UMS

UNIVERSITI MALAYSIA SABAH

KP00303 NETWORK SIMULATION

SEMESTER 1 2023/2024

DR SHALIZA HAYATI A. WAHAB

ASSIGNMENT 2

TEE YEW CHUN BI20110050

FONG HOW YAN BI20110070

KP00303 Network Simulation
Faculty of Computing and Informatics, Universiti Malaysia Sabah
Semester 1, 2023/24
Lecturer: Shaliza Hayati A. Wahab

Assignment 2 (100 marks)

This assignment is a group of three persons. Due date: 4 January 2024, 5:00 pm. Submit all the answers and simulations codes in class website and the printout to my office (Room 65, Level 2, Block A) .

1. Create OMNeT++ simulation source codes (.ini, .ned and .cc) to test a wireless network with one wireless router and two laptops. Put your names and matric numbers in the coding.

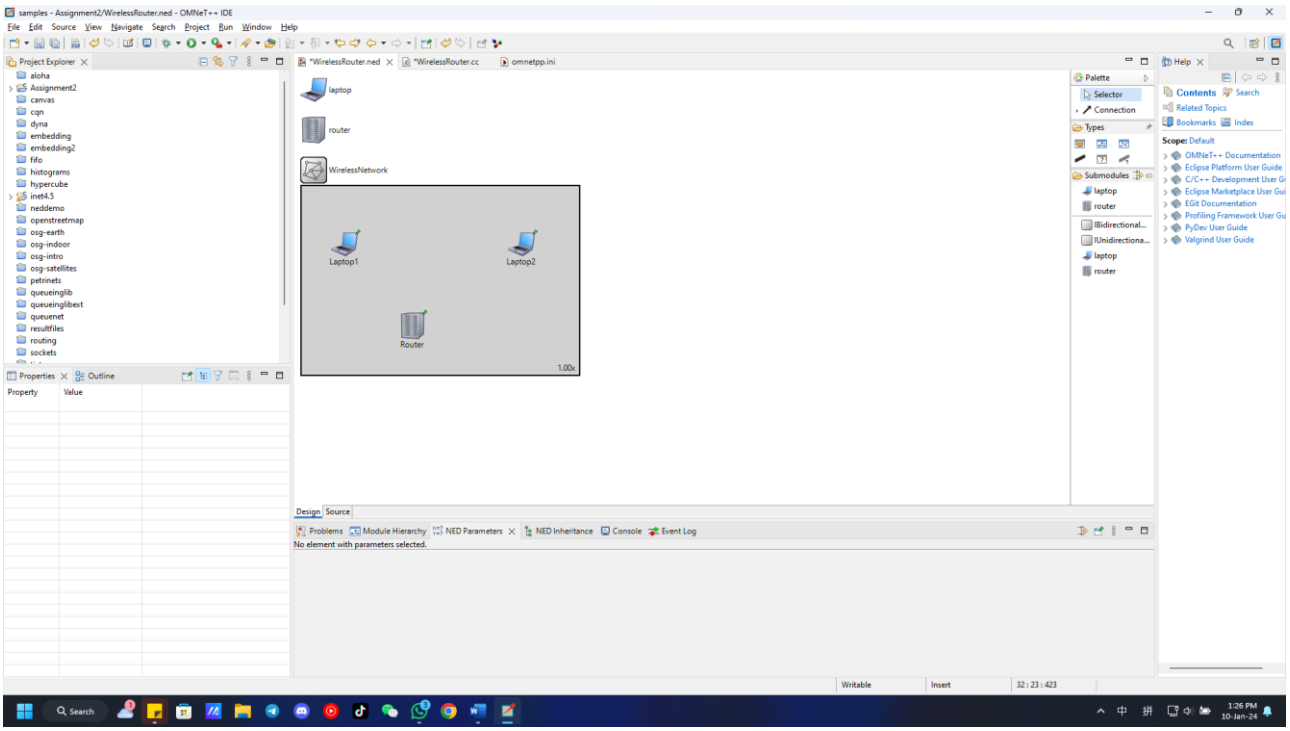
2. Consider the following single-server queuing system from time = 0 to time = 25 sec. Arrivals and service times are as follows:

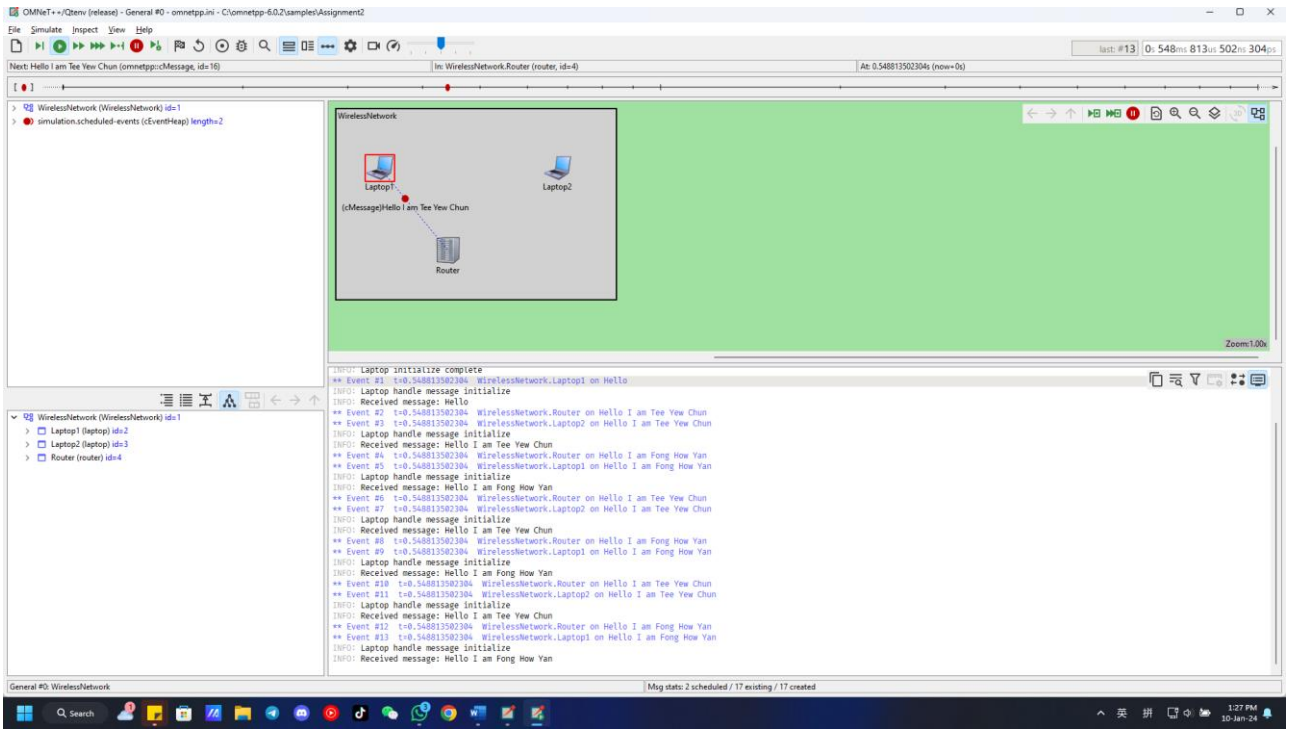
- Customer 1 arrives at t = 1 second and requires 5 seconds of service time
- Customer 2 arrives at t = 1 second and requires 2 seconds of service time
- Customer 3 arrives at t = 2 seconds and requires 3 seconds of service time
- Customer 4 arrives at t = 12 seconds and requires 6 seconds of service time

Calculate the system throughput (X), total busy time (B), mean service time (Ts), utilization (U), mean system time (delay in system) (W), and mean number in the system (L).

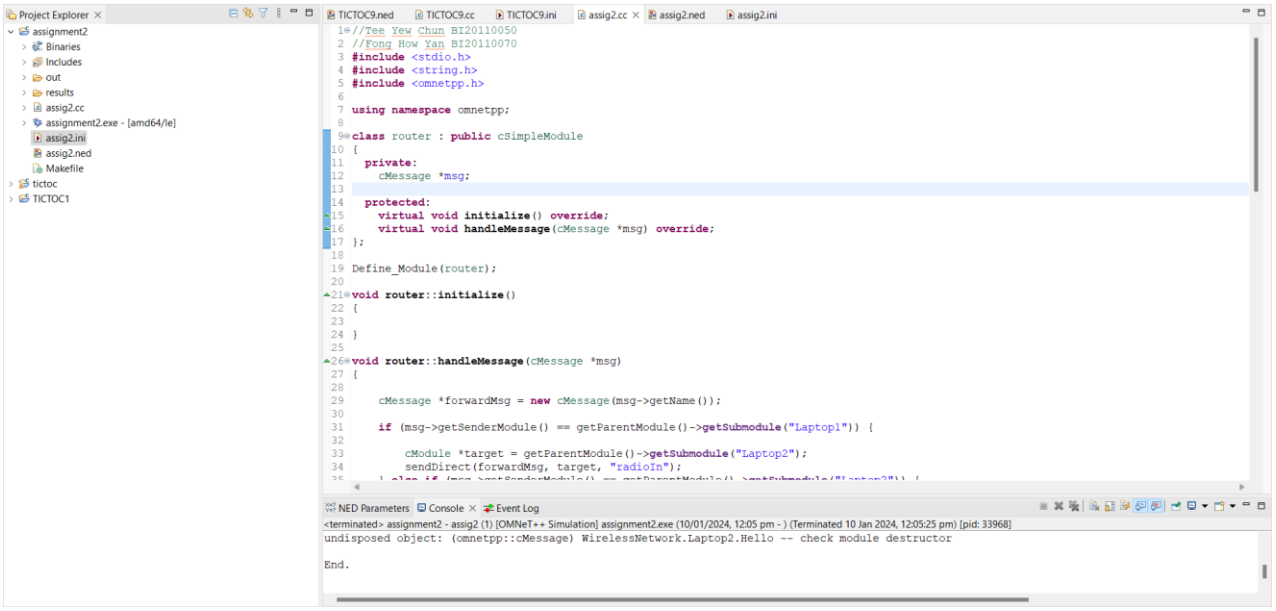
Question 1

Outcome:



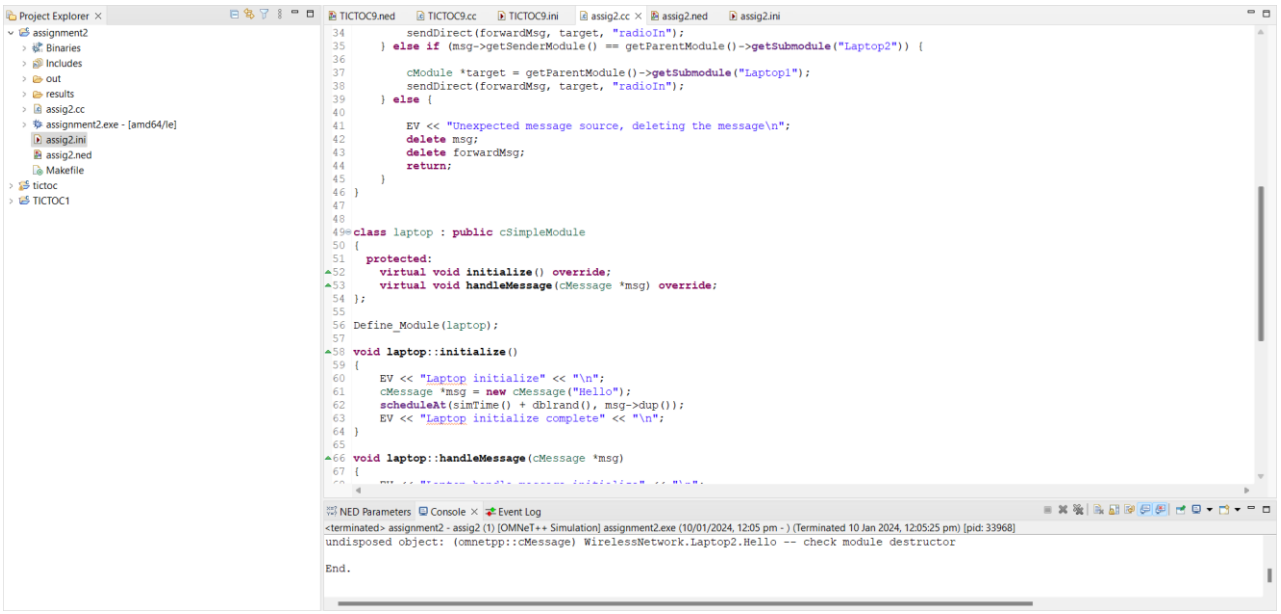


.cc screenshot



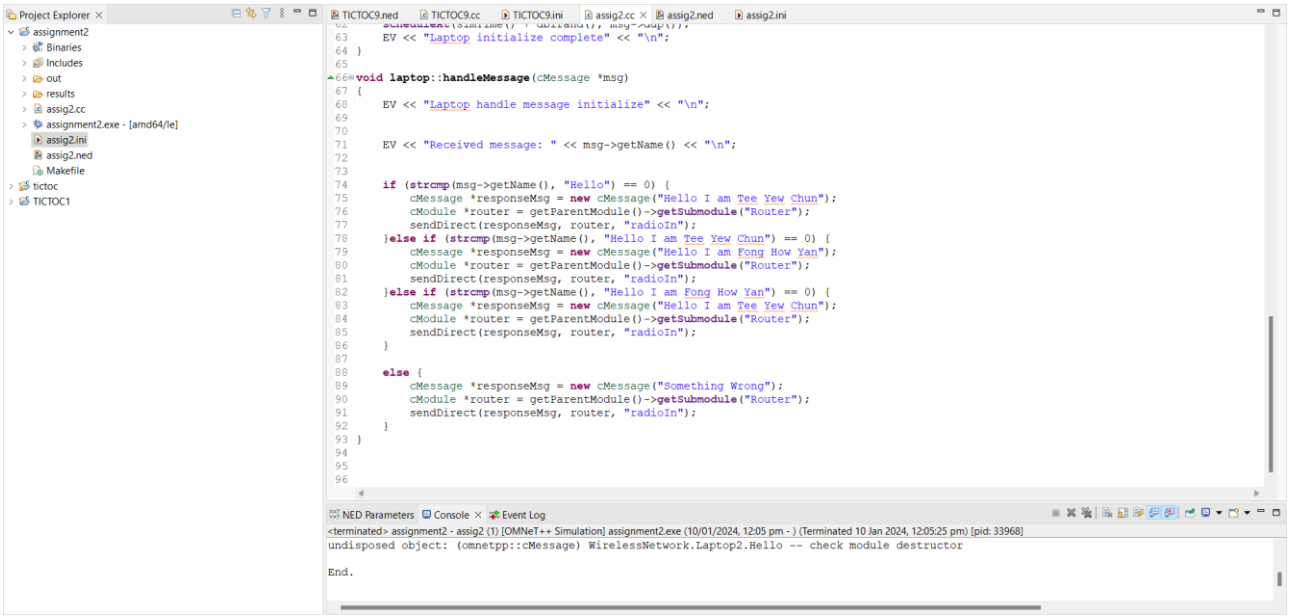
```
//Tee Yew Chun BI20110050
//Fong How Yan BI20110070
#include <stdio.h>
#include <string.h>
#include <omnetpp.h>

using namespace omnetpp;

class router : public cSimpleModule
{
  private:
    cMessage *msg;

  protected:
    virtual void initialize() override;
    virtual void handleMessage(cMessage *msg) override;
};

Define_Module(router);

void router::initialize()
{

}

void router::handleMessage(cMessage *msg)
{

    cMessage *forwardMsg = new cMessage(msg->getName());

    if (msg->getSenderModule() == getParentModule()->getSubmodule("Laptop1")) {

        cModule *target = getParentModule()->getSubmodule("Laptop2");
        sendDirect(forwardMsg, target, "radioIn");
```

```
<terminated> assignment2 - assig2 (1) [OMNeT++ Simulation] assignment2.exe (10/01/2024, 12:05 pm - ) (Terminated 10 Jan 2024, 12:05:25 pm) [pid: 33968]
undisposed object: (omnetpp::cMessage) WirelessNetwork.Laptop2.Hello -- check module destructor

End.
```



```
        sendDirect(forwardMsg, target, "radioIn");
    } else if (msg->getSenderModule() == getParentModule()->getSubmodule("Laptop2")) {

        cModule *target = getParentModule()->getSubmodule("Laptop1");
        sendDirect(forwardMsg, target, "radioIn");
    } else {

        EV << "Unexpected message source, deleting the message\n";
        delete msg;
        delete forwardMsg;
        return;
    }
}


class laptop : public cSimpleModule
{
  protected:
    virtual void initialize() override;
    virtual void handleMessage(cMessage *msg) override;
};

Define_Module(laptop);

void laptop::initialize()
{
    EV << "Laptop initialize" << "\n";
    cMessage *msg = new cMessage("Hello");
    scheduleAt(simTime() + dblrand(), msg->dup());
    EV << "Laptop initialize complete" << "\n";
}

void laptop::handleMessage(cMessage *msg)
{
```

```
<terminated> assignment2 - assig2 (1) [OMNeT++ Simulation] assignment2.exe (10/01/2024, 12:05 pm - ) (Terminated 10 Jan 2024, 12:05:25 pm) [pid: 33968]
undisposed object: (omnetpp::cMessage) WirelessNetwork.Laptop2.Hello -- check module destructor

End.
```



```
    EV << "Laptop initialize complete" << "\n";
}

void laptop::handleMessage(cMessage *msg)
{
    EV << "Laptop handle message initialize" << "\n";


    EV << "Received message: " << msg->getName() << "\n";


    if (strcmp(msg->getName(), "Hello") == 0) {
        cMessage *responseMsg = new cMessage("Hello I am Tee Yew Chun");
        cModule *router = getParentModule()->getSubmodule("Router");
        sendDirect(responseMsg, router, "radioIn");
    }else if (strcmp(msg->getName(), "Hello I am Tee Yew Chun") == 0) {
        cMessage *responseMsg = new cMessage("Hello I am Fong How Yan");
        cModule *router = getParentModule()->getSubmodule("Router");
        sendDirect(responseMsg, router, "radioIn");
    }else if (strcmp(msg->getName(), "Hello I am Fong How Yan") == 0) {
        cMessage *responseMsg = new cMessage("Hello I am Tee Yew Chun");
        cModule *router = getParentModule()->getSubmodule("Router");
        sendDirect(responseMsg, router, "radioIn");
    }

    else {
        cMessage *responseMsg = new cMessage("Something Wrong");
        cModule *router = getParentModule()->getSubmodule("Router");
        sendDirect(responseMsg, router, "radioIn");
    }
}
```

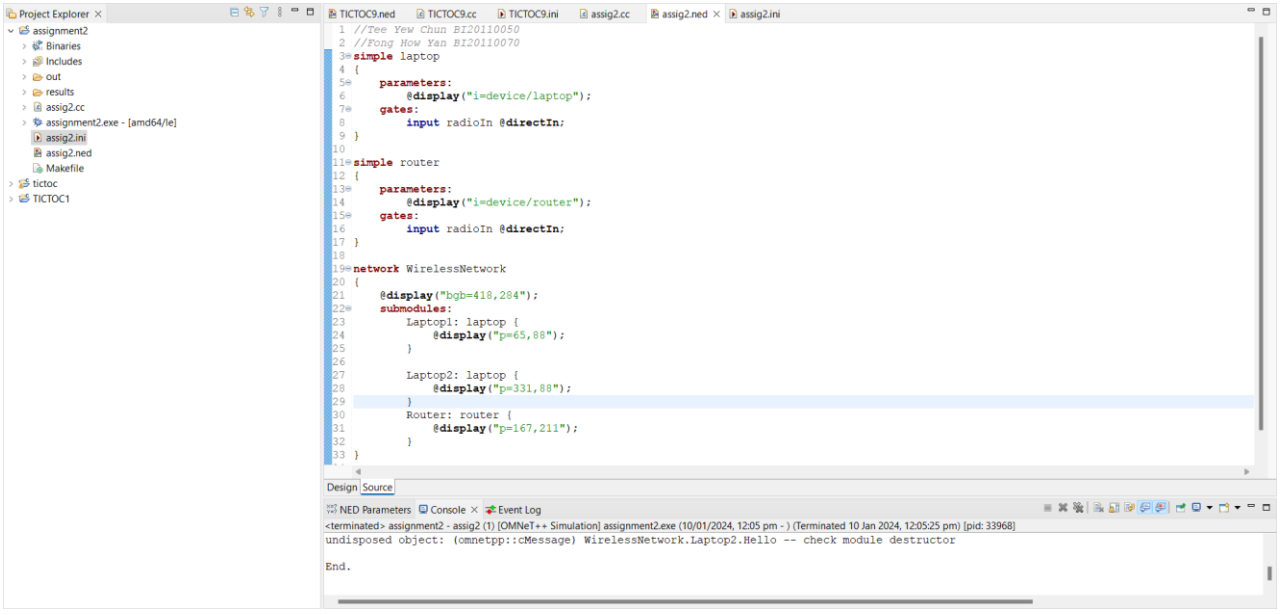
```
<terminated> assignment2 - assig2 (1) [OMNeT++ Simulation] assignment2.exe (10/01/2024, 12:05 pm - ) (Terminated 10 Jan 2024, 12:05:25 pm) [pid: 33968]
undisposed object: (omnetpp::cMessage) WirelessNetwork.Laptop2.Hello -- check module destructor

End.
```

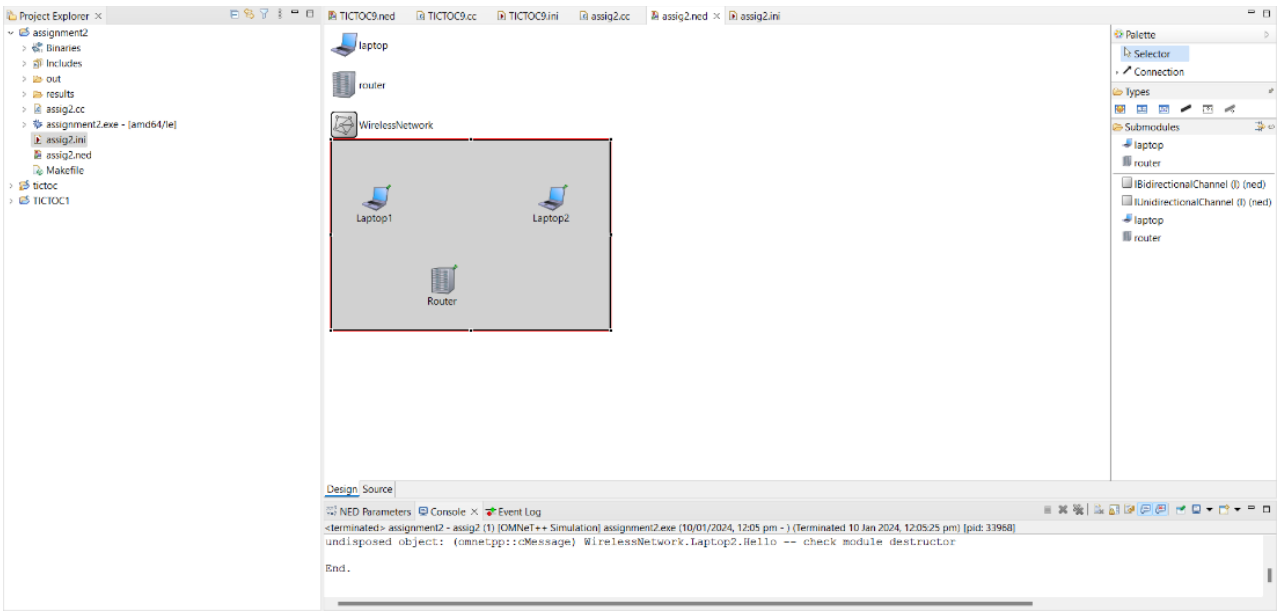
.cc file

```
//Tee Yew Chun BI20110050
//Fong How Yan BI20110070
#include <stdio.h>
#include <string.h>
#include <omnetpp.h>

using namespace omnetpp;

class router : public cSimpleModule
{
private:
cMessage *msg;

protected:
virtual void initialize() override;
virtual void handleMessage(cMessage *msg) override;
};

Define_Module(router);

void router::initialize()
{

}

void router::handleMessage(cMessage *msg)
{

cMessage *forwardMsg = new cMessage(msg->getName());

if (msg->getSenderModule() == getParentModule()->getSubmodule("Laptop1")) {

cModule *target = getParentModule()->getSubmodule("Laptop2");
sendDirect(forwardMsg, target, "radioIn");
} else if (msg->getSenderModule() == getParentModule()->getSubmodule("Laptop2"))
{

cModule *target = getParentModule()->getSubmodule("Laptop1");
sendDirect(forwardMsg, target, "radioIn");
} else {

EV << "Unexpected message source, deleting the message\n";
delete msg;
delete forwardMsg;
return;
}
}


class laptop : public cSimpleModule
{
protected:
virtual void initialize() override;
virtual void handleMessage(cMessage *msg) override;
};

Define_Module(laptop);

void laptop::initialize()
{
EV << "Laptop initialize" << "\n";
cMessage *msg = new cMessage("Hello");
scheduleAt(simTime() + dblrand(), msg->dup());
EV << "Laptop initialize complete" << "\n";
}

void laptop::handleMessage(cMessage *msg)
```

```
{
EV << "Laptop handle message initialize" << "\n";


EV << "Received message: " << msg->getName() << "\n";


if (strcmp(msg->getName(), "Hello") == 0) {
cMessage *responseMsg = new cMessage("Hello I am Tee Yew Chun");
cModule *router = getParentModule()->getSubmodule("Router");
sendDirect(responseMsg, router, "radioIn");
}else if (strcmp(msg->getName(), "Hello I am Tee Yew Chun") == 0) {
cMessage *responseMsg = new cMessage("Hello I am Fong How Yan");
cModule *router = getParentModule()->getSubmodule("Router");
sendDirect(responseMsg, router, "radioIn");
}else if (strcmp(msg->getName(), "Hello I am Fong How Yan") == 0) {
cMessage *responseMsg = new cMessage("Hello I am Tee Yew Chun");
cModule *router = getParentModule()->getSubmodule("Router");
sendDirect(responseMsg, router, "radioIn");
}

else {
cMessage *responseMsg = new cMessage("Something Wrong");
cModule *router = getParentModule()->getSubmodule("Router");
sendDirect(responseMsg, router, "radioIn");
}
}
```

.ned screenshot

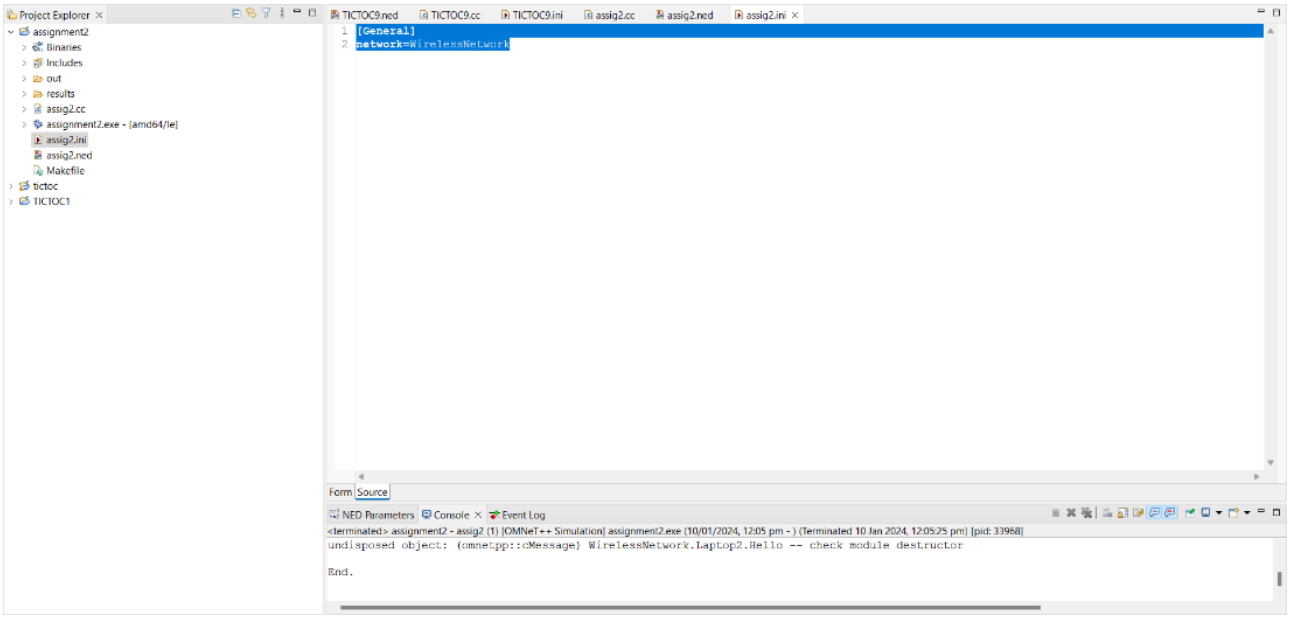




.ned file

```
//Tee Yew Chun BI20110050
//Fong How Yan BI20110070
simple laptop
{
parameters:
@display("i=device/laptop");
gates:
input radioIn @directIn;
}

simple router
{
parameters:
@display("i=device/router");
gates:
input radioIn @directIn;
}


network WirelessNetwork
{
@display("bgb=418,284");
submodules:
Laptop1: laptop {
@display("p=65,88");
}

Laptop2: laptop {
@display("p=331,88");
}
Router: router {
@display("p=167,211");
}

}
```

.ini screenshot



.ini file

```
[General]
network=WirelessNetwork
```

Question 2

Arrival and Service Time Data:

Customer 1: Arrival at t=1, Service time = 5 seconds

Customer 2: Arrival at t=1, Service time = 2 seconds

Customer 3: Arrival at t=2, Service time = 3 seconds

Customer 4: Arrival at t=12, Service time = 6 seconds

Calculate Service Completion Times:

Calculate the service completion time for each customer.

Customer	Arrival Time	Service Time	Service Start Time	Service Completion Time
1	1	5	1	6
2	1	2	6	8
3	2	3	8	11
4	12	6	12	18

Calculate Throughput (X):

Throughput (X) is the number of completed jobs (customers) per unit of time.

$X = \frac{Number\ of\ Customers}{Total\ Time}$

$X = \frac{4}{25}$ (Total time of server = 25 seconds)

Throughput (X) = 0.16 jobs per second

Calculate Total Busy Time (B):

Total Busy Time (B) is the total time the server is busy serving customers.

B = 5 + 2 + 3 + 6

Total Busy Time (B) = 16 seconds

Calculate Mean Service Time (Ts):

Mean Service Time (Ts) is the average time a customer spends in service.

$Ts = \frac{Total\ Busy\ Time}{Number\ of\ Customers}$

$Ts = \frac{16}{4}$

Mean Service Time (Ts) = 4 seconds per job

Calculate Utilization (U):

Utilization (U) is the ratio of busy time to total time.

$U = \frac{Total\ Busy\ Time}{Total\ Time}$

$U = \frac{16}{25}$

Utilization (U) = 0.64 or 64%

Calculate Mean System Time (W):

Mean System Time (W) is the average time a customer spends in the system (waiting + service).

$$W = \frac{Total\ Time\ in\ the\ System\ for\ all\ Customers}{Number\ of\ Customers}$$

$$W = \frac{[(6-1) + (8-1) + (11-2) + (18-12)]}{4}$$

Mean System Time (W) = 6.75 seconds

Calculate Mean Number in the System (L):

Mean Number in the System (L) is the average number of customers in the system.

$$L = \frac{Total\ Time\ in\ the\ System\ for\ all\ Customers}{Total\ Time}$$

$$L = \frac{[(6-1) + (8-1) + (11-2) + (18-12)]}{25}$$

Mean Number in the System (L) = 1.08 customers