NS3 Project Report

StudentNum:4519051

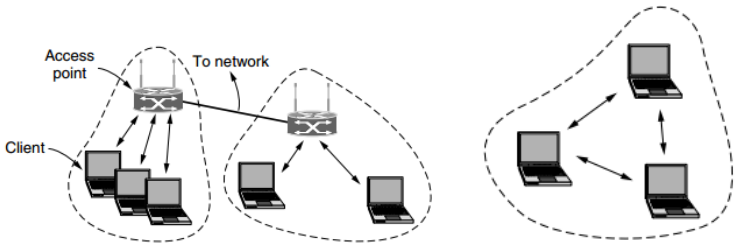
May 3, 2016

1 Introduction

Wireless technologies are playing an increasingly prominent role in the world Internet infrastructure. IEEE 802.11b standard is one of the popular technologies in the wireless local area network (WLAN) market. It operates in the unlicensed frequency band of 2.4–2.485 GHz and provides low cost wireless Internet capability for users.

In IEEE802.11b standard, the data transmission rate is able to be up to 11 Mbps at the physical layer. The channel access protocol named Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) is used at the MAC layer. At the data link layer, the frame contains 128-bit preamble, 16-bit delimiter, 48-bit Physical Layer Convergence Protocol (PLCP) header as well as a 24-byte MAC-layer header and variable size payload which carrying IP packets. When the frame is successfully transformed, the receiver will send a short acknowledgement. The frame without an acknowledgement will be retransmitted by the sender after the backoff period.

There are two modes, including infrastructure mode and ad hoc network [2]. In this project, the infrastructure mode using AP (Access Point) to connect clients is simulated with NS3. The performance of Wifi IEEE802.11b network is investigated through the various parameters.



(a) Infrastructure mode (b) Ad-hoc mode

Figure 1: The 802.11 architecture

2 Background

2.1 Scenario

The focus of this project is on the performance of Wifi IEEE802.11b network in a classroom as shown in figure 2. There are one Wifi AP and the students are clients. The number of the clients, the size of the classroom and the payload size as well as the data rate will affect the throughput, delay and other performance to some extent. Thus, this scenario is simulated and tested with NS3.

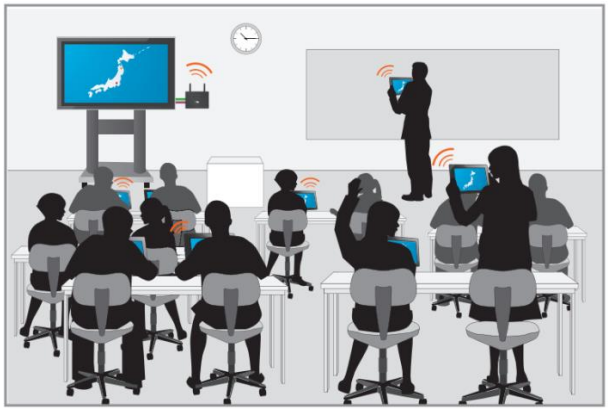


Figure 2: The classroom scenario of wireless network

2.2 Hypothesis

Before obtaining the results, there are some hypothesis on the effect of performance.

Wireless is a shared medium, it means that all clients and Aps are on the same channel and they compete for the same limited bandwidth. Thus the increasing number of clients connected to the AP would cause less throughput of every node.

The size of classroom will affect the distance from the AP to clients. The longer the distance, the more interference and attenuation will happen. So the less range of wireless network may have higher performance.

However, throughput will increase with the increasing size of payload and data rate. When the payload increases to a certain point, the throughput will reduce due to the retransmission.

3 Implementation

In this project, the NS3 is used for the simulation. NS3 as the discrete-event network simulator for internet systems is a free software based on C++ and Python. It is widely used for research and educational use. NS3 provides many containers and helper to help the user build and setup the system.

The first step is to create an AP and variable number of station nodes. Then the physical layer is configured. The purpose is to build the Wifi IEEE802.11b network, so the standard is set to be 802.11b through WifiHelper. Then the rate manager is set to be ConstantRateWifiManager which use constant rates for data transmission. It means that every packet is sent in the same transmission rate. The YansWifiPhyHelper is default, so the NistErrorRateModel is used. Finally, the propogation delay is set to ConstantSpeed, while the propogation loss is in FriisPropagationLossModel. In the Mac layer, it is set to a non-Qos upper mac through NqosWifiMacHelper and the ssid and devices are configured.

After the above configuration, the position and mobility of the nodes is set up. In this simulation, the access point is in fixed position and the station nodes are allocated on the grid with a constant interval. And the mobility of these station nodes is in the RandomWalk2DMobilityModel, so the station nodes are able to move in a random direction and at a random speed. The range of the movement is limited in a rectangle area. Subsequently, the InternetStack is set up and addresses are arranged through InternetStackHelper and Ipv4AddressHelper respectively.

Then it is the application part and the traffic is created. The ApplicationCon-

tainer is used to set the start time and the stop time. As for the UdpServerHelper and UdpClientHelper, they are used to set up the attributes like the packet size in the UDP traffic.

Finally, the throughput and mean delay are calculated through the flow monitor. The flow monitor monitors and reports back packets flows which is observed during the simulation. What is more, it is responsible for coordinating efforts regarding probes, and collects end-to-end flow statistics.

The function to get the throughput is listed below.

$$Throughput = \frac{rxBytes * 8.0}{(timeLastRxPacket - timeFirstTxPacket) * 1024 * nNodes}$$

4 Results

The simulation of the Wifi IEEE 802.11b network is implemented in NS3. In order to build and run this simulation, the waf compiler is used. Waf, a build automation tool written in Python, can assist the compilation of programs and installation of software. One of the simulation result obtained through the waf tool is shown in the figure 3. Here the number of node is 10, data rate and payload are 11Mbps and 1427.

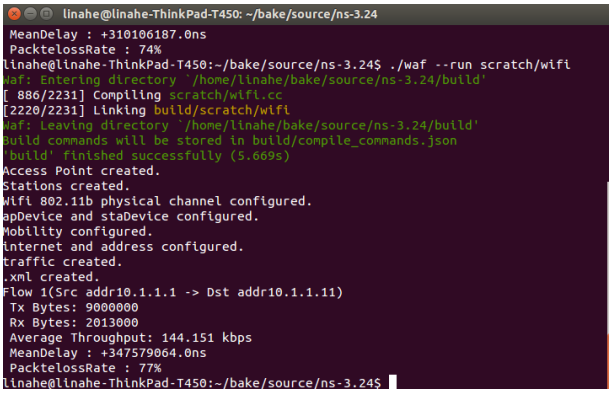


Figure 3: The results of NS3

The simulation can also be presented by NetAnim. NetAnim is an offline animator based on the Qt toolkit. It animates the simulation using an XML

trace file which is collected during simulation. The example result is shown in figure 4.

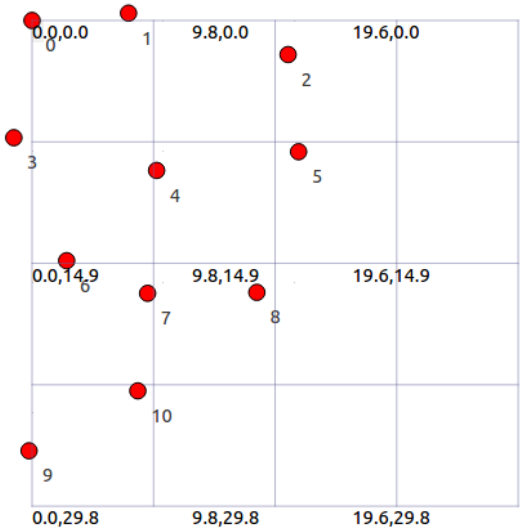
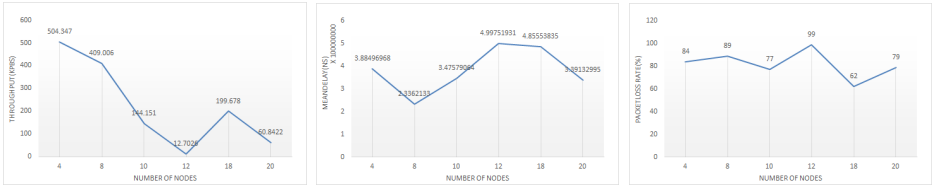


Figure 4: The results in NetAnim

4.1 The node number VS Performance

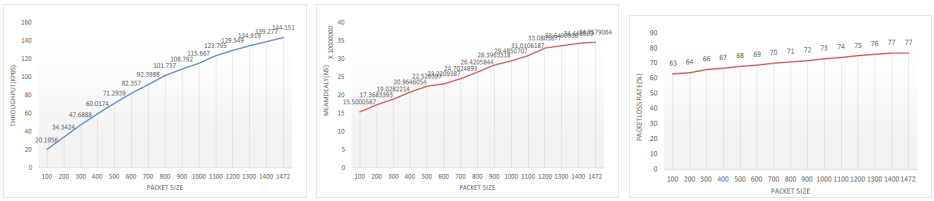


(a) Nodes VS Throughput (b) Nodes VS Mean Delay (c) Nodes VS Packet Loss Rate

Figure 5: Nodes VS Performance

With the increasing number of nodes, the performance of the wireless network including the throughput, mean delay and loss packet rate changes sequentially. In terms the throughput, the throughput decreases significantly at the beginning, then there is a fluctuation in the throughput. The main trend of the mean delay is increasing to a point and then reduce. As for the packet loss rate, the results fluctuate when increasing the number of the nodes. The sample data is not enough to indicate the general regulars.

4.2 The packet size VS Performance

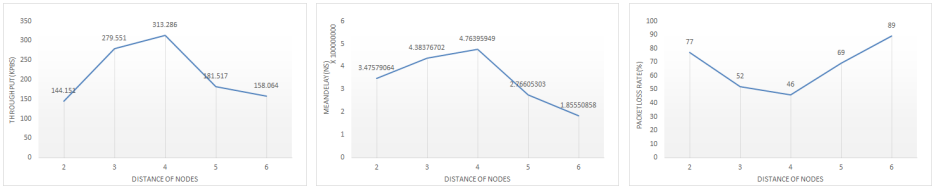


(a) Packet size VS Throughput (b) Packet size VS Mean Delay (c) Packet size VS Packet Loss Rate

Figure 6: Packet size VS Performance

In this section, the performance of the wireless network is compared with the various packet size. From the results of simulation, the throughput, mean delay as well as the loss packet rate all increase more or less with the increasing number of nodes.

4.3 The distance VS Performance



(a) Distance VS Throughput (b) Distance VS Mean Delay (c) Distance VS Loss Packet Rate

Figure 7: Distance VS Performance

Based on the results of the simulation with the various distance, there is a point where the wireless network has the higher performance. It means that the the network has higher throughput and lower packet loss rate at a certain distance. But the number of sample limited the results and analysis.

5 Conclusion

During this assignment, the wireless network is simulated in NS3. From the analysis of the results in different conditions, we found that the throughput,

mean delay and loss packet rate all increase when increasing the packet size. The other results are limited by the limited number of sample. But the three performance should be balanced when designing the network and deciding the number of nodes, the packet size and the distance between the nodes.

References

[1] https://www.nsnam.org/docs/tutorial/html/index.html

[2] Andrew S. Tanenbaum, David J. Wetherall. Computer Network. 5th ed, 2011.

[3] https://www.nsnam.org/docs/manual/html/index.html

[4] https://www.nsnam.org/docs/models/html/index.html

[5] Guangwei Bai and C. Williamson, "Simulation evaluation of wireless Web performance in an IEEE 802.11b classroom area network," Local Computer Networks, 2003.