

Network Simulation Using NS-3

Performance Analysis of a Computer Network

Aditya Sharma

2022038

Abhay Dagar

2022014

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1 Introduction

The aim of this assignment is to simulate a computer network using NS-3 and evaluate its performance in terms of:

- End-to-end delays between source and destination nodes.
- Packet drops during data transmission.
- Queue lengths at the outgoing links of routers.

This report details the implementation, results, and insights gained from the simulation.

2 Network Topology and Parameters

2.1 Topology Overview

The network consists of 4 routers and 5 workstations connected using point-to-point links. The topology diagram is shown in Figure 1.

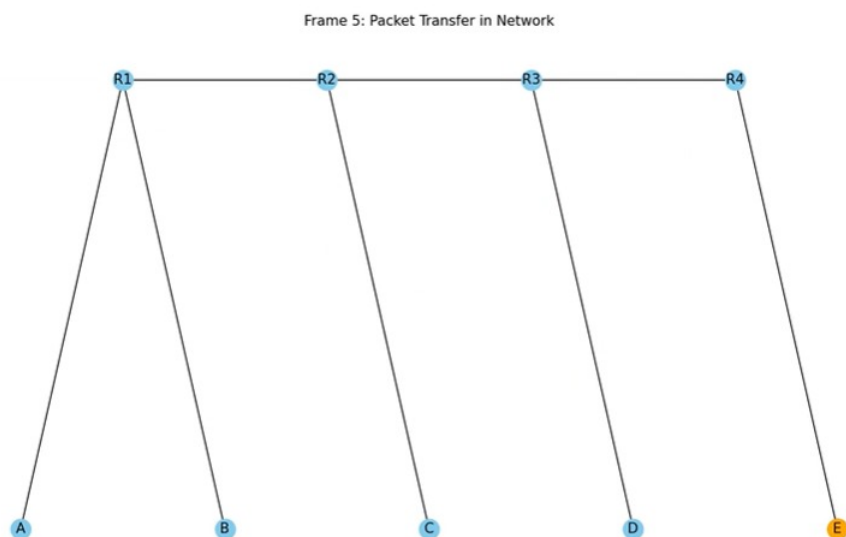


Figure 1: Network Topology

2.2 Network Configuration

The following parameters were used:

- **Link Capacities:** 2 Mbps
- **Propagation Delay:** 2 ms
- **Packet Size:** 4096 bits
- **Packet Drop Rate:** 1% using a RateErrorModel
- **Queue Discipline:** Random Early Detection (RED) on router links

3 Simulation Implementation

3.1 Programming Environment

The simulation was implemented using:

- Simulator: NS-3
- Language: C++
- Operating System: Linux

3.2 Steps Taken

1. **Node Creation:** 4 routers and 5 workstations were created and connected.
2. **IP Addressing:** Unique subnets were assigned to each link for proper routing.
3. **Traffic Generation:** Random traffic was generated between workstations using Poisson-distributed start and stop times.
4. **Flow Monitoring:** The FlowMonitor module was used to gather statistics for delays and packet drops.
5. **Queue Monitoring:** RED queue statistics were collected for outgoing links at routers.

4 Results and Analysis

4.1 Delay and Packet Drop Statistics

The average delay and packet drop statistics for all source-destination pairs are shown below:

Average Delay Matrix (s):

0.00	0.002	0.005	0.003	...
0.002	0.00	0.006	0.004	...
...				

Packet Drop Matrix:

0	2	1	3	...
2	0	0	1	...
...				

4.2 Queue Length Statistics

The queue lengths at outgoing links of routers were monitored. A summary of the queue statistics is shown in Table 1.

Router	Link	Packets in Queue	Packets Dropped
R1	R2	5	1
R2	R3	4	0
R3	R4	6	2

Table 1: Queue Length Statistics

4.3 Packet Tracing

Packet paths for specific flows (e.g., $A \rightarrow E$ and $B \rightarrow G$) were traced, confirming proper routing and network behavior.

5 Challenges Faced

- Configuring realistic traffic patterns and error models.
- Debugging issues in queue discipline installation.
- Ensuring accurate collection of flow statistics.

6 Conclusion

This simulation successfully modeled a realistic network and evaluated its performance under varying traffic conditions. Key observations include:

- Increased traffic led to higher delays and queue lengths.
- Packet drops occurred primarily at congested links.
- RED queue management reduced congestion by probabilistically dropping packets.

7 References

1. NS-3 Documentation: <https://www.nsnam.org/documentation/>
2. Course Slides: [CSE 232 Computer Networks]