**UNIVERSITY OF SCIENCE AND TECHNOLOGY OF HANOI**

****

**NETWORK SIMULATION**

*Lecturer: Mrs. Nguyen Minh Huong*

CSMA/CA Protocol Without RTS/CTS in

Ad-hoc WLAN Network

*Members:*

Phạm Tuấn Hiệp

Đỗ Quang Anh

Nguyễn Viết Minh Đức

Nguyễn Quý Đức

Ngô Hải Anh

Phạm Quang Dương

Lã Duy Anh

22BI13158

22BI13013

22BI13095

22BI13094

22BI13019

22BI13116

22BI13016

*March 13, 2025*

**Table of Content**

[1. Introduction 2](#_Toc192713459)

[2. Application Building 2](#_Toc192713460)

[2.1. Design Scenario 2](#_Toc192713461)

[a. Ad-Hoc Topology 2](#_Toc192713462)

[b. Protocol 2](#_Toc192713463)

[c, Mobility 3](#_Toc192713464)

[2.2. Parameters 4](#_Toc192713465)

[2.3. Implement 4](#_Toc192713466)

[3. Data Collection and Analysis 5](#_Toc192713467)

[3.1. Collected Data 5](#_Toc192713468)

[3.2. Analyze Data 5](#_Toc192713469)

[4. Conclusion 6](#_Toc192713470)

[5. References: 7](#_Toc192713471)

# 1. Introduction

Wireless networks are essential for modern communication, but as the number of connected devices grows, challenges like transmission optimization and collision management become more difficult. One key protocol, CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance), helps reduce collisions by allowing devices to sense the channel before transmitting data. When combined with RTS/CTS (Request to Send / Clear to Send), CSMA/CA addresses issues like the "hidden node" problem. This study will simulate an ad-hoc network using CSMA/CA without RTS/CTS in the NS-3.39 simulator to evaluate how RTS/CTS affects network performance and improves efficiency in wireless communication.

# 2. Application Building

## **2.1. Design Scenario**

### a. Ad-Hoc Topology

We are using an Ad-Hoc network where nodes communicate directly with each other without a central access point. Each node can send and receive packets from other nodes without relying on a router or access point.



### b. Protocol

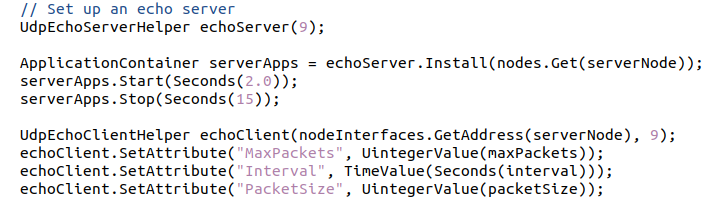
**Wifi Protocol**

* The **Wi-Fi** protocol is used for communication between the nodes. Wi-Fi is a widely used protocol for wireless networks, allowing nodes to communicate over wireless channels.



**UDP Protocol for Application Communication**

* The **UDP (User Datagram Protocol)** is used for communication between the client and the server application. We are using UdpEchoClientApplication and UdpEchoServerApplication to simulate client-server applications.



**RTS/CTS Protocol**

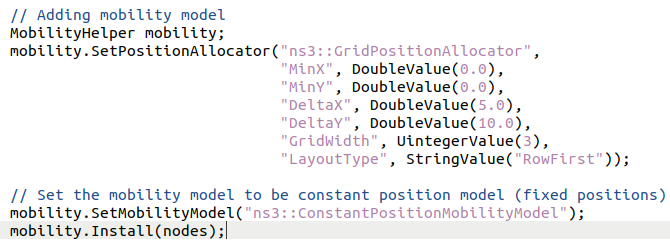
* If the packet size is smaller than or equal to 1000 bytes, RTS/CTS is not necessary, and the packets are sent directly without RTS/CTS exchange. This helps reduce collisions in an Ad-Hoc network.

**

### c, Mobility

The GridPositionAllocator arranges nodes in a grid with configurable spacing.

ConstantPositionMobilityModel keeps nodes static throughout the simulation.



## 

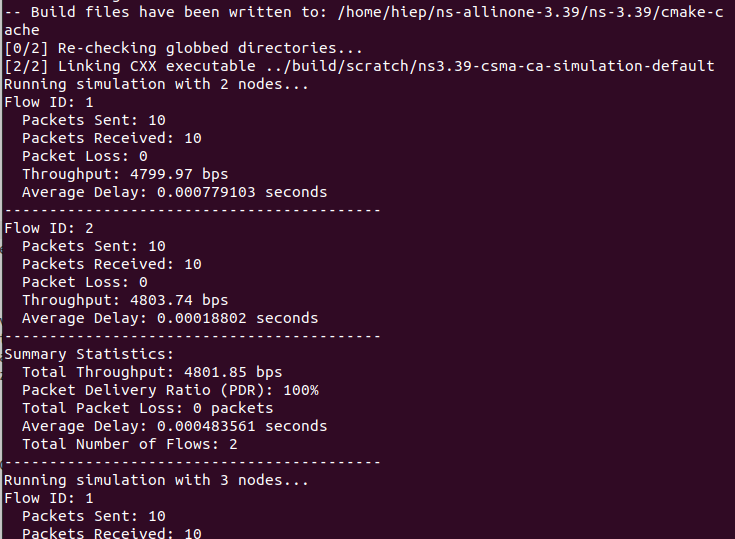
## **2.2. Parameters**

|  |  |
| --- | --- |
| Parameter | Value |
| Number of Nodes (N) | 2 to 30 (loop in steps of 1) |
| Packet Size | 512 bytes |
| Max Packets (each client) | 10 |
| Transmission Interval | 1 second |
| Simulation Time | 15 seconds |
| Mobility Model | ConstantPositionMobilityModel |
| Wi-Fi Standard | 802.11 ad-hoc (default) |
| RTS/CTS Threshold | 1000 (effectively off) |
| Flow Monitoring | Enabled |

*Table 1: Parameter of the application*

## 

## **2.3. Implement**



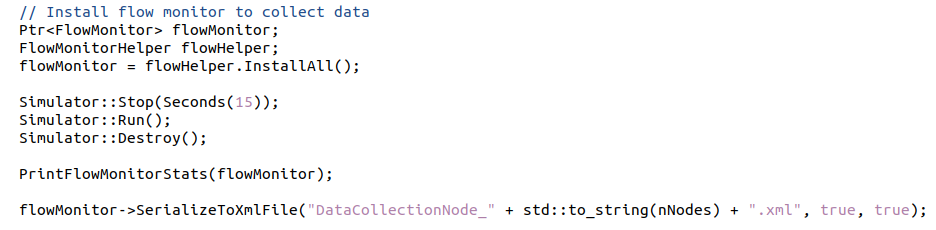
*Figure 1. Running the simulation with 2-30 nodes*

Figure 1 illustrates the simulation whenever it runs following each node and the flow IDs which are contained in the node.

# 3. Data Collection and Analysis

## **3.1. Collected Data**

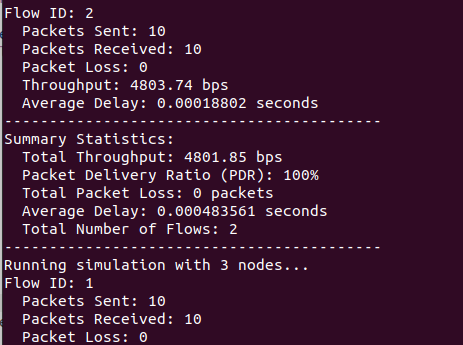
We use the flow monitor as the main method to collect data.



*Figure 2: FlowMonitor to store data*

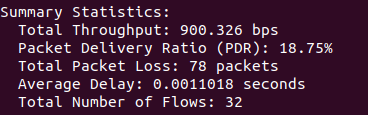
## **3.2. Analyze Data**

* Data from Flow Monitor: Data is stored in flows that contain all data about packets sent by a particular host to another.
* Data from the flows contains a lot of information, including:
  + The number of packets sent and received.
  + The average delay.
  + The throughput of each flow.
  + Number of lost packets.



*Figure 3: Example of data collection in each flow*

* All the data of flows are updated to the summarization of the node that they belong to.



*Figure 4: Example of summary node 30*

# 4. Conclusion

*Explain the results:* Data collision is more likely to occur in ad-hoc wireless networks if all devices are linked to one another if RTS/CTS is disabled. In light of this, as the number of nodes rises, so does the number of clients and the volume of packets be sent. More collisions occur, and more packets are lost as a result.

*Future Work:*

* Comparison with RTS/CTS: A follow-up experiment could be to re-enable RTS/CTS and compare the results against those presented here.
* Mobility: Introduce mobility models (RandomWaypoint, GaussMarkov, etc.) to see how movement affects ad-hoc performance.
* Different Traffic Patterns: Replace UDP Echo with other traffic types (TCP, real-time video, etc.) to see varied performance behaviors.

# 

# 

# 

# 

# 

# 

# 

# 

# 

# 

# 

# 

# 

# 5. References:

* NS-3 Official Website
  + Overview & Documentation: <https://www.nsnam.org/documentation/>
  + Tutorials: <https://www.nsnam.org/docs/tutorials/html/>
  + Manual: <https://www.nsnam.org/docs/manual/html/>
  + API Reference (Doxygen): <https://www.nsnam.org/doxygen/>
* FlowMonitor API in NS-3
  + Class Reference: <https://www.nsnam.org/doxygen/classns3_1_1_flow_monitor.html>
* IEEE 802.11 Standard
  + Official IEEE: <https://ieeexplore.ieee.org/document/7786995>
* CSMA/CA Background
  + Understanding the IEEE 802.11 Distributed Coordination Function (DCF): <https://www.ietf.org/proceedings/51/slides/manet-3/tsld002.htm>
  + CSMA/CA Definition: <https://www.techtarget.com/searchnetworking/definition/CSMA-CA#:~:text=Carrier%20sense%20multiple%20access%2Fcollision%20avoidance%20(CSMA%2FCA),over%20a%20data%20link%20layer>
* Mobility Models for Wireless Networks
  + NS-3 Mobility Models Reference: <https://www.nsnam.org/docs/doxygen/group__mobility.html>
* Hidden Node Problem in Wi-Fi (related to RTS/CTS)
  + Sharma, M. & Sonawane, K. (2016). A Comparative Study of Hidden Node Problem in Wireless Ad hoc Networks. IEEE International Conference on Computing, Analytics and Security Trends (CAST): <https://ieeexplore.ieee.org/document/7808897>