University of Science and Technology of Hanoi

NETWORK STIMULATION

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An Evaluation of CSMA/CA Protocol Without RTS/CTS in Ad-hoc WLAN Network

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Problems:

- Consider the CSMA/protocol Wifi Networks that work in ad-hoc mode.
- Evaluate the performance of the protocol without RTS/CTS scheme when the number of nodes within a communication range increases from 2 to 30.

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I. Introduction:

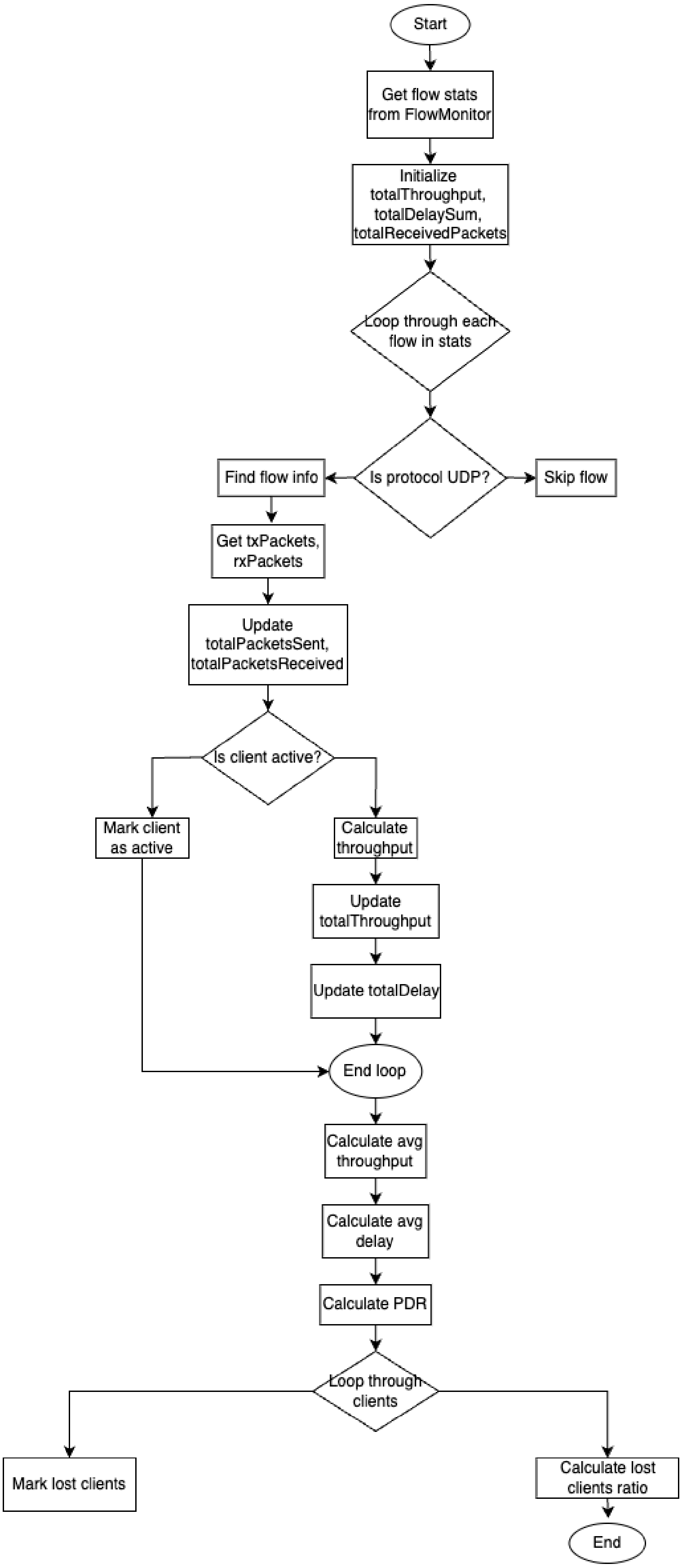
- WiFi ad-hoc networks allow devices to communicate without a central access point. The Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol is used to manage access to the wireless medium. However, when Request-to-Send (RTS)/Clear-to-Send (CTS) is disabled, increased node density may cause higher collisions and packet loss.
- This study evaluates the performance of CSMA/CA in an ad-hoc network with a Star topology, examining how throughput, delay, and packet loss are affected when the number of nodes increases from 2 to 30.

II. Network Design:

- Number of nodes: 2 - 30
  - 1 node acts as the server, the rest are clients
- Mobility: ConstantPositionMobilityModel
- Packet size: 1024 Bytes
- Number of packets: 100
- Traffic pattern:
  - Interval: 1.0
  - Simulation time: 100
  - Starting time: 10 - 100
  - Each node in the simulation starts its UDP Echo Client application 0.1 seconds apart from the previous node.

Protocol stack:		Ns3-model
NetDevices		WifiNetDevice
MAC	CSMA/CA Ad-hoc Mode	AdhocWifiMac
PHY	WIFI Phy 802.11	WifiPhy

III. Flow chart about how we use FlowMonitor tool to analyze:



IV. Result and Analysis

- After implementing this code, we utilize the Flowmonitor to trace and process the collected data. Once the processing is complete, we use Python to visualize the results. Moreover, we also find the lost Client's IPs.

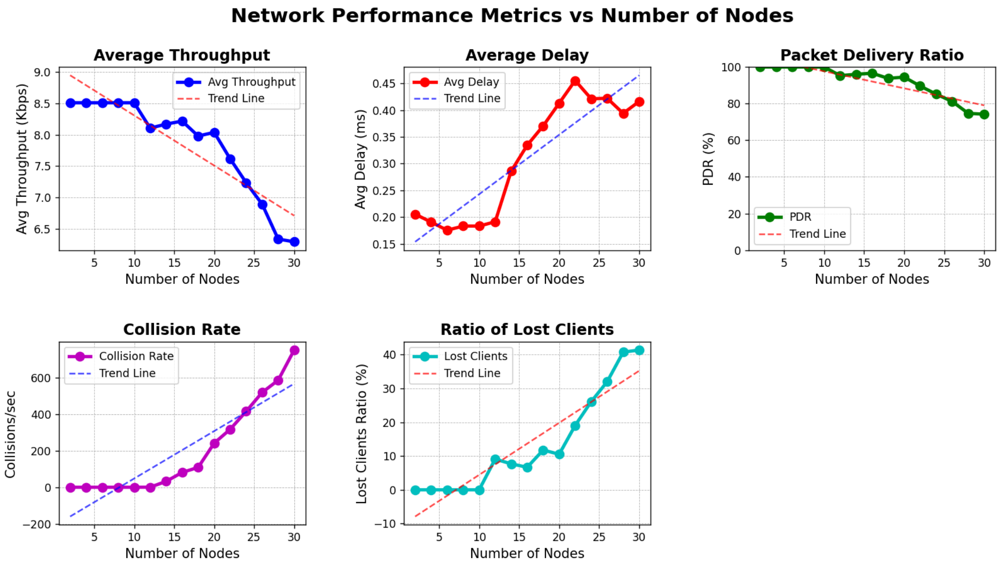
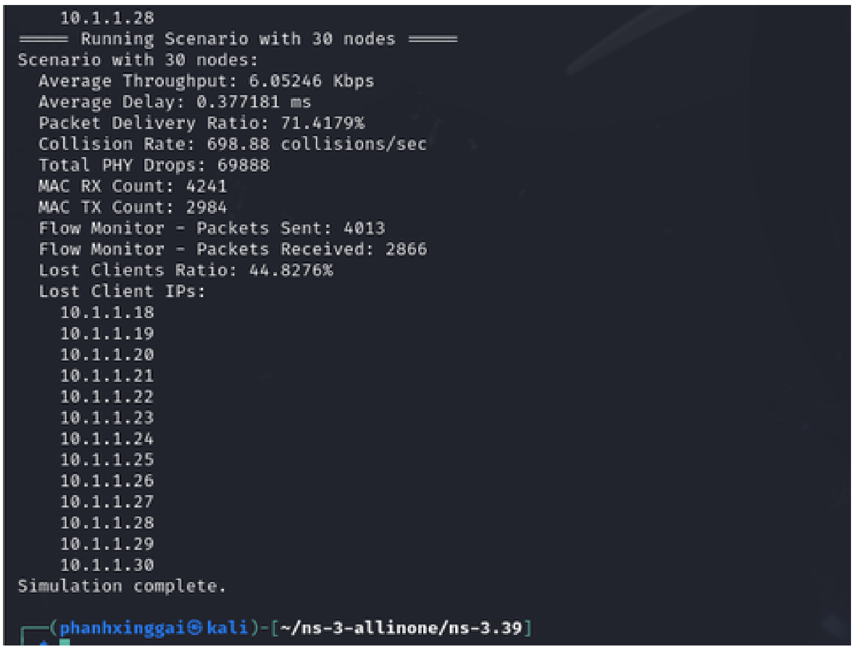


Figure 1

The plots effectively illustrate the impact of increasing node density on network performance. Throughput decreases, delay increases, and packet delivery ratio declines, primarily due to higher collisions and contention. The collision rate and lost client ratio grow significantly, further indicating network saturation. Overall, the results highlight CSMA's scalability limitations in ad-hoc networks.



```
    10.1.1.28
==== Running Scenario with 30 nodes ====
Scenario with 30 nodes:
  Average Throughput: 6.05246 Kbps
  Average Delay: 0.377181 ms
  Packet Delivery Ratio: 71.4179%
  Collision Rate: 698.88 collisions/sec
  Total PHY Drops: 69888
  MAC RX Count: 4241
  MAC TX Count: 2984
  Flow Monitor - Packets Sent: 4013
  Flow Monitor - Packets Received: 2866
  Lost Clients Ratio: 44.8276%
  Lost Client IPs:
    10.1.1.18
    10.1.1.19
    10.1.1.20
    10.1.1.21
    10.1.1.22
    10.1.1.23
    10.1.1.24
    10.1.1.25
    10.1.1.26
    10.1.1.27
    10.1.1.28
    10.1.1.29
    10.1.1.30
Simulation complete.

┌──(phanhxinggai㉿kali)-[~/ns-3-allinone/ns-3.39]
```

Figure 2: Showing Lost Client IPs

V. Conclusion:

- The analysis demonstrates that as the number of nodes increases in a CSMA-based ad-hoc network, **throughput decreases, delay rises, and packet delivery ratio declines**, primarily due to increased collisions and contention.
- **Main Causes:**
  - Network congestion, packet collisions, and signal interference as node density grows.
  - Disabling RTS/CTS leads to a higher lost client ratio.
- **Suggested Improvements:**
  - Enable RTS/CTS to reduce collisions.
  - Adjust node spacing or increase transmission power.
  - Limit the number of nodes or deploy multiple Access Points.
  - Optimizing these parameters can help reduce lost client ratio and enhance network performance.

VI. References:

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