Session: 5

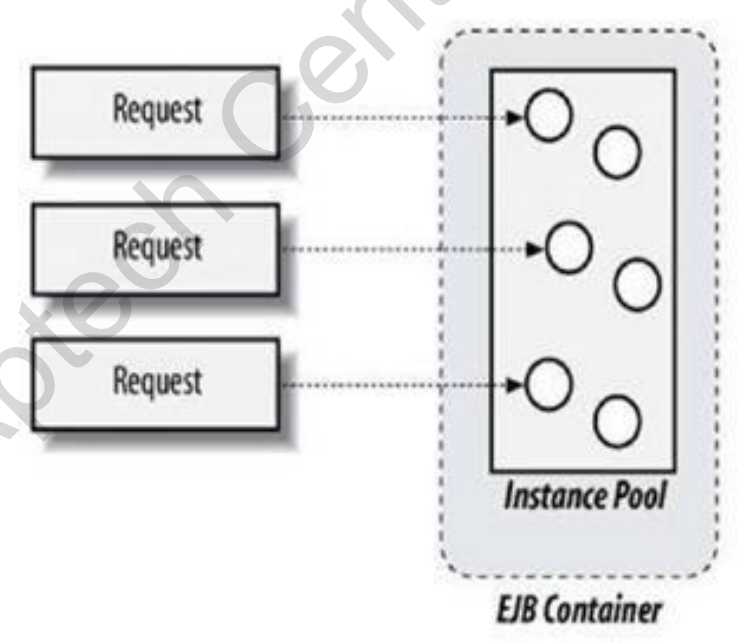
Singleton Session Beans

Objectives

- Explain the need of Singleton Session bean
- Describe the characteristics of Singleton Session bean
- Describe the various stages in the lifecycle of Singleton Session bean
- Explain Singleton Session bean specification and its initialization strategies
- Describe how to achieve concurrency access to Singleton Session bean
- Explain container-managed concurrent access to Singleton Session bean
- Explain bean-managed concurrent access to Singleton Session bean
- Explain the mechanism to configure access time out in concurrency
- Explain how to implement Singleton Session bean in an enterprise application

Introduction 1-2

- In both, the Stateless Session bean and Stateful Session bean model:
  - Only single request can access the bean instance at any time. This means these beans are thread-safe, as each request is represented by the invocation of a single thread.
- Following figure demonstrates how session beans are accessed from a pool of bean instances:



Introduction 2-2

- There are some situations when a single shared instances is used by all the clients.
- This lead to the concurrence access to the bean instance.

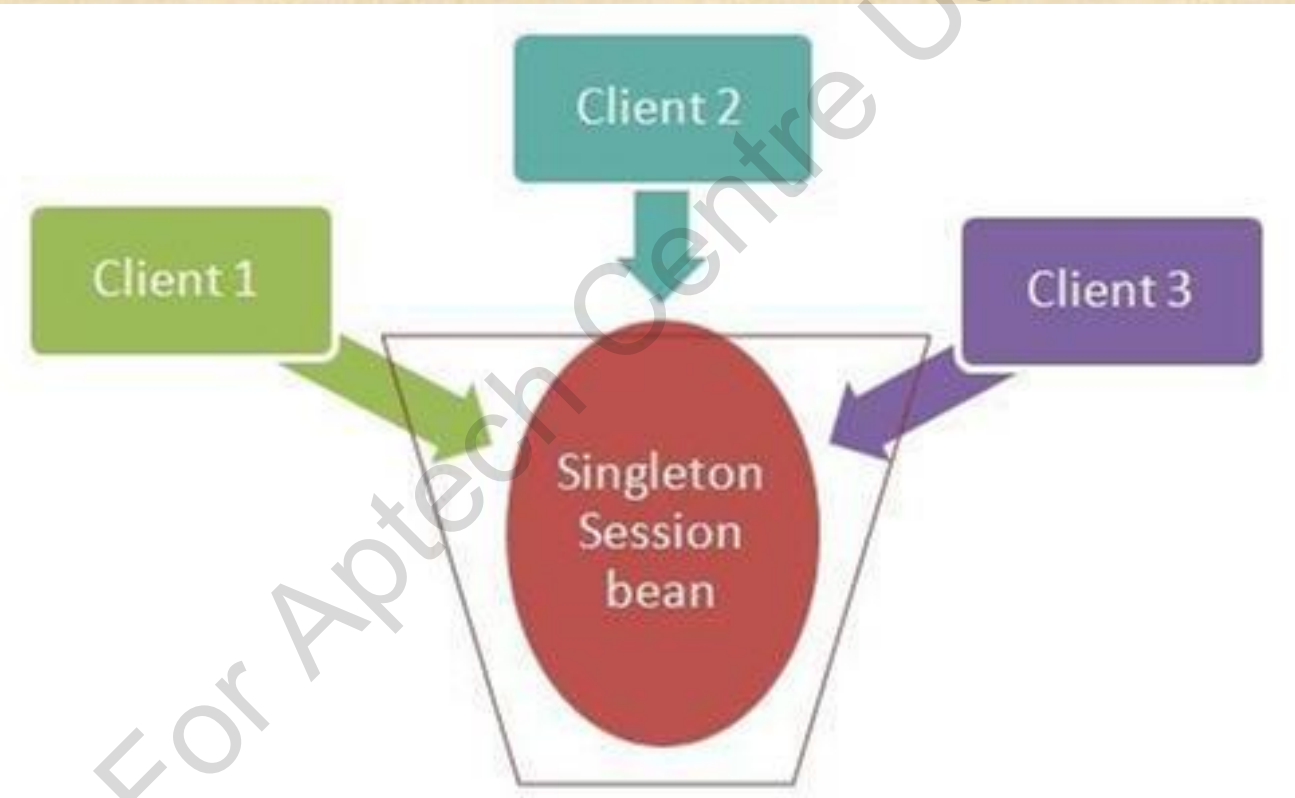
EJB 3.1 specification have introduced Singleton Session bean which provides concurrent access to the clients.

Singleton Session Bean 1-2

- A Singleton Session bean:
  - Is one which gets instantiated only once for every application.
  - Exists during the entire lifecycle of an application.
  - One or more clients can simultaneously access the same bean instance at the same time.

Singleton Session Bean 2-2

- Following figure demonstrates how a single bean instance can be accessed by multiple clients:

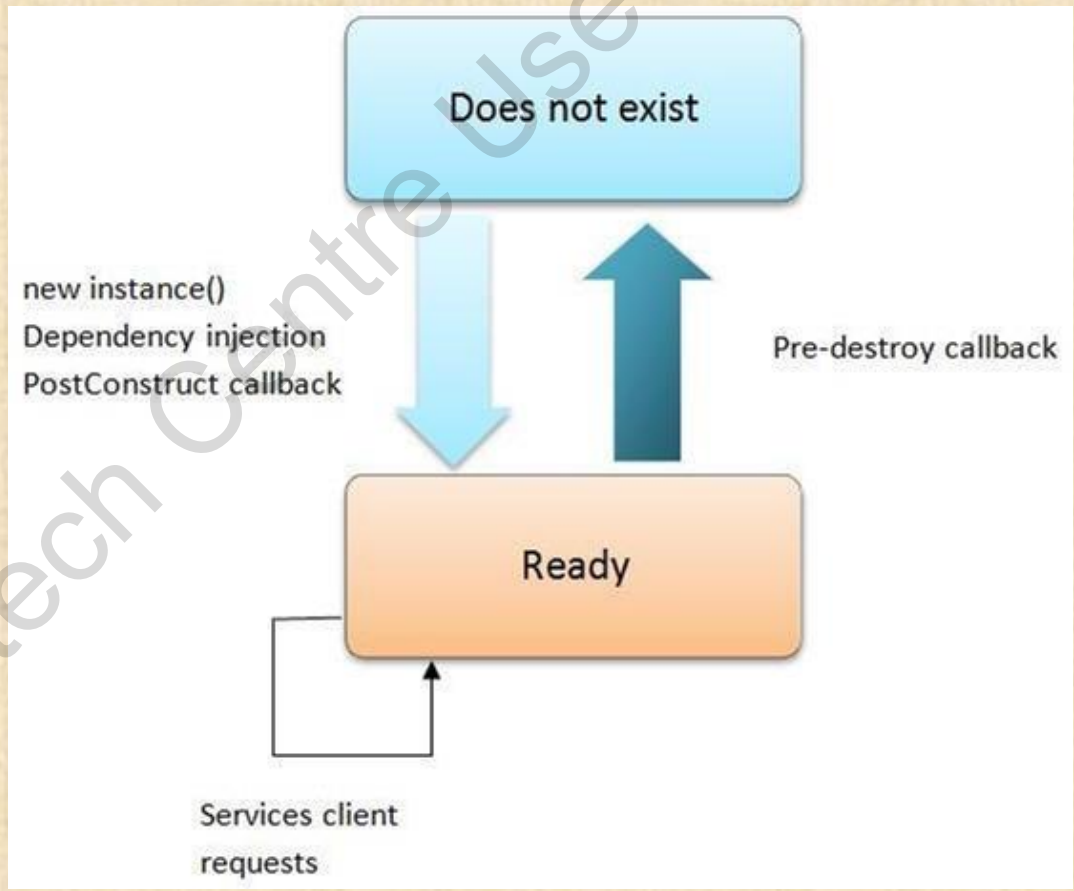


Characteristics of a Singleton Session Bean

- It is shared by all requests.
- It is similar to Stateless Session bean.
- Like Stateless Session beans, the conversational state of Singleton Session beans cannot be persisted onto permanent storage.
- It's instance cannot be passivated and must be thread-safe.
- It has less memory foot print as compared to other session beans.
- Container is responsible for deciding when to initialize a Singleton bean instance.

Lifecycle of a Singleton Session Bean 1-3

- Following figure demonstrates the lifecycle of a Singleton Session bean:



Lifecycle of a Singleton Session Bean 2-3

- '**Does not Exist**' State
  - The bean remains in this state until it has been instantiated by the container.
- '**Ready**' State
  - After the container instantiates the bean instance, it moves to the '**Ready**' state.
  - Bean instance is ready to accept client requests, once it is instantiated and injected with required resources.
- Once the session bean is instantiated all the required resources for the bean class are acquired through dependency injection:
  - **PostConstruct** callback methods are invoked by the container over the bean instance.
  - When the application shut downs, the **PreDestroy** callback method is invoked by the application container, before removing the bean instance from the container.

Lifecycle of a Singleton Session Bean 3-3

- Annotations supported by Singleton Session bean are:
  - `@javax.ejb.Startup` - A Singleton Session bean can be explicitly started by the container during the application startup by invoking a method annotated with `@Startup`.
  - `@javax.ejb.Singleton` – Is used to mark class declaration as a Singleton Session bean class.

Singleton Session Bean Specification 1-3

- A Singleton Session bean comprises a bean class and one or more optional business interfaces.

Bean class	It is a standard Java class which needs to be marked with `@Singleton` annotation.
Business interface	The business interface can be a local or remote. Singleton Session bean also supports no-interface local view for the clients deployed on the application server.

Singleton Session Bean Specification 2-3

- Following code snippet demonstrates the creation of Singleton Session bean:

```
import javax.ejb.Singleton;
import javax.ejb.Startup;

@Singleton(name = "ItemCount")
public class ShoppingItemCount {
private int counter = 0;

 // Increment number of shopper counter
     public void incrementCounter() {
        shopperCounter++;
     }
```


Singleton Session Bean Specification 3-3

```
// Return number of shoppers
    public int getCounter() {
      return Counter;
    }
// Reset counter
    public void initializeCounter() {
     shopperCounter = 0;
   }
}
```

- The code annotates the `ShoppingItemCount` class with `@Singleton` annotation. The `name` attribute of the annotation defines the `ejb-name` of the bean by which it is referenced by other beans in the container.

Initialize Singleton Session Bean

- By default, EJB container is responsible for initializing the Singleton Session bean instance.
- The bean developer can also configure when to initialize the Singleton Session bean instance.
- If the bean is annotated with `@Startup`, then the bean is initialized at application startup.
- This initialization is also known as **eager initialization**, where the container initializes the Singleton Session bean as soon as the application startup.
- Following code snippet demonstrates the usage of `@Startup` annotation:

```
@Startup
@Singleton
public class ShoppingItemCount {
. . .
}
```

- Instructs the container to configure and initialize the Singleton Session bean during the startup process of the application.

Startup Initialization Dependencies 1-2

Multiple Singleton Session beans components in an application can have explicit initialization ordering dependencies upon each other.

The container must define the sequence of initialization to address these dependencies.

`javax.ejb.DependsOn` annotation is used to ensure that a specific Singleton Session bean is initialized, before other Singleton Session beans dependent on it are initialized by the container.

The `value` attribute of `DependsOn` attribute holds the Singleton Session bean class name.

Based on this annotation, the container ensures that the dependency is satisfied, before the dependent beans are initialized.

Startup Initialization Dependencies 2-2

- Following code snippet demonstrates the usage of `DependsOn` annotation:

```
// Class definition of ShoppingItemPoints
@Singleton
@Startup
@DependsOn("ItemCount")

public class ShoppingItemPoints {
  private final int points;
  public void AddPoints() {
   // Business logic for adding points
  }
}
```

- The `ShoppingItemPoints` class has been annotated with the `@DependsOn` annotation indicating that the instantiation of the bean object is dependent on the `ShoppingItemCount` object.

LifeCycle Callback Methods 1-2

- Callback events handle the construction and destruction of a Singleton Session bean.
- Callback events are mapped to the following events:

PostConstruct

- It is denoted by `@PostConstruct` annotation and is fired after a bean instance is instantiated by the container, and before the invocation of the first business method defined in the class.

PreDestroy

- It is denoted by `@PreDestroy` annotation and is fired when the application is shutting down.

LifeCycle Callback Methods 2-2

- Following code snippet demonstrates the PostConstruct and PreDestroy interceptor methods:

```
. . .
@Singleton(name = "ItemCount")
@Startup
public class ShoppingItemCount {
. . .
@PostConstruct
public void applicationStartup() {
  System.out.println("ApplicationStartup – Initializing the
counter variable to zero.");
  Counter = 0;
}

@PreDestroy
public void applicationShutdown() {
   System.out.println("ApplicationShutdown Happening");
}
}
```

- The code handles the application startup and application shutdown in the callback interceptor methods.

Concurrency in Singleton Session Bean 1-2

- Every application has only one instance of a Singleton Session bean.
- When multiple clients access the same instance of the Singleton Session bean, then this results into **concurrency**.
- There are two ways by which the concurrent access to a singleton session bean can be controlled. These are as followed:
  - **Container-managed concurrent** - As the name suggests, the container is responsible for managing the concurrent access to the Singleton Session bean data or methods. This is the default concurrency management type.
  - **Bean-managed concurrent** – This container provides full access of the bean to the bean developer. Even the synchronization of bean state is managed by the bean developer.

Concurrency in Singleton Session Bean 2-2

- The concurrency management method used for the current enterprise bean can be defined through the annotation `javax.ejb.ConcurrencyManagement`.
- The type of concurrency management can be specified through a `type` attribute whose value can be either set to `javax.ejb.ConcurrencyManagementType.CONTAINER` or `javax.ejb.ConcurrencyManagementType.BEAN`.

Container Managed Concurrency 1-3

- Associates each business method of the Singleton Session bean with a lock.
- Annotations are used to define the type of the lock to be acquired.
- `javax.ejb.Lock` is used to specify the required locks.
  - It has an attribute `javax.ejb.LockType`, which accepts the lock type as READ or WRITE for the bean methods.
  - `READ` lock provides shared access and `WRITE` lock provides exclusive access.
  - For example, marking the business method with `@Lock(LockType.READ)` grants shared access to the bean method.

Container Managed Concurrency 2-3

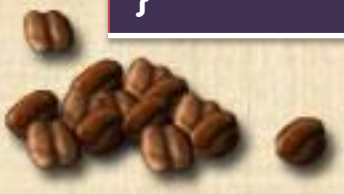
- Following code snippet demonstrates container-managed concurrency applied to the Singleton Session bean:

```
. . .
@Singleton(name = "WebsiteVisitCount")
@Startup
@ConcurrencyManagement(ConcurrencyManagementType.CONTAINER)

public class WebsitevisitCount{
....
private int Counter;

// Increment number of visitors
@Lock(LockType.WRITE)
public void incrementCounter() {
   Counter++;
}
```

- The `@ConcurrencyManagement` annotation specifies that the concurrency type is set to `CONTAINER`.
- The `@Lock(LockType.WRITE)` acquires the `WRITE` lock which blocks the access of the method for all other clients, while one client is accessing it.



Container Managed Concurrency 3-3

```
// Return number of visitors
@Lock(LockType.READ)
public int getVisitorCount() {
return Counter;
    . . .
}
}
```

- The `@Lock(LockType.READ)` annotation is specified at the method-level to the `getVisitorCount()` which returns the number of users visited to the site.

Bean Managed Concurrency

- Bean managed concurrency is specified through the annotation `ConcurrentManagementType.BEAN`.
- It is the responsibility of the bean developer to synchronize the state of the Singleton Session bean to avoid synchronization errors occurring due to the concurrent access.
- Bean developer uses `synchronized` and `volatile` primitive types for synchronization.

Concurrent Access Timeout 1-2

- When a client has an exclusive lock, other clients are blocked from accessing the bean.
- A client cannot hold the lock for unlimited time.
- `@AccessTimeOut` annotation can be used to specify the maximum amount of time for which a client can be blocked.
- `AccessTimeOut` annotation has two attributes `value` and `timeUnit`.
  - The default time unit specified in the `value` attribute is in milliseconds.
  - The developer can change it to one of the constants provided in the `java.util. concurrent.TimeUnit`.
  - If the `AccessTimeOut` value specified is -1, then it indicates that the client will block indefinitely until it gains access to the bean.

Concurrent Access Timeout 2-2

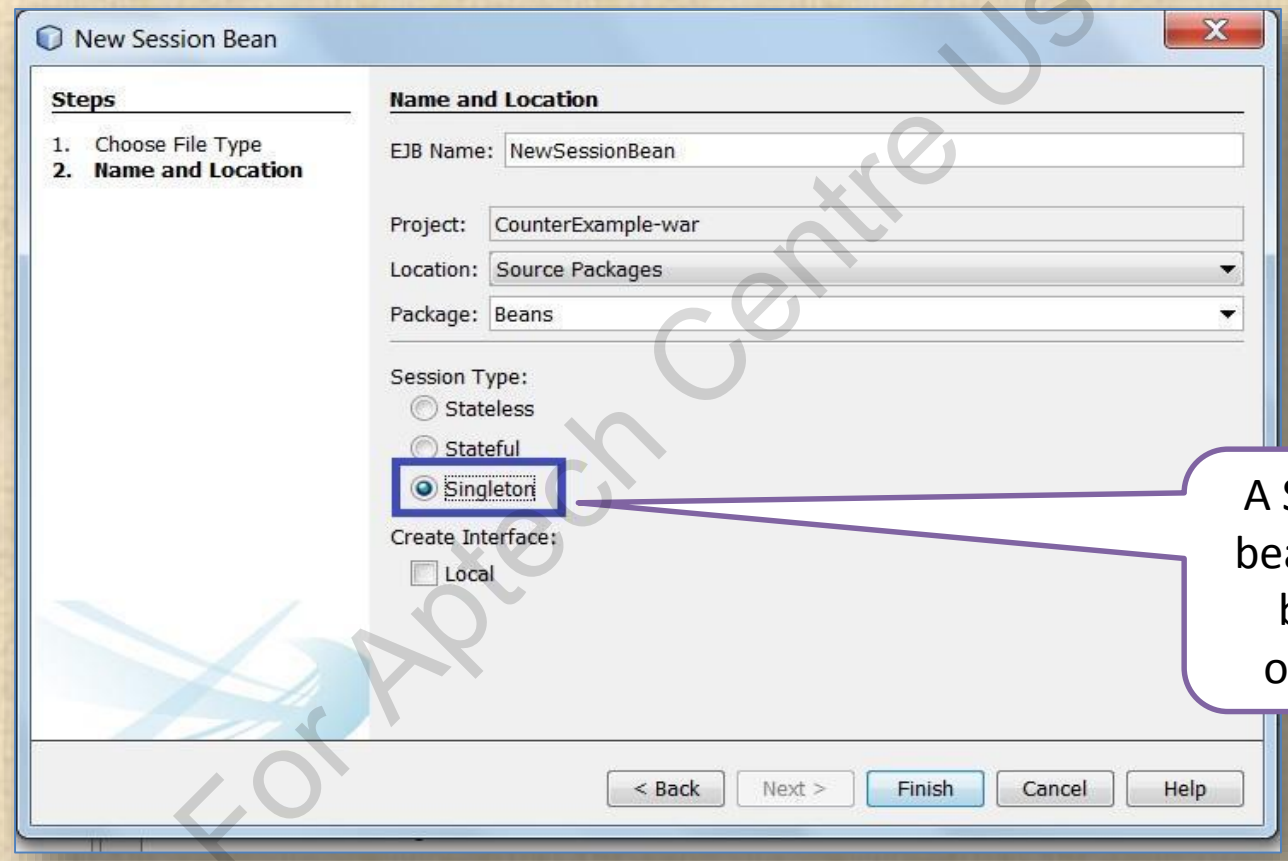
- Following code snippet demonstrates the configuration of access time value for the Singleton Session bean:

```
// Increment number of visitors
   @Lock(LockType.WRITE)
   @AccessTimeout(value=120000)
   public void incrementCounter() {
      Counter++;
   }
```

  - The code specifies the access time out for the `incrementCounter()` method to 120000 milliseconds.

Developing a Singleton Session Bean 1-6

- Following figure demonstrates creating a Singleton Session bean:



Developing a Singleton Session Bean 2-6

- Following code snippet demonstrates a Singleton Session bean to add a variable to the bean:

```
package Beans;
import javax.ejb.ConcurrencyManagement;
import static javax.ejb.ConcurrencyManagementType.CONTAINER;
import javax.ejb.LocalBean;
import javax.ejb.Lock;
import static javax.ejb.LockType.WRITE;
import javax.ejb.Singleton;
@Singleton
@ConcurrencyManagement(CONTAINER)
@LocalBean
public class CountBean {
 static int visits=0;
@Lock(WRITE)
    public int incrementCounter() {
        return ++visits;
    }}
```

Developing a Singleton Session Bean 3-6

- Following code snippet demonstrates how a client can access a Singleton Session bean:

```
. . .
public class Module5Client1{
public Module5Client1() {
     CountBean C = new CountBean();
    System.out.println("Counter value seen by Client 1
"+C.incrementCounter());

}
}
```


Developing a Singleton Session Bean 4-6

- Following code demonstrates how a second client accesses the Singleton Session bean:

```
. . .
public class Module5Client2{

    public Module5Client2() {
     CountBean C = new CountBean();
    System.out.println("Counter value seen by
Client 2 "+C.incrementCounter());
     }
 }
```

  - Earlier code snippet and the given code snippet are two Java classes that invoke the Singleton Session bean in the constructor of the class.
  - \Whenever an object of the client class is invoked, the Singleton Session bean is accessed.

Developing a Singleton Session Bean 5-6

- Following code snippet demonstrates multiple clients accessing a Singleton Session bean:

```
package Beans;
public class ClientRequest {
    public static void main(String[] args) {
        Module5Client1 m1 = new Module5Client1();
        Module5Client2 m3 = new Module5Client2();
        Module5Client1 m2 = new Module5Client1();
        Module5Client2 m4 = new Module5Client2();

      }

}
```

  - The code creates four instances of clients which are equivalent to client requests to access the Singleton Session bean.

Developing a Singleton Session Bean 6-6

- Following figure shows the execution of multiple client requests by the Singleton Session bean:

Summary

- A Singleton Session bean is instantiated only once in the application lifecycle and retained throughout the application lifecycle.
- Singleton Session bean cannot store the conversational state nor can it be passivated.
- Singleton Session bean has `@PreDestroy` and `@PostConstruct` callback methods.
- When there are multiple Singleton beans in the application and they are dependent on each other, then the EJB container should initialize them in right order.
- `@DependsOn` annotation is used to define the dependencies among the Singleton beans.
- Multiple clients can access the Singleton Session bean in the application; this concurrent access has to be managed.
- Container-managed and Bean-managed concurrent access are the two variants of concurrency management for Singleton Session beans.
- The client requests cannot be blocked indefinitely, therefore an access time out value is associated with each blocked request.