# LAB 4 Measuring performance of an Ad Hoc network

Fatema Mirza & Mohammad Newaj Jamil

D7030E Advanced Wireless Networks

# LAB 4 Measuring performance of an Ad Hoc network

by

Fatema Mirza & Mohammad Newaj Jamil

| | | |
|---|---|---|
| Submission Deadline: | October 18, 2021 | |
| Teachers: | Dr. Evgeny Osipov, | LULEÅ TEKNISKA UNIVERSITET |
| | Ahmed Afif Monrat, | LULEÅ TEKNISKA UNIVERSITET |

# Contents

# List of Tables

# List of Figures

# 1

# Scenario 1 –The effect of signal attenuation on communication ranges in WiFi networks

An ad hoc network is a network that is consists of individual devices that can communicate with each other directly bypassing the hardware that gate keeps access or central access point such as a router (techopedia, 2021).

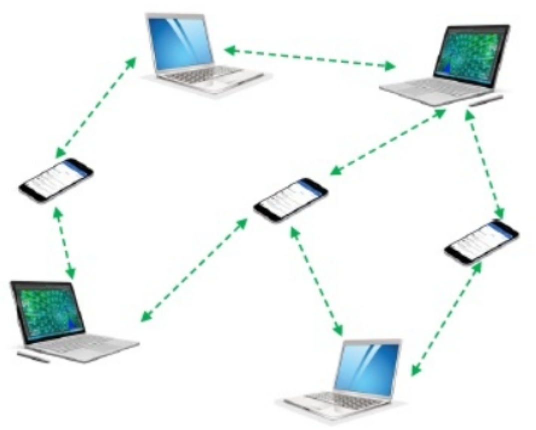

Figure 1.1: Ad hoc network

## 1.1. Create an Ad hoc scenario.

The Ad hoc scenario is created using the following topology.

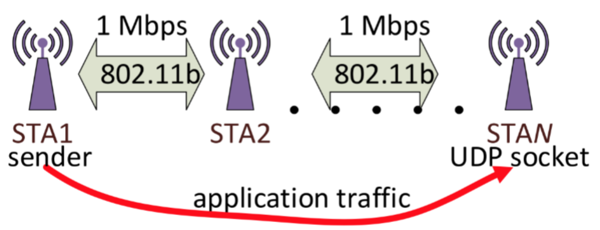


Figure 1.2: Ad hoc Scenario

The following settings were used:

1. Physicalmode is "DsssRate1Mbps"
2. "ns3::ConstantRateWifiManager" is used to keep the bitrate constant
3. MAC settings set to be agreed with the IEEE 802.11b specification
4. Two-Ray Ground propagation model is used
5. Each node is set to be a distance of 200 metres from amongst each other
6. Socket is kept open on the last station
7. onOff application is installed an on the first station
8. Routing is enabled between the stations

## 1.2. Simulate scenario for different number of stations [3, 4, 5, 6].

This will be demonstrated later in section 1.4.

## 1.3. Also vary the UDP payload in the range 300B, 700B, 1200B.

This will be demonstrated later in section 1.4.

## 1.4. For EACH number of stations from the range run experiment with EVERY packet size. Calculate an application level throughput in bits per second.

The throughput is calculated for different number of stations and UDP payload for UDP.

Table 1.1: Comparison of throughput for different number of stations and UDP payload for UDP

| Bitrate (Mbps) | Payload (B) | Throughput (kbps) | App. Throughput (kbps) |
|---|---|---|---|
| 3 | 300 | 272 | 224.1758 |
| 3 | 700 | 222 | 203.4031 |
| 3 | 1200 | 311 | 295.2532 |
| 4 | 300 | 203 | 167.3077 |
| 4 | 700 | 219 | 200.6545 |
| 4 | 1200 | 189 | 179.4304 |
| 5 | 300 | 137 | 112.9121 |
| 5 | 700 | 134 | 122.7749 |
| 5 | 1200 | 128 | 121.519 |
| 6 | 300 | 107 | 88.18681 |
| 6 | 700 | 54 | 49.47644 |
| 6 | 1200 | 107 | 101.5823 |

## 1.5. Plot graphs showing the dependency of the throughput versus packet size for each number of stations.

Using the information from table 1.1, the following plots were constructed.

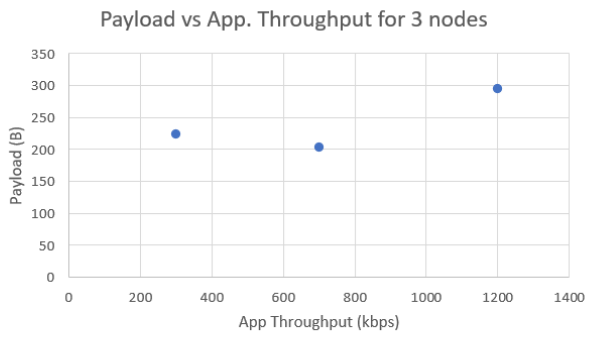


Figure 1.3: Payload vs App. Throughput for 3 nodes

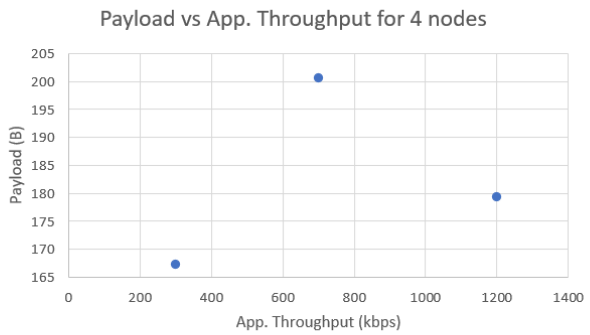


Figure 1.4: Payload vs App. Throughput for 4 nodes

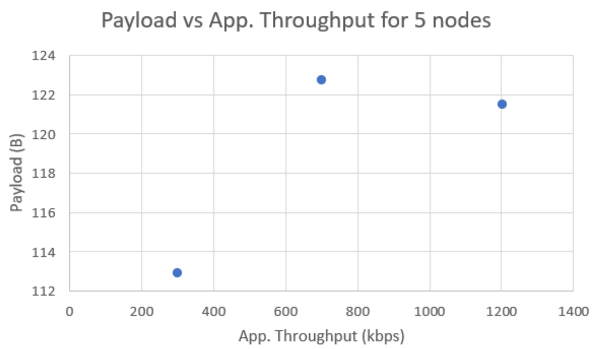


Figure 1.5: Payload vs App. Throughput for 5 nodes

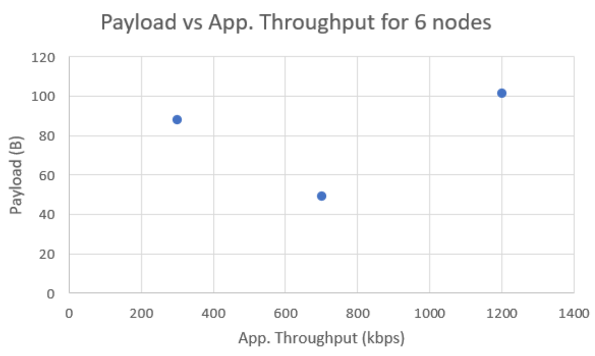


Figure 1.6: Payload vs App. Throughput for 6 nodes

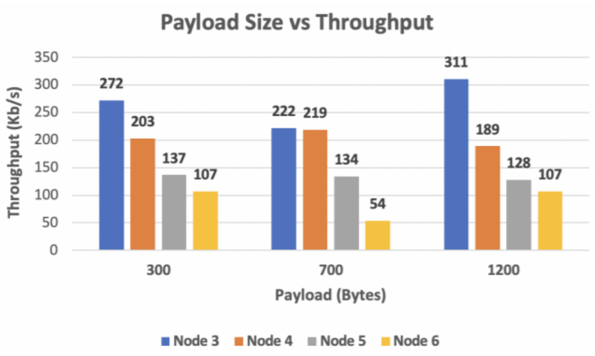


Figure 1.7: Payload vs App. Throughput for all nodes

## 1.6. Plot a graph showing the dependency of the throughput versus number of stations for packet size 1200B.

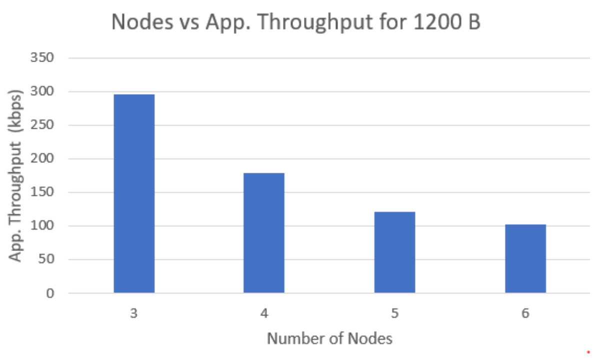


Figure 1.8: Nodes vs App. Throughput for 1200 B

It can be deduced that as the number of nodes increase, the throughput decreases. This is because the distance between the nodes increases with the increase in number of nodes.

## 1.7. Compare nominative bitrate of physical layer and real throughputs on application layer. Be able to explain dependencies on your plots.

Table 1.1 and figure 1.7 demonstrates that greater the number of nodes or stations, lower is the throughput. This is because the packet has to traverse greater distance with more number of nodes, which takes a longer time, and therefore reduces the throughput. Furthermore, with greater distance there is a greater probability of collisions, interference from other signals as well as signal attenuation. This all contribute to the overall reduction in throughput. As expected, the bitrate increases, the throughput increases, because it can support more transmission of data at one go. An interesting fact to note is that the size of the packet has no impact on the throughput and it varies in a random manner, as clearly illustrated by figures 1.3-1.6.

## 1.8. Reflect (speculate) on how one can theoretically predict the best packet size in order to minimize transmission time for 1GB of data in Ad Hoc multi-hop scenario.

The transmission time will depend on the number of stations and the distances between them. The payload size behaves randomly with constant bitrate versus number of nodes in relation to throughput.

$Throughput = \frac{\text{data bits}}{time}$, so $Time = \frac{\text{data bits}}{throughput}$ and therefore, it can be said that time and throughput are inversely proportional. Keeping all these in mind, a conclusion can be formed.

For 3 nodes placed at equidistant of 200m to each other, the best packet size for 1GB of data would be a payload of 1200B can be speculated to be best, because this gives the highest throughput, hence the lowest time.

For 4 nodes placed at equidistant of 200m to each other, the best packet size for 1GB of data would be a payload of 700B can be speculated to be best, because this gives the highest throughput, hence the lowest time.

For 5 nodes placed at equidistant of 200m to each other, the best packet size for 1GB of data would be a payload of 300B can be speculated to be best, because this gives the highest throughput, hence the lowest time.

For 6 nodes placed at equidistant of 200m to each other, the best packet size for 1GB of data would be a payload of 1200B can be speculated to be best, because this gives the highest throughput, hence the lowest time.

## 1.9. Change type of traffic to TCP, i.e. uncomment corresponding part of code for the TCP socket and delete the UDP socket. Simulate scenario for 3 stations and two different lengths of packets 300B and 1200B. Calculate application level throughput for stations 3. Compare results with corresponding values for UDP traffic. Draw your conclusions.

The following code snippet was added for TCP communication.

```
uint16_t port = 50000;
Address sinkLocalAddress (InetSocketAddress (Ipv4Address::GetAny (), port));
PacketSinkHelper sinkHelper ("ns3::TcpSocketFactory", sinkLocalAddress);
ApplicationContainer sinkApp = sinkHelper.Install (wifiStaNodes.Get (nWifi-1));
sinkApp.Start (Seconds (10.0));
sinkApp.Stop (Seconds (100.0));
```

Figure 1.9: Code snippet for TCP communication

The experiment was run with 3 nodes for 300B and 1200B. The results were tabulated and illustrated graphically.

Table 1.2: Comparison of throughput for different UDP payload for TCP

| Nodes | Payload (B) | Throughput (kbps) | App. Throughput (kbps) |
|---|---|---|---|
| 3 | 300 | 247 | 203.5714 |
| 3 | 1200 | 247 | 234.4937 |

The physical layer throughput remained constant regardless of the packet size for TCP. UDP results in better throughput compared to TCP. This is because TCP has a header size of 20 bytes whereas UDP has of 8 bytes.

# Bibliography

techopedia. (2021). *Ad Hoc Network*. Retrieved October 9, 2021, from https://www.techopedia.com/definition/5868/ad-hoc-network