Network Topology Simulator

Comprehensive Project Report

1. Introduction

Enterprise networks today are complex ecosystems consisting of routers, switches, VLANs, and endpoints. The Network Topology Simulator automates topology generation, validation, optimization, and simulation to meet the requirements of Cisco VIP 2025 Problem Statement for Networking stream.

2. Objectives

The simulator enables:

- Topology generation from configuration files.
- Validation of IPs, VLANs, MTUs, and loops.
- Capacity analysis and load balancing recommendations.
- Protocol suggestions (BGP vs OSPF) and node aggregation.
- Simulation of Day-1 discovery and Day-2 link failures.

3. System Architecture

- **Modules include:**
  - Configuration Parser: Extracts device data.
  - Topology Builder: Connects devices via VLAN and neighbor links.
  - Validator: Detects IP conflicts, MTU mismatches, loops, and missing configs.
  - Optimizer: Recommends load balancing, protocol selection, and node aggregation.
  - Simulator: Multithreaded device threads with IPC for message passing.
  - Orchestrator: CLI entrypoint managing workflow and outputs.

- **Architecture Principles:**
  - Modularity, scalability, concurrency, IPC via queues, visualization via Matplotlib.

4. Implementation Details

- **Configuration Grammar (example):**

  hostname R1
  role router
  interface Gi0/0 ip 10.0.0.1/24 vlan 10 mtu 1500 bw_mbps 100 neighbor R2

- **Validation Checks:**
  - Duplicate IPs per VLAN
  - MTU mismatch detection
  - Loop detection
  - Missing component detection

- **Optimization:**
  - Load balancing on saturated links
  - Protocol recommendations (BGP/OSPF)
  - Node aggregation suggestions

- **Simulation:**
  - Day-1: ARP, OSPF discovery
  - Day-2: Link failure injection, pause/resume simulation
  - Logging and reporting
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5. Testing

Tests include parser validation, MTU mismatch detection, and simulation fault injection.
Sample configs with R1, R2, SW1, and SW2 demonstrate expected outputs.

6. Sample Outputs

Example Run:

- MTU mismatch detected on R1-R2.
- Load balancing is recommended on R1-SW1 and R2-SW2.
- Protocol recommendation: BGP.
- Node aggregation recommended for SW1 and SW2.
- Affected nodes in link failure: R1 and R2.

7. Limitations & Future Work

- Extend parser for Cisco IOS/JunOS syntax.
- Replace in-memory IPC with TCP/FIFO.
- Implement detailed protocol packet exchanges.
- Enhance visualization with graph libraries.
- Integrate realistic traffic modeling.

8. Conclusion

The Network Topology Simulator automates topology generation, validation, and simulation.
It demonstrates a practical, extensible framework for academic learning and research in automated network analysis.