
- Finally, send the message

Example of sending email with attachment in Java

```
import java.util.*;
import javax.mail.*;
import javax.mail.internet.*;
import javax.activation.*;
class SendWithAttachment
{
    public static void main(String [] args)
    {
        String to="abc@xyz.com";                    // Receiver's email ID
        final String user="sonoojaiswal@javatpoint.com"; // Sender's email ID
        final String password="xxxxx";              // Password

        // First: get the session object
        Properties properties = System.getProperties();
        properties.setProperty("mail.smtp.host", "mail.xyz.com");
```

```
properties.put("mail.smtp.auth", "true");

Session ssn = Session.getDefaultInstance(properties,  new
                javax.mail.Authenticator()
{
        protected PasswordAuthentication getPasswordAuthentication()
        {
                return new PasswordAuthentication(user,password);
        }  });

// Second: compose message
try{
        MimeMessage msg = new MimeMessage(ssn);
        msg.setFrom(new InternetAddress(user));
        msg.addRecipient(Message.RecipientType.TO,new
        InternetAddress(to));
        msg.setSubject("Hi Message");

// Third: create MimeBodyPart object and set our message text
BodyPart msgBodyPart1 = new MimeBodyPart();
msgBodyPart1.setText("This is actual message");

//Fourth: create new MimeBodyPart object and set DataHandler object to this object
MimeBodyPart messageBodyPart2 = new MimeBodyPart();

String file = "SendWithAttachment.java";
DataSource source = new FileDataSource(file);
msgBodyPart2.setDataHandler(new DataHandler(source));
msgBodyPart2.setFileName(file);

//Fifth: Create Multipart object and add MimeBodyPart objects to this object
Multipart multipart = new MimeMultipart();
multipart.addBodyPart(msgBodyPart1);
multipart.addBodyPart(msgBodyPart2);
```

```
        //Sixth: Set the multiplart object to the message object
        msg.setContent(multipart);

        //Seventh: send the message
        Transport.send(msg);

        System.out.println("The Message is sent successfully!");
        }
        catch (MessagingException e)
        {
                e.printStackTrace();
        }
    }
}
```

As you can see in the above code, total 7 steps are followed to send email with attachment. Now run this program by :

Load the jar file	c:\> set classpath=mail.jar;activation.jar;.;
Compile the source file	c:\> javac SendWithAttachment.java
Run using	c:\> java SendWithAttachment

Sending Email in Java through Gmail Server

We can send email by using the SMTP server of gmail. It is good if you are don't have any SMTP server and reliable. The SSL, Secure Socket Layer is basically used for security if we are sending email through gmail server.

Sending Email through Gmail Server with SSL

```
import java.util.Properties;
import javax.mail.*;
import javax.mail.internet.*;
class Gmailer
{
    public static void send (String from,String password,String to,String sub,String message)
```

```
{
//Get properties object
Properties properties = new Properties();
properties.put("mail.smtp.host", "smtp.gmail.com");
properties.put("mail.smtp.socketFactory.port", "465");
properties.put("mail.smtp.socketFactory.class",
                        “javax.net.ssl.SSLSocketFactory");
properties.put("mail.smtp.auth", "true");
properties.put("mail.smtp.port", "465");
// Get Session object
Session session = Session.getDefaultInstance(properties, new
            javax.mail.Authenticator()
    {
    protected PasswordAuthentication getPasswordAuthentication()
            {
            return new PasswordAuthentication(from,password);
    }
});
// No compose the message
try {
    MimeMessage msg = new MimeMessage(session);
    msg.addRecipient(Message.RecipientType.TO,new InternetAddress(to));
    msg.setSubject(sub);
    msg.setText(messsage);
    // Now send the message
    Transport.send(message);
    System.out.println("The message sent successfully!");
}
    catch (MessagingException e)
    {
            throw new RuntimeException(e);
    }
}
```

```
}
public class SendMailSSL
{
    public static void main(String[] args)
    {
        // from, password, to, subject, message
        Mailer.send("from@gmail.com","xxxxx","to@gmail.com","Welcome!","Hi Friend");
    }
}
```

As we can see in the above example, userid and password need to be authenticated. As, this program illustrates, we can send email easily but change the username and password as per the account used.

Receiving email in Java

For receiving email Store and Folder classes are used in collaboration with MimeMessage, Session and Transport classes.

For sending the email using JavaMail API, we need to load the same jar files:

mail.jar

activation.jar

download these jar files (or) go to the Oracle site to download the latest version.

Steps for receiving the email using JavaMail API

- Create the session object
- Create the POP3 store object and connect with the pop server
- Create the folder object and open it
- Retrieve the messages from the folder in an array format and print it on screen
- Close the store and folder objects

Example : Receiving email in Java

```
import javax.mail.Message;
import javax.mail.MessagingException;
import javax.mail.NoSuchProviderException;
```

```
import javax.mail.Session;
import java.io.IOException;
import java.util.Properties;
import javax.mail.Folder;
import com.sun.mail.pop3.POP3Store;
public class ReceiveMail
{
    public static void receiveEmail(String pop3Host, String storeType, String user, String password)
    {
    try {
    //First:Create the session object
    Properties properties = new Properties();
    properties.put("mail.pop3.host", pop3Host);
    Session emailSession = Session.getDefaultInstance(properties);

    //Second: create the POP3 store object and connect with the pop server
    POP3Store emailStore = (POP3Store) emailSession.getStore(storeType);
    emailStore.connect(user, password);

    //Third: create the folder object and open it
    Folder emailFolder = emailStore.getFolder("MYDATA");
    emailFolder.open(Folder.READ_ONLY);

    //Fourth:acquire the messages from the folder in an array element and print it
    Message[ ] messages = emailFolder.getMessages();
    for (int i = 0; i < messages.length; i++)
    {
        Message message = messages[i];
        System.out.println("---------------------------------");
        System.out.println("Email Number: " + (i + 1));
        System.out.println("Subject: " + message.getSubject());
        System.out.println("From: " + message.getFrom()[0]);
        System.out.println("Text: " + message.getContent().toString());
    }
```

```
    //Fifth: close the store and folder objects
    emailFolder.close(false);
    emailStore.close();
    }
    catch (IOException e)
    {
        e.printStackTrace();
    }
    catch (NoSuchProviderException e)
    {
        e.printStackTrace();
    }
    catch (MessagingException e)
    {
        e.printStackTrace();
    }
}
    public static void main(String[] args)
    {
        String host = "mail.gmail.com";             // Change as per requirement
        String mailStoreType = "pop3";
        String username= "data@gmail.com";
        String password= "xxxxx";        // User password
        receiveEmail(host, mailStoreType, username, password);
    }
}
```

In the above example, userid and password need to be authenticated. We can receive email easily but change the username and password as per our account.

Receiving email with attachment

As we receive the email, we can receive the attachment also by using Multipart and BodyPart classes available in JavaMail API.

```
import java.util.*;
```

```
import javax.mail.internet.*;
import javax.activation.*;
import javax.mail.*;
import java.io.*;
class ReadAttachments
{
    public static void main(String [] args) throws Exception
    {
        String host="mail.zoho.com";
        final String user="mail@zoho.com";
        final String password="xxxxx";          // Actual password

        Properties properties = System.getProperties();
        properties.setProperty("mail.smtp.host",host );
        properties.put("mail.smtp.auth", "true");

        Session session = Session.getDefaultInstance(properties,
        new javax.mail.Authenticator()
        {
            protected PasswordAuthentication getPasswordAuthentication()
            {
                return new PasswordAuthentication(user, password);
            }
        });

        Store store = session.getStore("pop3");
        store.connect(host,user,password);

        Folder folder = store.getFolder("MYDATA");
        folder.open(Folder.READ_WRITE);

        Message[] message = folder.getMessages();
        for (int a = 0; a < message.length; a++)
```

```
        {
                System.out.println(message[a].getSentDate());
                Multipart multipart = (Multipart) message[a].getContent();
                for (int i = 0; i < multipart.getCount(); i++)
                {
                        BodyPart bodyPart = multipart.getBodyPart(i);
                        InputStream stream = bodyPart.getInputStream();
                        BufferedReader reader = new BufferedReader
                                        (new InputStreamReader(stream));
                        while (reader.ready()) {
                                System.out.println(reader.readLine());
                        }
                        System.out.println();
                }
                System.out.println();
        }
        folder.close(true);
        store.close();
    }
}
```

7.8 Forwarding an email

We can forward the received mail to someone else as we send emails. There are severalJavaMail classes that are used to forward the messages to the destination. See the below example for forwarding email.

```
import java.util.*;
import javax.mail.*;
import javax.mail.internet.*;
public class ForwardingEMail
{
    public static void main(String[] args) throws Exception
    {
        final String user="maya@abc.com";       // User ID
```

```
final String password="xxxxx";              // Password

// Get the session object
Properties properties = new Properties();
properties.put("mail.smtp.host", "mail.abc.com");
properties.put("mail.smtp.auth", "true");

Session session = Session.getDefaultInstance
                    (properties, new javax.mail.Authenticator()
{
          protected PasswordAuthentication getPasswordAuthentication()
          {
                    return new PasswordAuthentication(user,password);
          }
});

// Get a Store object and connect to current host
Store store = session.getStore("pop3");
store.connect("mail.abc.com", user, password);

// Create a Folder object and open the folder
Folder folder = store.getFolder("MYDATA");
folder.open(Folder.READ_ONLY);

Message msg = folder.getMessage(1);

// Retrive all the information from the message
String from = InternetAddress.toString(msg.getFrom());
 if (from != null)
{
          System.out.println("From: " + from);
}
String replyTo = InternetAddress.toString( msg.getReplyTo());
```

```
if (replyTo != null)
{
        System.out.println("Reply-to: " + replyTo);
}
String to = InternetAddress.toString ( msg.getRecipients
                (Message.RecipientType.TO));
if (to != null)
{
        System.out.println("To: " + to);
}

String subject = msg.getSubject();
if (subject != null)
{
        System.out.println("Subject: " + subject);
}
Date sent = msg.getSentDate();
if (sent != null)
{
        System.out.println("Sent: " + sent);
}
System.out.println(msg.getContent());

// Compose the message to forward
Message msg2 = new MimeMessage(session);
msg2.setSubject("Fwd: " + message.getSubject());
msg2.setFrom(new InternetAddress(from));
msg2.addRecipient(Message.RecipientType.TO, new InternetAddress(to));

// Create your new message part
BodyPart messageBodyPart = new MimeBodyPart();
messageBodyPart.setText("Original message is: ");
```

```
        // Create a multi-part to combine the parts
        Multipart multipart = new MimeMultipart();
        multipart.addBodyPart(messageBodyPart);

        // Create and fill part for the forwarded content
        messageBodyPart = new MimeBodyPart();
        messageBodyPart.setDataHandler(message.getDataHandler());

        // Add part to multi part
        multipart.addBodyPart(messageBodyPart);

        // Associate multi-part with message
        msg2.setContent(multipart);

        // Send message
        Transport.send(msg2);
        System.out.println("The message is forwarded!");
    }
}
```

Unit 8

JSON

Introduction

JavaScript Object Notation (JSON) is an open-standard file format that uses human-readable text to transfer data objects consisting of attribute–value pairs and array data types (or any other serializable value). It is a very common type of data format used for asynchronous browser–server communication.

JSON is a language-independent data format. It was derived from JavaScript, but many modern programming languages include code to produce and parse JSON-format data. The official Internet media type for JSON is application/json. The JSON filenames use the extension .json.

Developer Douglas Crockford originally specified the JSON format in the early 2000s. It was first standardized in 2013 as RFC 7158 and ECMA-404.

8.1 What is JSON ?

- JSON is an acronym of JavaScript Object Notation.
- It is a lightweight data-interchange file format.
- It is simple to read and write than XML.
- It is language independent file format.
- It supports array, object, string, number and values.

Applications of JSON

- It is used while writing JavaScript based applications that has browser extensions and websites.
- JSON data format is used for serializing and transmitting structured data all over network connection.
- It is primarily used to transfer data among a server and web applications.
- Web services and APIs use JSON format to provide public data for various services.
- It is compatible with all modern programming languages like Python, Ruby and R.

Differentiating the JSON and XML formats.

Sr. No.	JSON	XML
1	JavaScript Object Notation	Extensible markup language
2	Based on JavaScript programming language.	Derived from SGML.
3	Representation is done in objects.	This markup language uses tag structure to

		represent data items.
4	No support for name-spaces.	It supports namespaces.
5	Array support present	No Array support present
6	Files are very easy to read as compared to XML.	Its documents are comparatively difficult to read and interpret than JSON.
7	No end tag available.	Start and end tags are available.
8	Less security.	It is more secured than JSON.
9	No support to comments.	Support for comments.
10	Supports UTF-8 encoding.	Support for various encoding is present.

Similarities between JSON and XML

- Both are simple and open.
- Both supports unicode. So internationalization is supported by JSON and XML both.
- Both represents self describing data formats.
- Both are inter-operable or independent of programming languages.

8.2 Simple Example in JSON

The example below shows how to use JSON to store information related to books having properties like topic and edition.

```
{
"book": [
{
"id":"01",
"language": "C",
"edition": "15th",
"author": "Yashwant Kanetkar"
},

{
"id":"02",
"language": "Python",
"edition": "Fifth",
"author": "Yela Rawbundy"
}
]
```

}

This file data format can be added for the HTML code and JavaScript. Following is the code for json.htm −

```
<html>
<head>
<title>JSON </title>
<script language = "javascript">
var object1 = { "language" : "C", "author"  : "Yashwant Kanetkar" };
document.write("<h1>JSON with JavaScript example</h1>");
document.write("<br>");
document.write("<h3>Language = " + object1.language+"</h3>");
document.write("<h3>Author = " + object1.author+"</h3>");

var object2 = { "language" : "Python", "author"  : "Yela Rawbundy" };
document.write("<br>");
document.write("<h3>Language = " + object2.language+"</h3>");
document.write("<h3>Author = " + object2.author+"</h3>");

document.write("<hr />");
document.write(object2.language + " programming language can be studied from book written by " +
   object2.author);
document.write("<hr />");
</script>
</head>
<body>
</body>
</html>
```

Now let's try to open json.htm using any web browser or any other javascript enabled browser that produces the following result −

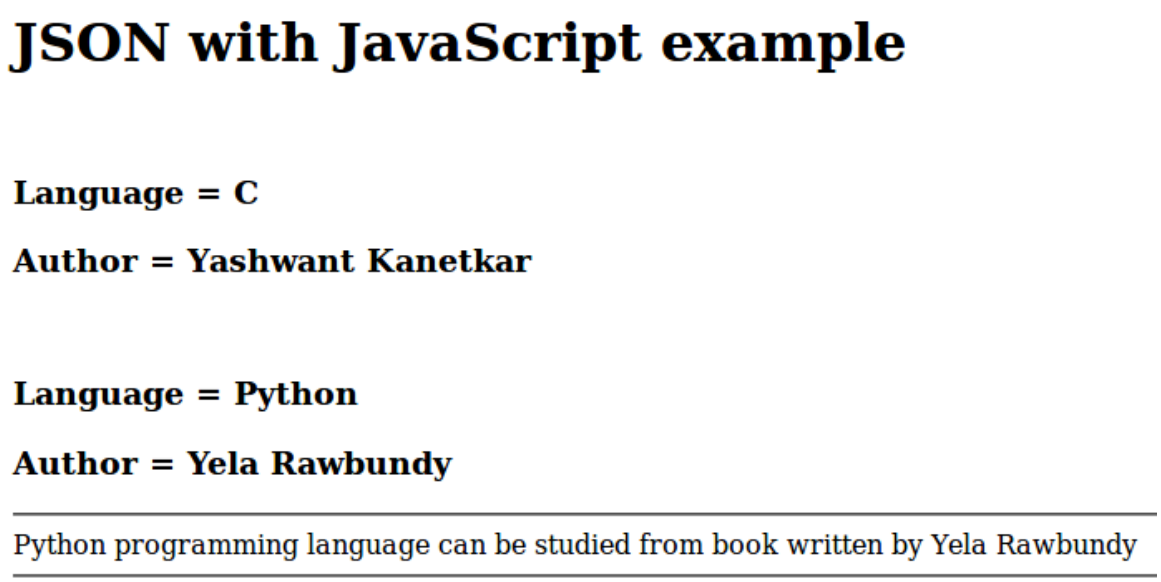


Fig. 8.1 Output of JavaScript using JSON data format

8.3 JSON – Syntax

Let's look at the basic syntax of JSON. JSON syntax is basically considered as a subset of JavaScript syntax; it includes the following −

- Data is represented in the format of key/value pairs.
- Four symbols are used in JSON. The curly braces { } hold objects and each name is followed by ':' (colon), and the key/value pairs are separated by , (comma).
- Square brackets hold arrays and values are separated by , (comma).

Below is a simple example.

```
{
"student": [
{
"roll": "01",
"name": "Rashmi",
"class": "SY",
"marks": "68.77"
},
{
"roll": "02",
"name": "Akash",
"class": "SY",
```

"marks": "58.23"
},
{
"roll": "03",
"name": "Paramanand",
"class": "TY",
"marks": "66.20"
}
]
}

8.4 DataTypes of JSON

JSON format supports the following data types.

Sr.No.	Type & Description
1	**Number** It is double-precision floating-point format of JavaScript
2	**String** It is double-quoted Unicode set of characters
3	**Boolean** either true or false
4	**Array** It is an ordered sequence of values of same type
5	**Value** It can be a string, a number, a boolean, or null value
6	**Object** It is an unordered collection of key-value pairs
7	**Whitespace** This can be used between any pair of tokens
8	**null** The empty character (referred as nothing)

Number

It is a double precision floating-point format in JavaScript and it depends on its implementation.

Unlike other programming languages, Octal and hexadecimal formats are not used. It does not have a NaN or Infinity number.

The following table shows the number types data.

Sr.No.	Type & Description
1	**Integer** All decimal Digits from 0 to 9 including the positive and negative numbers
2	**Fraction** Floating point values with a decimal dot (.)
3	**Exponent** The float values including e, -e, E or -E e.g. 4.5e12

Syntax:

The following way is used to declare the variable with the data type and constant.

var json-object-name = { string : number_value, ...}

Example:

The example below shows Number Datatype, value should not be quoted −

var obj = {marks: 59}

String

It is a sequence of double quoted Unicode characters which also allows the escape sequence characters. Character is a single character string i.e. a string with length 1. The table below shows various special characters that you can use in strings of a JSON document.

Sr No.	Type & Description
1	\" double quotation character
2	\\ backslash character

3	\/ forward slash character
4	**\b** backspace character
5	**\f** form feed character
6	**\n** new line character
7	**\r** carriage return
8	**\t** horizontal tab character
9	**\u** four hexadecimal digits or unicode character

Syntax:

var json-object-name = { string : "string value", ...}

Example

The example below showsthe String type data.

var obj = { name: “Rashmi” }

Boolean:

It includes either true or false values. The concept is similar to the one in Java

Syntax

var json-object-name = { string : true/false, ...}

Example

var obj = {name: 'Rashmi', marks: 59, distinction: false}

8.5 Array

It is an ordered collection of values stored in homogeneous order in memory. The values of array are enclosed in pair of square brackets which means that array begins with .[. and ends with .].. The values are separated by, (comma) within it. Array indexing can be started at 0 and ends till n-1,

where n is total number of elements in array. Arrays should be used when the key names are sequential integers.

Syntax

[value, ...]

Example

Example showing array containing multiple objects −

```
{
"books": [
{ "language":"Marathi" , "Region":"Goa" },
{ "language":"Urdu" , "Type":"Indo-Aryan" },
{ "language":"Kannada" , "Region":"Karnataka" }
]
}
```

Object

The object is an unordered set of key – value pairs. They are enclosed in a pair of curly braces that is, it starts with '{' and ends with '}'. Each key in this pair is followed by ':'(colon) and the key-value pairs are separated by , (comma). The keys must be strings and should be unique in all the set.The objects should be used when the key names are arbitrary strings.

Syntax

{ string : value, ...}

Example

Example showing Object −

```
{
"pin": "411061",
"city": "Pune",
"ranking": 2,
}
```

Whitespace

The whitespace can be inserted between any pair of tokens. It is added to make a code more readable. The example shown below gives declaration with and without whitespace.

Syntax:

{string:"",....}

Example:

```
var obj1 = {"name": "Amar Choudhary"}
var obj2 = {"name": "Shane Warne"}
var obj3 = {"name": "Aniket Vishwasrao"}
```

null

It means empty type.

Syntax

null

Example:

```
var i = null;
if(i == null)
{
document.write("<h3>value is null</h3>");
}
else
{
document.write("<h3>value is not null</h3>");
}
```

JSON Value

The JSON value includes the following types of data.

- number (integer or floating point)
- string
- boolean
- array
- object
- null

Syntax:

String | Number | Object | Array | TRUE | FALSE | NULL

Example

```
var i = 45.44;

var j = "Hi Python";

var b = true;

var k = null;
```

8.6 JSON Object

The JSON object holds a key-value pair. In which each key is represented as a string in JSON and value can be of any type. The keys and values are separated by colon. Each key/value pair is separated by comma. The curly brace { represents JSON object. Let's understand it by an example of JSON object.

```
{
"player": {
"name":      "Ajinkya Rahane",
"runs":     4867,
"bowler":   false
}
}
```

In the given example, player is an object in which "name", "runs" and "bowler" are the keys. And there are string, number and boolean value are used for the keys.

JSON Object with Strings

The string value must be enclosed within double quote.

```
{
"name":      "Rashmi Thorave",
"email":     "rashmi1988@gmail.com"
}
```

JSON Object with Numbers

The JSON object supports numbers in double precision floating-point format i.e. 64 bit float format. The number can have decimal digits (0 to 9), the fraction number with a decimal point (.245, .102 etc) and exponents (e, e+, e-,E, E+, E-).

```
{
"integer": 15,
```

"fraction": 0.4527,

"exponent": 95.22e12

}

JSON Object with Booleans

The JSON object also supports boolean values i.e. true or false.

{

"first": true,

"second": false

}

JSON Nested Object Example

A JSON object can contain another object also. The example below shows the JSON object having another object within it.

{

"firstName": "Rakesh",

"lastName": "Sharma",

"age": 35,

"address" : {

"streetAddress": "301, Akanksha Plaza",

"city": "Nashik",

"state": "Maharashtra",

"postalCode": "422006"

}

}

JSON Array

The JSON array represents ordered list of values stored in a homogeneous locations. The JSON array can store multiple values of same type of data. It can store string, number, boolean or object in JSON array. The values here must be separated by comma. The [(square bracket) represents JSON array.

JSON Array of Strings

The below example shows the JSON arrays storing string values.

["January", "February", "March", "April", "May", "June", "July", “August”, “September”, “October”, “November”, “December”]

JSON Array of Numbers

The below example shows the JSON arrays storing number values.

[45,67,88,16,39,83,47,33,18,78]

JSON Array of Booleans

The below example shows the JSON arrays storing boolean values.

[true, true, false, false, true, false]

JSON Array of Objects

The below example shows the JSON arrays storing array of 4 object values.

{"employees":[

{"name":"Bahubali", "email":"bahubali@gmail.com", "age":26},

{"name":"Chitti", "email":"chittibhau@gmail.com", "age":56},

{"name":"Chulbul Pandey", "email":"chulbulpandey@gmail.com", "age":33},

{"name":"Sir Jadeja", "email":"jaddusuperkings@gmail.com", "age":31}

]}

JSON Multidimensional Array

We can store array inside JSON array, it is known as array of arrays or a multidimensional array.

[

["y", "z", "x"],

["q", "w", "e"],

["m", "a", "n"]

]

8.7 JSON library in Java

As we have already studied, the JSON format is one of the most favourite formats to transmit and exchange data in web. Almost all RESTful web services take JSON format data input and provide JSON output. ButunluckilyOracle Java Development Kit doesn't have built-in support for this one of the most common web standard. As a Java developer if we want to develop RESTful web service and produce JSON data or if we are developing a client to an existingRESTFul web

services and want to consume JSON response, we don't have to worry about this. Luckily, there are so many open source libraries and API available for making, parsing and processing JSON response in Java e.g. Jackson, Google GSon, json-simple etc.

There are numerous JSON libraries exists in Java but we don't need to learn all of them, learning just one of them e.g. Jackson should be enough, but, another side, it's worth knowing what are some of the most popular JSON parsing library exists in our disposal. Let us see the topfive useful JSON libraries which every Java Enterprise Edition developer should be aware of.

Useful JSON libraries in Java

There are a lot many JSON libraries and APIs are available for Java but depending upon your need, we can choose any of them.

Jackson

The Jackson is a multi-purpose Java library for processing JSON data format. Jackson aims to be the best possible combination of fast, correct, lightweight, and ergonomic for developers.

The Jackson offers three methods for processing JSON format, each of them having it’s own advantages and disadvantages.

- Streaming API or incremental parsing/generation: reads and writes JSON content as discrete events.
- Tree model: provides a mutable in-memory tree representation of a JSON document. The data representation is done in graphical format.
- Data binding: converts JSON to and from POJO’s

If we are only interested in converting Java object to and from JSON string then the third method can be used more effectively.

The advantage of Jackson is that it suppliesthe heaps of features, and looks to be a good tool for reading and writing JSON in a variety of ways, but same time its size becomes a disadvantage if our requirement is just to serialize and deserialize Java object to JSON String.

In order to use Jackson, we can include following maven dependency or manually include jackson-core-2.3.1.jar, jackson-databind-2.3.1.jar, and jackson-annotations-2.3.1.jar in Classpath.

Jackson Serialization Annotations

@JsonAnyGetter

The @JsonAnyGetter annotation allows the flexibility of using a Map field as standard properties to us.

Lets see an example. The ExtendableBean entity has the name property and a set of extendable attributes in the form of key-value pairs:

public class ExtendableBean

```
{
public String name;
private Map<String, String> properties;
@JsonAnyGetter
public Map<String, String> getProperties()
{
return properties;
}
}
```

When we serialize an instance of this entity, we get all the key-values in the Map as standard, plain properties:

```
{
"name":"The First Bean",
"attr2":"val2",
"attr1":"val1"
}
```

And here how the serialization of this entity looks like in practice:

```
@Test
public void whenSerializingUsingJsonAnyGetter_thenCorrect()  throws JsonProcessingException
{
ExtendableBean bean = new ExtendableBean("My bean");
bean.add("attr1", "val1");
bean.add("attr2", "val2");

String result = new ObjectMapper().writeValueAsString(bean);

assertThat(result, containsString("attr1"));
assertThat(result, containsString("val1"));
}
```

We can also use optional argument enabled as false to disable @JsonAnyGetter(). In this case, the Map will be converted as JSON and will appear under properties variable after serialization.

GSON

The full form of GSON is the google-gson library. Gson is a Java library capable of converting Java objects into their JSON representation and JSON strings to an equivalent Java object without the requirement of placing Java annotations in our classes.

Features of Gson library:

- It provides simple toJson() and fromJson() methods to convert Java objects to JSON and vice-versa.
- It Supports arbitrarily complex objects
- It has extensive support of Java Generics library
- It allows custom representation for Java objects
- It allows pre-existing unmodifiable objects to be converted to and from JSON.

How to use GSON?

1. Maven Dependency

First of all, we have to include the gson dependency in our pom.xml file as-

<dependency>

<groupId>com.google.code.gson</groupId>

<artifactId>gson</artifactId>

<version>2.8.5</version>

</dependency>

We can find the latest version of gson on Maven Central online website.

2. Using JsonParser

The first approach is for converting a JSON String to a JsonObject is a two-step process that uses the JsonParser class. In this step, we need to parse our original String. Gson provides us a parser called JsonParser, which parses the specified JSON String into a parse tree of JsonElements:

```
public JsonElement parse(String json) throws JsonSyntaxException
```

Once we have our String parsed in a JsonElement tree, we'll use the getAsJsonObject() method, which will return the desired result to us.

Let's see how we get our final JsonObject:

```
String json = "{ \"name\": \"Schildt\", \"python\": false }";

JsonObject jsonObject = new JsonParser().parse(json).getAsJsonObject();

Assert.assertTrue(jsonObject.isJsonObject());
```

Assert.assertTrue(jsonObject.get("name").getAsString().equals("Baeldung"));

Assert.assertTrue(jsonObject.get("java").getAsBoolean() == true);

3. Using fromJson( ) method.

In the second approach, we create a Gson instance and use the fromJson method. This method deserializes the specified JSON String into an object of the specified class:

public <T> T fromJson(String json, Class<T> classOfT) throws JsonSyntaxException

The following way is used to see this method to parse our JSON String, passing the JsonObject class as the second parameter:

String json = "{ \"name\": \"Schildt\", \"python\": false }";

JsonObject convertedObject = new Gson().fromJson(json, JsonObject.class);

Assert.assertTrue(convertedObject.isJsonObject());

Assert.assertTrue(convertedObject.get("name").getAsString().equals("Schildt"));

Assert.assertTrue(convertedObject.get("python").getAsBoolean() == true);

8.8 json-simple

The json-simple is one of the simplest JSON library used by developers, which is also lightweight. We can use this library to encode or decode JSON text in any format specified. It's an open source library which is flexible and simple to be used by reusing Map and List interfaces from Java Development Kit. A good thing about this library that it has no external dependency present and both source and binaries are JDK 1.2 and above compatible.

The benefit of using Json-simple is that it is lightweight, having just 12 classes and it provides support for Java IO readers and writers classes. We can take our decision better if we know about JSON format i.e. how information is represented there in JSON.

If we are looking for a simple lightweight Java library that reads and writes JSON and supports Streams, json-simple is probably a good match. It does what it says with just 12 classes, and works on legacy (1.4) JREs also.

In order to use JSON-Simple API, we need to include maven dependency in our project's pom.xml file or alternatively, we can also include following JAR files in your classpath. You can also see this tutorial to learn about how to read JSON String in Java using json-simple.

How to use the json-simple?

Following steps are undertaken to use the json-simple library in Java.

1. Install json.simple

In order to install json.simple, we need to set classpath of json-simple.jar or add the Maven dependency from their online website.

2. Add maven dependency, in pom.xml file.

<dependency>

<groupId>com.googlecode.json-simple</groupId>

<artifactId>json-simple</artifactId>

<version>1.2</version>

</dependency>

3. Java JSON Encode

See the below code, which shows simple example to encode JSON object in Java.

```
import org.json.simple.JSONObject;
public class JsonEncode
{
    public static void main(String args[])
    {
        JSONObject obj=new JSONObject();
        obj.put("name","Amarpreet");
        obj.put("age",new Integer(22));
        obj.put("salary",new Double(22000));
        System.out.print(obj);
    }
}
```

Output:

```
{"name":"Amarpreet","salary":22000.0,"age":22}
```

JSON Encode using Map

Apart from previous method, the following example shows the procedure to encode JSON object using map in Java.

```
import java.util.Map;
import org.json.simple.JSONValue;
import java.util.HashMap;
public class JsonEncode2
{
    public static void main(String args[])
    {
        Map obj=new HashMap();
        obj.put("name","Rashmi");
```

```
        obj.put("age",new Integer(30));
        obj.put("salary",new Double(67000));
        String jText = JSONValue.toJSONString(obj);
        System.out.print(jText);
    }
}
```

Output:

```
{"name":"Rashmi","salary":67000 .0,"age":30}
```

JSON Array Encode method

The following example shows the procedure to encode JSON array.

```
import org.json.simple.JSONArray;
public class JsonEncode2
{
    public static void main(String args[])
    {
        JSONArray arr = new JSONArray();
        arr.add("Ranaji");
        arr.add(new Integer(35));
        arr.add(new Double(10000));
        System.out.print(arr);
    }
}
```

Output:

```
["Ranaji", 35, 10000.0]
```

JSON Array Encode using List

The ArrayList class object can be used to encode JSON array using List also.

```
import java.util.List;
import org.json.simple.JSONValue;
import java.util.ArrayList;
```

```
public class JsonEncode3
{
    public static void main(String args[])
    {
        List arr = new ArrayList();
        arr.add("Parampara");
        arr.add(new Integer(42));
        arr.add(new Double(111000));
        String jText = JSONValue.toJSONString(arr);
        System.out.print(jText);
    }
}
```

Output:

```
["Parampara",42,111000.0]
```

4. Java JSON Decode

The following code shows the way to decode JSON string.

```
import org.json.simple.JSONObject;
import org.json.simple.JSONValue;
public class JsonDecode
{
    public static void main(String[] args)
    {
        String s="{\"name\":\"Rajinikanth\",\"salary\":55000,\"age\":66}";
        Object obj=JSONValue.parse(s);
        JSONObject jsonObject = (JSONObject) obj;

        String name = (String) jsonObject.get("name");    // Decode method
        double salary = (Double) jsonObject.get("salary");
        long age = (Long) jsonObject.get("age");
        System.out.println(name+""+salary+""+age);
    }
```

}

Output:

Rajinikanth 55000.0 66

Flexjson

The Flexjson is another lightweight library for serializing and deserializing Java objects into and from JSON format. It allowscreation of both deep and shallow copies of objects. The depth to which an object is serialized can be controlled with Flexjson and thus making it similar to lazy-loading, allowing us to extract only the information that we need. This is not the case since we want an entire object to be written to file, but it's good to know that it can do that.

If we know that we are going to use only a small amount of data in our application and we wish to store or read it to and from JSON format, we should consider using Flexjson or Gson.

How to use Flexjson?

The Flexjson takes a different approach allowing us to control the depth to which it will serialize. It's very similar in concept to lazy loading in Hibernate which allows us to have a connected object model, but control what objects are loaded out of our database for performance. Let's look at a simple example first to get a feel for how the library works. Say we are serializing an instance of Animal. We might do it in the following way.

```
public String do( Object arg1, ... )
{
        Animal a = ...load an animal...;
        JSONSerializer serializer = new JSONSerializer();
        return serializer.serialize( a );
}
```

Output:

{

"class": "Animal",

"name": "Xenial Xerus",

"nickname": "Wolf"

}

JSON-lib

JSON-lib is a Java library, based on the original work by creator of JSON, Douglas Crockford, capable of transforming beans, maps, collections, Java arrays and XML to JSON and back again to beans and DynaBeans.

If we are going to use big amounts of data and wish to store or read it to and from JSON format, we should consider using Jackson or JSON-lib.

How to use this library ?

1. Here is our pom.xml:

<dependency>

<groupId>org.json</groupId>

<artifactId>json</artifactId>

<version>20180130</version>

</dependency>

The latest version can be found in the Maven Central repository online. This package has already been included in Android SDK, so we shouldn't include it while using the same.

2. JSON in Java [package org.json]

The JSON-Java library is also known as org.json (not Google's org.json.simple) provides us with classes that are used to parse and manipulate JSON.

Furthermore, this library can also convert among JSON, XML, HTTP Headers, Cookies, Comma-Delimited List or Text, etc.

Following are the classes used to JSON embedding in Java.

- JSONObject – similar to Java's native Map like object which stores unsorted key-value pairs in it.
- JSONArray – This is ordered sequence of values similar to Java's native Vector class implementation.
- JSONTokener – This is a tool that breaks a piece of text into a series of tokens which can be used by JSONObject or JSONArray to parse JSON strings from it.
- CDL – This tool provides methods to convert comma-delimited text into a JSONArray and vice versa.
- Cookie – It is used to convert from JSON String to cookies and vice versa.
- HTTP – It is used to convert from JSON String to HTTP headers and vice versa.
- JSONException – This is subclass of Exception and a standard exception thrown by this library.

JSONObject

The A JSONObject is an unsorted collection of key and value pairs, corresponding Java's native Map implementations. Keys are unique Strings that cannot be null. The values can be anything from a Boolean, Number, String, JSONArray or even a JSONObject.NULL object.

The A JSONObject can be represented by a String enclosed within curly braces { } with keys and values separated by a colon, and pairs separated by a comma like general JSON format. It has several constructors with which to construct a JSONObject. It also supports the following methods:

- get(String key) – It is used to get the object associated with the supplied key, throws JSONException if the key is not found in it.
- opt(String key)- It is used get the object associated with the supplied key, null otherwise.
- put(String key, Object value) – It is used to insert or replace a key-value pair in current JSONObject.

The put() method is an overloaded method which accepts a key of type String and multiple types for the value.

Following are the operations supported by JSON library here.

1. Creating JSON Directly from JSONObject

The JSONObject explores an API similar to Java's Map interface. We can use the put( ) method and supply the key and value as an argument:

```
JSONObject jo = new JSONObject();

jo.put("name", "Aniket");

jo.put("age", "28");

jo.put("city", "Pune");
```

Now our JSONObject would look like:

```
{"city":"Pune","name":"Aniket","age":"28"}
```

There are seven different overloaded signatures of JSONObject.put() method are available. The data present in the object will have the key only be unique, non-null String, the value can be anything.

2. Creating JSON from Map

Instead of directly putting key and values in a JSONObject, we can construct a custom Map and then pass it as an argument to JSONObject's constructor as shown in the example below.

```
Map<String, String> map = new HashMap<>();

map.put("name", "Aniket");

map.put("age", "28");

map.put("city", "Pune");

JSONObject jo = new JSONObject(map);
```

3. Creating JSONObject from JSON String

In order to parse a JSON String to a JSONObject, we can just pass the String to the constructor. The example below shows the JSON String.

```
JSONObject jo = new JSONObject(
"{\"city\":\"Pune\",\"name\":\"Aniket\",\"age\":\"28\"}"
);
```

The passed String argument must be a legal JSON string otherwise this constructor may throw a JSONException.

4. Serialize Java Object to JSON

One of JSONObject's constructors takes a POJO as its argument. In the example below, the package uses the getters from the DemoBean class and creates an appropriate JSONObject for it.

In order to get a JSONObject from a Java Object, we have to use a class that is a legal Java Bean object:

```
DemoBean demo = new DemoBean();
demo.setId(1);
demo.setName("Mahabharat");
demo.setActive(true);
JSONObject jo = new JSONObject(demo);
```

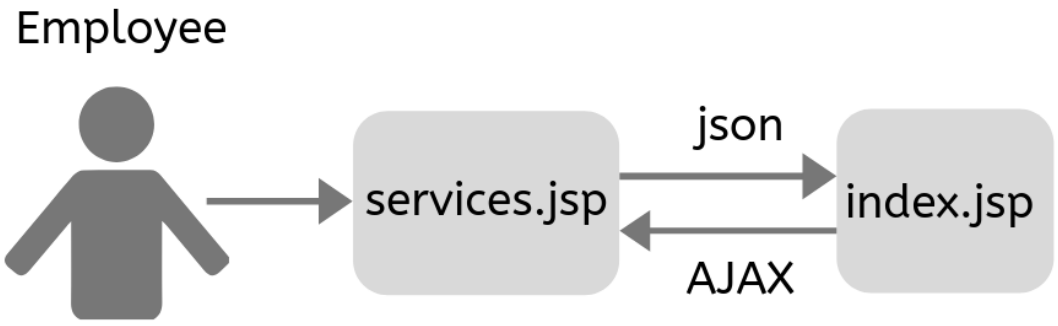
The JSONObject jo for this example is going to be:

```
{"name":"Mahabharat","active":true,"id":1}
```

Although we have a way to serialize a Java object to JSON string, there is no way to convert it back using this library.

8.9 Publishing a Service using JSON in JSP

In order to publish a service using JSON, at plain jsp project, it will need json library. We may use any json library. Here we used json-simple. We need to download the library from Maven repository.



The Apache Tomcat 6 is also required, so jar file will put at lib folder, just paste and restart server.

Fig. 8.1 The JSON and JSP Communication

The concept is index.jsp will request some params send through ajax to services.jsp. From there it will process as params and take data from database employees, return to index.jsp as json.

Our project I contain the following.

- index.jsp
- services.jsp
- mysql_employees_jspjson.sql
- jquery-1.10.2.min.js (jQuery Library of JS)

1. index.jsp (front-end view that show what will be requested)

```
<%@ page contentType="text/html; charset=iso-8859-1" language="java" import="java.sql.*" errorPage="" %>
<!DOCTYPE html>
<html>
<head>
<title>JSP JSON Tester</title>
<script src="jquery-1.11.1.min.js"></script>
</head>
<body bgcolor="white">
<div id="con">
<label>What department ? (IT / COMM / HR / FINANCE)</label><br/>
```

```
<input id="dept" type="text" name="dept" placeholder="Department"/>
<button id="conBtn" type="submit">Submit</button>
</div><br/>
<div id="json" style="display: none;">
<h3>JSON Data</h3>
<p id="conCode"></p><br/>
</div>
<div id="table"  style="display:none;">
<h3>Table Result</h3>
<table border="1" padding="1">
<thead>
<th>No</th>
<th>Name</th>
<th>Department</th>
<th>Address</th>
</thead>
<tbody id="tableBody">
</tbody>
</table>
</div>

<script>
function submitForm(){
var inp = $('#dept').val().toUpperCase();
$.ajax({
async: false,
type: "GET",
contentType: "application/json; charset=utf-8",
url: "services.jsp",
data: { dept: inp}
}).success(function(data){
var jsondata = JSON.parse(data);
loadData(jsondata);
```

```
$('#conCode').html(data);
}).fail(function(jqXHR, textStatus){
console.log("[AJAX] Error: JSON WSDL Lookup>>>" + textStatus);
}).done(function(){
console.log("[AJAX] Complete: JSON WSDL Lookup");
});
}

function loadData(datas){
var sb = '';
var table = $('#tableBody');
$('#json').show();
$('#table').show();
table.html('');

$.each(datas, function(index, value){
sb += '<tr>';
sb += '<td>' + value.no + '</td>';
sb += '<td>' + value.name + '</td>';
sb += '<td>' + value.dept + '</td>';
sb += '<td>' + value.addr + '</td>';
sb += '</tr>';
});

table.append(sb);
}
$(function(){
$('#conBtn').click(function(e){
e.preventDefault();
submitForm();
});
});
</script>
```

```
</body>
</html>
```

2. services.jsp (will process as params requested and response data as json)

```
<%@page language="java" import="java.sql.*"%>
<%@page import="java.util.*" %>
<%@page contentType="text/html; charset=UTF-8"%>
<%@page import="org.json.simple.JSONArray"%>
<%@page import="org.json.simple.JSONObject"%>
<%@page import="org.json.simple.parser.JSONParser"%>
<%@page import="org.json.simple.parser.ParseException"%>
<%
String dept = (String)request.getParameter("dept");
String sql  = "SELECT * FROM employees WHERE department="'+dept+'"";
try
{
Class.forName("com.mysql.jdbc.Driver");          // Database connectivity
Connection conn=null;
conn=DriverManager.getConnection("jdbc:mysql://localhost/jspjsons","root","123456");
ResultSet rs=null;
Statement stm1=conn.createStatement();

JSONArray list = new JSONArray();
rs=stm1.executeQuery(sql);
while(rs.next())
{
JSONObject obj=new JSONObject();
obj.put("no", rs.getString("id"));
obj.put("name", rs.getString("name"));
obj.put("dept", rs.getString("department"));
obj.put("addr", rs.getString("address"));
list.add(obj);
}
```

```
out.print(list);
}
catch(Exception ex)
{
out.println("<h1>"+ex+"</g1>");
}
%>
```

3. mysql_employees_jspjson.sql (sample database structure)

```
CREATE TABLE 'employees' (
'id' int(10) AUTO_INCREMENT,
'name' varchar(20) ,
'department' varchar(20) ,
'address' varchar(50),
PRIMARY KEY ('id')
);

INSERT INTO 'employees' VALUES ('1', 'Akbar', 'IT', '301, Pimple Anex, Pune');
INSERT INTO 'employees' VALUES ('2', 'Baban', 'COMM', 'Rno. 34, Rajat Soc, Pune');
INSERT INTO 'employees' VALUES ('3', 'Chandrakant', 'IT', 'Katepuram Chowk, Pune');
INSERT INTO 'employees' VALUES ('4', 'Dattu', 'HR', 'Akashay Plaza First, Pune');
INSERT INTO 'employees' VALUES ('5', 'Eknath', 'FINANCE', 'Ambar Apartment, Pune');
```

In the above example our MySQL Database with database name is jspjson, username root, with no password. The json-simple library is installed and setup first. The example at services can accept more params and use more fun query. The main purpose is with response as JSON data, we could retrieve it at jsp or android or anywhere we want.