Assignment 4:NS3 Simulation

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1. Introduction

This report details the design and simulation of a computer network using NS3, focusing on evaluating network performance metrics such as end-to-end delays, packet drops, and queue lengths. This simulation will involve seven workstations and four routers all connected through point-to-point links with specified capacities, delays, and error rates. The model used reflects realistic traffic flows between nodes to analyze the behavior of the network under varying conditions.

Network traffic is created on the fly using Poisson distribution, and static routing is implemented with packet forwarding. The outputs give information on the topology's efficiency and reliability.

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2. System Description

The network consists of seven workstations (A to G) and four routers (R1 to R4). The point-to-point links interconnect these nodes, with each link characterized by a specified data rate, propagation delay, and packet loss probability.

Topology

- **Nodes**: 7 workstations and 4 routers.
- **Links**: Bi-directional point-to-point links with defined attributes for data rate and delay.
- **Traffic Matrix**: Randomly generated distributed traffic matrix representing packet flows between workstations.

Routing

Static routing tables are used to direct packets through the network. Each router maintains routes to other nodes, ensuring packets take efficient paths toward their destination.

Link Configurations

- Data rates: Ranges from 500 Kbps to 1 Mbps.
- Delays: 1–7 ms depending on the link.

- Packet loss: Noise and buffer overflow are simulated with error rates between 0.5% and 6%.

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3. Assumptions

Several assumptions were made to simplify the simulation:

1. **Propagation Delay**: Fixed at variable ms for all links.
2. **Packet Drop Probability**: Ranges from 0.5% to 5%, reflecting noise or buffer overflow.
3. **Packet Size**: Set to 512 bytes to ensure consistent packet generation.
4. **Simulation Time**: Configured for 100 seconds , with results based on data generated during this period.

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4. Implementation Details

The simulation was implemented in C++ using the NS3 framework. Key components include:

Network Configuration

- **Topology Creation**: Nodes and links were defined programmatically, with routers interconnected.
- **Traffic Setup**: A traffic matrix defined packet flows dynamically between source-destination pairs.

Features and Tools

- **Error Models**: Simulated packet losses on specific links.
- **Routing**: Implemented static routing to avoid dynamic route computation overhead.
- **Metrics Collection**: Used flow monitors to gather data on delays, packet losses, and queue lengths.

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5. Performance Metrics and Observations

End-to-End Delays

Delays were calculated for each source-destination pair, both average delay and variance. This measurement shows bottlenecks and how well the routing strategy works.

Packet Drops

Packet drops were measured using a source-destination matrix. Most of the losses were seen on links with high traffic intensity or high error rates.

Queue Lengths

The lengths of the queues in the router outgoing links were also monitored to assess congestion levels. These values determined points where failure might occur.

Packet Tracing

Selected packets are traced through the network as a means of testing routing as well as to observe where these packets may not have gone the best.

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6. Conclusion

This simulation allowed for a detailed analysis of a simplified network's performance in terms of the effects that link characteristics, traffic patterns, and routing policies might have on key metrics. Observations from this analysis suggest that careful design of traffic flows and link configurations can minimize packet losses and delays.

Future work can be in the extension of this project by incorporating dynamic routing protocols, varying traffic patterns, and more realistic network scenarios to further explore performance in diverse conditions.