PROJECT 1
Group 3

EE286- Mobile and Wireless Networks
Prof.Pedro SantaCruz

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1. Point to Point Communication

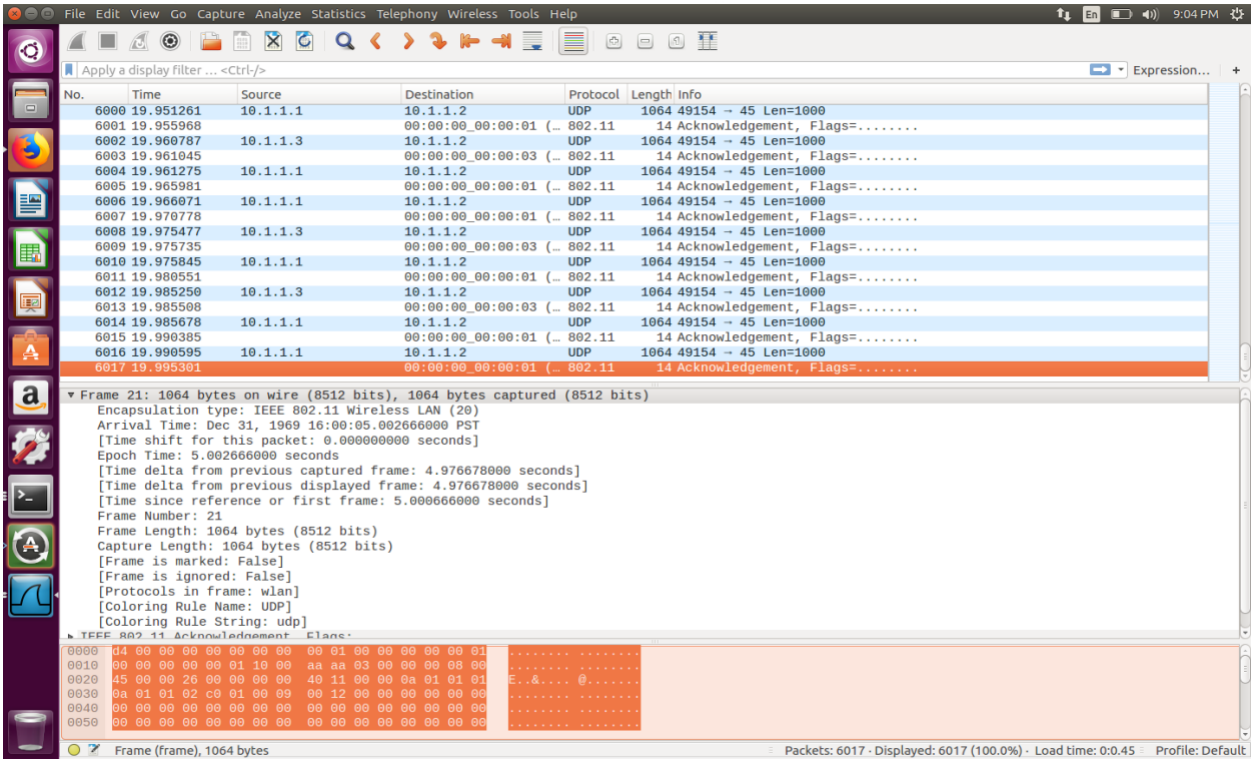
1. What is the distance between the two nodes in the network?

```
using namespace ns3;

NS_LOG_COMPONENT_DEFINE ("ProjectOneTemplate");

int main (int argc, char *argv[])
{
  uint32_t packetSize = 1000;
  uint32_t n=2;
  double dist = 100;


  CommandLine cmd;
  cmd.AddValue ("packetSize", "size of application packet sent", packetSize);
  cmd.AddValue ("n", "number of nodes", n);
  cmd.AddValue ("dist", "distance between nodes", dist);

  cmd.Parse (argc, argv);
```

As per the above code, double dist = 100;
Which implies the distance between the codes is 100. We can change this value as needed.

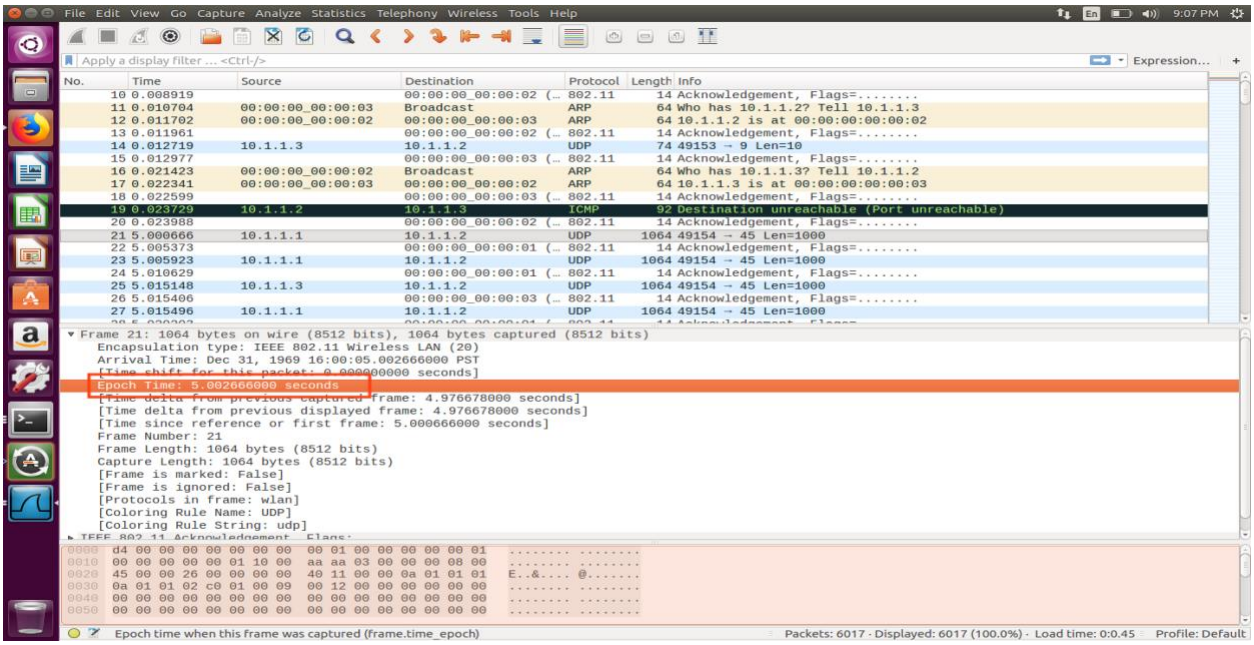
2. How many seconds of this simulation are we running?

```
/////Setup Simulator
  Simulator::Stop (Seconds (20.0));

  Simulator::Run ();
  Simulator::Destroy ();

/////Count number of packets received
  uint32_t totalPacketsThrough = DynamicCast<UdpServer> (serverApp.Get (0))->GetReceived ();

  std::cout << "Total Packets Received: " << totalPacketsThrough << '\n';

  return 0;
}
```



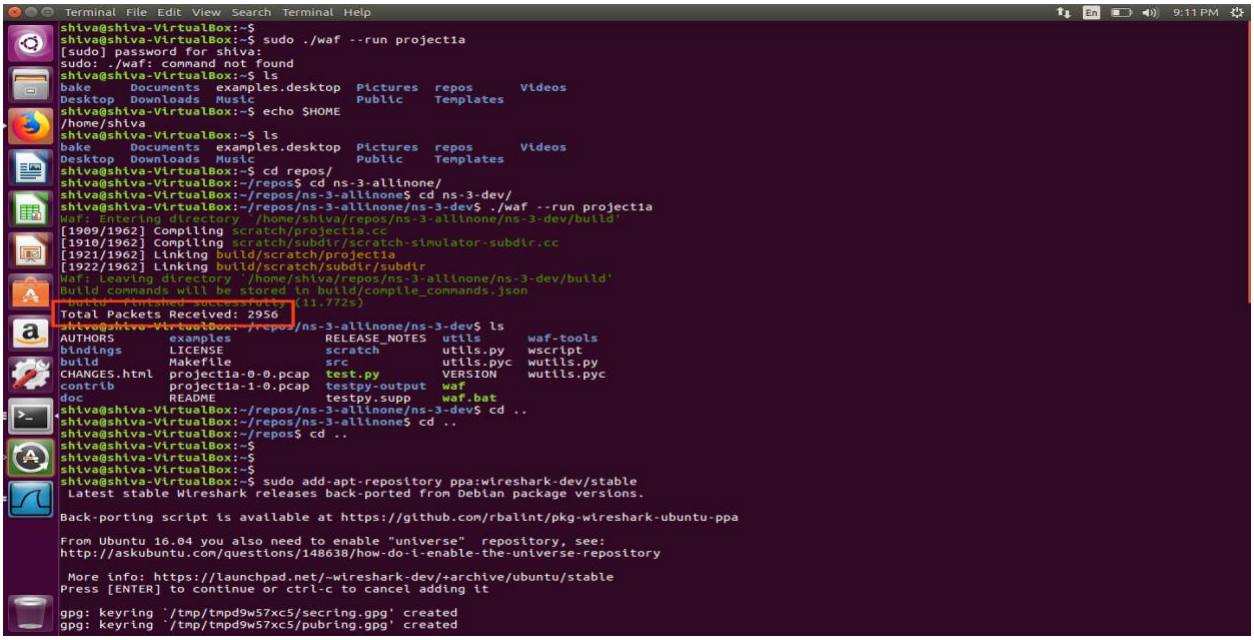
As per the code above, the total time (seconds) for the simulation is 20 seconds. Also, on wireshark, we are able to capture packets only up to 19.995 seconds.

3. When does the transmitter start transmitting data packets?



As per the Wireshark snapshot above, the transmitter starts transmitting data packets at 5.0026 seconds.

4. What is the throughput of the network, that is, how many bytes per second are being exchanged in the network?



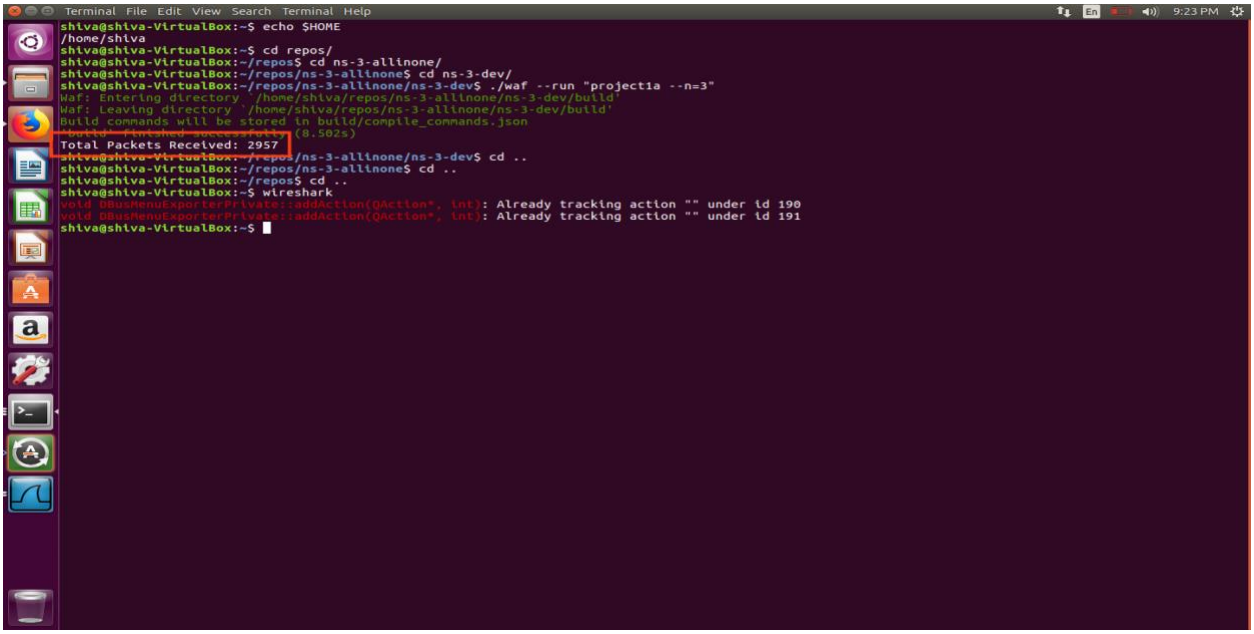
Total Packets received as per the above snapshot = 2956; Length of each packet = 1000;
Start time of transmission = 5.0026 seconds (As per question 3);
End time of transmission = 20 seconds (As per question 2);

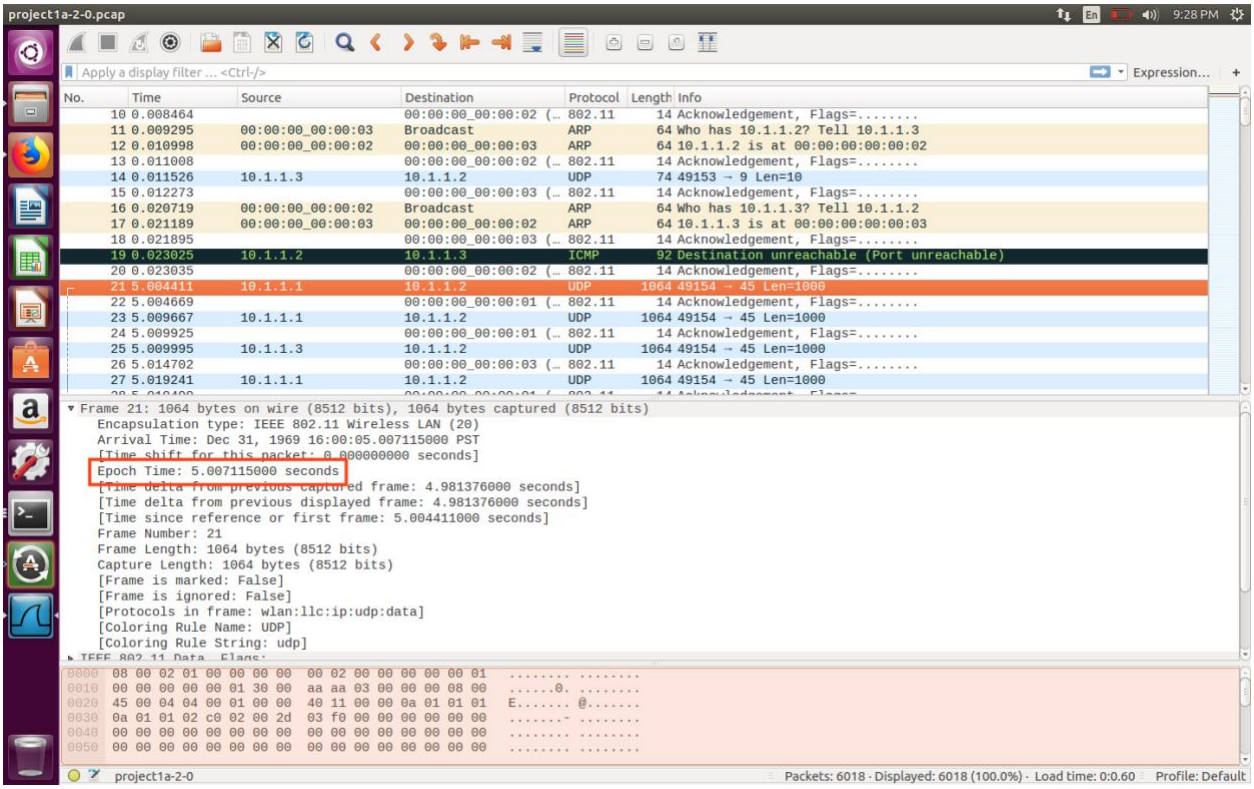
Therefore, Total Transmission time = (20 – 5.0026) seconds
No. of bytes = (2956*1000)

Throughput of the Network = (2956*1000*8) / (20 – 5.0026)
= 1.577 Mbps

2. Three Node Network

1. What is the throughput of the network?





Total Packets received as per the above snapshot = 2957; Length of each packet = 1000;
Start time of transmission = 5.0071 seconds (As per the snapshot on wireshark);
End time of transmission = 20 seconds;

Therefore, Total Transmission time = (20 – 5.0071) seconds
No. of bytes = (2957*1000)

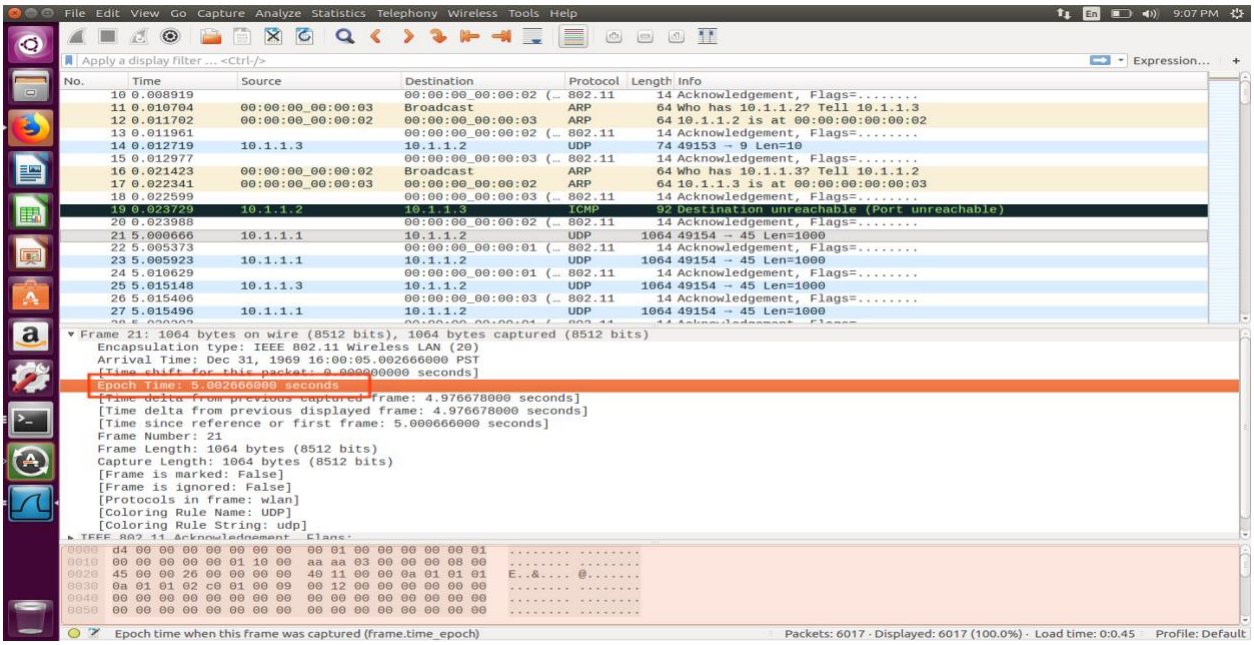
Throughput of the Network = (2957*1000*8) / (20 – 5.0071)

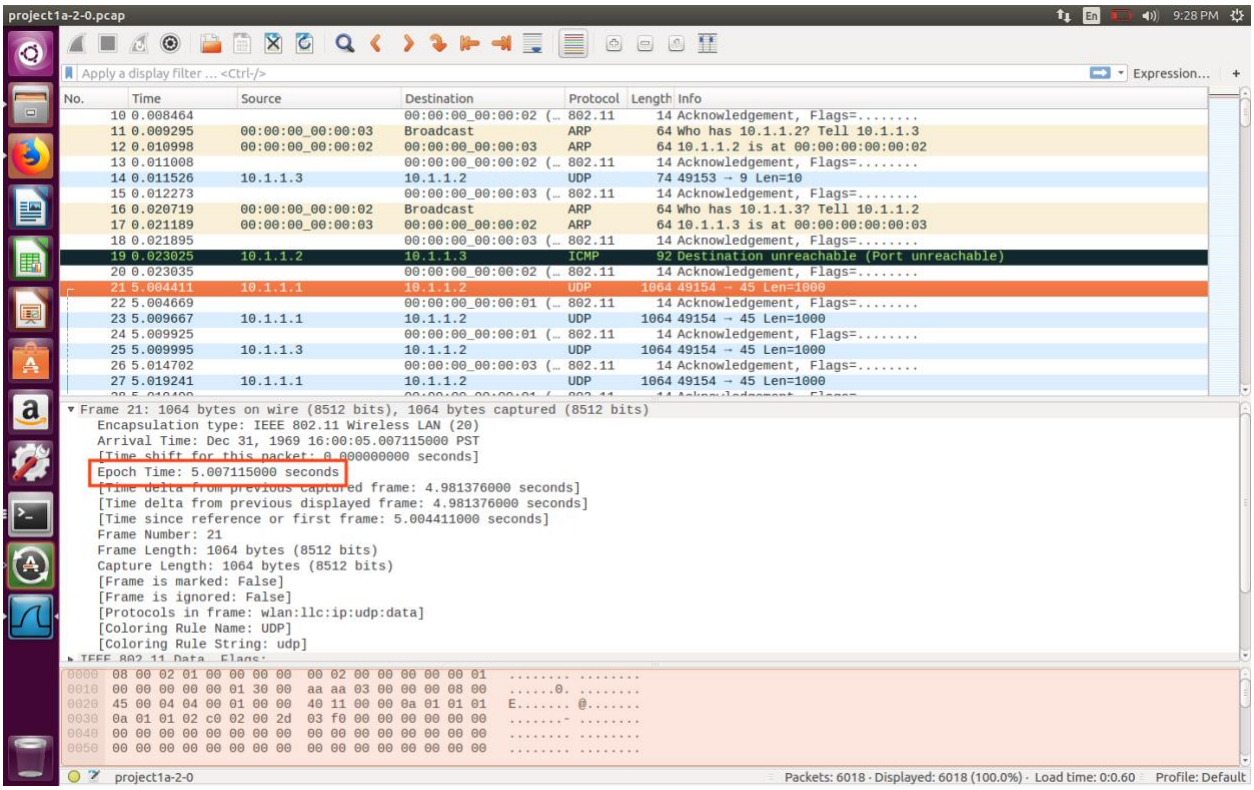
= 1.578 Mbps

2. We now have two users offering traffic at the same time, are we receiving more packets?

We are receiving more packets i.e. 2957 as per the snapshot in question 1 in comparison to 2956 packets received in Task 1 where there was only 1 user.

3. How long does it take for a packet sent by a transmitter to be received by receiver? What factors determine how long it takes?



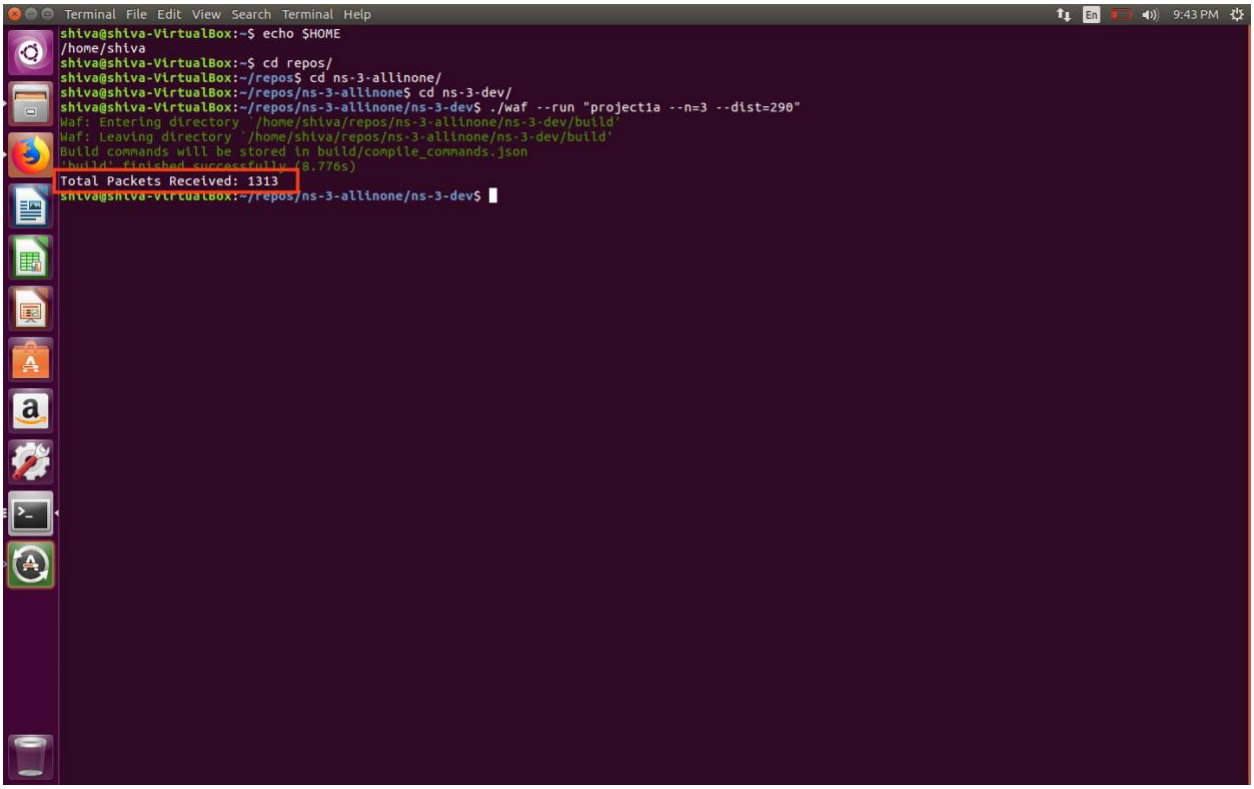


By looking at the snapshots above,
The transmitter sends the packet at 5.0026 seconds and receiver receives the packet at 5.0071 seconds.
Therefore, total time taken for transmission = 5.0071 – 5.0026 seconds

= 0.00448 seconds
= 4.48 milliseconds

3. Increasing the Distance

1. How many packets are received in the network this time?



On increasing the distance between two nodes to 290, we receive 1313 packets as shown in the snapshot above.

2. Provide an explanation to the observed behavior?

On increasing the distance between the nodes, transmission time for the packet also increases, which results in packet taking more time to reach the destination. Also, there are chances of collisions. Therefore, for the above reasons, we receive less packets in comparison to the previous tasks.

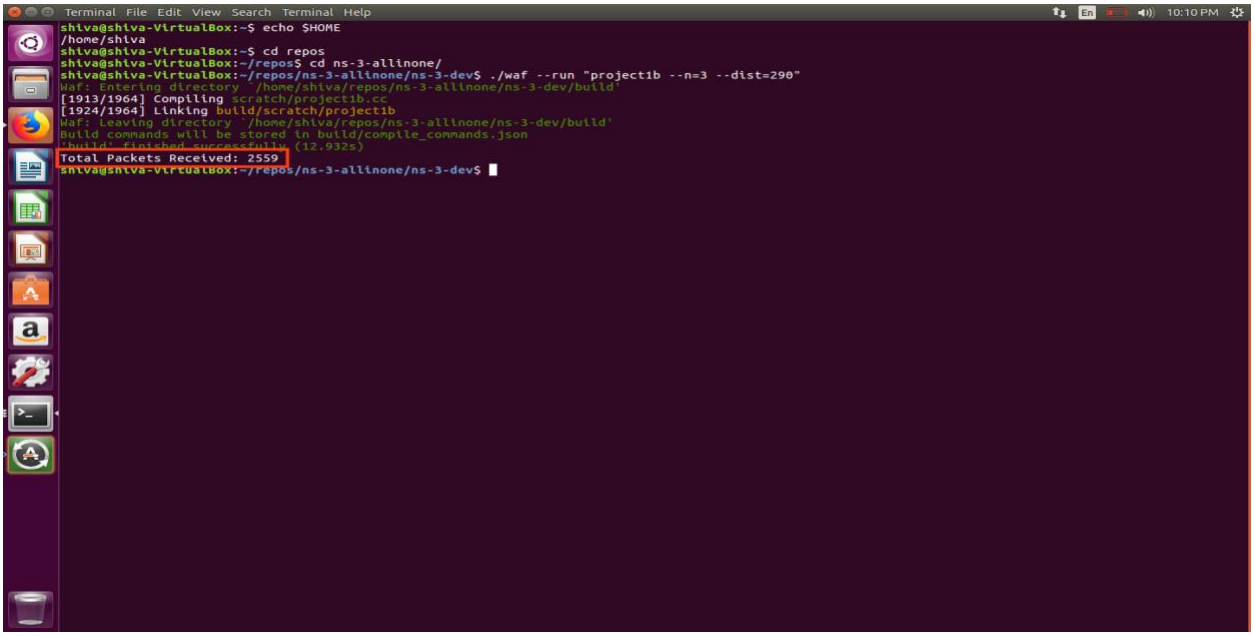
4. RTS/CTS

1. What lines of code did you change and why?

```
/////Fragmentation and RTS/CTS properties
  Config::SetDefault ("ns3::WifiRemoteStationManager::FragmentationThreshold", StringValue ("2200"));
  Config::SetDefault ("ns3::WifiRemoteStationManager::RtsCtsThreshold", StringValue ("0"));
```

To have RTS/CTS handshake before Transmitter sends the data packet, packet size should be greater than the RTS/CTS Threshold function. Hence, we changed the value from 2200 to 0.

2. How many packets are received in the network this time? Compare the result to the one in part 3?



Total Number of packets received in this part using RTS/CTS = 2559 in comparison to
Total Number of packets received in the part 3 without RTS/CTS = 1313.

3. Provide an explanation for the observed behavior?

By enabling RTS/CTS, number of collisions in the network decreases, thereby increasing the total number of successful transmission of packets to the receiver.

4. What is the throughput of the network? Compare this result to the one in part 2?

Total Packets received as per the above snapshot = 2559; Length of each packet = 1000;
Start time of transmission = 5.0089 seconds (As per the snapshot on wireshark);
End time of transmission = 20 seconds;

Therefore, Total Transmission time = (20 – 5.0089) seconds
No. of bytes = (2559*1000)

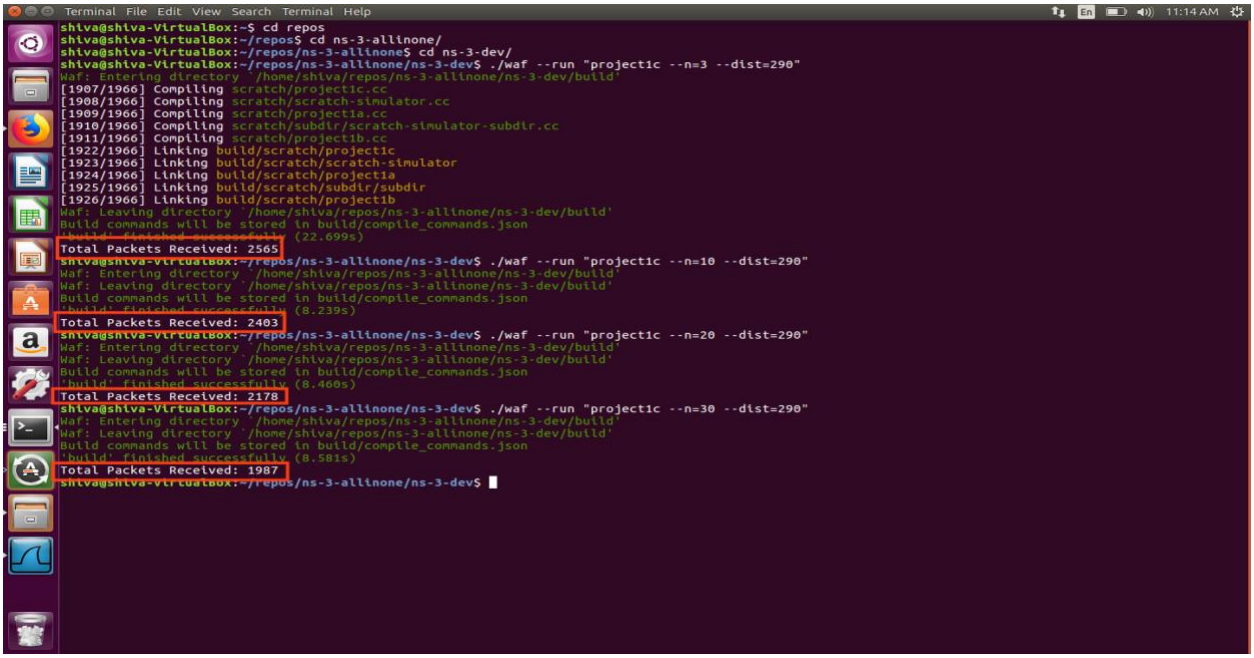
Throughput of the Network = (2559*1000*8) / (20 – 5.0089)
= 1.365 Mbps

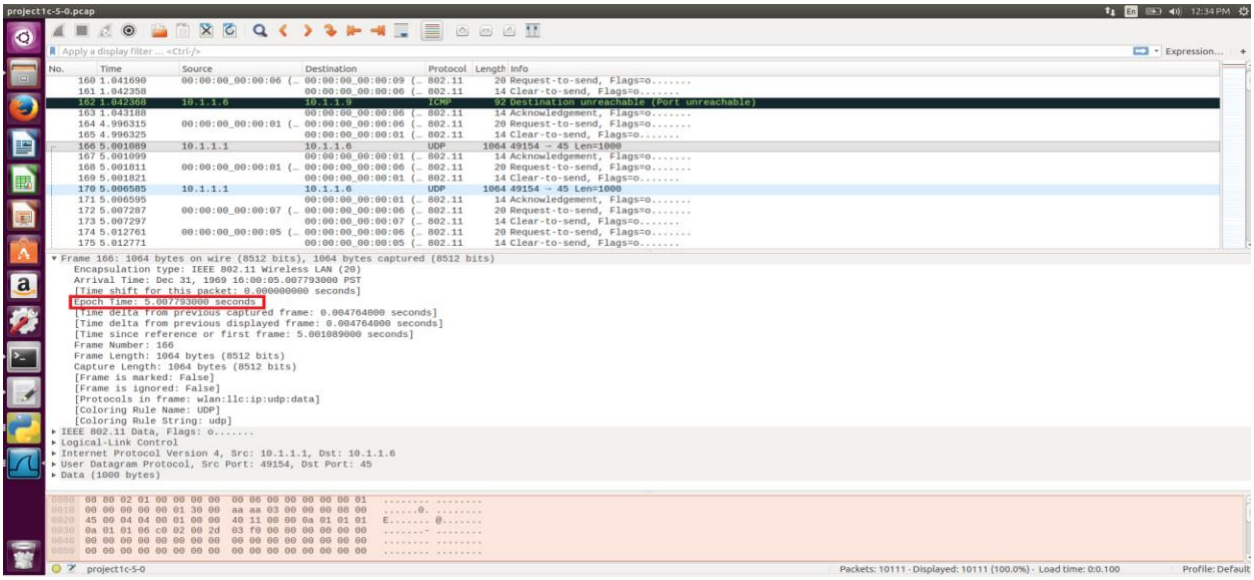
5. Provide an explanation for the observed behavior?

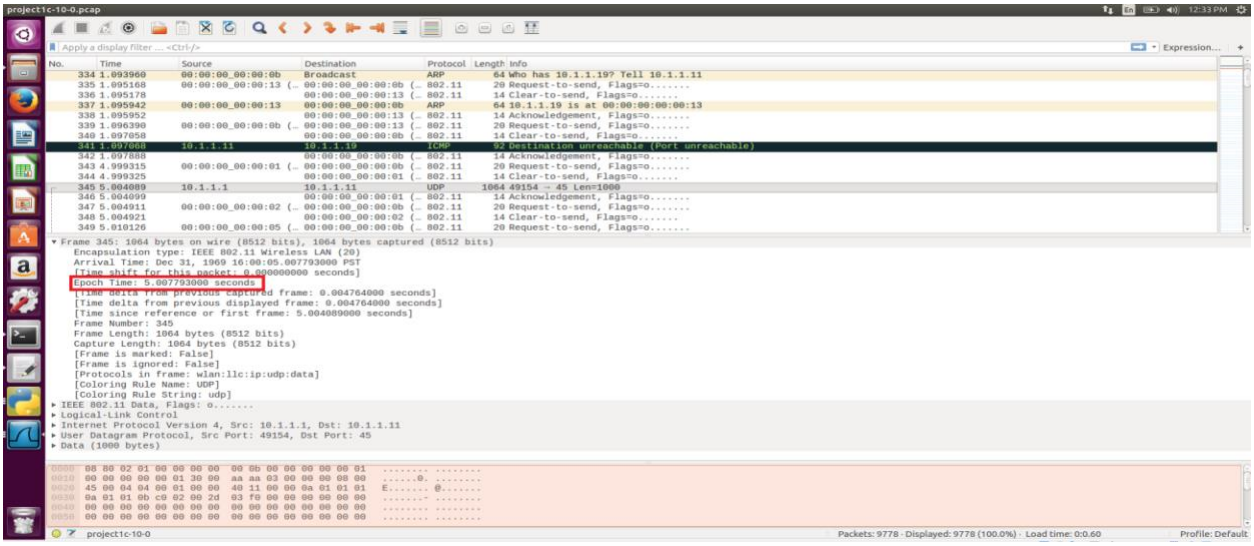
Throughput obtained here is lesser than what is observed in Part 2, since, even though the number of collisions decreases, the overall time taken including data transmitting time, RTS, CTS time increase and therefore reduce the throughput of the network.

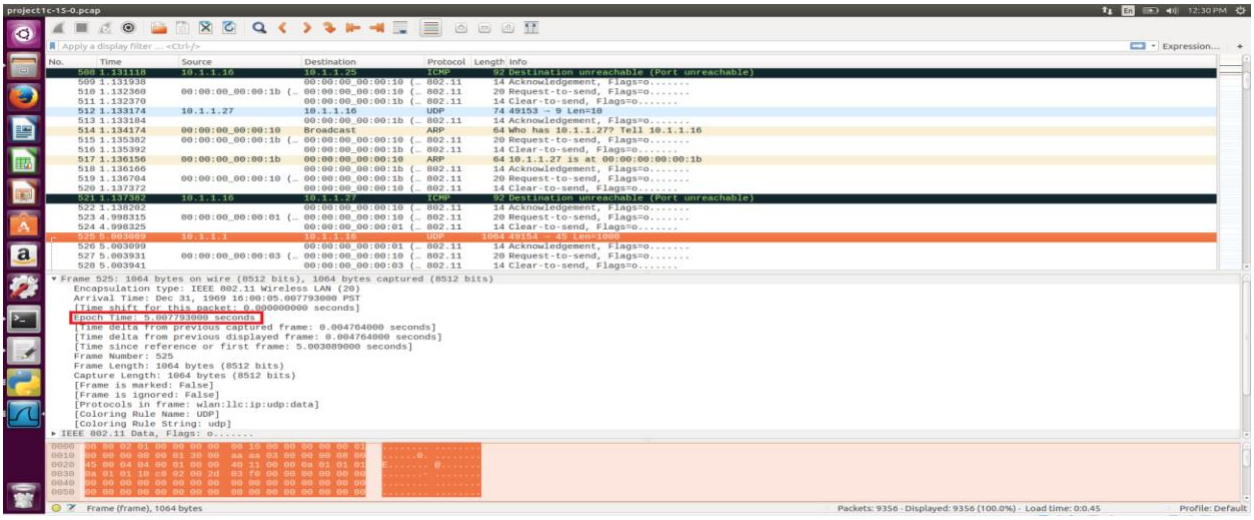
5. Throughput as a Function of Number of Users

1. With RTS/CTS Enabled:



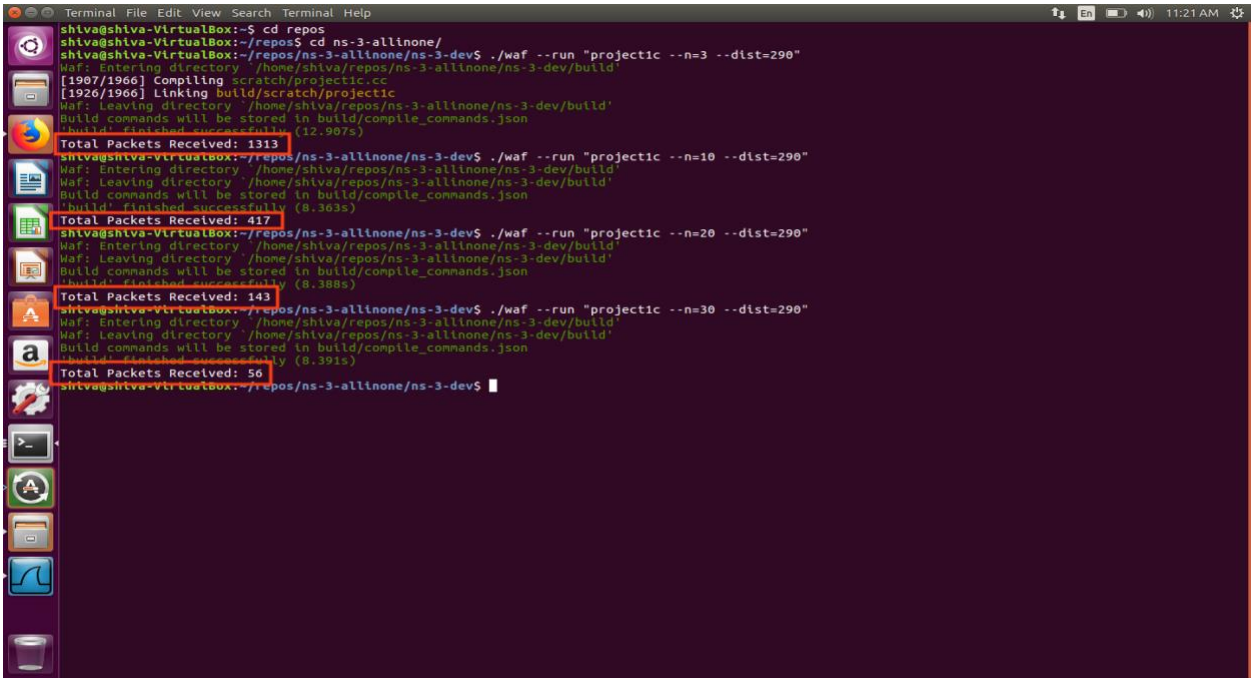




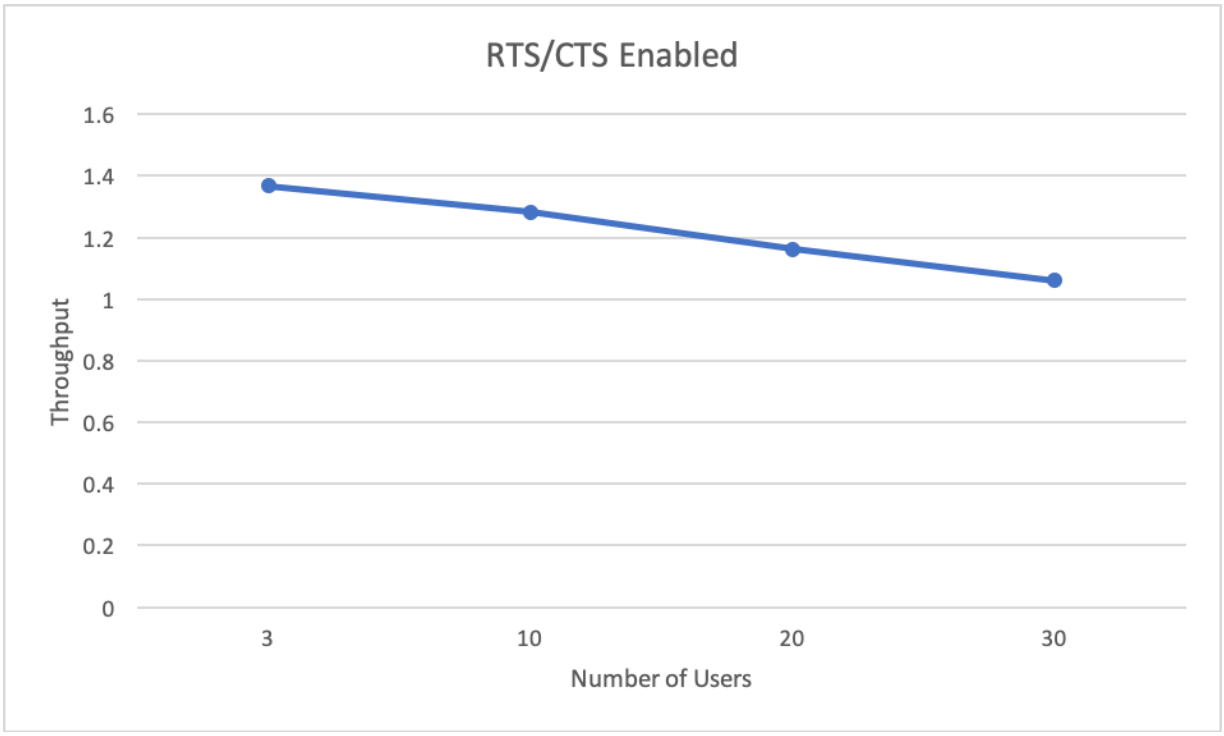


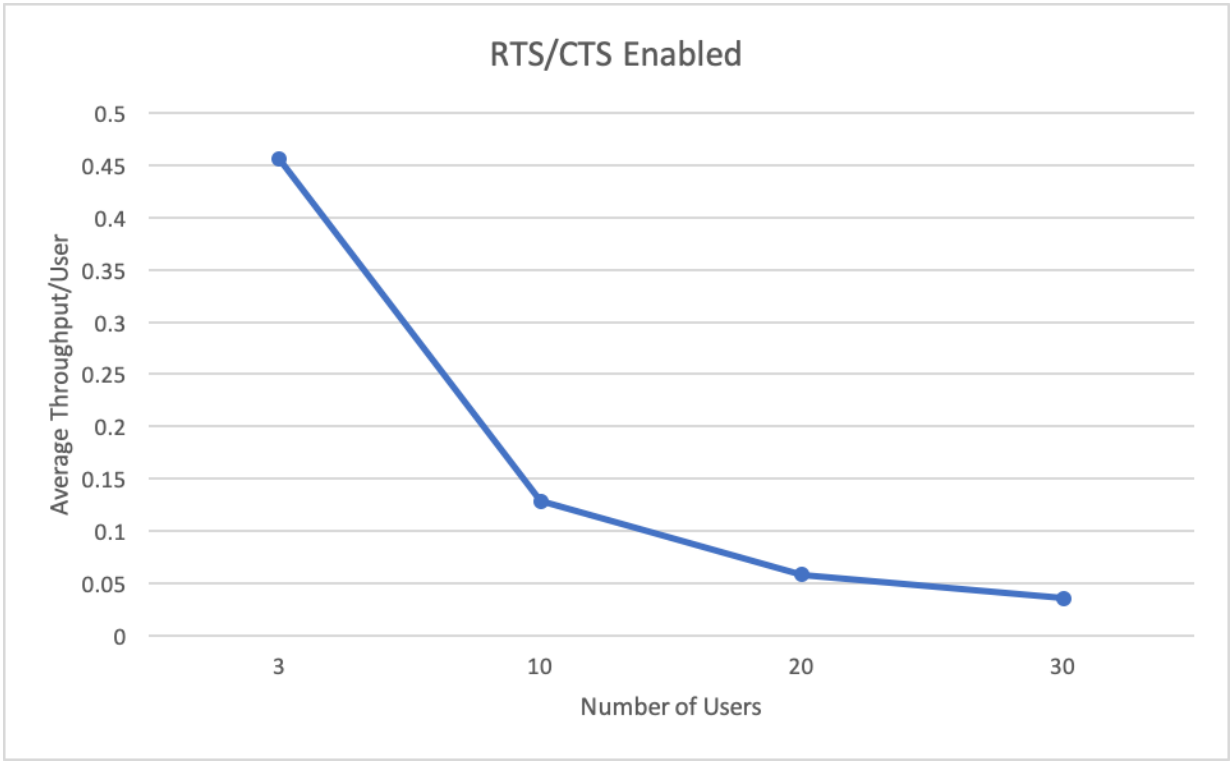
No. Of Users	No. of Packets	Throughput (Mbps)	Throughput/user (Mbps)
3	2565	1.368	0.456
10	2403	1.282	0.128
20	2178	1.162	0.058
30	1987	1.060	0.035

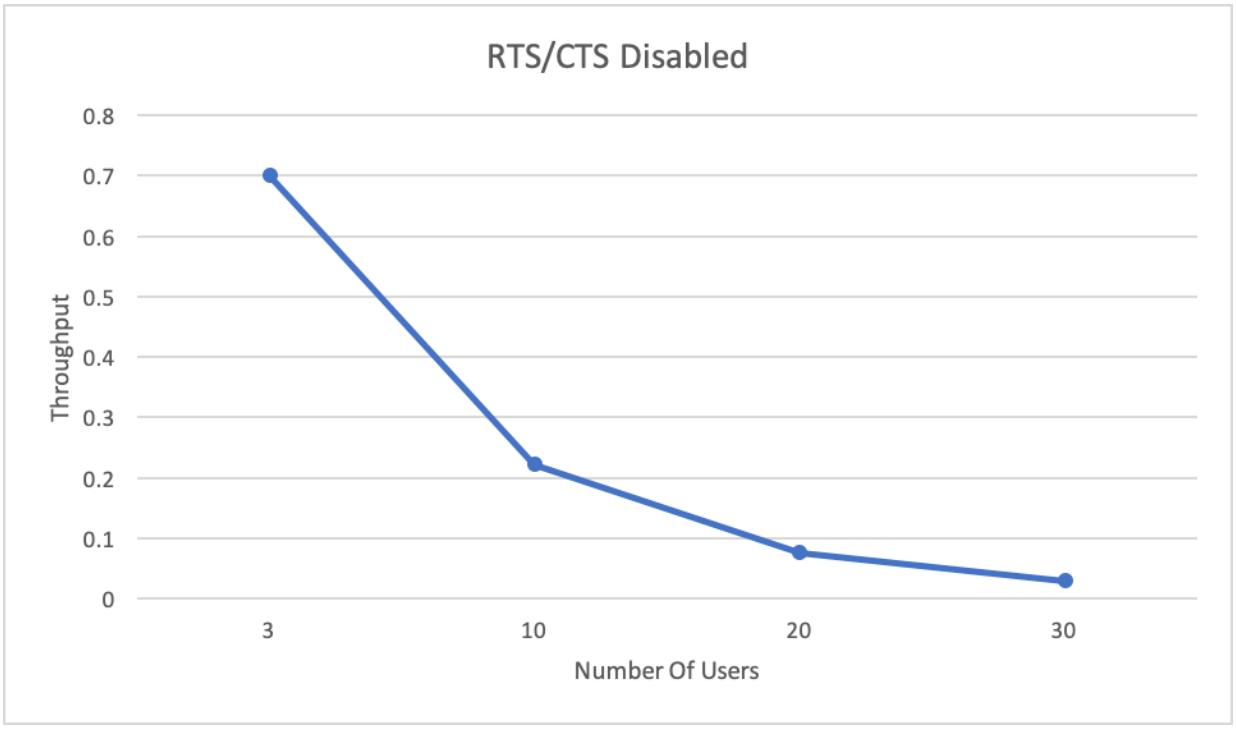
2. With RTS/CTS Disabled:

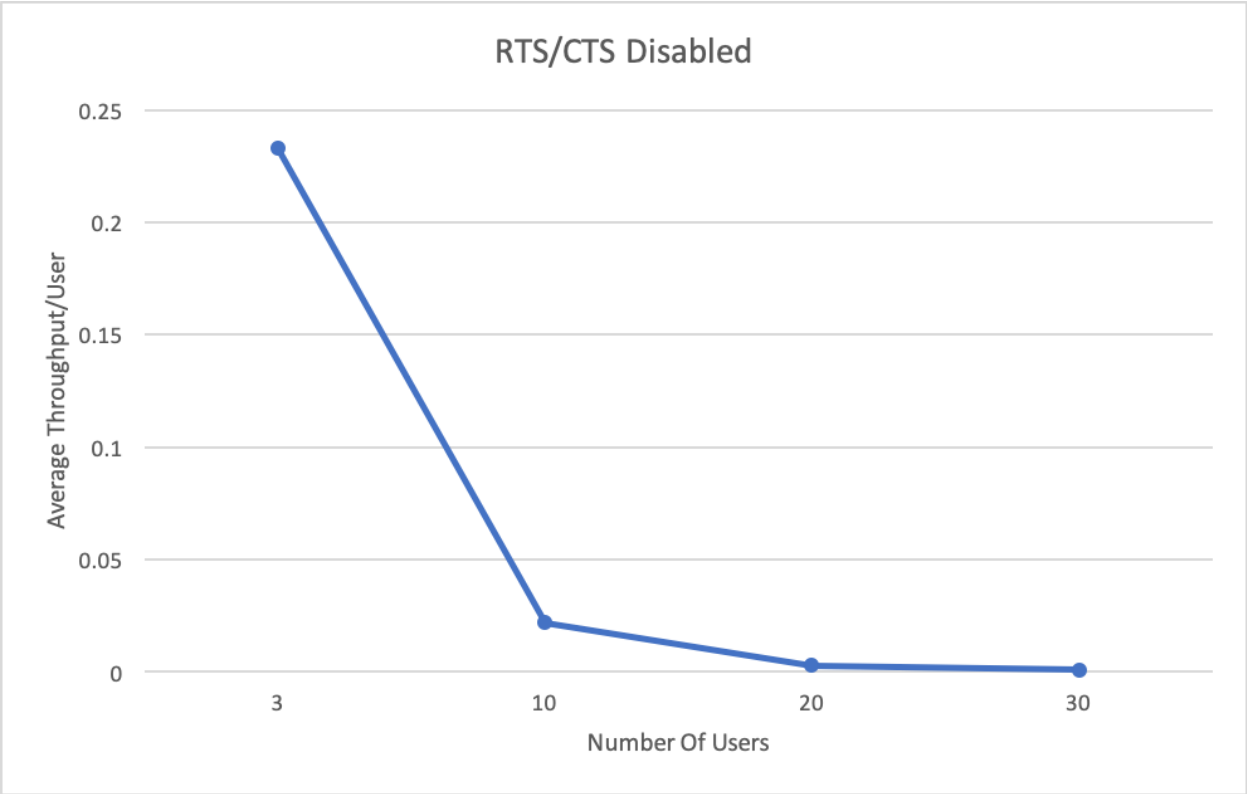


No. Of Users	No. of Packets	Throughput (Mbps)	Throughput/user (Mbps)
3	1313	0.700	0.233
10	417	0.222	0.022
20	143	0.076	0.003
30	56	0.029	0.0009




RTS/CTS Enabled
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Average Throughput/User
3
10
20
30
Number of Users


RTS/CTS Disabled
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Throughput
3
10
20
30
Number Of Users


RTS/CTS Disabled
0.25
0.2
0.15
0.1
0.05
0
Average Throughput/User
3
10
20
30
Number Of Users