Networks ns3 assignment (2) report

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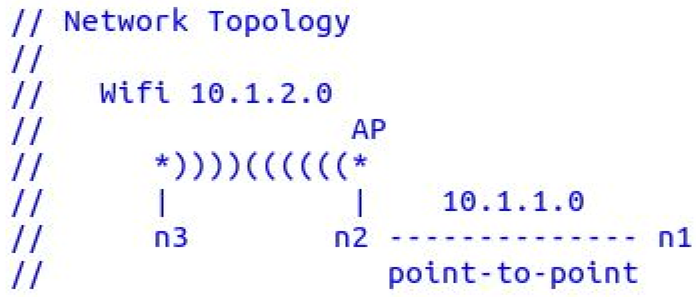
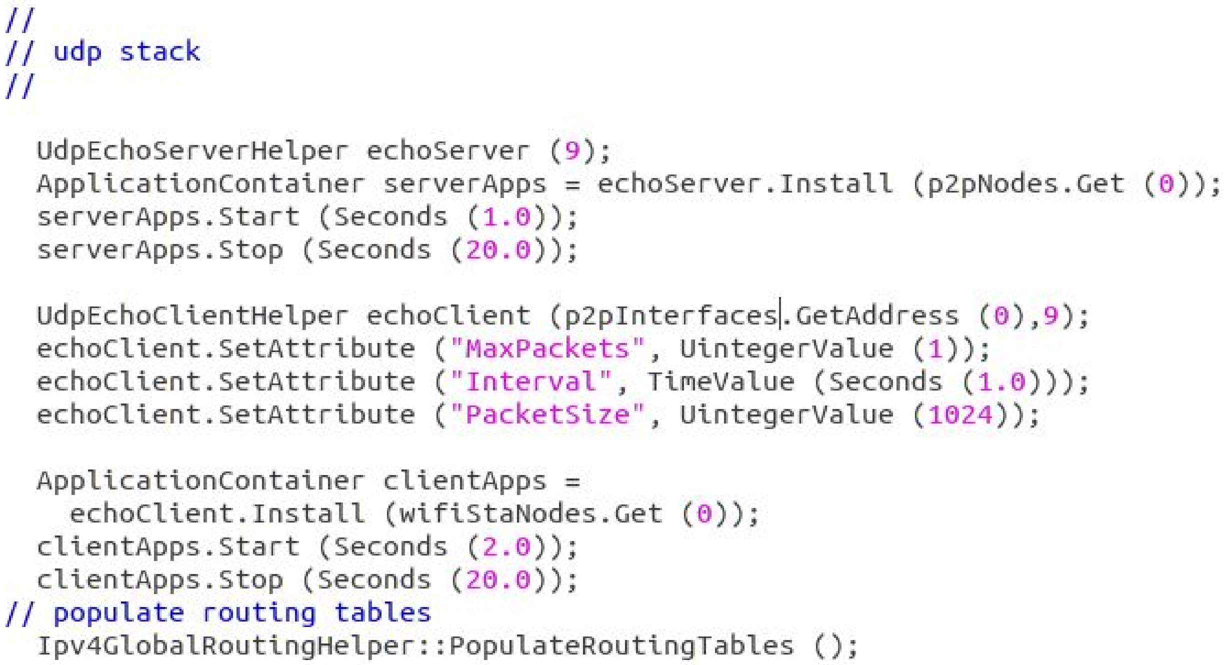
Programming the simulation

In this lab assignment we were tasked to set-up a simulation scenario that hs the following network topology:



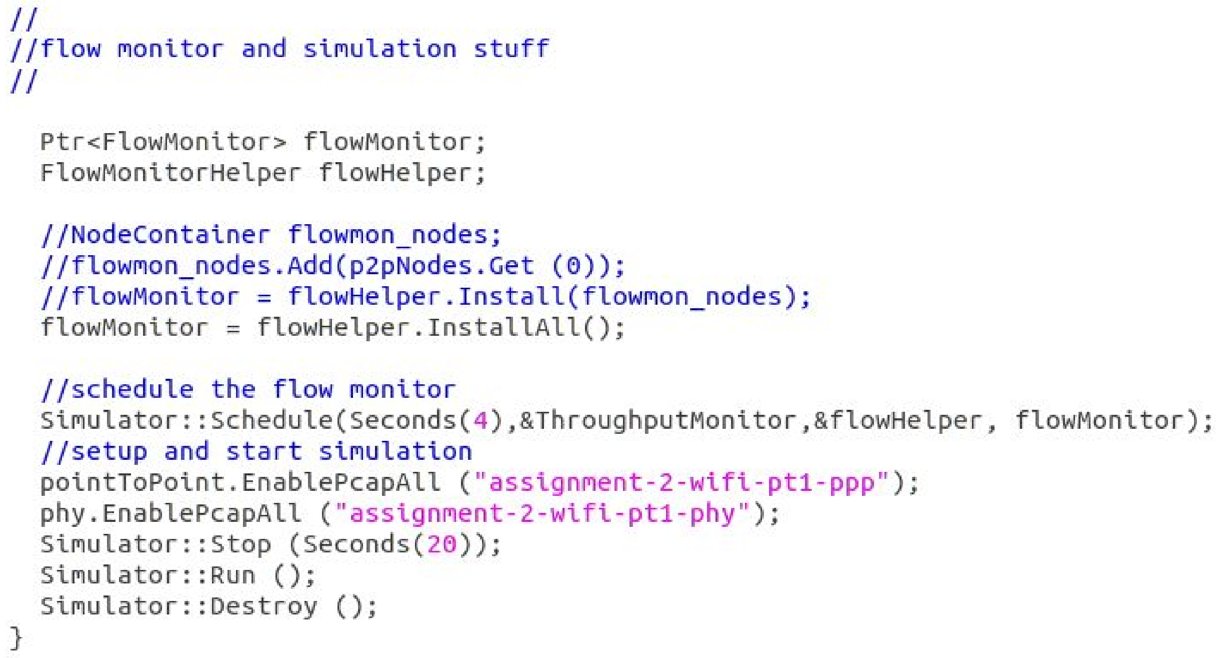
```
// Network Topology
//
//   Wifi 10.1.2.0
//                  AP
//      *))))((((((*
//      |           |    10.1.1.0
//      n3         n2 -------------- n1
//                    point-to-point
```

After setting-up this topology, we installed both the IP and UDP stacks on those nodes, then created a UDP server/client pair on nodes n1 and n2 respectively.



```
//
// udp stack
//

  UdpEchoServerHelper echoServer (9);
  ApplicationContainer serverApps = echoServer.Install (p2pNodes.Get (0));
  serverApps.Start (Seconds (1.0));
  serverApps.Stop (Seconds (20.0));

  UdpEchoClientHelper echoClient (p2pInterfaces.GetAddress (0),9);
  echoClient.SetAttribute ("MaxPackets", UintegerValue (1));
  echoClient.SetAttribute ("Interval", TimeValue (Seconds (1.0)));
  echoClient.SetAttribute ("PacketSize", UintegerValue (1024));

  ApplicationContainer clientApps =
    echoClient.Install (wifiStaNodes.Get (0));
  clientApps.Start (Seconds (2.0));
  clientApps.Stop (Seconds (20.0));
// populate routing tables
  Ipv4GlobalRoutingHelper::PopulateRoutingTables ();
```

We also did adjust the simulation parameters, to schedule the flow monitor function to run each second starting from 4 seconds.

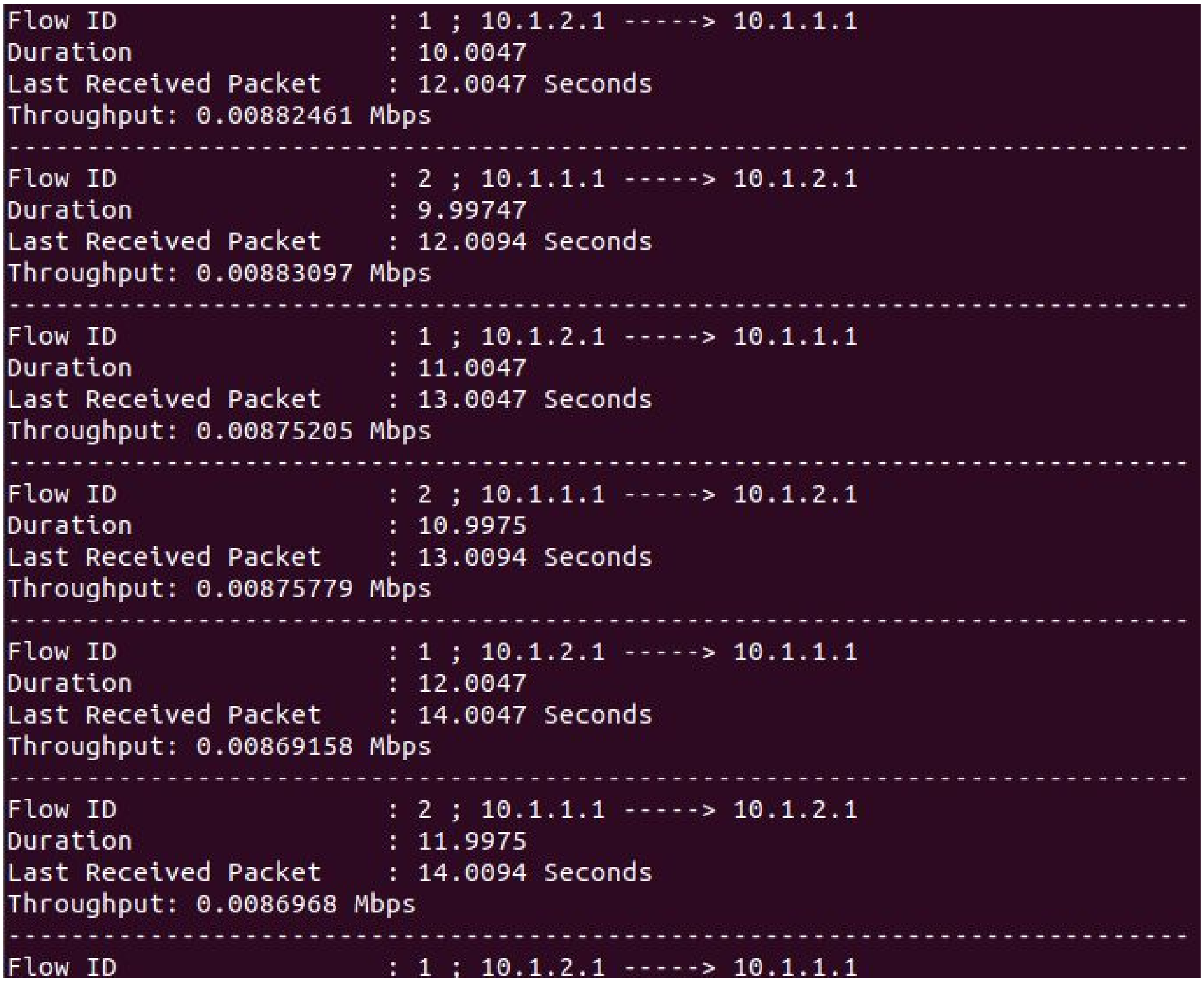


```
//
//flow monitor and simulation stuff
//

  Ptr<FlowMonitor> flowMonitor;
  FlowMonitorHelper flowHelper;

  //NodeContainer flowmon_nodes;
  //flowmon_nodes.Add(p2pNodes.Get (0));
  //flowMonitor = flowHelper.Install(flowmon_nodes);
  flowMonitor = flowHelper.InstallAll();

  //schedule the flow monitor
  Simulator::Schedule(Seconds(4),&ThroughputMonitor,&flowHelper, flowMonitor);
  //setup and start simulation
  pointToPoint.EnablePcapAll ("assignment-2-wifi-pt1-ppp");
  phy.EnablePcapAll ("assignment-2-wifi-pt1-phy");
  Simulator::Stop (Seconds(20));
  Simulator::Run ();
  Simulator::Destroy ();
}
```

We used the class FlowMonitorHelper to provide us with the throughput measurement capabilities.

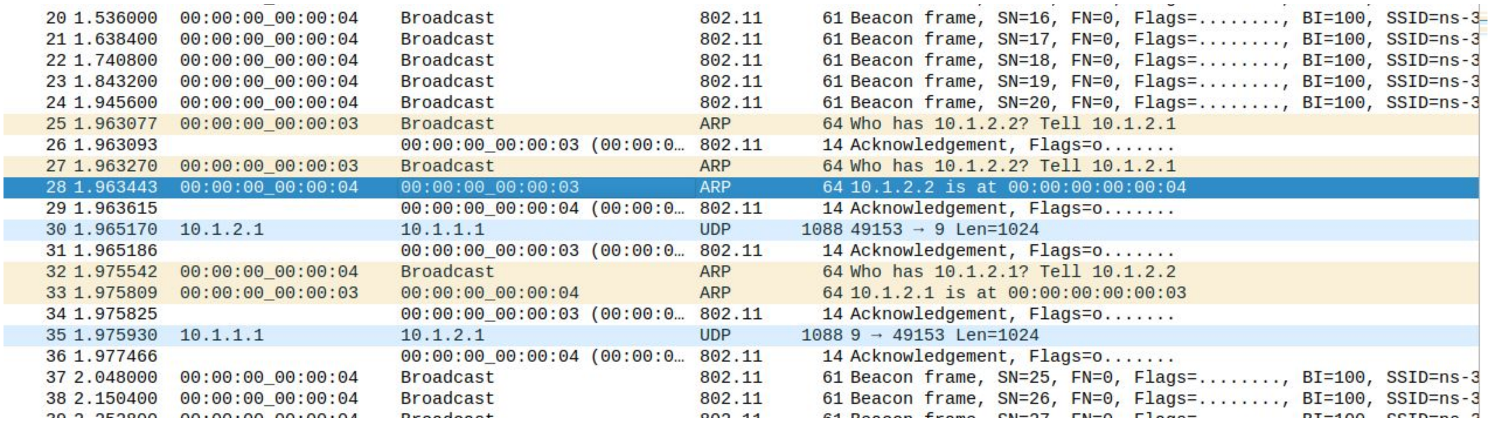
Running the simulation

We ran the simulation under the “RandomWalk2dMobilityModel” mobility model, producing the following console traces:



```
Flow ID                  : 1 ; 10.1.2.1 -----> 10.1.1.1
Duration                 : 10.0047
Last Received Packet     : 12.0047 Seconds
Throughput: 0.00882461 Mbps
---------------------------------------------------------------------------
Flow ID                  : 2 ; 10.1.1.1 -----> 10.1.2.1
Duration                 : 9.99747
Last Received Packet     : 12.0094 Seconds
Throughput: 0.00883097 Mbps
---------------------------------------------------------------------------
Flow ID                  : 1 ; 10.1.2.1 -----> 10.1.1.1
Duration                 : 11.0047
Last Received Packet     : 13.0047 Seconds
Throughput: 0.00875205 Mbps
---------------------------------------------------------------------------
Flow ID                  : 2 ; 10.1.1.1 -----> 10.1.2.1
Duration                 : 10.9975
Last Received Packet     : 13.0094 Seconds
Throughput: 0.00875779 Mbps
---------------------------------------------------------------------------
Flow ID                  : 1 ; 10.1.2.1 -----> 10.1.1.1
Duration                 : 12.0047
Last Received Packet     : 14.0047 Seconds
Throughput: 0.00869158 Mbps
---------------------------------------------------------------------------
Flow ID                  : 2 ; 10.1.1.1 -----> 10.1.2.1
Duration                 : 11.9975
Last Received Packet     : 14.0094 Seconds
Throughput: 0.0086968 Mbps
---------------------------------------------------------------------------
Flow ID                  : 1 ; 10.1.2.1 -----> 10.1.1.1
```

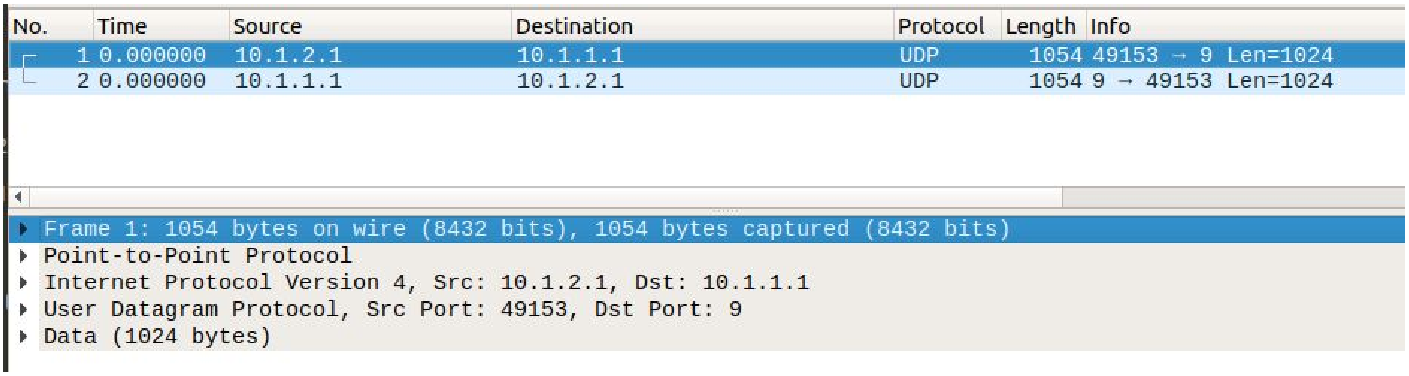
And the following pcap traces (pcap traces from all the 3 nodes), we used wireshark to preview them:



```
20 1.536000  00:00:00_00:00:04   Broadcast                     802.11      61 Beacon frame, SN=16, FN=0, Flags=........, BI=100, SSID=ns-3
21 1.638400  00:00:00_00:00:04   Broadcast                     802.11      61 Beacon frame, SN=17, FN=0, Flags=........, BI=100, SSID=ns-3
22 1.740800  00:00:00_00:00:04   Broadcast                     802.11      61 Beacon frame, SN=18, FN=0, Flags=........, BI=100, SSID=ns-3
23 1.843200  00:00:00_00:00:04   Broadcast                     802.11      61 Beacon frame, SN=19, FN=0, Flags=........, BI=100, SSID=ns-3
24 1.945600  00:00:00_00:00:04   Broadcast                     802.11      61 Beacon frame, SN=20, FN=0, Flags=........, BI=100, SSID=ns-3
25 1.963077  00:00:00_00:00:03   Broadcast                     ARP         64 Who has 10.1.2.2? Tell 10.1.2.1
26 1.963093                      00:00:00_00:00:03 (00:00:0…   802.11      14 Acknowledgement, Flags=o.......
27 1.963270  00:00:00_00:00:03   Broadcast                     ARP         64 Who has 10.1.2.2? Tell 10.1.2.1
28 1.963443  00:00:00_00:00:04   00:00:00_00:00:03             ARP         64 10.1.2.2 is at 00:00:00:00:00:04
29 1.963615                      00:00:00_00:00:04 (00:00:0…   802.11      14 Acknowledgement, Flags=o.......
30 1.965170  10.1.2.1            10.1.1.1                      UDP       1088 49153 → 9 Len=1024
31 1.965186                      00:00:00_00:00:03 (00:00:0…   802.11      14 Acknowledgement, Flags=o.......
32 1.975542  00:00:00_00:00:04   Broadcast                     ARP         64 Who has 10.1.2.1? Tell 10.1.2.2
33 1.975809  00:00:00_00:00:03   00:00:00_00:00:04             ARP         64 10.1.2.1 is at 00:00:00:00:00:03
34 1.975825                      00:00:00_00:00:03 (00:00:0…   802.11      14 Acknowledgement, Flags=o.......
35 1.975930  10.1.1.1            10.1.2.1                      UDP       1088 9 → 49153 Len=1024
36 1.977466                      00:00:00_00:00:04 (00:00:0…   802.11      14 Acknowledgement, Flags=o.......
37 2.048000  00:00:00_00:00:04   Broadcast                     802.11      61 Beacon frame, SN=25, FN=0, Flags=........, BI=100, SSID=ns-3
38 2.150400  00:00:00_00:00:04   Broadcast                     802.11      61 Beacon frame, SN=26, FN=0, Flags=........, BI=100, SSID=ns-3
```

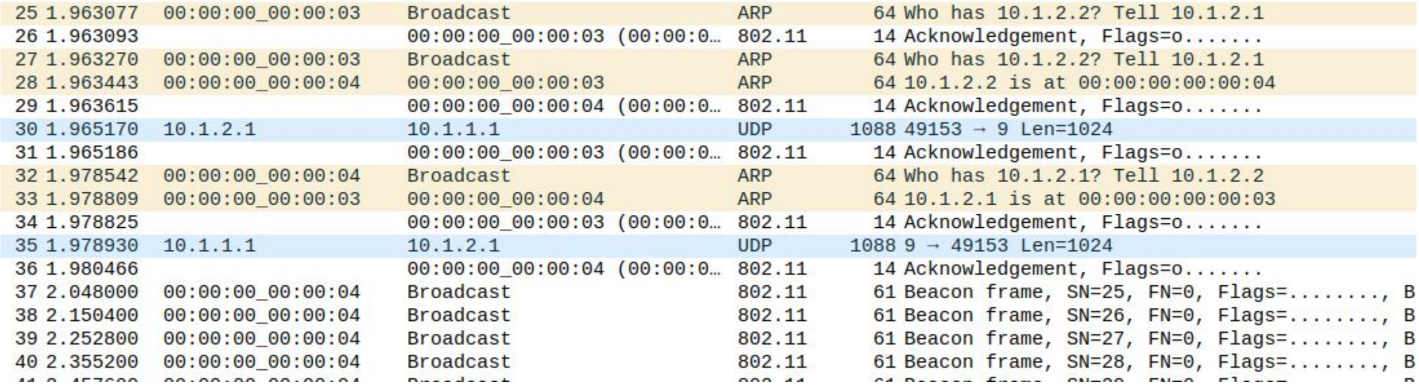
This is a pcap trace of the physical wifi channel, most frames are 802.11 beacon frames, with our UDP client request and UDP server response highlighted in blue.

The point to point network trace also shows these request/response packets:

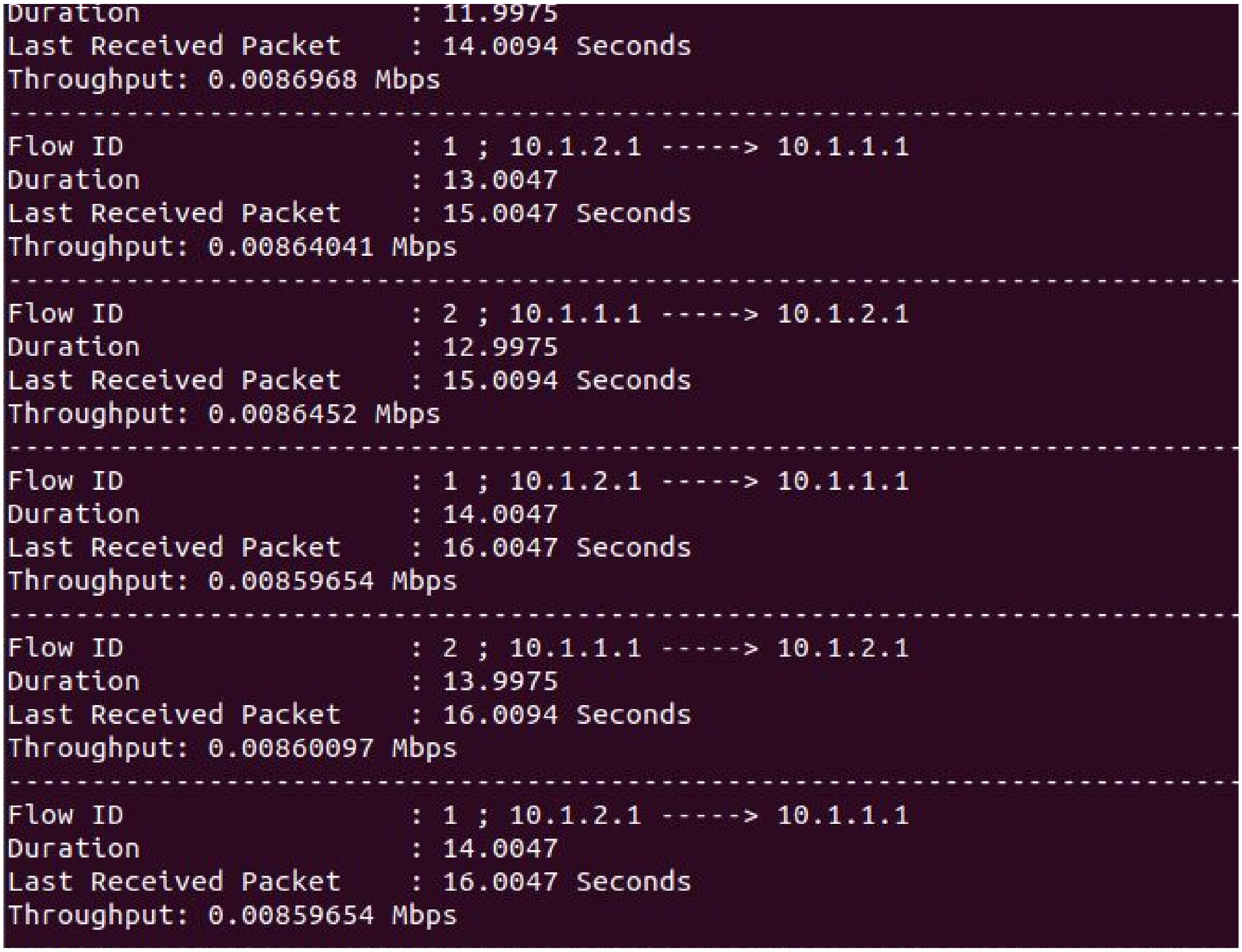


```
No.    Time       Source      Destination    Protocol  Length  Info
  1 0.000000   10.1.2.1    10.1.1.1       UDP       1054 49153 → 9 Len=1024
  2 0.000000   10.1.1.1    10.1.2.1       UDP       1054 9 → 49153 Len=1024

▸ Frame 1: 1054 bytes on wire (8432 bits), 1054 bytes captured (8432 bits)
▸ Point-to-Point Protocol
▸ Internet Protocol Version 4, Src: 10.1.2.1, Dst: 10.1.1.1
▸ User Datagram Protocol, Src Port: 49153, Dst Port: 9
▸ Data (1024 bytes)
```

Next, we repeated the simulation using the “ConstantPositionMobilityModel” representing constant stations, with the following results:



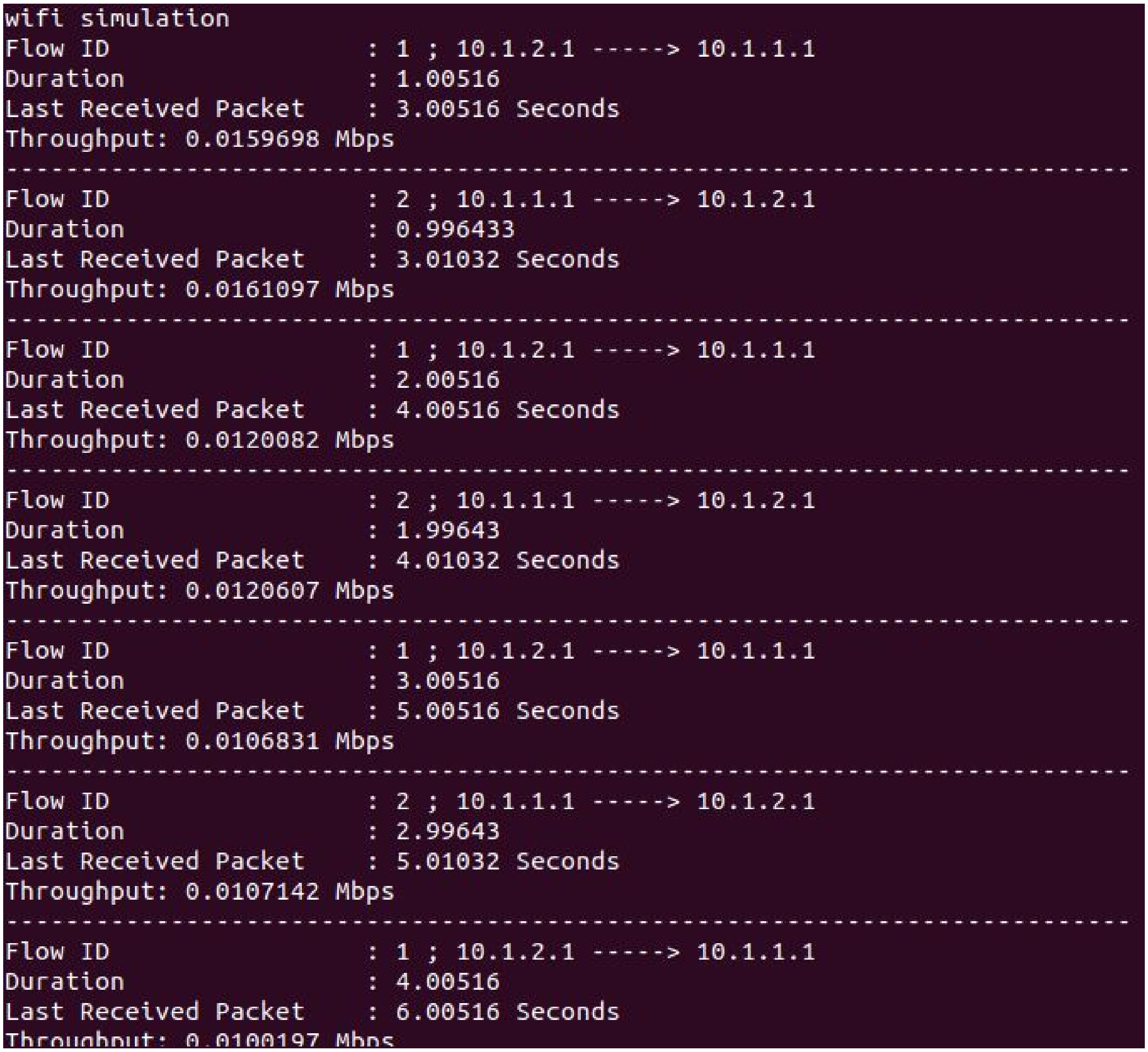
```
25 1.963077  00:00:00_00:00:03   Broadcast                     ARP         64 Who has 10.1.2.2? Tell 10.1.2.1
26 1.963093                      00:00:00_00:00:03 (00:00:0…   802.11      14 Acknowledgement, Flags=o.......
27 1.963270  00:00:00_00:00:03   Broadcast                     ARP         64 Who has 10.1.2.2? Tell 10.1.2.1
28 1.963443  00:00:00_00:00:04   00:00:00_00:00:03             ARP         64 10.1.2.2 is at 00:00:00:00:00:04
29 1.963615                      00:00:00_00:00:04 (00:00:0…   802.11      14 Acknowledgement, Flags=o.......
30 1.965170  10.1.2.1            10.1.1.1                      UDP       1088 49153 → 9 Len=1024
31 1.965186                      00:00:00_00:00:03 (00:00:0…   802.11      14 Acknowledgement, Flags=o.......
32 1.978542  00:00:00_00:00:04   Broadcast                     ARP         64 Who has 10.1.2.1? Tell 10.1.2.2
33 1.978809  00:00:00_00:00:03   00:00:00_00:00:04             ARP         64 10.1.2.1 is at 00:00:00:00:00:03
34 1.978825                      00:00:00_00:00:03 (00:00:0…   802.11      14 Acknowledgement, Flags=o.......
35 1.978930  10.1.1.1            10.1.2.1                      UDP       1088 9 → 49153 Len=1024
36 1.980466                      00:00:00_00:00:04 (00:00:0…   802.11      14 Acknowledgement, Flags=o.......
37 2.048000  00:00:00_00:00:04   Broadcast                     802.11      61 Beacon frame, SN=25, FN=0, Flags=........, B
38 2.150400  00:00:00_00:00:04   Broadcast                     802.11      61 Beacon frame, SN=26, FN=0, Flags=........, B
39 2.252800  00:00:00_00:00:04   Broadcast                     802.11      61 Beacon frame, SN=27, FN=0, Flags=........, B
40 2.355200  00:00:00_00:00:04   Broadcast                     802.11      61 Beacon frame, SN=28, FN=0, Flags=........, B
```



```
Duration                 : 11.9975
Last Received Packet     : 14.0094 Seconds
Throughput: 0.0086968 Mbps
--------------------------------------------------------------------------
Flow ID                  : 1 ; 10.1.2.1 -----> 10.1.1.1
Duration                 : 13.0047
Last Received Packet     : 15.0047 Seconds
Throughput: 0.00864041 Mbps
--------------------------------------------------------------------------
Flow ID                  : 2 ; 10.1.1.1 -----> 10.1.2.1
Duration                 : 12.9975
Last Received Packet     : 15.0094 Seconds
Throughput: 0.0086452 Mbps
--------------------------------------------------------------------------
Flow ID                  : 1 ; 10.1.2.1 -----> 10.1.1.1
Duration                 : 14.0047
Last Received Packet     : 16.0047 Seconds
Throughput: 0.00859654 Mbps
--------------------------------------------------------------------------
Flow ID                  : 2 ; 10.1.1.1 -----> 10.1.2.1
Duration                 : 13.9975
Last Received Packet     : 16.0094 Seconds
Throughput: 0.00860097 Mbps
--------------------------------------------------------------------------
Flow ID                  : 1 ; 10.1.2.1 -----> 10.1.1.1
Duration                 : 14.0047
Last Received Packet     : 16.0047 Seconds
Throughput: 0.00859654 Mbps
```

We note here that the throughput parameter is very stable, compared to the mobile stations case.

We also tried the “RandomDirection2dMobilityModel” with these results:



```
wifi simulation
Flow ID                 : 1 ; 10.1.2.1 -----> 10.1.1.1
Duration                : 1.00516
Last Received Packet    : 3.00516 Seconds
Throughput: 0.0159698 Mbps
---------------------------------------------------------------------------
Flow ID                 : 2 ; 10.1.1.1 -----> 10.1.2.1
Duration                : 0.996433
Last Received Packet    : 3.01032 Seconds
Throughput: 0.0161097 Mbps
---------------------------------------------------------------------------
Flow ID                 : 1 ; 10.1.2.1 -----> 10.1.1.1
Duration                : 2.00516
Last Received Packet    : 4.00516 Seconds
Throughput: 0.0120082 Mbps
---------------------------------------------------------------------------
Flow ID                 : 2 ; 10.1.1.1 -----> 10.1.2.1
Duration                : 1.99643
Last Received Packet    : 4.01032 Seconds
Throughput: 0.0120607 Mbps
---------------------------------------------------------------------------
Flow ID                 : 1 ; 10.1.2.1 -----> 10.1.1.1
Duration                : 3.00516
Last Received Packet    : 5.00516 Seconds
Throughput: 0.0106831 Mbps
---------------------------------------------------------------------------
Flow ID                 : 2 ; 10.1.1.1 -----> 10.1.2.1
Duration                : 2.99643
Last Received Packet    : 5.01032 Seconds
Throughput: 0.0107142 Mbps
---------------------------------------------------------------------------
Flow ID                 : 1 ; 10.1.2.1 -----> 10.1.1.1
Duration                : 4.00516
Last Received Packet    : 6.00516 Seconds
Throughput: 0.0100197 Mbps
```

Notice that the throughput is getting less and less as the station moves away from the access point.

The WIFI channel parameters that can possibly enhance the communication through the network are:

1. wifi channel delay time
2. congestion (the number of active wifi stations in range)
3. distance from the access point
4. access point transmitting power (SNR is a function of the transmitting power)