PA -2 Report

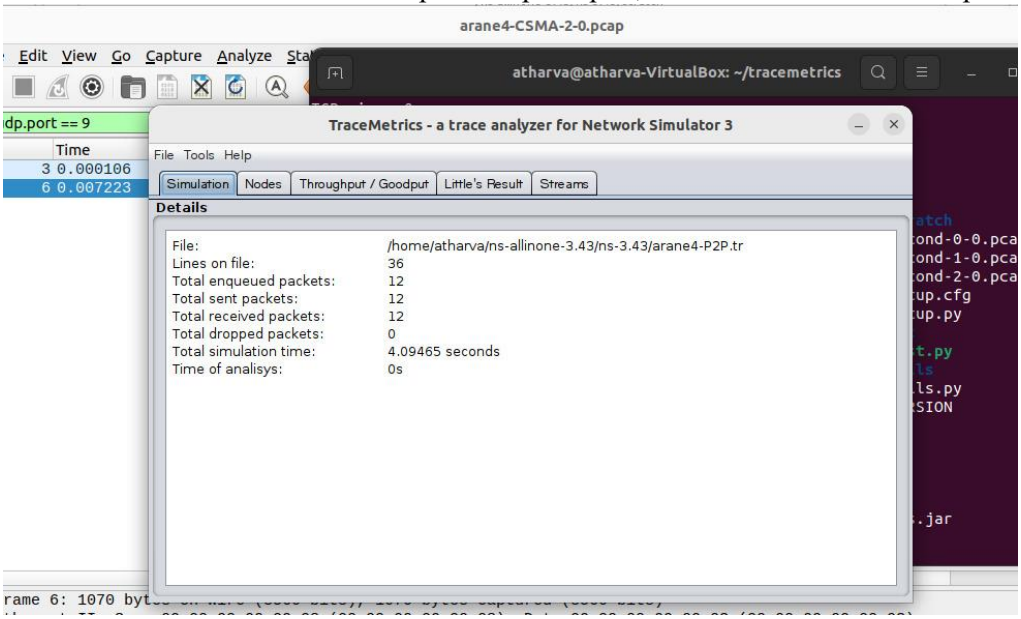
Task 1 – Review of Example Scripts

Part A – first.cc (Point-to-Point two nodes)

- Change done: Removed fixed network 10.1.1.0/24 and fixed port 9. Program now picks random /24 subnet and random port < 65000 each run.
- Why: Makes every test a little different and checks code works with other addresses.
- Result: Throughput still near 1 Mbps, so link works and no packets drop.

Part B – second.cc (P2P + CSMA LAN)

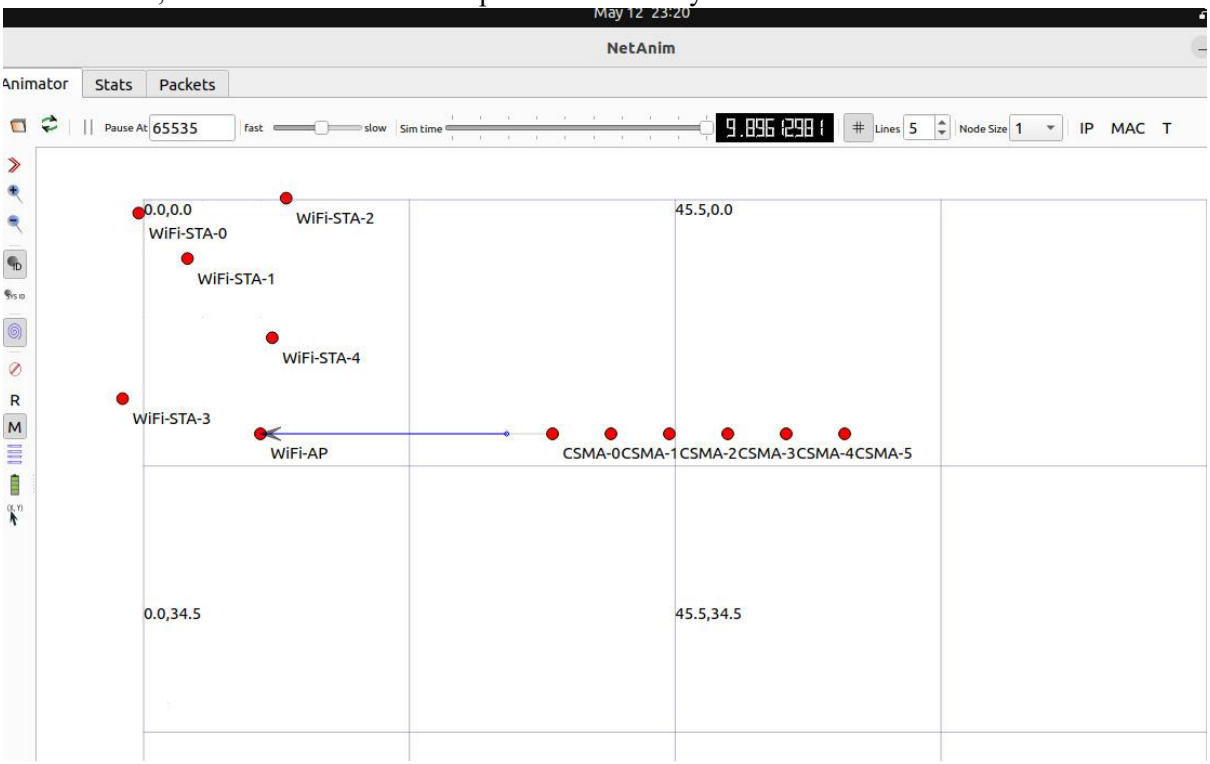
- Trace files made: arane4-P2P.tr for point-to-point part, arane4-CSMA.tr for LAN part.



- Metrics:
  - Packet size = 2048 B
  - Link rate = 3 Mbps
  - Delay = 15 ms
- Observation: Real throughput about 2 Mbps and delay stays close to 15 ms plus small processing time.

Part C – third.cc (P2P + CSMA + Wi-Fi)

- Visualization: Made XML animation file. In NetAnim we see three zones: wired backbone, CSMA cloud, Wi-Fi field. Arrows show packet flow clearly.



- Packet capture: Three PCAP files opened in Wireshark.
    - P2P: Ethernet → IP → UDP
    - Wi-Fi: Radiotap + 802.11 frames
    - CSMA: Ethernet frames in shared LAN

Using this 2 trace files, arane4-P2P.tr and arane4-CSMA.tr are generated.

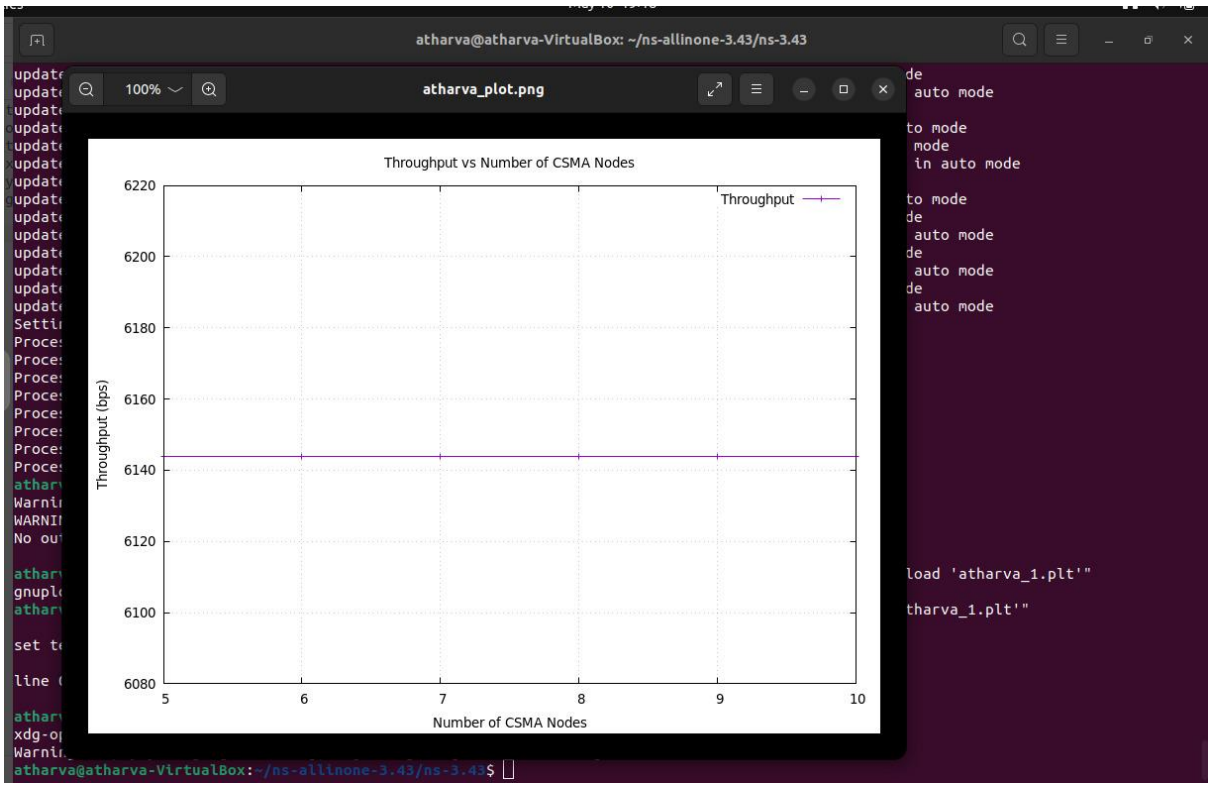
Also .pcap and .xml file was created after running the third script. Which were analysed using tcpdump, tracemetrics and wireshark. (shown in the video)

Task 2: Throughput vs Number of CSMA Nodes

Throughput and Reliability Study

2-a Throughput vs. Number of CSMA Nodes

- Ran modified mysecond.cc script. CSMA nodes varied 5 → 10.
- Each run sent 3 UDP packets (2048 B) from client to server during 8 s window.
- Throughput formula: (3 × 2048 × 8) / 8 = 6144 bps.
- Graph: Line is flat. More nodes did not change throughput because traffic is light.



Graph Interpretation:

The graph of "Throughput vs Number of CSMA Nodes" is flat, indicating that increasing the number of CSMA nodes from 5 to 10 did not affect the throughput under this low-traffic UDP echo configuration. Since only one client-server pair was active and the total data volume was small, the LAN did not experience congestion or collisions significant enough to degrade performance.

This confirms that under light network load, the number of LAN nodes does not significantly impact throughput, especially in CSMA networks with low contention.

b)

Objective

2-b Histogram: Sent vs. Received Packets

- Fixed 10 CSMA nodes. Changed NPackets 5 → 10.
- Stored results in atharva_2.txt and drew histogram with Gnuplot.
- Finding: For every packet sent, one packet returned (Echo). No loss even at NPackets = 10.

nCsma: 10

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At time +9.04765s server received 2048 bytes from 10.1.1.1 port 49153
At time +9.04765s server sent 2048 bytes to 10.1.1.1 port 49153
At time +9.09389s client received 2048 bytes from 10.1.2.11 port 9
atharva@atharva-VirtualBox:~/ns-allinone-3.43/ns-3.43$ ./ns3 run "scratch/mysecond --PacketSize=2048 --NPackets=5 --Delay=15ms --nCs
ma=10"
[0/2] Re-checking globbed directories...
ninja: no work to do.
At time +2s client sent 2048 bytes to 10.1.2.11 port 9
At time +2.078s server received 2048 bytes from 10.1.1.1 port 49153
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At time +2.15671s client received 2048 bytes from 10.1.2.11 port 9
At time +3s client sent 2048 bytes to 10.1.2.11 port 9
At time +3.04758s server received 2048 bytes from 10.1.1.1 port 49153
At time +3.04758s server sent 2048 bytes to 10.1.1.1 port 49153
At time +3.09436s client received 2048 bytes from 10.1.2.11 port 9
At time +4s client sent 2048 bytes to 10.1.2.11 port 9
At time +4.04776s server received 2048 bytes from 10.1.1.1 port 49153
At time +4.04776s server sent 2048 bytes to 10.1.1.1 port 49153
At time +4.09465s client received 2048 bytes from 10.1.2.11 port 9
At time +5s client sent 2048 bytes to 10.1.2.11 port 9
At time +5.04789s server received 2048 bytes from 10.1.1.1 port 49153
At time +5.04789s server sent 2048 bytes to 10.1.1.1 port 49153
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At time +6s client sent 2048 bytes to 10.1.2.11 port 9
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At time +6.09467s client received 2048 bytes from 10.1.2.11 port 9
atharva@atharva-VirtualBox:~/ns-allinone-3.43/ns-3.43$
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At time +6s client sent 2048 bytes to 10.1.2.11 port 9
At time +6.04816s server received 2048 bytes from 10.1.1.1 port 49153
At time +6.04816s server sent 2048 bytes to 10.1.1.1 port 49153
At time +6.09467s client received 2048 bytes from 10.1.2.11 port 9
At time +7s client sent 2048 bytes to 10.1.2.11 port 9
At time +7.04827s server received 2048 bytes from 10.1.1.1 port 49153
At time +7.04827s server sent 2048 bytes to 10.1.1.1 port 49153
At time +7.09442s client received 2048 bytes from 10.1.2.11 port 9
atharva@atharva-VirtualBox:~/ns-allinone-3.43/ns-3.43$
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At time +8.09464s client received 2048 bytes from 10.1.2.11 port 9
atharva@atharva-VirtualBox:~/ns-allinone-3.43/ns-3.43$
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At time +8.09464s client received 2048 bytes from 10.1.2.11 port 9
atharva@atharva-VirtualBox:~/ns-allinone-3.43/ns-3.43$ ./ns3 run "scratch/mysecond --PacketSize=2048 --NPackets=8 --Delay=15ms --nCs
ma=10"
[0/2] Re-checking globbed directories...
ninja: no work to do.
At time +2s client sent 2048 bytes to 10.1.2.11 port 9
At time +2.078s server received 2048 bytes from 10.1.1.1 port 49153
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ma=10"
[0/2] Re-checking globbed directories...
ninja: no work to do.
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atharva@atharva-VirtualBox:~/ns-allinone-3.43/ns-3.43$
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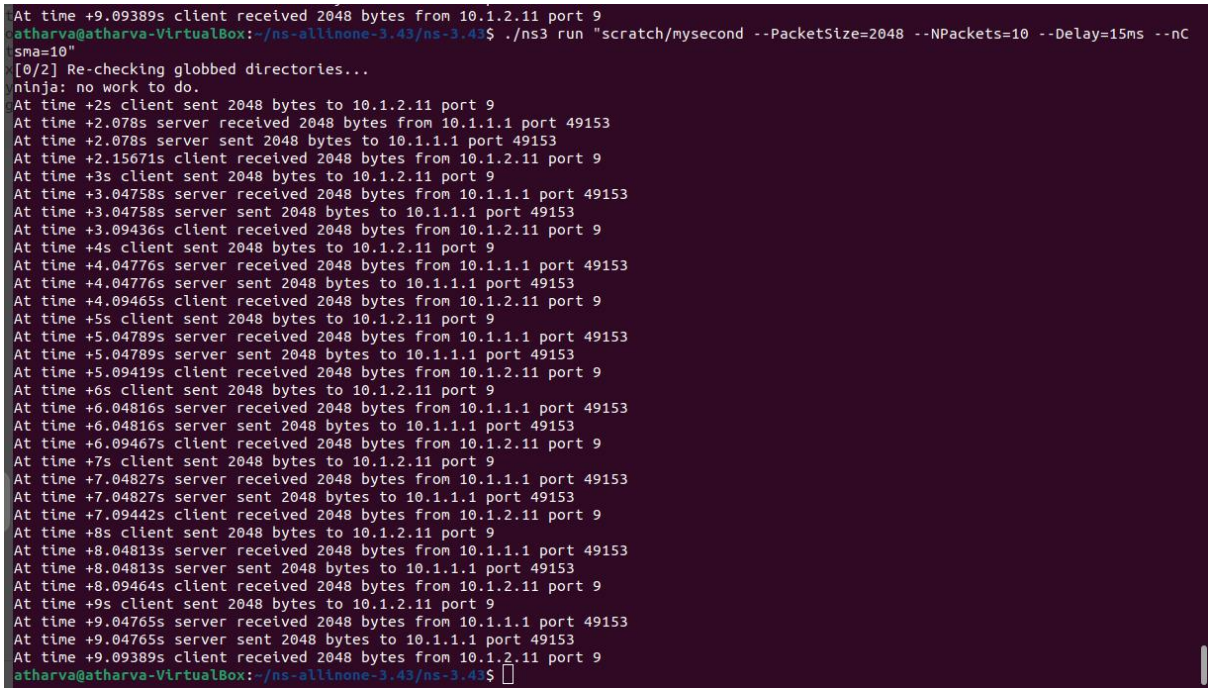
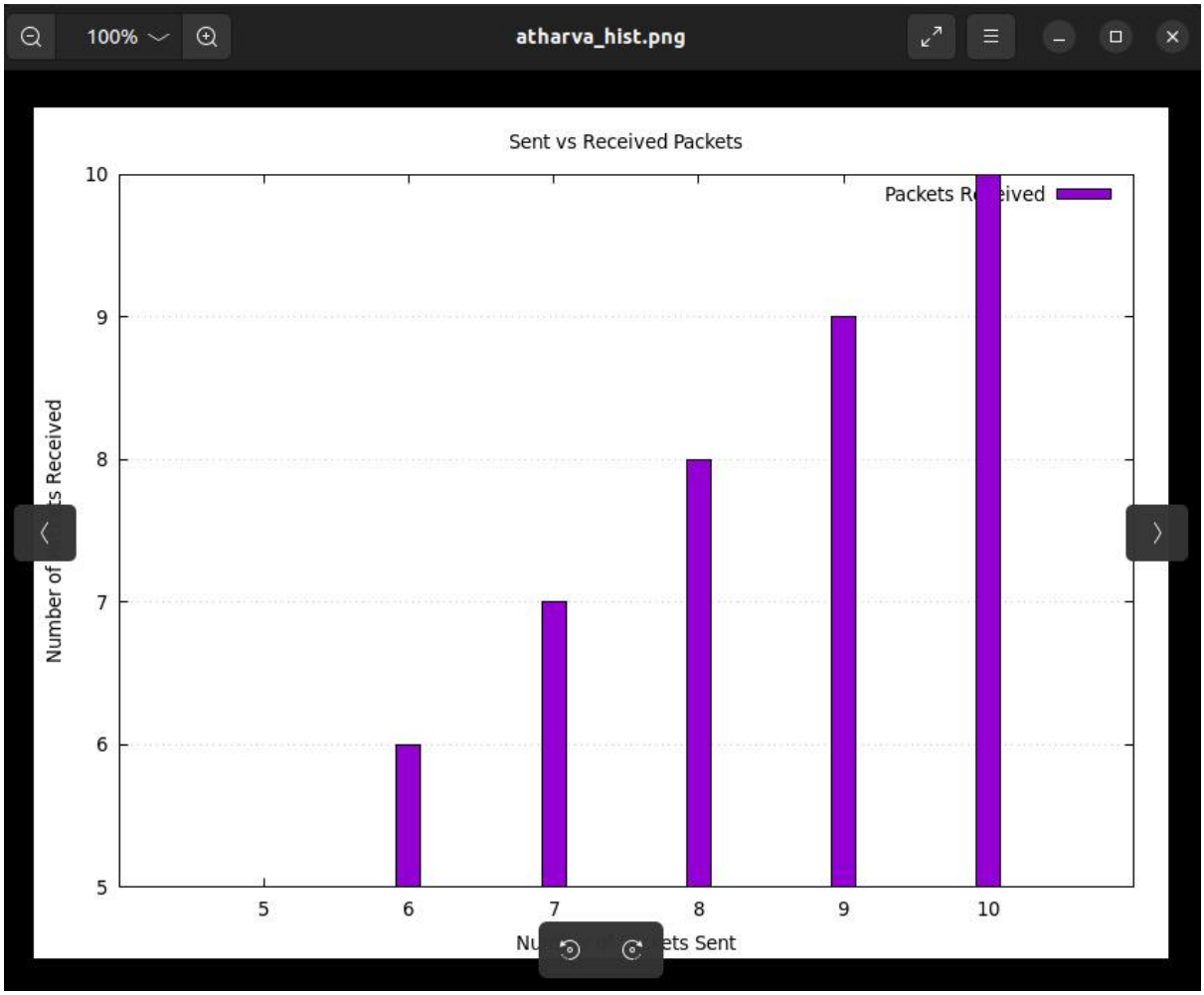


For each simulation run:

The total number of UDP packets sent by the client was counted.

The number of packets successfully received back from the server (i.e., echoed packets) was recorded.

These results were stored in a file atharva_2.txt and visualized as a histogram using Gnuplot.



The resulting histogram shows that for every packet sent, one was successfully received and echoed back — even at the highest load (NPackets = 10). This 1:1 delivery ratio across all values indicates that the network experienced no packet loss under the tested conditions.

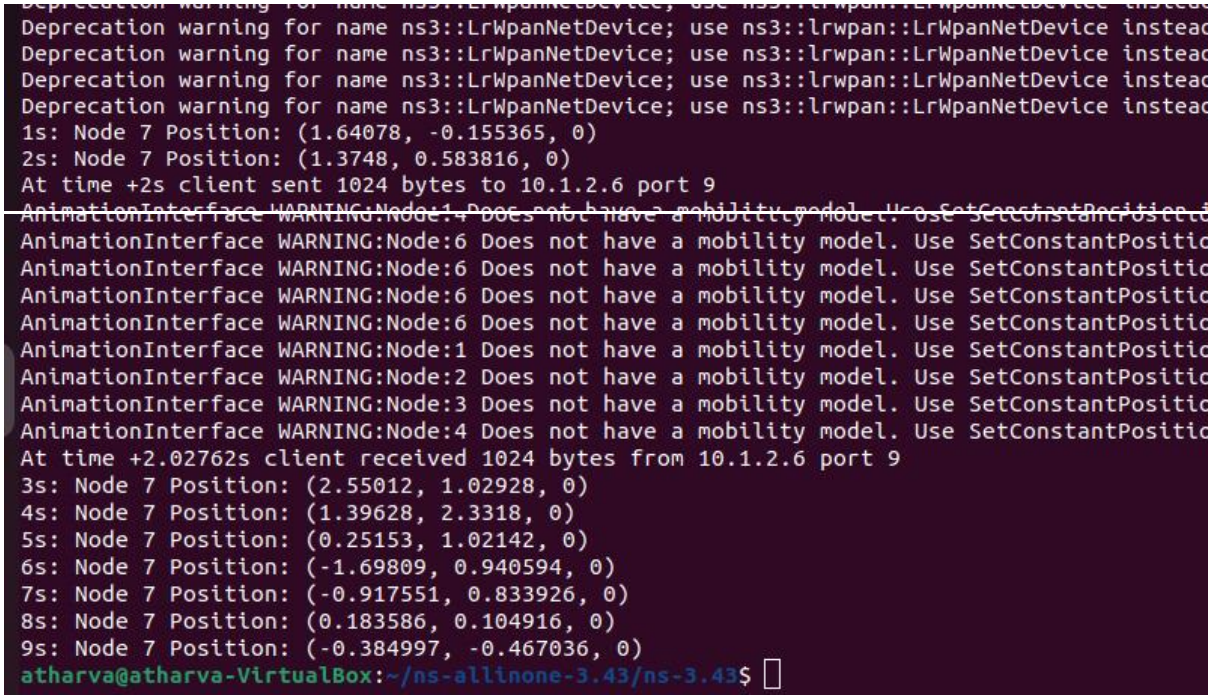
This result demonstrates that:

- The CSMA network with 10 nodes is capable of handling increasing traffic volumes reliably at this moderate load.
- The echo server can respond in a timely manner without collisions or congestion affecting delivery.
- The network maintains delivery integrity as NPackets scales linearly.

c) Mobile Node Position Tracking

Objective

- In mythird.cc we added a function TrackPosition() for node 7 (first Wi-Fi STA).
- Function prints x y z every second (t = 1 to 10 s).
- Movement proves RandomWalk2dMobilityModel works.



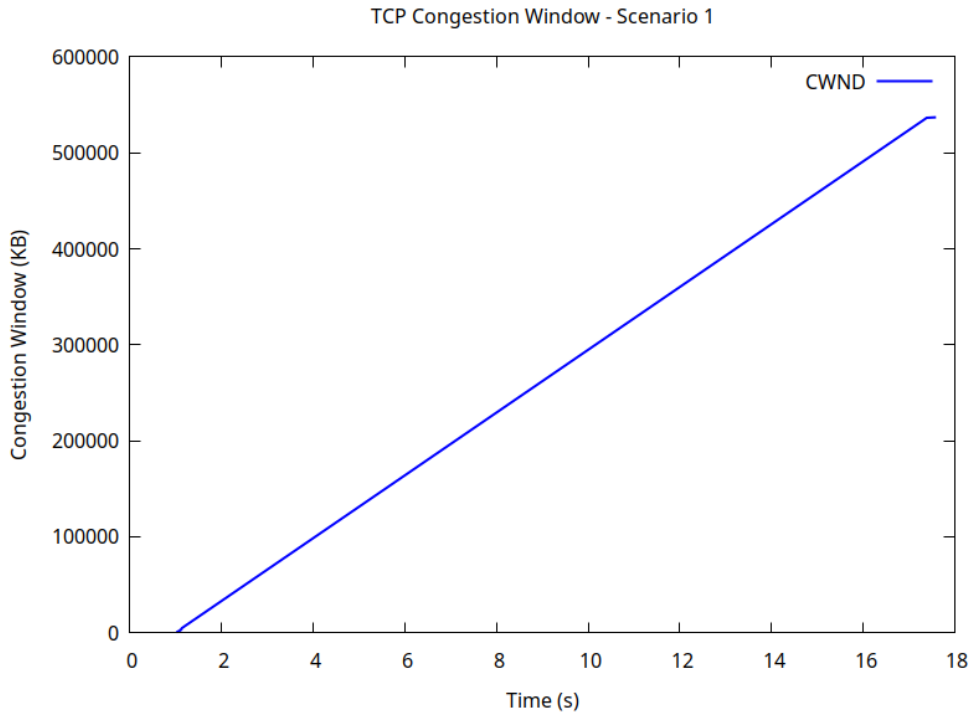
- **Interpretation**
- The logged positions show that the mobile node continuously changed its location during simulation time, verifying that the RandomWalk2dMobilityModel was correctly configured and active. This confirms that mobility behavior was successfully tracked and can be visualized in future enhancements using NetAnim or plotted if required.

Task-3

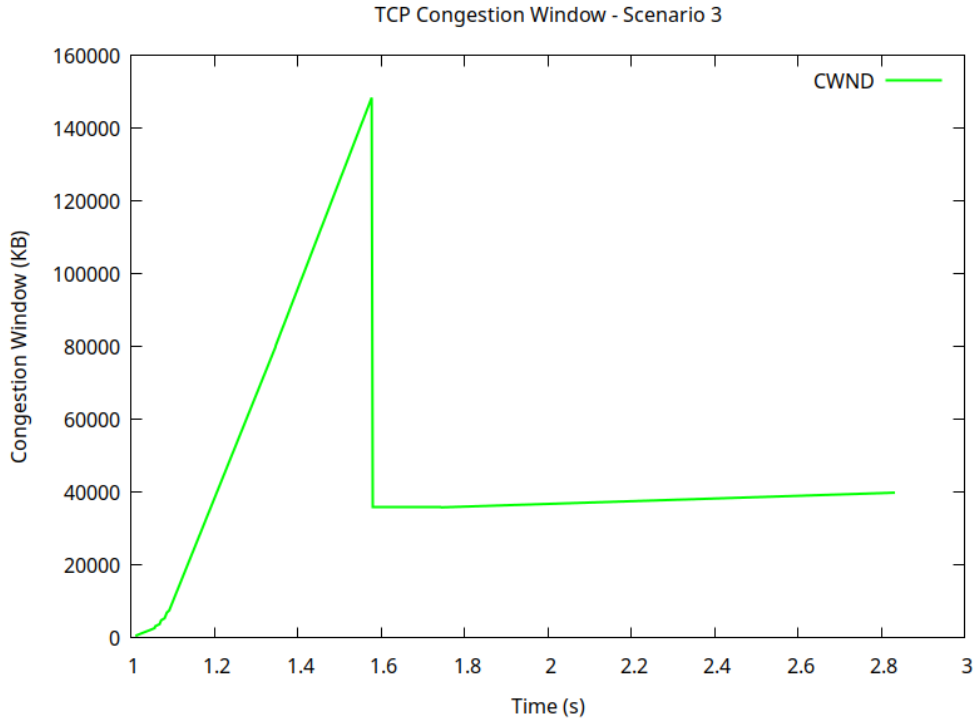
third.cc stitches together a 3-domain topology (P2P ↔ CSMA LAN ↔ Wi-Fi) with fully parameterizable node counts and packet loads.It shows you how to configure devices, mobility, addressing, and apps for each domain.Finally, it captures both visual animations (NetAnim XML) and packet-level traces (pcap) so you can inspect real traffic behavior in every segment.

Scenario analysis using provided parameters:

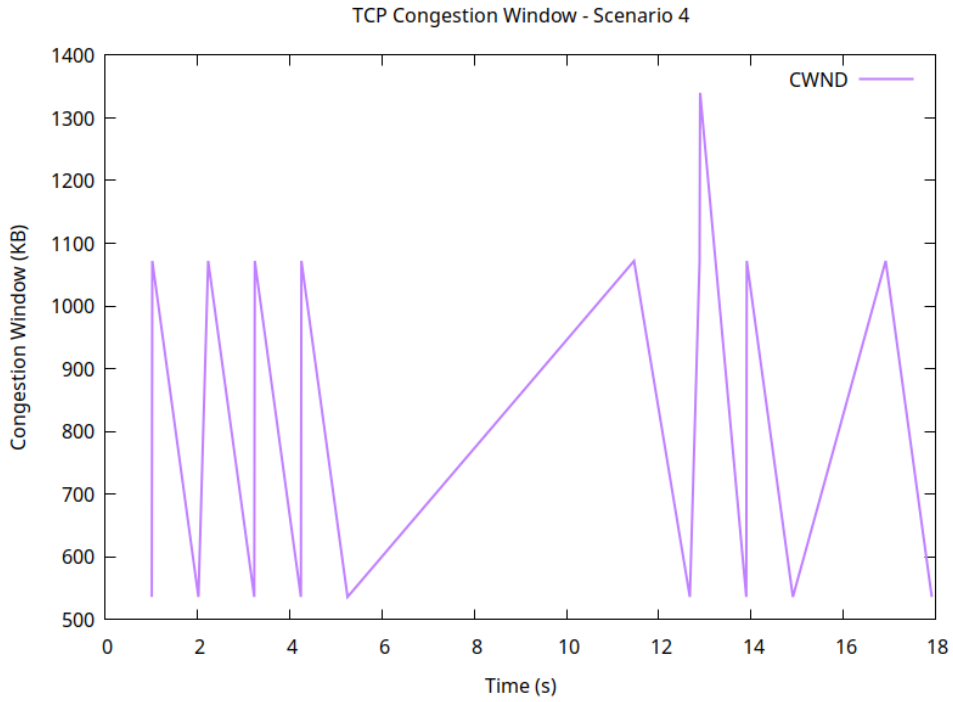
./ns3 run "scratch/pa2_task3/fifth --packetSize=1024 --dataRateApp=500Kbps --datarate=5Mbps --delay=10ms --errorRate=0 --outputFile=prasadma-1.dat"



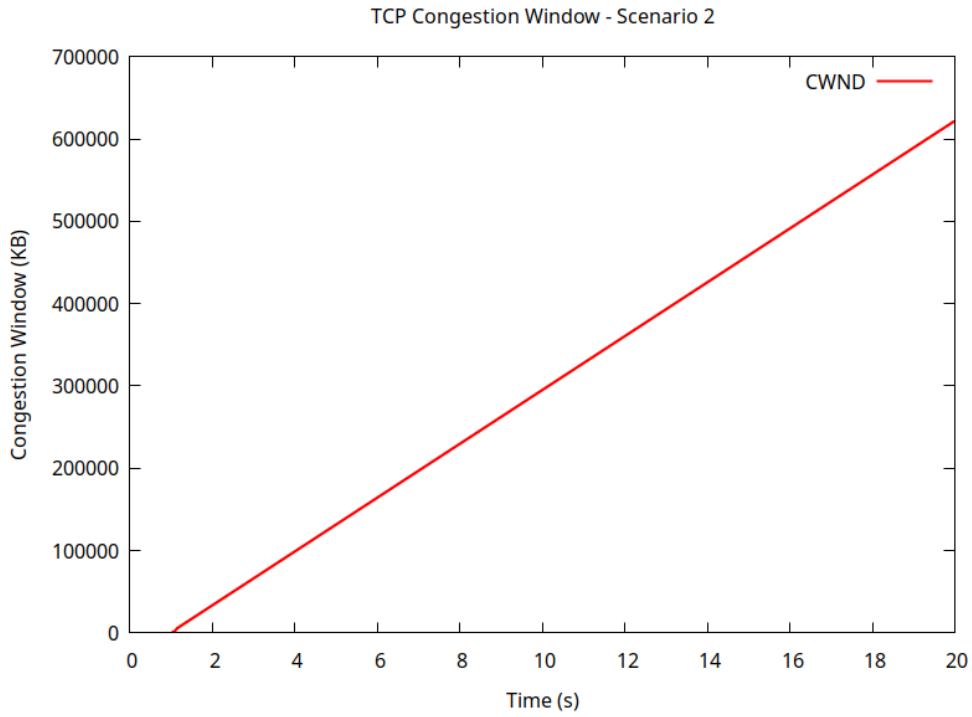
./ns3 run "scratch/pa2_task3/fifth --packetSize=1024 --dataRateApp=5Mbps --datarate=5Mbps --delay=5ms --errorRate=0 --outputFile=prasadma-3.dat"



./ns3 run "scratch/pa2_task3/fifth --packetSize=1024 --dataRateApp=4Mbps --datarate=6Mbps --delay=5ms --errorRate=1e-3 --outputFile=prasadma-4.dat"



./ns3 run "scratch/pa2_task3/fifth --packetSize=2048 --dataRateApp=500Kbps --datarate=5Mbps --delay=10ms --errorRate=1e-10 --outputFile=prasadma-2.dat"



Interpretation:

Scenario 1

No losses occur, so TCP never drops back into Slow-Start. It must already be past the ssthresh, so it spends the entire run in congestion-avoidance, adding roughly one MSS every RTT. The slope is constant because both RTT and MSS are fixed.

Scenario 2

Still loss-free—no slow-start or back-off—but either the RTT is smaller or the MSS is larger, so TCP completes more additive-increases per second (or adds more bytes per RTT). The result is a higher CWND growth rate.

Scenario 3:

1.0 s–1.6 s (Exponential)

CWND shoots upward in a curve—each RTT roughly doubles the window. This is Slow-Start.

~1.6 s (Loss Event)

A packet is lost (timeout or triple-dup ACK). TCP cuts CWND down to ~½ its peak (or to the ssthresh).

1.6 s–3.0 s (Linear)

Having exited slow-start, TCP enters congestion-avoidance, increasing CWND by ~1 MSS per RTT again.

This classic "boom-and-bust" shows the slow-start/exponential phase, the multiplicative decrease on loss, and then the additive increase afterward.

Scenario- 4

The link is experiencing frequent losses, so TCP cycles through:

1. Slow-Start (or fast-recovery) growth until loss
2. Multiplicative Decrease (cut-CWND) on each loss
3. Recovery back into congestion-avoidance or slow-start

Final Summary:

- 1 & 2 show clean, loss-free runs in congestion-avoidance (the only difference being growth rate).
- 3 illustrates a single loss after slow-start.
- 4 depicts a volatile network with repeated losses and the resulting TCP "sawtooth" of window growth and back-off.

Task -4 + Bonus Network setup

The task 4 thorough explanation is done in demo video which also contains which cc files are used and also what files are created.

Network has four nodes: A, B, C, D.
Links are Point-to-Point, data-rate 35 Mbps, delay 27 ms.

- Flow 1: A → B (UDP).
- Flow 2: A → D (path goes across B-D link, also UDP).

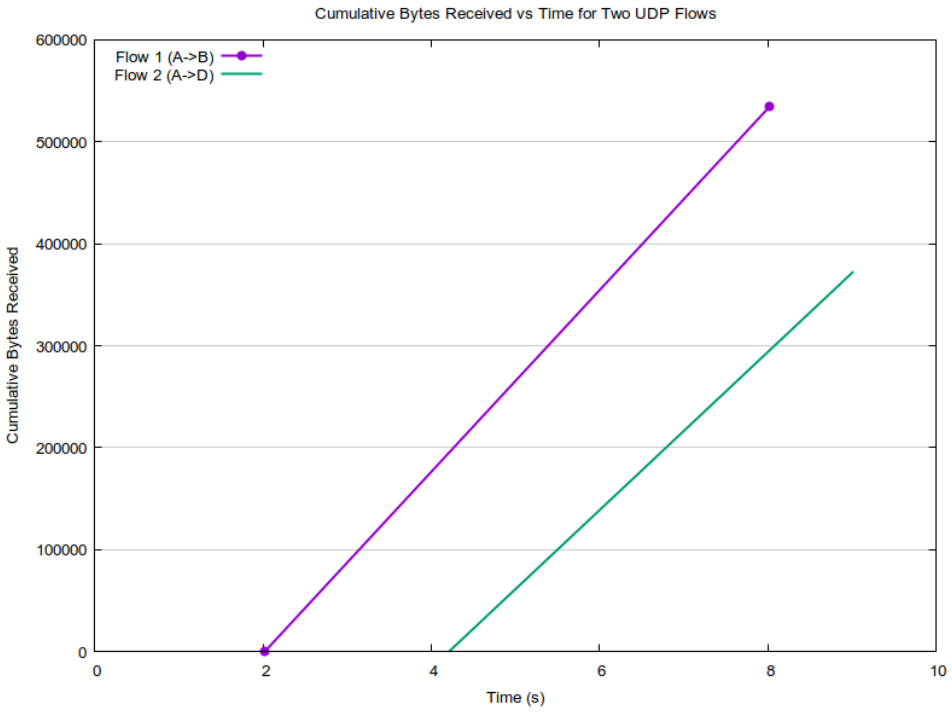
Files coming from simulation:

prasadma_4.xml – which was used for animation using netAnim.

FlowMonitor collects bytes for each flow automatic.
Shell script parse_flows.sh reads XML and makes two small files:

- prasadma_flow1.dat – bytes vs time for Flow 1.
- prasadma_flow2.dat – bytes vs time for Flow 2.

Gnuplot script prasadma_flows.plt draws picture prasadma_flows.png.



4. Results:

- Purple line = Flow 1. Finish near 540 kB at 8 s.
- Green line = Flow 2. Finish near 370 kB at 9 s.

Lines go up smooth → no packet loss.
Flow 1 ends first because start earlier.

FlowMonitor collects bytes for each flow automatic.
Shell script parse_flows.sh reads XML and makes two small files:

- prasadma_flow1.dat – bytes vs time for Flow 1.
- prasadma_flow2.dat – bytes vs time for Flow 2.