Experiment No.: 5

Use middleware to implement connectors

39_BE-COMP-B_Harsh-Mishra

Learning Objective: Student should be able to understand use of middleware to implement connectors.

Theory:

What is Middleware ?

Middleware is a more effective program that acts as bridge in between various applications and other databases otherwise tools. It is placed in between operating system and other applications which run on it. Middleware allows making better communication, application services, messaging, authentication, API management and management of data between different kinds of applications which help to exchange data.

The connectors sit between the two APIs or you can say and the ends of the connectors are APIs. The connectors receive data from one app/solution and process it to make it understandable and accessible in the other app/solution, regardless of whether any direct form of integration was available in the two apps.

Role of Middleware is :-

Middleware is a potentially useful tool when building software connectors. First, it can be used to bridge thread, process and network boundaries. Second, it can provide pre-built protocols for exchanging data among software components or connectors. Finally, some middleware packages include features of software connectors such as filtering, routing, and broadcast of messages or other data.

A signal interaction is a one-way interaction between an initiating object, called a client, and a responding object, called a server. An operation interaction is an interaction between a client object and server object that is either an interrogation or an announcement. An interrogation is composed of two one-way interactions: a request and a response. An announcement is a one-way request from a client object to a server object in which the client object expects no response, and the server object does not respond. A flow interaction is an ordered set of one or more one-way communications from a producer object to a consumer object. These interactions are a generalized

metamodel for describing communication styles between objects that hat can be implemented using a variety of middleware such as Remote Procedure Call (RPC) and Remote Method Invocation (RMI) and message queues (as selected and specified in the technology view).

can be implemented using a variety of middleware such as Remote Procedure Call (RPC) and Remote Method Invocation (RMI) and message queues.

Connectors as a primary vehicle for interprocess communication. A single conceptual connector can be "broken up" vertically (a) or horizontally (b) for this purpose.

Vertical Connectors :

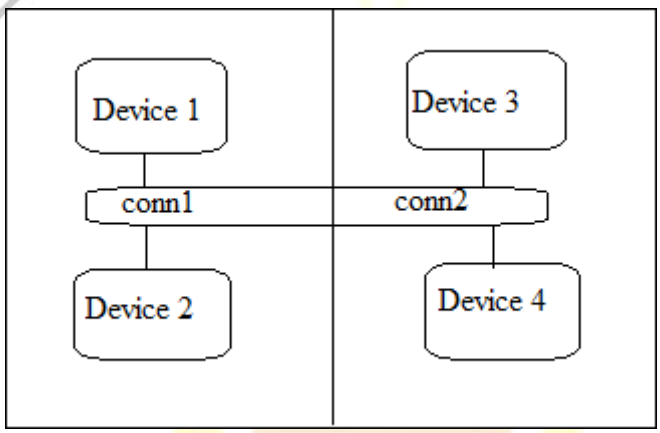


Figure (a)

Horizontal Connectors :

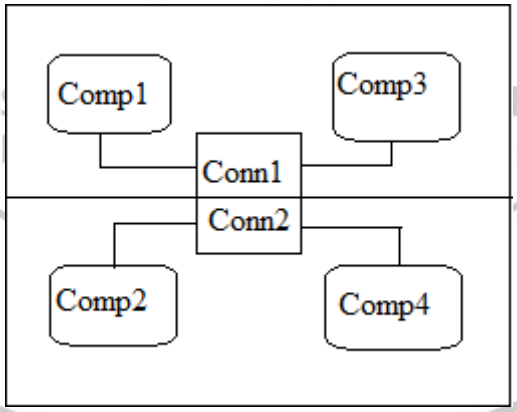


Figure (b)

Linking Ports Across Process Boundaries :

The ports can call methods on each other, sending messages as method parameters. Our intent was to simply use the middleware to exchange port references across process boundaries and usethe existing technique for message passing.
The middleware technology would be entirely encapsulated within the port entity and would not be visible to architects or developers. The singleprocess implementation of a C2 connector links two ports together by having each port contain a reference to the other one.

Linking Connectors Across Process Boundaries :

Sharing communication ports across process boundaries gave us fine-grained control over implementing an architecture as a multi-process application. However, it required additional functionality in the C2 implementation framework and did not isolate the change to the appropriate abstraction: the connector. In order to remedy this, we devised two connectorbased approaches. Both of these approaches consist of implementing a single conceptual software connector using two or more actual connectors that are linked across process or network boundaries. Each actual connector thus becomes a segment of a single " virtual connector." All access to the underlying middleware technology is encapsulated entirely within the abstraction ofa connector, meaning that it is unseen by both architects and developers. We call the first approach " lateral welding," depicted in Fig. 2a. Messages sent to any segment of the multi- process connector are broadcast to all other segments. Upon receiving a message, each segment has the responsibility of filtering and forwarding it to components in its process as appropriate. Only messages are sent across process boundaries. While the lateral welding approach allowedus to " vertically slice" a C2 application, we also developed an approach to " horizontally slice" an application, as shown in Fig. 2b. This approach is similar to the idea of lateral welding: a conceptual connector is broken up into top and bottom segments, each of which exhibits thesame properties as a single-process connector to the components attached above and below it, respectively. However, the segments themselves are joined using the appropriate middleware. When used with a middleware technology that supports dynamic change at run-time, all of these approaches, both using ports and connectors, can be used to build applications where processes can join and leave a running application.

Using Middleware Technologies :

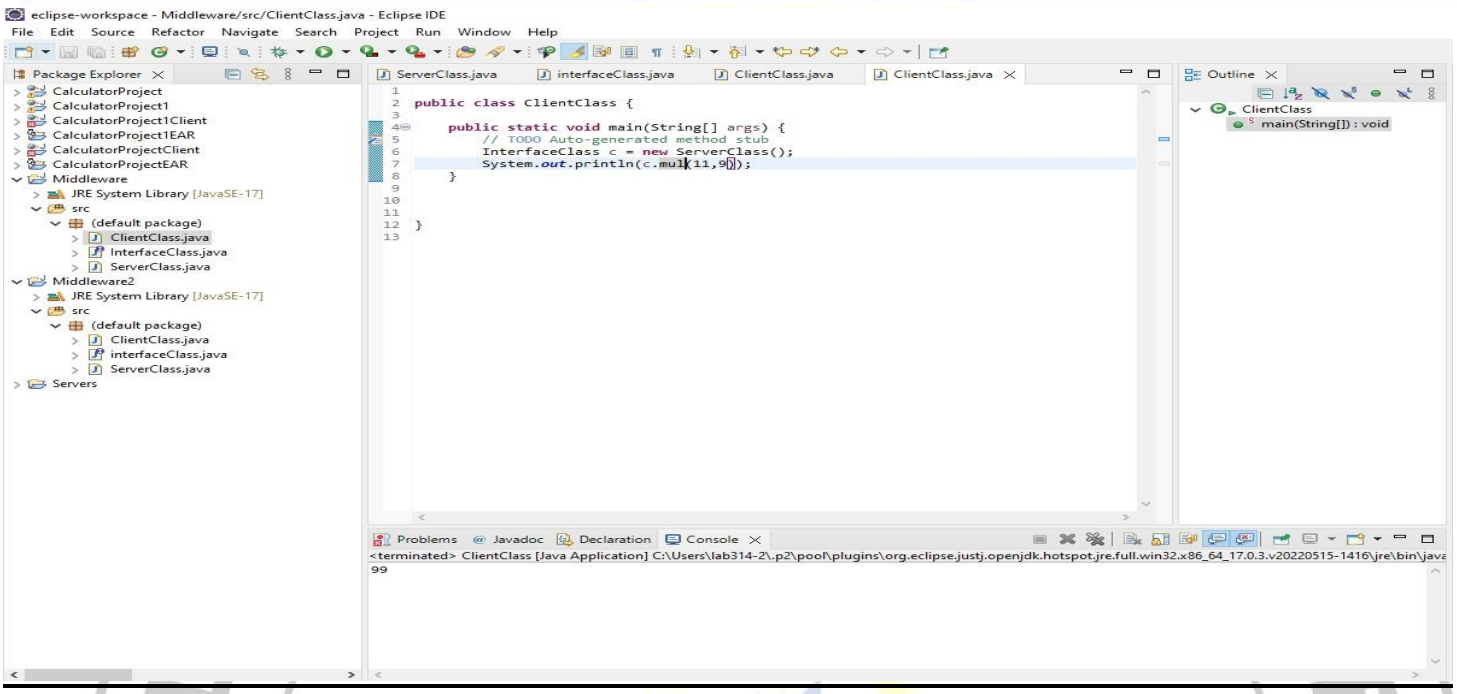
To explore the use of OTS middleware with software connectors, we chose four representative technologies from the field of available middleware packages. These were Q, an RPC system, Polylith, a message bus, RMI, a connection mechanism for Java objects, and ILU, a distributed objects package.A description of one of our efforts involving integrating two middleware technologies simultaneously in the same application is given here. With each middleware package, we were able to encapsulate all the middleware functionality within the connectors

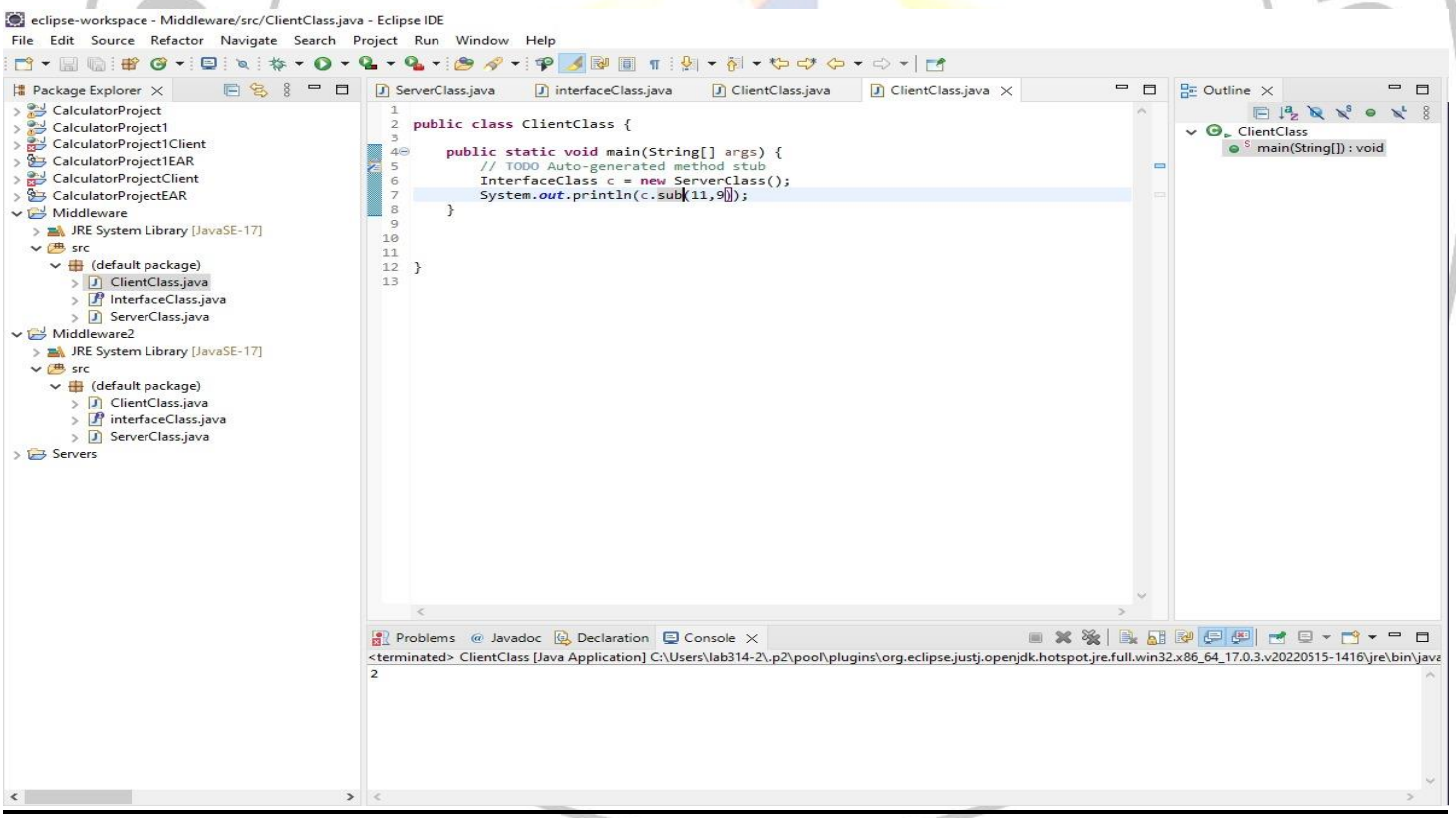
themselves. This means that architects and developers can use the middleware-enhanced connectors thus created just as they would use normal, in-process C2 connectors.

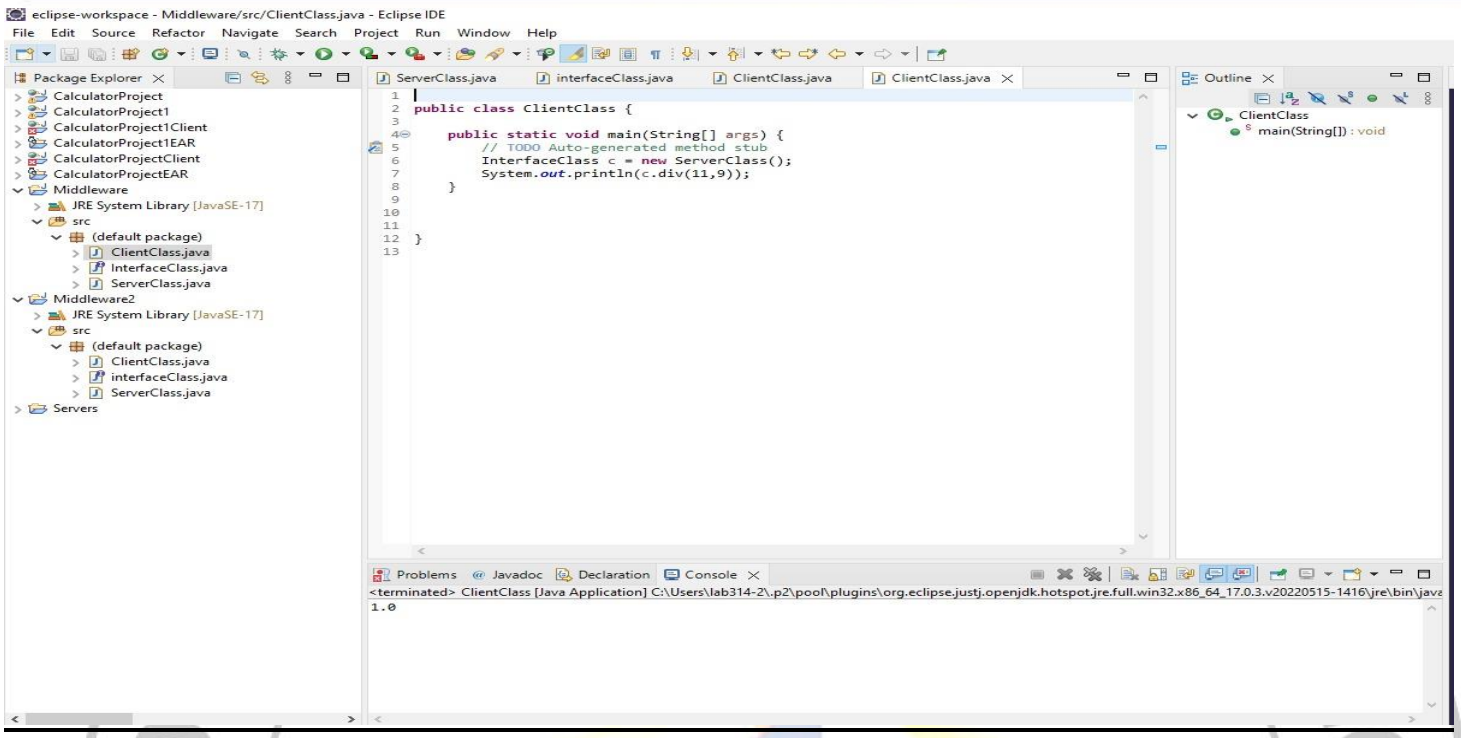
Simultaneous Use of Multiple Middleware Packages :

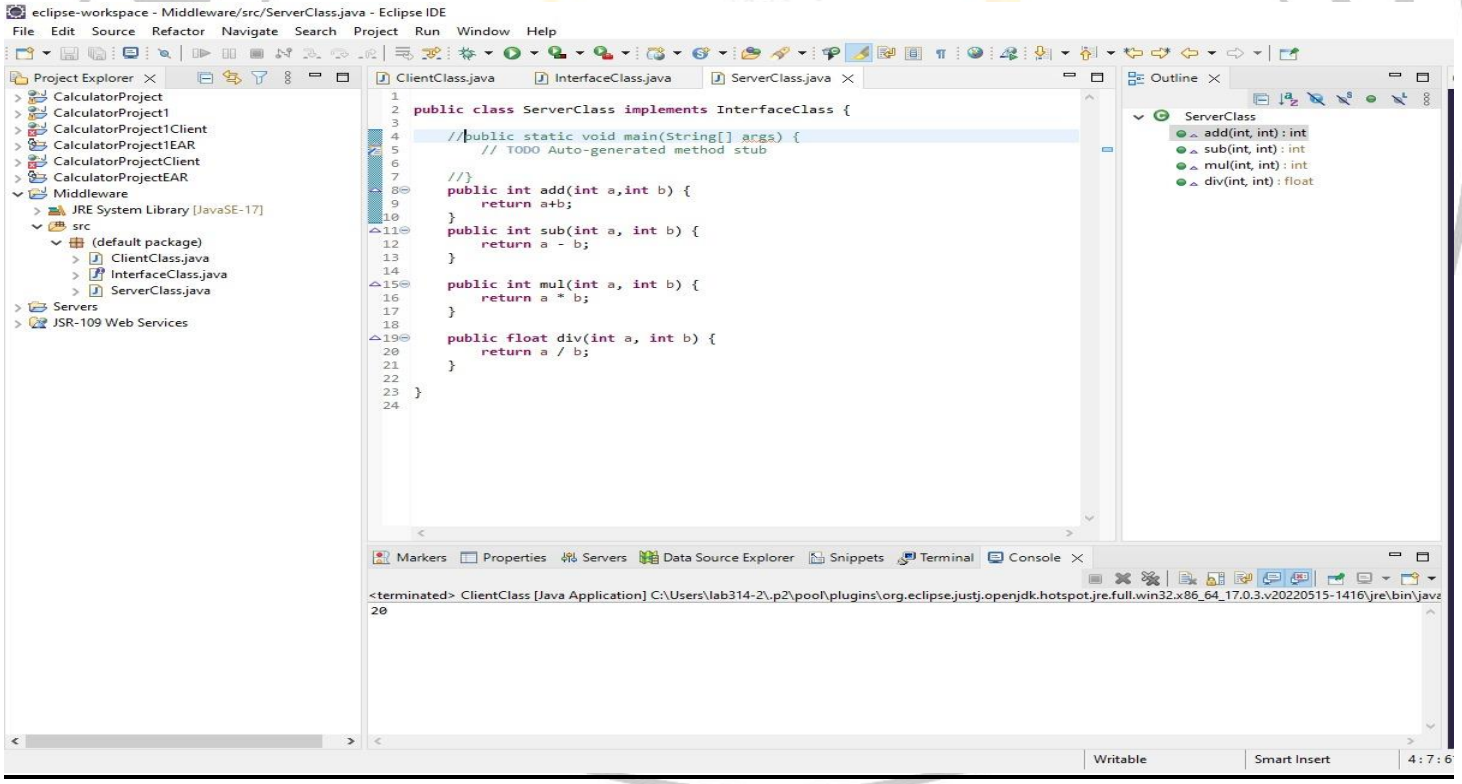
Each middleware technology we evaluated has unique benefits. By combining multiple such technologies in a single application, the application can potentially obtain the benefits of all of them. For instance, a middleware technology that supports multiple platforms but only a single language, such as RMI, could be combined with one that supports multiple languages but a single platform, such as Q, to create an application that supports both multiple languages and multiple platforms. The advantages of combining multiple middleware technologies within software connectors are manifold. In the absence of a single panacea solution that supports all required platforms, languages, and network protocols, the ability to leverage the capabilities of several different middleware technologies significantly widens the range of applications that can be implemented within an architectural style such as C2. We combined our implementations of ILU-C2 and RMI-C2 connectors in a version of the KLAX application, a real time video game application built as an experimental platform for work on the C2 architecture. We were able to do so with no modification to the middleware-enhanced C2 framework or the connectors themselves by combining the lateral welding technique shown in Fig. 2a with the horizontal slicing technique shown in Fig. 2b. This approach works for any combination of OTS connectorsthat use the lateral welding technique. An alternative approach would have been to create a single connector that supported both ILU and RMI, but this would have required changes to the framework.

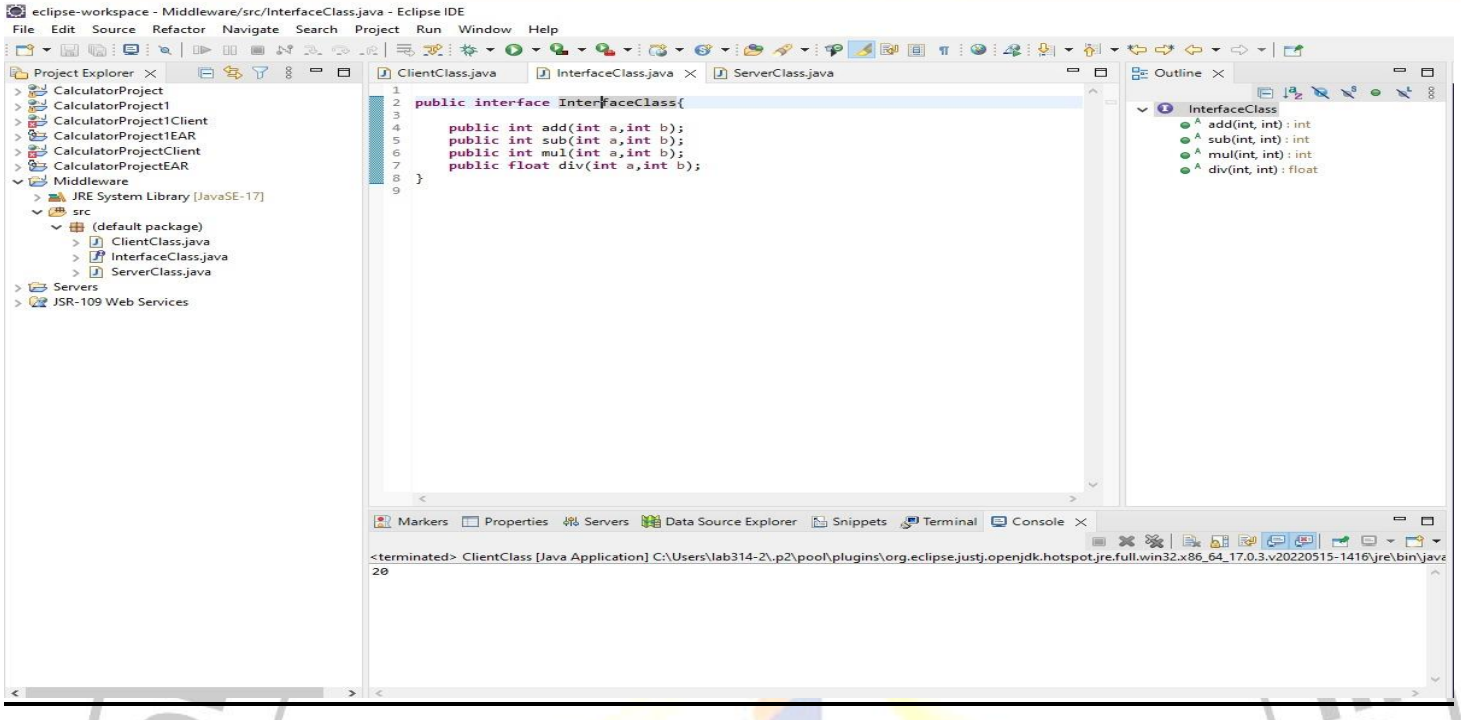
OUTPUTS:

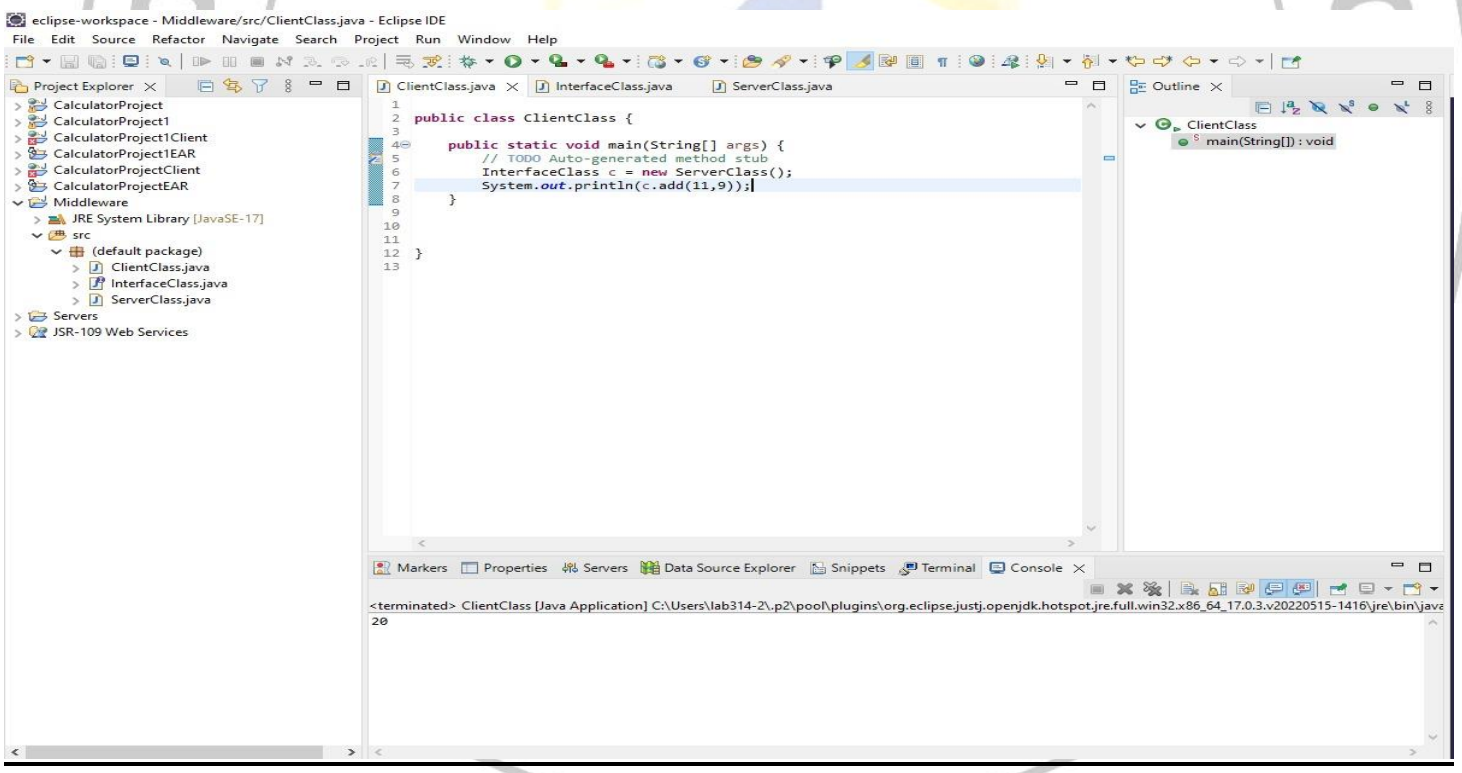

eclipse-workspace - Middleware/src/ClientClass.java - Eclipse IDE
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer
CalculatorProject
CalculatorProject1
CalculatorProject1Client
CalculatorProject1EAR
CalculatorProjectClient
CalculatorProjectEAR
Middleware
JRE System Library [JavaSE-17]
src
(default package)
ClientClass.java
InterfaceClass.java
ServerClass.java
Middleware2
JRE System Library [JavaSE-17]
src
(default package)
ClientClass.java
interfaceClass.java
ServerClass.java
Servers
ServerClass.java
interfaceClass.java
ClientClass.java
ClientClass.java
public class ClientClass {
public static void main(String[] args) {
// TODO Auto-generated method stub
InterfaceClass c = new ServerClass();
System.out.println(c.mul(11,9));
}
}
Outline
ClientClass
main(String[]) : void
Problems
Javadoc
Declaration
Console
<terminated> ClientClass [Java Application] C:\Users\lab314-2\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\java
99


eclipse-workspace - Middleware/src/ClientClass.java - Eclipse IDE
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer
CalculatorProject
CalculatorProject1
CalculatorProject1Client
CalculatorProject1EAR
CalculatorProjectClient
CalculatorProjectEAR
Middleware
JRE System Library [JavaSE-17]
src
(default package)
ClientClass.java
InterfaceClass.java
ServerClass.java
Middleware2
JRE System Library [JavaSE-17]
src
(default package)
ClientClass.java
interfaceClass.java
ServerClass.java
Servers
ServerClass.java
interfaceClass.java
ClientClass.java
ClientClass.java
public class ClientClass {
public static void main(String[] args) {
// TODO Auto-generated method stub
InterfaceClass c = new ServerClass();
System.out.println(c.sub(11,9));
}
}
Outline
ClientClass
main(String[]) : void
Problems
Javadoc
Declaration
Console
<terminated> ClientClass [Java Application] C:\Users\lab314-2\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\java
2


eclipse-workspace - Middleware/src/ClientClass.java - Eclipse IDE
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer
CalculatorProject
CalculatorProject1
CalculatorProject1Client
CalculatorProject1EAR
CalculatorProjectClient
CalculatorProjectEAR
Middleware
JRE System Library [JavaSE-17]
src
(default package)
ClientClass.java
InterfaceClass.java
ServerClass.java
Middleware2
JRE System Library [JavaSE-17]
src
(default package)
ClientClass.java
interfaceClass.java
ServerClass.java
Servers
ServerClass.java
interfaceClass.java
ClientClass.java
ClientClass.java
1 2 3 4 5 6 7 8 9 10 11 12 13
public class ClientClass {
public static void main(String[] args) {
// TODO Auto-generated method stub
InterfaceClass c = new ServerClass();
System.out.println(c.div(11,9));
}
}
Outline
ClientClass
main(String[]) : void
Problems Javadoc Declaration Console
<terminated> ClientClass [Java Application] C:\Users\lab314-2\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\java
1.0


eclipse-workspace - Middleware/src/ServerClass.java - Eclipse IDE
File Edit Source Refactor Navigate Search Project Run Window Help
Project Explorer
CalculatorProject
CalculatorProject1
CalculatorProject1Client
CalculatorProject1EAR
CalculatorProjectClient
CalculatorProjectEAR
Middleware
JRE System Library [JavaSE-17]
src
(default package)
ClientClass.java
InterfaceClass.java
ServerClass.java
Servers
JSR-109 Web Services
ClientClass.java
InterfaceClass.java
ServerClass.java
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
public class ServerClass implements InterfaceClass {
//public static void main(String[] args) {
// TODO Auto-generated method stub
//}
public int add(int a,int b) {
return a+b;
}
public int sub(int a, int b) {
return a - b;
}
public int mul(int a, int b) {
return a * b;
}
public float div(int a, int b) {
return a / b;
}
}
Outline
ServerClass
add(int, int) : int
sub(int, int) : int
mul(int, int) : int
div(int, int) : float
Markers Properties Servers Data Source Explorer Snippets Terminal Console
<terminated> ClientClass [Java Application] C:\Users\lab314-2\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\java
20
Writable
Smart Insert
4 : 7 : 6


eclipse-workspace - Middleware/src/InterfaceClass.java - Eclipse IDE
File Edit Source Refactor Navigate Search Project Run Window Help
Project Explorer
CalculatorProject
CalculatorProject1
CalculatorProject1Client
CalculatorProject1EAR
CalculatorProjectClient
CalculatorProjectEAR
Middleware
JRE System Library [JavaSE-17]
src
(default package)
ClientClass.java
InterfaceClass.java
ServerClass.java
Servers
JSR-109 Web Services
ClientClass.java
InterfaceClass.java
ServerClass.java
1 public interface InterfaceClass{
2
3 public int add(int a,int b);
4 public int sub(int a,int b);
5 public int mul(int a,int b);
6 public float div(int a,int b);
7 }
8
Outline
InterfaceClass
add(int, int) : int
sub(int, int) : int
mul(int, int) : int
div(int, int) : float
Markers Properties Servers Data Source Explorer Snippets Terminal Console
<terminated> ClientClass [Java Application] C:\Users\lab314-2\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\java
20


eclipse-workspace - Middleware/src/ClientClass.java - Eclipse IDE
File Edit Source Refactor Navigate Search Project Run Window Help
Project Explorer
CalculatorProject
CalculatorProject1
CalculatorProject1Client
CalculatorProject1EAR
CalculatorProjectClient
CalculatorProjectEAR
Middleware
JRE System Library [JavaSE-17]
src
(default package)
ClientClass.java
InterfaceClass.java
ServerClass.java
Servers
JSR-109 Web Services
ClientClass.java
InterfaceClass.java
ServerClass.java
1 public class ClientClass {
2
3 public static void main(String[] args) {
4 // TODO Auto-generated method stub
5 InterfaceClass c = new ServerClass();
6 System.out.println(c.add(11,9));
7 }
8
9
10 }
11
Outline
ClientClass
main(String[]) : void
Markers Properties Servers Data Source Explorer Snippets Terminal Console
<terminated> ClientClass [Java Application] C:\Users\lab314-2\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.3.v20220515-1416\jre\bin\java
20

Result and Discussion:

Learning Outcomes: Students should have be able to

LO1: Define Middleware.

LO2: Identify different connectors in middleware.

LO3: Explain middleware implements in connectors.

Course Outcomes: Upon completion of the course students will be able to understand middleware and its connectors.

Conclusion:

Viva Questions:

1. Define Middleware.
2. Explain use of middleware.
3. Explain implementation of connectors.

For Faculty Use

Correction Parameters	Formative Assessment [40%]	Timely completion of Practical [40%]	Attendance / Learning Attitude [20%]	