Network Simulator Report

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March 23, 2025

1 Introduction

This document presents a Network Simulator that implements key networking concepts at the Data Link Layer and Physical Layer. The simulator models frame transmission, collision detection using CSMA/CD, and flow control mechanisms such as Stop-and-Wait ARQ. The simulation also includes switching functionality.

2 Language used

Python

3 Project Structure

```
network-simulator/
 data_link_layer/         # Implements Data Link Layer components
    __init__.py
    access_control.py    # CSMA/CD implementation
    bridge.py            # Bridge functionality
    end_device.py        # End devices in the network
    error_control.py     # Error detection mechanisms (parity/CRC)
    frame.py             # Frame structure definition
    switch.py            # Switch with MAC learning functionality

 physical_layer/          # Implements Physical Layer simulation
    __init__.py
    physical_layer.py    # Physical layer logic

 tests/                   # Contains test scripts
    __init__.py
    test_data_link.py    # Tests for data link layer
```

```
general/                # Environment setup files
   bin/
   lib/
   .gitignore
   pyvenv.cfg

main.py                 # Entry point of the simulation
README.md               # Project documentation
```

4 Features

- Dedicated Link Simulation: Simulates direct communication between two devices.
- Star Topology Simulation: Models hub-based and switch-based star topologies.
- CRC Error Detection: Implements Cyclic Redundancy Check (CRC) for error detection.
- Bridge Simulation: Simulates bridges to divide networks into smaller segments.
- Stop-and-Wait ARQ: Implements an automatic repeat request protocol.
- CSMA/CD Testing: Tests Carrier Sense Multiple Access with Collision Detection (CSMA/CD) for Ethernet.

4.1 Setting Up a Virtual Environment

```
python -m venv venv
source venv/bin/activate  # On Windows use `venv\Scripts\activate`
```

5 Running Tests

To test the Data Link Layer implementation:

```
python tests/test_data_link.py
```

6 Running the Simulation

To run the complete network simulation:

```
python main.py
```

The following menu will be displayed:

```
========== NETWORK SIMULATOR MENU ==========
1. Dedicated Link (End-to-End Connection)
2. Simulation through Hub | STAR TOPOLOGY
3. CRC Error Detection Simulation
4. Bridge Simulation
5. Stop and Wait Simulation
6. Switch with 5 Devices
7. Two Star Topologies with Hubs + Switch
8. Testing CSMA/CD
9. Exit
============================================
Enter your choice (1-9):
```

7 References

- Collision Detection in CSMA/CD - GeeksforGeeks
- CSMA with Collision Detection (CSMA/CD) - TutorialsPoint
- Stop and Wait ARQ - GeeksforGeeks
- Network Packet Sniffer: Process an Ethernet frame (MAC src & dest address + protocol) using Python - StackOverflow
- Introduction to Ethernet - NetworkLessons
- The Data Link Layer and the Local Area Networks - Computer Networking: Principles, Protocols and Practice
- A Network Simulator Implementing Entire Protocol Stack - GitHub