Building Topologies (Part 2)

BI12-076 Mai Hai Dang

April 6, 2024

1 Purpose of the simulation

Simulate a wifi network topology using ns-3. Understanding the implementation of the wifi protocol stack, how the communication works.

2 Objects of the simulation

The network technology used are models of a wireless network interface controller base on the IEEE 802.11 standard from ns-3 library `ns3::WifiNetDevice`, which contains different layer of wifi protocol and their corresponding implementation:

- PHY layer: `ns3::YansWifiChannel`
- MAC layer:
  - Station: `ns3::StaWifiMac`
  - Access Point: `ns3::ApWifiMac`

There will also be a simple point-to-point channel that connect the wifi network to a single server node.

3 Data Collection

We will be capturing the network traffic through the point-to-point channel, and the wifi physical layer. The data collecting window will be in 10 seconds when the simulation run. Then the trace will be collect into pcap format.

4 Metrics

We will calculate the packet delivery ratio and average delay of received packets of flows inside the network.

5 Scenario Design

5.1 General Topology

For the general topology (see Figure 1) there will be total of four nodes, in which:

- Two stationary nodes, responsible for data transmitting (STA1, STA2)
- One access point node, which is also one end node of the point-to-point channel (AP)
- Server node, the remaining node of the point-to-point channel (Server)

Both point-to-point channel and the wifi network nodes will have IPv4 address of 10.1.1.0 and 10.1.2.0 respectively.

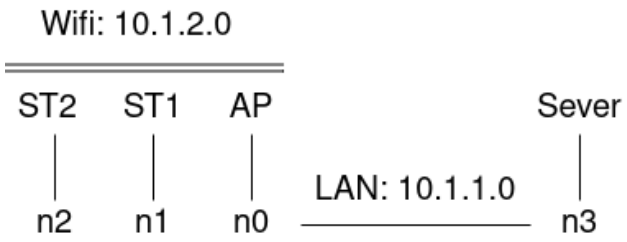

Figure 1: Topology

5.2 Scenario 1

The STA1 is a client that sends 100 packets every 0.05s within 10s to the Server. We will set the mobility to default, which all the node are in the same position.

In reality, this is not probable as two devices cannot occupy the exact same physical space. But in network simulation, the position of a node is used mainly to calculate the distance between nodes, which affects the signal strength and propagation delay.

5.3 Scenario 2

All nodes are arranged on an initial grid with $\Delta x = 5$, $\Delta y = 10$, the nodes will insert by row (see Figure 2). 2 STAs move in random direction and speed respecting to Random Walk 2D Mobility Model. Where the AP stay in the same position respecting Constant Position Mobility Model. The traffic generated will be the same as *Scenario 1*, but with both STAs sending. This will introduce more complexity and better simulate reality.

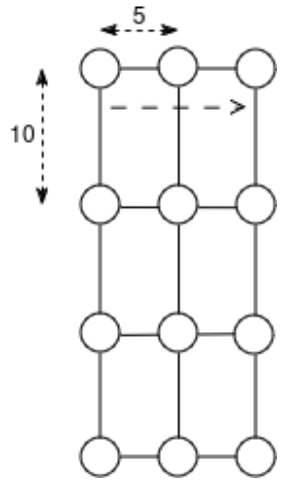

Figure 2: Topology

6 Analysis

From *Scenario 1* output below, we can see that all the packets are delivered with no problem:

```
Flow 1 (10.1.2.1 -> 10.1.1.1)
  Tx Packets: 100
  Rx Packets: 100
  Delivery Ratio: 1
  Average Delay: 0.00010498
```

From *Scenario 2* output below, with both station trying to send packets through the access point, there exist a flow with higher average delay probably due to queueing. From the trace file, which was rather hard to read, there was one node that send data to an intermediate node, before sending it through the channel, this extra propagation delay is what cause the extra lag.

```
Flow 1 (10.1.2.1 -> 10.1.1.1)
  Tx Packets: 100
  Rx Packets: 100
  Delivery Ratio: 1
  Average Delay: 0.000608128
Flow 2 (10.1.2.2 -> 10.1.1.1)
  Tx Packets: 100
  Rx Packets: 100
  Delivery Ratio: 1
  Average Delay: 0.00042312
```