

## Program 3: Mobile-Agent Execution Platform

### Documentation:

#### Agent.java

A user derives an application-specific mobile agent from the Mobile.Agent base class that is instantiated as an independent thread at run time.

#### run()

This method is the body of Mobile.Agent class that is executed upon an injection or a migration as an independent thread. The run () method identifies the function and arguments given in hop(), and invokes it. This method checks if the arguments are null or not, depending on this gets the method and invokes it. The invoked function includes hop() to further transfer the calling agent to a remote host or simply return back to run() that terminates the agent.

#### hop(String hostname, String function, String[] args)

This method transfers this agent to a given host, and invokes a given function of this agent as passing given arguments to it. It sets the function, hostname and arguments to the agent's variables and loads bytecode, classname to the agentLoader. It then serializes the bytecode and transfers these parameters to place by using object of place interface.

#### Place.java :

Place behaves as an RMI server to receive incoming agents and to execute them as independent threads.

#### transfer(String classname, byte[] bytecode, byte[] entity)

This method is called from Agent.hop() remotely. The transfer() method receives this calling agent, deserializes it, sets this agent's identifier if it has not yet been set by adding sequencer to the hostAddress, instantiates a Thread object as passing this agent to its constructor, and invokes this thread's start() method. In the end, transfer() should return true if it is a success, otherwise false.

#### main( String args[] )

This is the main method that starts an RMI registry in local, instantiates a Mobile.Place class object, which is an agent execution platform, and registers into the registry. The main() sets the port and checks the validity (i.e. 5001-65535) to launch its local RMI Registry.

**TestAgent.java :** The class TestAgent.java similar to MyAgent will perform the execution of Mobile agents, will be executed on four different places i.e. it includes 3 methods with an init() function. It will print the messages at the places it hops. It also tests the additional feature implemented in this program which will be discussed in the below sections.

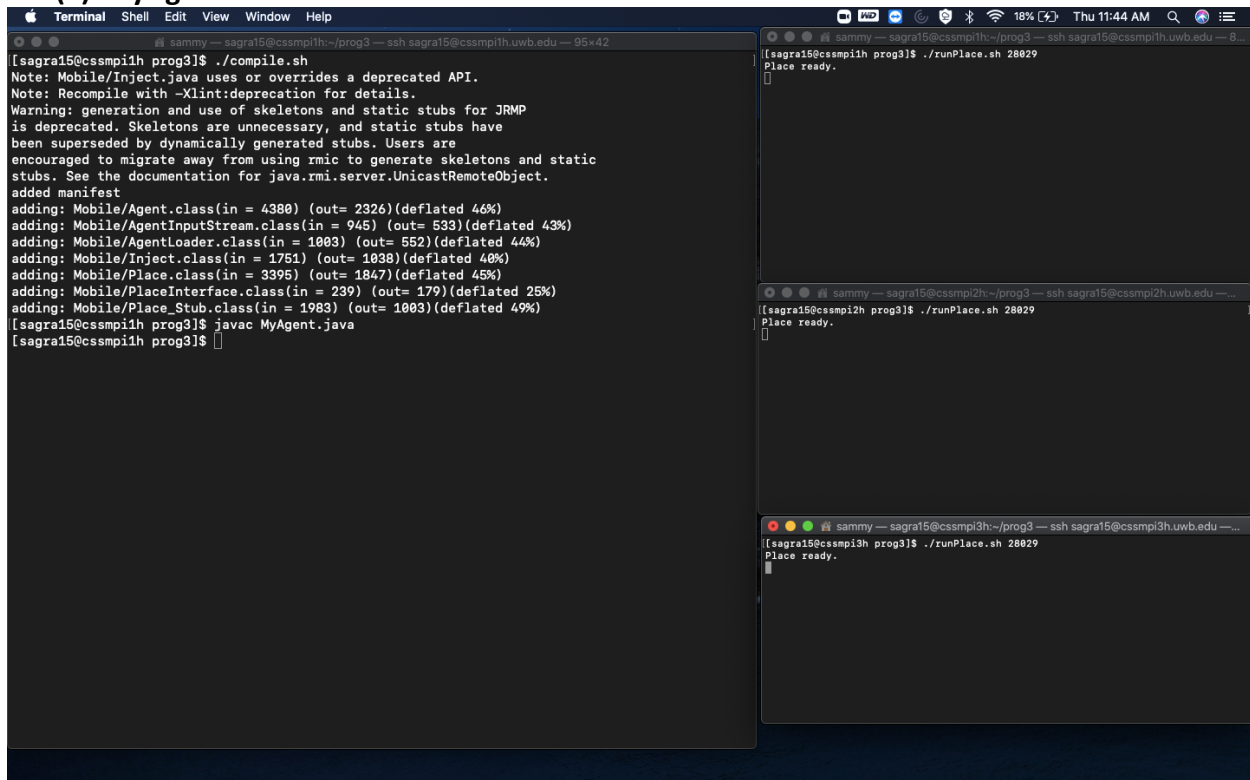
## Source code:

Zip folder contains source code for:

1. Prog3
2. Lab6
3. Lab7

## Execution output:

### (1) MyAgent.class execution with three different Places



The image displays three terminal windows from a macOS environment, showing the process of compiling and running a Java application named MyAgent.

**Terminal 1 (Left):** Shows the compilation of MyAgent.java. The command `./compile.sh` is executed, which runs `javac MyAgent.java`. The output includes several warnings about deprecated APIs and skeletons, and a list of class files being added to the manifest, such as `Mobile/Agent.class`, `Mobile/AgentInputStream.class`, `Mobile/AgentLoader.class`, `Mobile/Inject.class`, `Mobile/Place.class`, `Mobile/PlaceInterface.class`, and `Mobile/Place_Stub.class`.

**Terminal 2 (Top Right):** Shows the execution of the compiled class. The command `./runPlace.sh 28029` is executed, resulting in the output `Place ready.`

**Terminal 3 (Bottom Right):** Shows the execution of the compiled class. The command `./runPlace.sh 28029` is executed, resulting in the output `Place ready.`

```
Terminal Shell Edit View Window Help
sammy — sagra15@cssmpi1h:~/prog3 — ssh sagra15@cssmpi1h.uwb.edu — 95x42
[sagra15@cssmpi1h prog3]$ ./compile.sh
Note: Mobile/Inject.java uses or overrides a deprecated API.
Note: Recompile with -Xlint:deprecation for details.
Warning: generation and use of skeletons and static stubs for JRMP
is deprecated. Skeletons are unnecessary, and static stubs have
been superseded by dynamically generated stubs. Users are
encouraged to migrate away from using rmic to generate skeletons and static
stubs. See the documentation for java.rmi.server.UnicastRemoteObject.
added manifest
adding: Mobile/Agent.class(in = 3867) (out= 2057)(deflated 46%)
adding: Mobile/AgentInputStream.class(in = 945) (out= 533)(deflated 43%)
adding: Mobile/AgentLoader.class(in = 1003) (out= 552)(deflated 44%)
adding: Mobile/Inject.class(in = 1751) (out= 1038)(deflated 40%)
adding: Mobile/Place.class(in = 3242) (out= 1767)(deflated 45%)
adding: Mobile/PlaceInterface.class(in = 239) (out= 179)(deflated 25%)
adding: Mobile/Place_Stub.class(in = 1983) (out= 1003)(deflated 49%)
[sagra15@cssmpi1h prog3]$ java -cp Mobile.jar Mobile.Inject localhost 28029 MyAgent cssmpi2h cs
smi3h
[sagra15@cssmpi1h prog3]$
```

```
Terminal Shell Edit View Window Help
sammy — sagra15@cssmpi1h:~/prog3 — ssh sagra15@cssmpi1h.uwb.edu — 8...
[sagra15@cssmpi1h prog3]$ ./runPlace.sh 28029
Place ready.
agent( 2611) invoked init: hop count = 0, next dest = cssmpi2h
[]

Terminal Shell Edit View Window Help
sammy — sagra15@cssmpi2h:~/prog3 — ssh sagra15@cssmpi2h.uwb.edu — ...
[sagra15@cssmpi2h prog3]$ ./runPlace.sh 28029
Place ready.
agent( 2611) invoked step: hop count = 1, next dest = cssmpi3h, message = Hello!
[]

Terminal Shell Edit View Window Help
sammy — sagra15@cssmpi3h:~/prog3 — ssh sagra15@cssmpi3h.uwb.edu — ...
[sagra15@cssmpi3h prog3]$ ./runPlace.sh 28029
Place ready.
agent( 2611) invoked jump: hop count = 2, message = Oi!
```

## (2) TestAgent.class execution with four different Places

```
Terminal Shell Edit View Window Help
sammy — sagra15@cssmpi1h:~/prog3 — ssh sagra15@cssmpi1h.uwb.edu — 122x37
[sagra15@cssmpi1h prog3]$ ./compile.sh
Note: Mobile/Inject.java uses or overrides a deprecated API.
Note: Recompile with -Xlint:deprecation for details.
Warning: generation and use of skeletons and static stubs for JRMP
is deprecated. Skeletons are unnecessary, and static stubs have
been superseded by dynamically generated stubs. Users are
encouraged to migrate away from using rmic to generate skeletons and static
stubs. See the documentation for java.rmi.server.UnicastRemoteObject.
added manifest
adding: Mobile/Agent.class(in = 4147) (out= 2179)(deflated 47%)
adding: Mobile/AgentInputStream.class(in = 945) (out= 533)(deflated 43%)
adding: Mobile/AgentLoader.class(in = 1003) (out= 552)(deflated 44%)
adding: Mobile/Inject.class(in = 1751) (out= 1038)(deflated 40%)
adding: Mobile/Place.class(in = 5143) (out= 2657)(deflated 48%)
adding: Mobile/PlaceInterface.class(in = 239) (out= 179)(deflated 25%)
adding: Mobile/Place_Stub.class(in = 1983) (out= 1003)(deflated 49%)
[sagra15@cssmpi1h prog3]$ javac TestAgent.java
[sagra15@cssmpi1h prog3]$ java -cp Mobile.jar Mobile.Inject localhost 28029 TestAgent cssmpi2h cssmpi3h cssmpi4h
[sagra15@cssmpi1h prog3]$
```

```
Terminal Shell Edit View Window Help
sammy — sagra15@cssmpi1h:~/prog3 — ssh sagra15@cssmpi1h.uwb.edu — 8...
[sagra15@cssmpi1h prog3]$ ./runPlace.sh 28029
Place ready.
agent( 2611) invoked init: hop count = 0, next dest = cssmpi2h
[]

Terminal Shell Edit View Window Help
sammy — sagra15@cssmpi2h:~/prog3 — ssh sagra15@cssmpi2h.uwb.edu — 85...
[sagra15@cssmpi2h prog3]$ ./runPlace.sh 28029
Place ready.
agent( 2611) invoked step: hop count = 1, next dest = cssmpi3h, message = Hello!
[]

Terminal Shell Edit View Window Help
sammy — sagra15@cssmpi3h:~/prog3 — ssh sagra15@cssmpi3h.uwb.edu — ...
[sagra15@cssmpi3h prog3]$ ./runPlace.sh 28029
Place ready.
agent( 2611) invoked move: hop count = 2, next dest = cssmpi4h, message = Oi!
```

```
Terminal Shell Edit View Window Help
sammy — sagra15@cssmpi4h:~/prog3 — ssh sagra15@cssmpi4h.uwb.edu — ...
[sagra15@cssmpi4h prog3]$ ./runPlace.sh 28029
Place ready.
agent( 2611) invoked jump: hop count = 3, message = Hola!
```

### (3) TestAgent.class to demonstrate your own additional agent/place feature

1. Run MyAgent at cssmpi1h : java -cp Mobile.jar Mobile.Inject localhost 28029 MyAgent cssmpi3h cssmpi5h  
cssmpi3h cssmpi5h

```
Terminal Shell Edit View Window Help

[sagra15@cssmpi1h prog3]$ java -cp Mobile.jar Mobile.Inject localhost 28029 MyAgent cssmpi3h cssmpi5h
[sagra15@cssmpi1h prog3]$

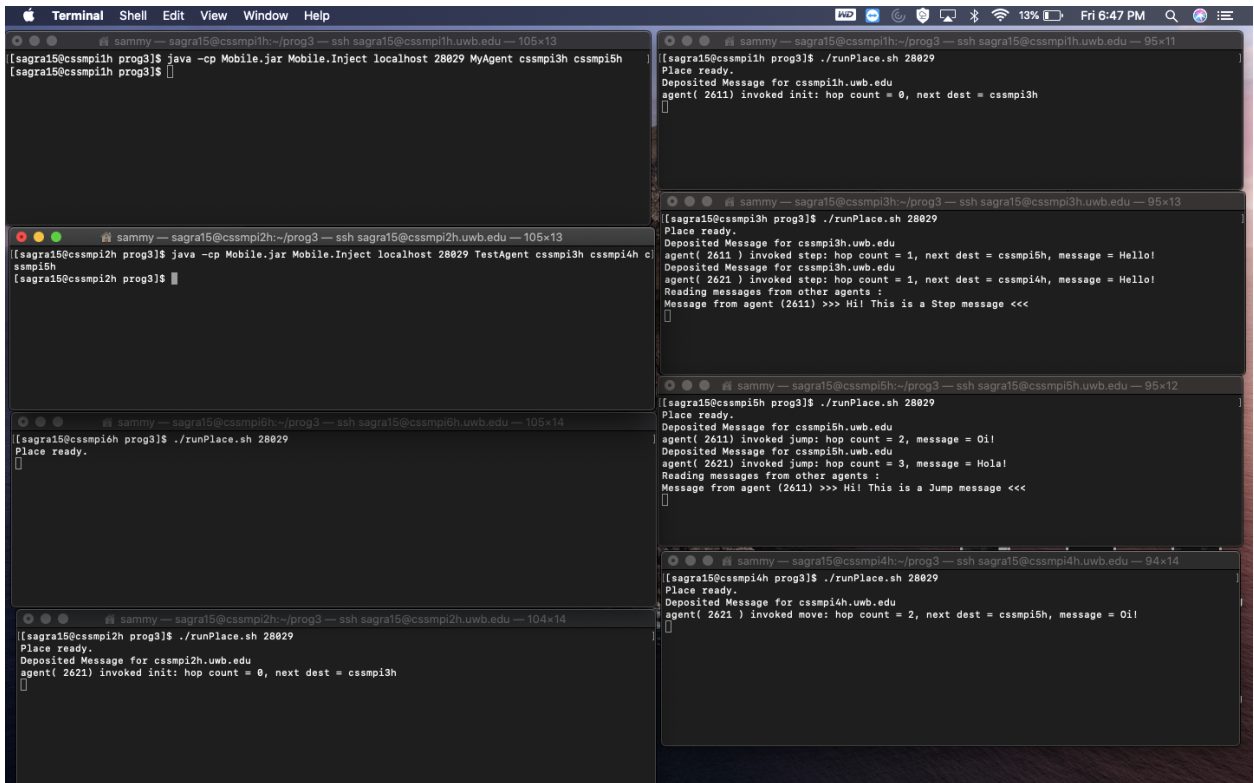
[sagra15@cssmpi3h prog3]$ ./runPlace.sh 28029
Place ready.
Deposited Message for cssmpi3h.uwb.edu
agent( 2611 ) invoked init: hop count = 0, next dest = cssmpi3h

[sagra15@cssmpi5h prog3]$ ./runPlace.sh 28029
Place ready.
Deposited Message for cssmpi5h.uwb.edu
agent( 2611 ) invoked step: hop count = 1, next dest = cssmpi5h, message = Hello!

[sagra15@cssmpi6h prog3]$ ./runPlace.sh 28029
Place ready.
Deposited Message for cssmpi6h.uwb.edu
agent( 2611 ) invoked jump: hop count = 2, message = Oi!

[sagra15@cssmpi4h prog3]$ ./runPlace.sh 28029
Place ready.
```

2. Run TestAgent at cssmpi2h : java -cp Mobile.jar Mobile.Inject localhost 28029 TestAgent cssmpi3h cssmpi5h  
TestAgent cssmpi3h cssmpi4h cssmpi5h



```
sammy — sagrat5@cssmpi1h:~/prog3 — ssh sagrat5@cssmpi1h.uwb.edu — 105x13
[sagrat5@cssmpi1h prog3]$ java -cp Mobile.jar Mobile.Inject localhost 28029 MyAgent cssmpi3h cssmpi5h
[sagrat5@cssmpi1h prog3]$

sagrat5@cssmpi2h prog3$ java -cp Mobile.jar Mobile.Inject localhost 28029 TestAgent cssmpi3h cssmpi4h
cssmpi5h
[sagrat5@cssmpi2h prog3]$

sagrat5@cssmpi6h prog3$ ./runPlace.sh 28029
Place ready.

sagrat5@cssmpi2h prog3$ ./runPlace.sh 28029
Place ready.
Deposited Message for cssmpi2h.uwb.edu
agent( 2621 ) invoked init: hop count = 0, next dest = cssmpi3h

sagrat5@cssmpi3h prog3$ ./runPlace.sh 28029
Place ready.
Deposited Message for cssmpi3h.uwb.edu
agent( 2611 ) invoked init: hop count = 0, next dest = cssmpi3h

sagrat5@cssmpi3h prog3$ ./runPlace.sh 28029
Place ready.
Deposited Message for cssmpi3h.uwb.edu
agent( 2611 ) invoked step: hop count = 1, next dest = cssmpi5h, message = Hello!
Deposited Message for cssmpi3h.uwb.edu
agent( 2621 ) invoked step: hop count = 1, next dest = cssmpi4h, message = Hello!
Reading messages from other agents :
Message from agent (2611) >>> Hi! This is a Step message <<<

sagrat5@cssmpi5h prog3$ ./runPlace.sh 28029
Place ready.
Deposited Message for cssmpi5h.uwb.edu
agent( 2611 ) invoked jump: hop count = 2, message = Oi!
Deposited Message for cssmpi5h.uwb.edu
agent( 2621 ) invoked jump: hop count = 3, message = Hola!
Reading messages from other agents :
Message from agent (2611) >>> Hi! This is a Jump message <<<

sagrat5@cssmpi4h prog3$ ./runPlace.sh 28029
Place ready.
Deposited Message for cssmpi4h.uwb.edu
agent( 2621 ) invoked move: hop count = 2, next dest = cssmpi5h, message = Oi!
```

3. Run TestAgent at cssmpi2h : `java -cp Mobile.jar Mobile.Inject localhost 28029 TestAgent cssmpi3h cssmpi4h cssmpi6h`

## Discussions:

### Additional features

I have added the second feature on the recommended list that is (b)Indirect inter-agent communication via Place. I have added these new changes in each:

1. **Place:** In this, I have added the static variables “placeMessageTracker” which tracks the agents messages at a respective place using agentKey and hostname and “msgList” which stores the messages of agents to pass to next agents. In transfer() method, I am calling these two functions to read and write the agent messages.  
**getMessagesFromPreviousAgents** (String key, String hostName) : This gets the messages from previous agents using its key and hostname and return the list of strings.  
**depositMyMessage** (String messageKey, String msg, String hostname) : deposits the agent message in the hashmap "placeMessageTracker" with the agentKey, message and hostname in local to this Place.
2. **Agent:** I have added new variables in this file “messageToNextAgents” for passing a message to next agents and “keyToReadMessage” for accessing to read the message. The method “setAgentMessageList” sets the list passed from place.

3. **MyAgent/TestAgent:** I am accessing the parent variables “messageToNextAgents” and “keyToReadMessage” in this file and setting these variables. In each method(i.e. place) , I am reading the messages of previous agents who deposited the message.

Example as shown in above screenshots mean as follows:

1. 1h machine will deposit its agent messages at 3h and 5h
2. 2h machine will deposit its agent messages at 3h,4h,5h and read the messages from previous agent at 3h and 5h
3. 2h machine will deposit its agent messages at 3h,4h,6h and read the messages of previous agents at 3h and 4h.

So, here we agents can indirectly communicate(i.e. read and write messages to other agents) via place. Below is an snippet from a place.

```
[sagra15@cssmpi3h prog3]$ ./runPlace.sh 28029
Place ready.
Deposited Message for cssmpi3h.uwb.edu
agent( 2611 ) invoked step: hop count = 1, next dest = cssmpi5h,
message = Hello!
Deposited Message for cssmpi3h.uwb.edu
agent( 2621 ) invoked step: hop count = 1, next dest = cssmpi4h,
message = Hello!
Reading messages from other agents :
Message from agent (2611) >>> Hi! This is a Step message <<<
Deposited Message for cssmpi3h.uwb.edu
agent( 2622 ) invoked step: hop count = 1, next dest = cssmpi4h,
message = Hello!
Reading messages from other agents :
Message from agent (2611) >>> Hi! This is a Step message <<<
Message from agent (2621) >>> Hi! This is a Step message <<<
```

#### Limitations

1. In the current program, if the agent gets crashed in between and could not hop to the next place, we have to restart the place to make it work.
2. Using java reflection enables code to conduct operations that would be illegal in non-reflective code, such as accessing private fields and methods, it can have unintended consequences, rendering code inefficient and destroying portability.
3. As this is week migration, the agents cannot communicate to its previous agents.

#### Possible Improvements

1. Better usage of data structure may decrease the execution time.
2. We can improve the communication between the agents by adding direct communication between using UDP multicast and can also include authentication of agents using a security key.

## Lab Session 6:

### Output:

```

● ● ● ● sammy — sagra15@cssmpi1h:~/lab6 — ssh sagra15@cssmpi1h.uwb.edu — 80...
Last login: Fri May 14 15:30:54 on ttys002

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
[Samridhis-MacBook-Air:~ sammy$ ssh sagra15@cssmpi1h.uwb.edu
sagra15@cssmpi1h.uwb.edu's password:
Last login: Thu May 13 13:16:52 2021 from 10.102.32.43
[sagra15@cssmpi1h ~]$ cd lab6
[sagra15@cssmpi1h lab6]$ ll
total 52
-rw-r--r-- 1 sagra15 sagra15 2366 May  4 09:31 Client.class
-rw-rw-r-- 1 sagra15 sagra15 1362 May  4 09:31 ClientImplementation.class
-rw-r--r-- 1 sagra15 sagra15 723 May  4 09:22 ClientImplementation.java
-rw-r--r-- 1 sagra15 sagra15 306 May  4 09:31 ClientInterface.class
-rw-r--r-- 1 sagra15 sagra15 214 May  4 09:13 ClientInterface.java
-rw-r--r-- 1 sagra15 sagra15 1531 May  4 09:26 Client.java
-rw-r--r-- 1 sagra15 sagra15 1403 May  4 09:13 Client.java~
-rw-r--r-- 1 sagra15 sagra15 1786 May  4 09:31 Server.class
-rw-rw-r-- 1 sagra15 sagra15 2227 May  4 09:31 ServerImplementation.class
-rw-r--r-- 1 sagra15 sagra15 1566 May  4 09:31 ServerImplementation.java
-rw-r--r-- 1 sagra15 sagra15 389 May  4 09:31 ServerInterface.class
-rw-r--r-- 1 sagra15 sagra15 376 May  4 09:15 ServerInterface.java
-rw-r--r-- 1 sagra15 sagra15 1120 May  4 09:13 Server.java
[sagra15@cssmpi1h lab6]$ java Server 28000
Server Ready.
^[[ARegistered: Proxy[ClientInterface,RemoteObjectInvocationHandler[UnicastRef [
liveRef: [endpoint:[10.158.82.62:34922](remote),objID:[-2c6eca9e:17971c08c09:-7ffe,
-5318864578915005920]]]]]
Callbacks.....
Call back received at cssmpi2h.uwb.edu
Registered: Proxy[ClientInterface,RemoteObjectInvocationHandler[UnicastRef [live
Ref: [endpoint:[10.158.82.63:37742](remote),objID:[-496b5a0b:17971c0e118:-7ffe,
-4749858894302421173]]]]]
Callbacks.....
Call back received at cssmpi2h.uwb.edu
Call back received at cssmpi3h.uwb.edu
Registered: Proxy[ClientInterface,RemoteObjectInvocationHandler[UnicastRef [live
Ref: [endpoint:[10.158.82.64:43417](remote),objID:[-7e59d181:17971c0f370:-7ffe,
6541789891015327426]]]]]
Callbacks.....
Call back received at cssmpi2h.uwb.edu
Call back received at cssmpi3h.uwb.edu
Call back received at cssmpi4h.uwb.edu
[]

● ● ● ● sammy — sagra15@cssmpi2h:~/lab6 — ssh sagra15@cssmpi2h.uwb.edu — 8...
The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
[Samridhis-MacBook-Air:~ sammy$ ssh sagra15@cssmpi2h.uwb.edu
sagra15@cssmpi2h.uwb.edu's password:
Last login: Tue May  4 12:25:36 2021 from 10.102.3.56
[sagra15@cssmpi2h ~]$ cd lab6
[sagra15@cssmpi2h lab6]$ java Client 28000
usage: java Client serverIp port
[sagra15@cssmpi2h lab6]$ java Client cssmpi1h 28000
connected to server: hello
Number of registered clients=1
Number of registered clients=2
Number of registered clients=3
[Hola!!
cssmpi2h.uwb.edu: Hola!!
cssmpi3h.uwb.edu: Good Evening!
cssmpi4h.uwb.edu: Good bye!
[]

● ● ● ● sammy — sagra15@cssmpi3h:~/lab6 — ssh sagra15@cssmpi3h.uwb.edu — 8...
Last login: Sat May 15 13:28:55 on ttys004

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
[Samridhis-MacBook-Air:~ sammy$ ssh sagra15@cssmpi3h.uwb.edu
sagra15@cssmpi3h.uwb.edu's password:
Last login: Tue May  4 09:34:53 2021 from 10.102.3.56
[sagra15@cssmpi3h ~]$ cd lab6
[sagra15@cssmpi3h lab6]$ java Client cssmpi1h 28000
connected to server: hello
Number of registered clients=2
Number of registered clients=3
cssmpi2h.uwb.edu: Hola!!
[Good Evening!
cssmpi3h.uwb.edu: Good Evening!
cssmpi4h.uwb.edu: Good bye!
[]

● ● ● ● sammy — sagra15@cssmpi4h:~/lab6 — ssh sagra15@cssmpi4h.uwb.edu — 8...
Last login: Sat May 15 13:29:03 on ttys005

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
[Samridhis-MacBook-Air:~ sammy$ ssh sagra15@cssmpi4h.uwb.edu
sagra15@cssmpi4h.uwb.edu's password:
Last login: Tue May  4 09:35:14 2021 from 10.102.3.56
[sagra15@cssmpi4h ~]$ cd lab6
[sagra15@cssmpi4h lab6]$ java Client cssmpi1h 28000
connected to server: hello
Number of registered clients=3
cssmpi2h.uwb.edu: Hola!!
cssmpi3h.uwb.edu: Good Evening!
[Good bye!
cssmpi4h.uwb.edu: Good bye!
[]
```



```
● ● ● ● sammy — sagra15@cssmpi1h:~/lab6 — ssh sagra15@cssmpi1h.uwb.edu — 80...
Last login: Fri May 14 15:30:54 on ttys002

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
Samridhis-MacBook-Air:~ sammy$ ssh sagra15@cssmpi1h.uwb.edu
sagra15@cssmpi1h.uwb.edu's password:
Last login: Thu May 13 13:16:52 2021 from 10.102.32.43
[sagra15@cssmpi1h ~]$ cd lab6
[sagra15@cssmpi1h lab6]$ ll
total 52
-rw-r--r-- 1 sagra15 sagra15 2366 May  4 09:31 Client.class
-rw-rw-r-- 1 sagra15 sagra15 1362 May  4 09:31 ClientImplementation.class
-rw-r--r-- 1 sagra15 sagra15 723 May  4 09:22 ClientImplementation.java
-rw-r--r-- 1 sagra15 sagra15 306 May  4 09:31 ClientInterface.class
-rw-r--r-- 1 sagra15 sagra15 214 May  4 09:13 ClientInterface.java
-rw-r--r-- 1 sagra15 sagra15 1531 May  4 09:26 Client.java
-rw-r--r-- 1 sagra15 sagra15 1403 May  4 09:13 Client.java~
-rw-r--r-- 1 sagra15 sagra15 1786 May  4 09:31 Server.class
-rw-rw-r-- 1 sagra15 sagra15 2227 May  4 09:31 ServerImplementation.class
-rw-r--r-- 1 sagra15 sagra15 1566 May  4 09:31 ServerImplementation.java
-rw-r--r-- 1 sagra15 sagra15 389 May  4 09:31 ServerInterface.class
-rw-r--r-- 1 sagra15 sagra15 376 May  4 09:15 ServerInterface.java
-rw-r--r-- 1 sagra15 sagra15 1120 May  4 09:13 Server.java
[sagra15@cssmpi1h lab6]$ java Server 28000
Server ready.
^[[ARegistered: Proxy[ClientInterface,RemoteObjectInvocationHandler[UnicastRef [liveRef: [endpoint:[10.158.82.62:34922]](remote),objID:[-2c6eca9e:17971c08c09:-7ffe,-5318864578915905920]]]]]]
Callbacks.....
Call back received at cssmpi2h.uwb.edu
Registered: Proxy[ClientInterface,RemoteObjectInvocationHandler[UnicastRef [liveRef: [endpoint:[10.158.82.63:37742]](remote),objID:[-496b5a0b:17971c0e118:-7ffe,-4749858894302421173]]]]]]
Callbacks.....
Call back received at cssmpi2h.uwb.edu
Call back received at cssmpi3h.uwb.edu
Registered: Proxy[ClientInterface,RemoteObjectInvocationHandler[UnicastRef [liveRef: [endpoint:[10.158.82.64:43417]](remote),objID:[-7e59d181:17971c0f370:-7ffe,6641789891015327426]]]]]]
Callbacks.....
Call back received at cssmpi2h.uwb.edu
Call back received at cssmpi3h.uwb.edu
Call back received at cssmpi4h.uwb.edu
^C[sagra15@cssmpi1h lab6]$
```

```
● ● ● ● sammy — sagra15@cssmpi2h:~/lab6 — ssh sagra15@cssmpi2h.uwb.edu — 8...
The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
Samridhis-MacBook-Air:~ sammy$ ssh sagra15@cssmpi2h.uwb.edu
sagra15@cssmpi2h.uwb.edu's password:
Last login: Tue May  4 12:25:36 2021 from 10.102.3.56
[sagra15@cssmpi2h ~]$ cd lab6
[sagra15@cssmpi2h lab6]$ java Client 28000
usage: java Client serverIp port
[sagra15@cssmpi2h lab6]$ java Client cssmpi1h 28000
connected to server: hello
Number of registered clients=1
Number of registered clients=2
Number of registered clients=3
HOLA!!
cssmpi2h.uwb.edu: HOLA!!
cssmpi3h.uwb.edu: Good Evening!
cssmpi4h.uwb.edu: Good bye!
^C[sagra15@cssmpi2h lab6]$
```

```
● ● ● ● sammy — sagra15@cssmpi3h:~/lab6 — ssh sagra15@cssmpi3h.uwb.edu — 8...
Last login: Sat May 15 13:28:56 on ttys004

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
Samridhis-MacBook-Air:~ sammy$ ssh sagra15@cssmpi3h.uwb.edu
sagra15@cssmpi3h.uwb.edu's password:
Last login: Tue May  4 09:34:53 2021 from 10.102.3.56
[sagra15@cssmpi3h ~]$ cd lab6
[sagra15@cssmpi3h lab6]$ java Client cssmpi1h 28000
connected to server: hello
Number of registered clients=2
Number of registered clients=3
cssmpi2h.uwb.edu: HOLA!!
Good Evening!
cssmpi3h.uwb.edu: Good Evening!
cssmpi4h.uwb.edu: Good bye!
^C[sagra15@cssmpi3h lab6]$
```

```
● ● ● ● sammy — sagra15@cssmpi4h:~/lab6 — ssh sagra15@cssmpi4h.uwb.edu — 8...
Last login: Sat May 15 13:29:03 on ttys005

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
Samridhis-MacBook-Air:~ sammy$ ssh sagra15@cssmpi4h.uwb.edu
sagra15@cssmpi4h.uwb.edu's password:
Last login: Tue May  4 09:35:14 2021 from 10.102.3.56
[sagra15@cssmpi4h ~]$ cd lab6
[sagra15@cssmpi4h lab6]$ java Client cssmpi1h 28000
connected to server: hello
Number of registered clients=3
cssmpi2h.uwb.edu: HOLA!!
cssmpi3h.uwb.edu: Good Evening!
Good bye!
cssmpi4h.uwb.edu: Good bye!
^C[sagra15@cssmpi4h lab6]$
```

## Lab Session 7:

### Output:

```

● ● ● # sammy — sagra15@cssmpi1h:~/lab7 — ssh sagra15@cssmpi1h.uwb.edu — 80...
AnAgent.java  css533_prog2  lab2  lab5  lab9  prog2  setup_mpi_cluster.sh
css533_lab4   examples  lab3  lab6  old  prog3  Storm
css533_lab5   lab1      lab4  lab8  prog1 prog3_key
[sagra15@cssmpi1h ~]$ rm AnAgent.java
[sagra15@cssmpi1h ~]$ ls
css533_lab4  examples  lab3  lab6  old  prog3  Storm
css533_lab5  lab1      lab4  lab8  prog1 prog3_key
css533_prog2 lab2      lab5  lab9  prog2  setup_mpi_cluster.sh
[sagra15@cssmpi1h ~]$ mkdir lab7
[sagra15@cssmpi1h ~]$ ls
css533_lab4  examples  lab3  lab6  lab9  prog2  setup_mpi_cluster.sh
css533_lab5  lab1      lab4  lab7  old  prog3  Storm
css533_prog2 lab2      lab5  lab8  prog1 prog3_key
[sagra15@cssmpi1h ~]$ cd lab7
[sagra15@cssmpi1h lab7]$ ls
[sagra15@cssmpi1h lab7]$ cp -css533/programming/lab7/* .
cp: cannot open '/home/NETID/css533/programming/lab7/MyAgent.class' for reading:
Permission denied
cp: cannot open '/home/NETID/css533/programming/lab7/MyAgent.java' for reading:
Permission denied
[sagra15@cssmpi1h lab7]$ ls
AnAgent.class AnAgent.java  compile.sh  Mobile.jar  runAgent.sh  runPlace.sh
[sagra15@cssmpi1h lab7]$ cat runPlace.sh
#!/bin/sh

# $1: Your IP port

java -cp Mobile.jar Mobile.Place $1
[sagra15@cssmpi1h lab7]$ cat compile.sh
#!/bin/sh

javac -cp Mobile.jar:. *.java[sagra15@cssmpi1h lab7]$ ./compile.sh AnAgent
[sagra15@cssmpi1h lab7]$ ls
AnAgent.class AnAgent.java  compile.sh  Mobile.jar  runAgent.sh  runPlace.sh
[sagra15@cssmpi1h lab7]$ ./runAgent.sh cssmpi1h 28029 AnAgent cssmpi2h
Injected
[sagra15@cssmpi1h lab7]$

● ● ● # sammy — sagra15@cssmpi4h:~/lab7 — ssh sagra15@cssmpi4h.uwb.edu — 80...
sagra15@cssmpi4h ~]$ cd lab7
sagra15@cssmpi4h lab7]$ ./runPlace.sh 28029
Place ready.

● ● ● # sammy — sagra15@cssmpi1h:~/lab7 — ssh sagra15@cssmpi1h.uwb.edu — 80...
at Mobile.Place.main(Place.java:100)
Caused by: java.net.BindException: Address already in use (Bind failed)
at java.base/java.net.PlainSocketImpl.socketBind(Native Method)
at java.base/java.net.AbstractPlainSocketImpl.bind(AbstractPlainSocketIm
pl.java:436)
at java.base/java.net.ServerSocket.bind(ServerSocket.java:395)
at java.base/java.net.ServerSocket.<init>(ServerSocket.java:257)
at java.base/java.net.ServerSocket.<init>(ServerSocket.java:149)
at java.rmi/sun.rmi.transport.tcp.TCPDirectSocketFactory.createServerSoc
ket(TCPDirectSocketFactory.java:45)
at java.rmi/sun.rmi.transport.tcp.TCPEndpoint.newServerSocket(TCPEndpoi
nt.java:670)
at java.rmi/sun.rmi.transport.tcp.TCPTransport.listen(TCPTransport.java:
324)
... 9 more
[sagra15@cssmpi1h lab7]$ ./runPlace.sh 28029
Place ready.
I'll hop to cssmpi2h

● ● ● # sammy — sagra15@cssmpi2h:~/lab7 — ssh sagra15@cssmpi2h.uwb.edu — 80...
[sagra15@cssmpi2h ~]$ cd lab7
[sagra15@cssmpi2h lab7]$ ./runPlace.sh 28029
Place ready.
hello

● ● ● # sammy — sagra15@cssmpi3h:~/lab7 — ssh sagra15@cssmpi3h.uwb.edu — 80...
[sagra15@cssmpi3h ~]$ cd lab7
[sagra15@cssmpi3h lab7]$ ./runPlace.sh 28029
Place ready.
```

```
sammy — sagra15@cssmpi1h:~/lab7 — ssh sagra15@cssmpi1h.uwb.edu — 81x37
[sagra15@cssmpi1h ~]$ cd lab7
[sagra15@cssmpi1h lab7]$ ls
[sagra15@cssmpi1h lab7]$ cp -css533/programming/lab7/* .
cp: cannot open '/home/NETID/css533/programming/lab7/MyAgent.class' for reading: Permission denied
cp: cannot open '/home/NETID/css533/programming/lab7/MyAgent.java' for reading: Permission denied
[sagra15@cssmpi1h lab7]$ ls
AnAgent.class  AnAgent.java  compile.sh  Mobile.jar  runAgent.sh  runPlace.sh
[sagra15@cssmpi1h lab7]$ cat runPlace.sh
#!/bin/sh

# $1: Your IP port

java -cp Mobile.jar Mobile.Place $1
[sagra15@cssmpi1h lab7]$ cat compile.sh
#!/bin/sh

javac -cp Mobile.jar:*.java[sagra15@cssmpi1h lab7]$ ./compile.sh AnAgent
[sagra15@cssmpi1h lab7]$ ls
AnAgent.class  AnAgent.java  compile.sh  Mobile.jar  runAgent.sh  runPlace.sh
[sagra15@cssmpi1h lab7]$ ./runAgent.sh cssmpi1h 28029 AnAgent cssmpi2h
Injected
[sagra15@cssmpi1h lab7]$ ls
AnAgent.class  AnAgent.java  compile.sh  Mobile.jar  runAgent.sh  runPlace.sh
[sagra15@cssmpi1h lab7]$ cp AnAgent.java MyAgent.java
[sagra15@cssmpi1h lab7]$ ls
AnAgent.class  compile.sh  MyAgent.java  runPlace.sh
AnAgent.java  Mobile.jar  runAgent.sh
[sagra15@cssmpi1h lab7]$ vim MyAgent.java
[sagra15@cssmpi1h lab7]$ ./compile.sh MyAgent.java
[sagra15@cssmpi1h lab7]$ ls
AnAgent.class  compile.sh  MyAgent.class  runAgent.sh
AnAgent.java  Mobile.jar  MyAgent.java  runPlace.sh
[sagra15@cssmpi1h lab7]$ ./runAgent.sh cssmpi1h 28029 MyAgent
Injected
[sagra15@cssmpi1h lab7]$ █

sagamiy — sagra15@cssmpi4h:~/lab7 — ssh sagra15@cssmpi4h.uwb.edu — 80...
[sagra15@cssmpi4h ~]$ cd lab7
[sagra15@cssmpi4h lab7]$ ./runPlace.sh 28029
Place ready.
jump
█

sagamiy — sagra15@cssmpi1h:~/lab7 — ssh sagra15@cssmpi1h.uwb.edu — 80...
at Mobile.Place.main(Place.java:100)
Caused by: java.net.BindException: Address already in use (Bind failed)
at java.base/java.net.PlainSocketImpl.socketBind(Native Method)
at java.base/java.net.AbstractPlainSocketImpl.bind(AbstractPlainSocketImpl.java:436)
at java.base/java.net.ServerSocket.bind(ServerSocket.java:395)
at java.base/java.net.ServerSocket.<init>(ServerSocket.java:257)
at java.base/java.net.ServerSocket.<init>(ServerSocket.java:149)
at java.rmi/sun.rmi.transport.tcp.TCPDirectSocketFactory.createServerSocket(TCPDirectSocketFactory.java:45)
at java.rmi/sun.rmi.transport.tcp.TCPEndpoint.newServerSocket(TCPEndpoint.java:670)
at java.rmi/sun.rmi.transport.tcp.TCPTransport.listen(TCPTransport.java:324)
... 9 more
[sagra15@cssmpi1h lab7]$ ./runPlace.sh 28029
Place ready.
I'll hop to cssmpi2h
█

sagamiy — sagra15@cssmpi2h:~/lab7 — ssh sagra15@cssmpi2h.uwb.edu — 80...
[sagra15@cssmpi2h ~]$ cd lab7
[sagra15@cssmpi2h lab7]$ ./runPlace.sh 28029
Place ready.
hello
hop
█

sagamiy — sagra15@cssmpi3h:~/lab7 — ssh sagra15@cssmpi3h.uwb.edu — 80...
[sagra15@cssmpi3h ~]$ cd lab7
[sagra15@cssmpi3h lab7]$ ./runPlace.sh 28029
Place ready.
step
█
```