Wireless Communications

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Contents

1 Implementation

By using the Experimental Infrastructure Indoor Testbed of NITlab, I Create a Pair of Access Point and Station which is Transmitting a UDP Traffic pursuing the following Specifications:

1. Channel 2 with Bandwidth = 20MHz and Frequency Band at 2.4GHz
   - Since my AEM is 03121 last digit is 1 and Channel Number = Last Digit + 1
2. Operating on Protocol IEEE 802.11g
3. Name of AP : SSID →apostolopoulou

2 General Steps Followed

2.1 Access Point as Server

1. Selection of Nodes form Nitos by using my Slice-Name
2. Connect to Nitlab3 Server with ssh:

   ssh iapostolopoulou@nitlab3.inf.uth.gr

3. Loading an OMF-compatible Image on my Resources:

   omf load -i baseline_wireless_communications.ndz -t node056,node059

4. Turning ON the Nodes I will use :

   omf tell -a on -t node056,node059

To Run the Experiment Scenarios I need to Create an Access Point Node and a Station Node. In order to do that, I am runnunig the folowing commands:

1. Access Point Node 056
   (a) Connect to Node with ssh :

   ssh root@node056

   (b) Enable Wireless Driver :

   modprobe ath9k

   (c) Enable Wireless Interface & Set IP Address:

   ifconfig wlan0 192.168.2.56 up

   (d) Enable Access Point:

   hostapd -dd hostap.conf

   (e) Initialize iperf Server & Client :

   iperf -s -u -p 7010 -i 1

2. Station Node 059
   (a) Connect to Node with ssh :

   ssh root@node056

   (b) Enable Wireless Driver :

modprobe ath9k

(c) Enable Wireless Interface & Set IP Address:

ifconfig wlan0 192.168.2.59 up

(d) Connect to Access Point :

iw dev wlan0 connect apostolopoulou

(e) Initialize iperf Server & Client :

iperf -c 192.168.2.56 -u -b 10M -p 7010 -t 30 -i 1

2.2 Station as Server & Access Point as Client

1. Selection of Nodes form Nitos by using my Slice-Name
2. Connect to Nitlab3 Server with ssh:

   ssh iapostolopoulou@nitlab3.inf.uth.gr

3. Loading an OMF-compatible Image on my Resources:

   omf load -i baseline_wireless_communications.ndz -t node056,node059

4. Turning ON the Nodes I will use :

   omf tell -a on -t node056,node059

To Run the Experiment Scenarios I need to Create an Access Point Node and a Station Node. In order to do that, I am runnunig the folowing commands:

1. Access Point Node 056 as a Server
   (a) Connect to Node with ssh :

   ssh root@node056

   (b) Enable Wireless Driver :

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   (c) Enable Wireless Interface & Set IP Address:

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   (d) Enable Access Point:

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   (e) Initialize iperf Server & Client :

   iperf -c 192.168.2.56 -u -b 10M -p 7010 -t 30 -i 1

2. Station Node 059 as Cient
   (a) Connect to Node with ssh :

   ssh root@node056

   (b) Enable Wireless Driver :

   modprobe ath9k

   (c) Enable Wireless Interface & Set IP Address:

ifconfig wlan0 192.168.2.59 up

(d) Connect to Access Point :

iw dev wlan0 connect apostolopoulou

(e) Initialize iperf Server & Client :

iperf -s -u -p 7010 -i 1

3 Scenarios

In this Assignment I am using Node056 as an Access Point and Node059 as Station.

After I have Created the Access Point on Node056 and Connected the Station Node 059 by running the previous general commands from Section 2.2, I start running the following experiment scenarios.

3.1 Scenario 1

From the Access Point Node056 of the Network I am sending UDP Traffic to Station Node059 pursuing the followings:

1. Transmission Duration 30 seconds
2. Transmission Speed 5Mbps

In order to run this Experiment I use the following commands for Access Point in 2 terminals connected to Node 056 :

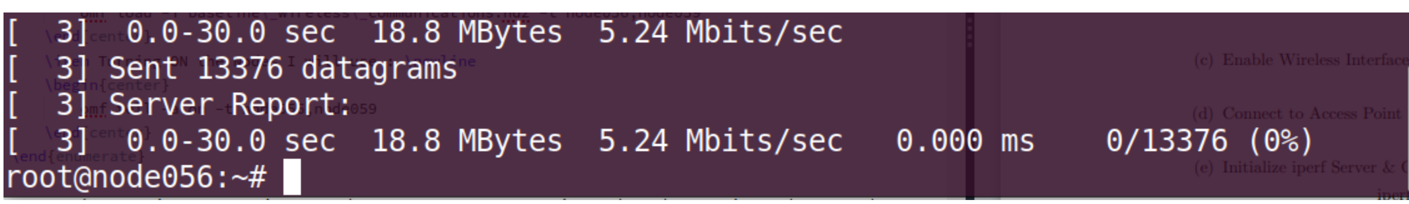
Terminal 1: hostapd -dd hostap.conf

Terminal 2: iperf -c 192.168.2.59 -u -b 5M -p 7010 -t 30 -i 1

And the following command for the Station Node 059 in 1 terminal:

iperf -s -u -p 7010 -i 1

Below there are some Results from the Scenario 1 Experiment:



```
[  3]  0.0-30.0 sec  18.8 MBytes  5.24 Mbits/sec
[  3] Sent 13376 datagrams
[  3] Server Report:
[  3]  0.0-30.0 sec  18.8 MBytes  5.24 Mbits/sec   0.000 ms    0/13376 (0%)
root@node056:~#
```

Figure 1: Shows the Results of the UDP Communication from Server.

By observing the packet traffic on the Server Side, I see that:

$$maxBandwidth = 5.24 Mbits/Sec$$

I can also observe that the throughput at this transmission rate is very stable and there is zero packet loss. Due to the reason that 5Mbps is not the common transmission rate in WiFi IEEE 802.11g Standard the throughput is stable and exactly the requested rate.

3.2 Scenario 2

From the Access Point Node056 of the Network I am sending UDP Traffic to Station Node059 pursuing the followings:

1. Transmission Duration 30 seconds
2. Transmission Speed 15Mbps

In order to run this Experiment I use the following commands for Access Point in 2 terminals connected to Node 056 :

Terminal 1: hostapd -dd hostap.conf

Terminal 2: iperf -c 192.168.2.59 -u -b 15M -p 7010 -t 30 -i 1

And the following command for the Station Node 059 in 1 terminal:

iperf -s -u -p 7010 -i 1

Below there are some Results from the Scenario 2 Experiment:

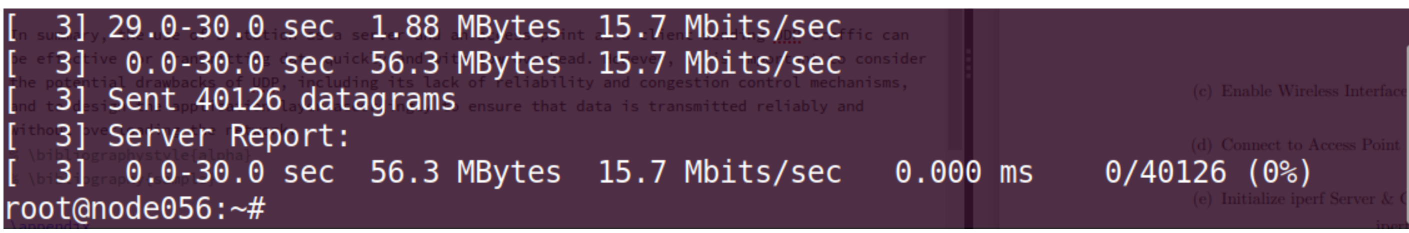


Figure 2: Shows the Results of the UDP Communication from Server.

By observing the packet traffic on the Server Side, I see that:

$$maxBandwidth = 15.8Mbits/Sec$$

I can also observe that the Bandwidth at this transmission rate is very stable with zero packet loss. As mentioned above low transmission rate are not common in WiFi IEEE 802.11g Standard, thus the Throughput does not diverge.

3.3 Scenario 3

From the Access Point Node056 of the Network I am sending UDP Traffic to Station Node059 pursuing the followings:

1. Transmission Duration 30 seconds
2. Transmission Speed 100Mbps

In order to run this Experiment I use the following commands for Access Point in 2 terminals connected to Node 056 :

Terminal 1: hostapd -dd hostap.conf

Terminal 2: iperf -c 192.168.2.59 -u -b 100M -p 7010 -t 30 -i 1

And the following command for the Station Node 059 in 1 terminal:

iperf -s -u -p 7010 -i 1

Below there are some Results from the Scenario 3 Experiment:

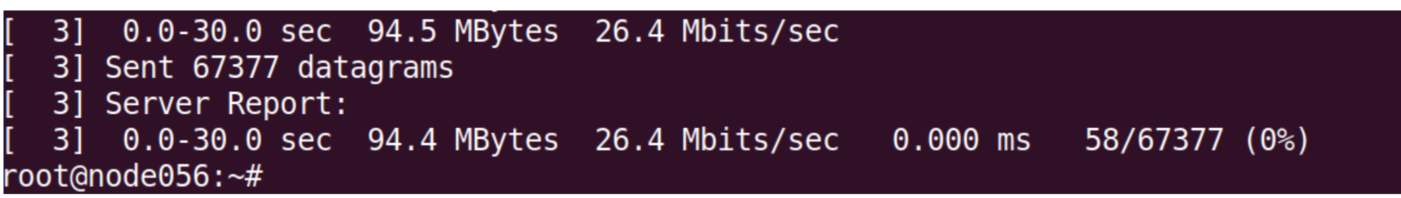


Figure 3: Shows the Results of the UDP Communication from Server.

By observing the packet traffic on the Server Side, I see that:

$$maxBandwidth = 27.3 Mbits/Sec$$

Bandwidth is more stable than Client's, after the first packet received with:

$$minimumBandwidth = 22.0 Mbit/Sec$$

Additionally, there is a small packet loss from 0.26% - 2.2%

Furthermore, the Bandwidth between Intervals has a lot of ups & downs, in range of 22.4%-27.4%

4 Theoretical Analysis

In this scenario, the station is acting as a server, which means that it is waiting for incoming UDP packets from the access point acting as a client. The access point, acting as a client, will send UDP packets to the station as a server.

The UDP protocol does not guarantee reliable delivery of data. It does not provide mechanisms for detecting lost or corrupted packets, nor does it provide any re-transmission or flow control mechanisms. Therefore, it is up to the application layer to implement any necessary mechanisms to ensure reliable delivery of data.

In terms of performance, UDP is a lightweight protocol that has low overhead and can transmit data quickly. However, because it does not provide any congestion control mechanisms, it can potentially cause congestion on the network if too much traffic is sent too quickly. Therefore, it is important to use UDP only when necessary and to carefully design the application layer to avoid overloading the network.

As for the Transmission Rates used for Wireless Communications depend on the specific technology and standards being used. In the Standard I am using for the Experiments (IEEE 802.11g) it is supported a maximum theoretical transmission rate of 54 Mbps. Although, the actual data transfer rate is lower and typically ranging between 20-30 Mbps.

Usually lower transmission rates are not used for WiFi Wireless Communications, thus do not diverge a lot from the requested rate.

Most of the diversions from the Expected Data Transfer Rate are caused due to Network Overhead, Signal Strength and Distance between the Devices.

5 Conclusions

In summary, the use of a station as a server and an access point as a client sending UDP traffic can be effective for transmitting data quickly and with low overhead. However, it is important to consider the potential drawbacks of UDP, including its lack of reliability and congestion control mechanisms, and to design the application layer accordingly to ensure that data is transmitted reliably and without overloading the network.

As the Experiment proves the Theory in Scenario 3 where the Requested Data Transfer Rate is 100Mbps the outcome is approximately 30Mbps, due to the Propagation Delays, Weak Signal Strength, Interference from other Node Traffic, the Topology of the Nodes I used and the Number of Nodes Transmitting Traffic while sharing the same Network.

Additionally, the use of UDP traffic instead of TCP traffic can also impact the network's throughput. UDP is a transport protocol that does not have any built-in congestion control mechanism, which means it can send data as fast as possible without regulating the network's congestion. Therefore, if you use UDP traffic in a wireless network, it can lead to higher network congestion and reduce the overall throughput.

In this case, it's possible that the wireless network is capable of transmitting data at up to 100Mbps, but when using UDP traffic, the actual maximum throughput achievable is 30Mbps due to congestion or other factors.

6 Configuration File

The configuration File used in Access Point Side must be modified as shown in the following link.