# Labwork 3: Building Topology (Part 1)

BI12-076 Mai Hai Dang

March 26, 2024

## 1 Concepts

### 1.1 CSMA/CD

CSMA/CD stands for Carrier Sense Multiple Access with Collision Detection. It is a network protocol that listens to the network before transmitting data. If the network is busy, the sender waits for a random amount of time before attempting to send the data again. If two senders attempt to send data at the same time, a collision occurs and the data is retransmitted after a random amount of time.

### 1.2 LAN

LAN stands for Local Area Network. It is a network that connects computers and devices in a limited geographical area such as a home, office, or group of buildings.

## 2 Bus Network Topology

> The code for each section a, b, c should be in separate files as csma-a.cc, csma-b.cc, csma-c.cc inside the zip file.

### 2.1 a

The bus topology consist of 3 nodes ($n0, n1, n2$) connected by a LAN using CSMA channel with a data rate of 100Mbps and a delay of 6560ns with the address of 10.1.1.0.

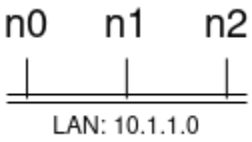


Figure 1: Part a

### 2.2 b

We implement scenario of $n0$ is a client and $n2$ is an echo server. They exchange 100 packets of 1024 bytes each within 10s using UDP. Then we capture the pcap trace from $n1$, this node doesn't

participate in the communication but captures the traffic passing through the network for analysis or debugging purposes.

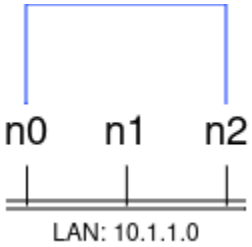


Figure 2: Part b

The trace file will be provided as "node1-1-0.pcap" in the zip file. Then to read the pcap trace, we use tcpdump command as follows:

```
tcpdump -nn -tt -r [trace file]
```

### 2.3 c

Now we implement a scenario with 5 nodes $(n0, n1, n2, n3, n4)$ connected by a LAN using CSMA channel, on which there are 2 pairs of client-server: $n0 \longleftrightarrow n2$ and $n1 \longleftrightarrow n3$ exchanging packets at the same time. Each pair exchanges 10 packets/s of 1024 bytes each within 10s using UDP.

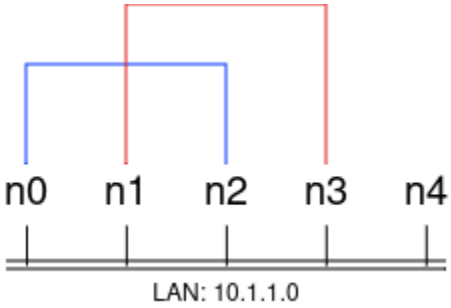


Figure 3: Part c

The average delay of received packets can be calculated as:

$$\text{Average Delay} = \frac{\text{Total Delay}}{\text{Total Packets}}$$

$$\text{Total Delay} = \sum Delay$$

$$\text{Delay} = \text{Received Time} - \text{Start of Transmission}$$

The Packet Delivery Ratio (PDR) is the ratio of the number of packets received by the destination to the number of packets sent by the source.

$$\text{PDF} = \frac{\text{Number of packet received by the server}}{\text{Number of packet sent by the client}}$$

In ns-3, we can use FlowMonitor to capture the packet traces and calculate the above metrics. After running the simulation, we obtain the following output:

```
Flow 1 (10.1.1.1 -> 10.1.1.3)
  Tx Packets: 10
  Rx Packets: 10
  Delivery Ratio: 1
  Average Delay: 0.000694696
Flow 2 (10.1.1.2 -> 10.1.1.4)
  Tx Packets: 10
  Rx Packets: 10
  Delivery Ratio: 1
  Average Delay: 0.000395696
Flow 3 (10.1.1.4 -> 10.1.1.2)
  Tx Packets: 10
  Rx Packets: 10
  Delivery Ratio: 1
  Average Delay: 0.000395596
Flow 4 (10.1.1.3 -> 10.1.1.1)
  Tx Packets: 10
  Rx Packets: 10
  Delivery Ratio: 1
  Average Delay: 0.000695596
```

Flow 1 ($10.1.1.1 \rightarrow 10.1.1.3$) and Flow 4 ($10.1.1.3 \rightarrow 10.1.1.1$) represent the communication between $n0, n2$. Flow 2 ($10.1.1.2 \rightarrow 10.1.1.4$) and Flow 3 ($10.1.1.4 \rightarrow 10.1.1.2$) represent the communication between $n1, n3$.

From the above output, we can see that the delivery ratio is 1 and the average delay is less than 1ms for all flows. However, the average delay of Flow 2 and Flow 3 is slightly less than Flow 1 and Flow 4. This is because the communication between $n1, n3$ is more direct than $n0, n2$. The packets have to pass through only 1 node in the former case, while they have to pass through 2 nodes in the latter case.