NATIONAL UNIVERSITY OF SCIENCES AND TECHNOLOGY

School of Electrical Engineering and Computer Sciences

COMPUTER NETWORKS (EE353)

END-SEMESTER PROJECT REPORT

Project Scenario 4

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Project Scenario 4:

Code Overview:

The purpose of the code is to simulate a network scenario with 50 nodes, where each node has specific connectivity requirements. The goal is to establish connections between nodes, assign random link values, implement a routing algorithm, and finally, simulate and analyze the network's performance.

Purpose:

The primary objective of the code is to simulate a network scenario comprising 50 nodes with specific connectivity requirements. This simulation aims to establish connections between nodes, assign random link values, implement a routing algorithm, and ultimately analyze the network's performance. The code serves as a comprehensive tool for evaluating the effectiveness of network design, including aspects such as optimal routing and inter-AS communication.

Key Components:

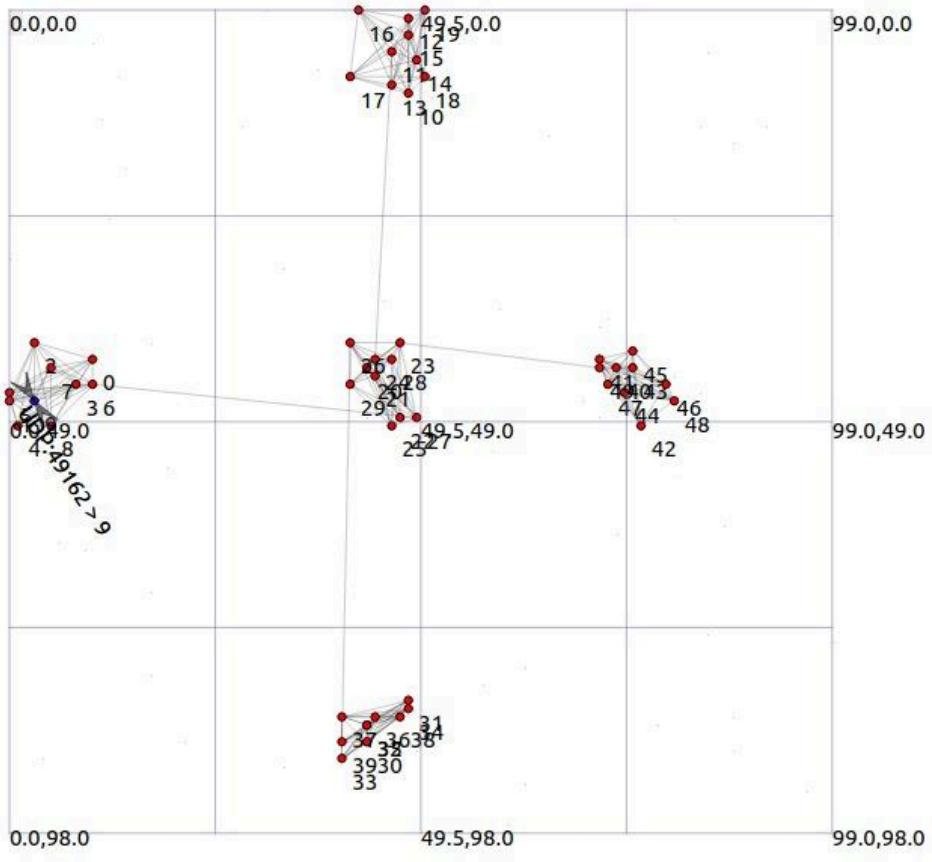
- **Node Creation and Internet Stack Installation:**
  50 nodes are created, and the Internet stack is installed on each node.
- **Point-to-Point Links and Random Bandwidth Assignment:**
  1. Point-to-point links are established between nodes with specific requirements (e.g., nodes 6 and 27).
  2. Random bandwidth values (between 50 and 250 Mbps) are assigned to these links.
- **AS Division and Interconnection:**
  1. The nodes are divided into five Autonomous Systems (AS) with specific ranges (0-9, 10-19, 20-29, 30-39, 40-49).
  2. Random bandwidth is assigned to links connecting nodes within each AS.
- **Animation Interface:**
  An animation interface is created to visualize the network topology.
- **Dijkstra's Algorithm for Shortest Paths:**
  1. Dijkstra's algorithm is implemented to find the shortest paths within and between ASes.
  2. The shortest paths from Source (Node 0) to Destination (Node 47) are calculated, considering gateways (6, 27, 23, 49) in between.

- **Simulation Setup:**
    1. The simulation is set to run for 10 seconds.
    2. Animation interface positions are set based on AS divisions.
- **Total Shortest Path Calculation:**

  The shortest path from source to destination is calculated by summing the distances from each step.
- **Simulation Run and Cleanup:**
    1. The simulation is run, and the results are displayed.
    2. Animation features like packet metadata and IPv4 L3 protocol counters are enabled.

Network Topology:

In this network topology, a total of 50 nodes are organized into five autonomous systems (AS), each representing a distinct administrative domain. The AS division ranges from AS 0 to AS 4, with nodes grouped accordingly (AS 0: 0-9, AS 1: 10-19, AS 2: 20-29, AS 3: 30-39, AS 4: 40-49). Within each AS, a gateway node is established and connected to the source node (Node 0), serving as the entry point for communication within its respective AS. Nodes within an AS are interconnected through point-to-point links, forming a mesh-like structure. These links are assigned random bandwidth values between 50 and 250 Mbps. To optimize communication within each AS, Dijkstra's algorithm is employed for routing, calculating the shortest paths. The overall optimal path from the source node (Node 0) to the destination node (Node 47) is determined by combining the optimal paths within each AS. The NetAnim module visualizes this complex network topology, aiding in a clearer understanding of the AS divisions and interconnections.



AS Division and Interconnection:

- **AS Division:**
    1. The network is logically divided into five autonomous systems (AS), each identified by a range of nodes (AS 0: 0-9, AS 1: 10-19, AS 2: 20-29, AS 3: 30-39, AS 4: 40-49).
    2. This division is beneficial for simulating a realistic network scenario where different AS may represent distinct administrative domains or geographical regions.
- **Gateway Connections:**
    1. Within each AS, a gateway node is established and connected to the source node (node 0).

2. These gateways act as entry points for communication within their respective AS and facilitate routing toward the destination.

- **Interconnection:**

1. Nodes within an AS are interconnected with Point-to-Point links, forming a mesh-like structure within each AS.
2. Random bandwidth values are assigned to these links, reflecting diverse network conditions within an AS.

Routing:

- **Dijkstra's Algorithm:**
    1. Dijkstra's algorithm is employed for routing within the network.
    2. The algorithm calculates the shortest paths from the source node (node 0) to other nodes, considering link costs based on random bandwidth assignments.
    3. It operates independently within each AS, optimizing paths for intra-AS communication.
- **Optimal Path Calculation:**
    1. The overall optimal path from the source node (node 0) to the destination node (node 47) is determined by combining the optimal paths within each AS.
    2. The cost associated with each link is considered, enabling the selection of the path with the minimum cumulative cost.

Application and Traffic Generation:

The application and traffic generation aspects of the code involve the creation of UDP sockets, packet transmission, and simulation of packet delivery. This section focuses on simulating the transmission of five packets from a source node to a destination node within an established network scenario.

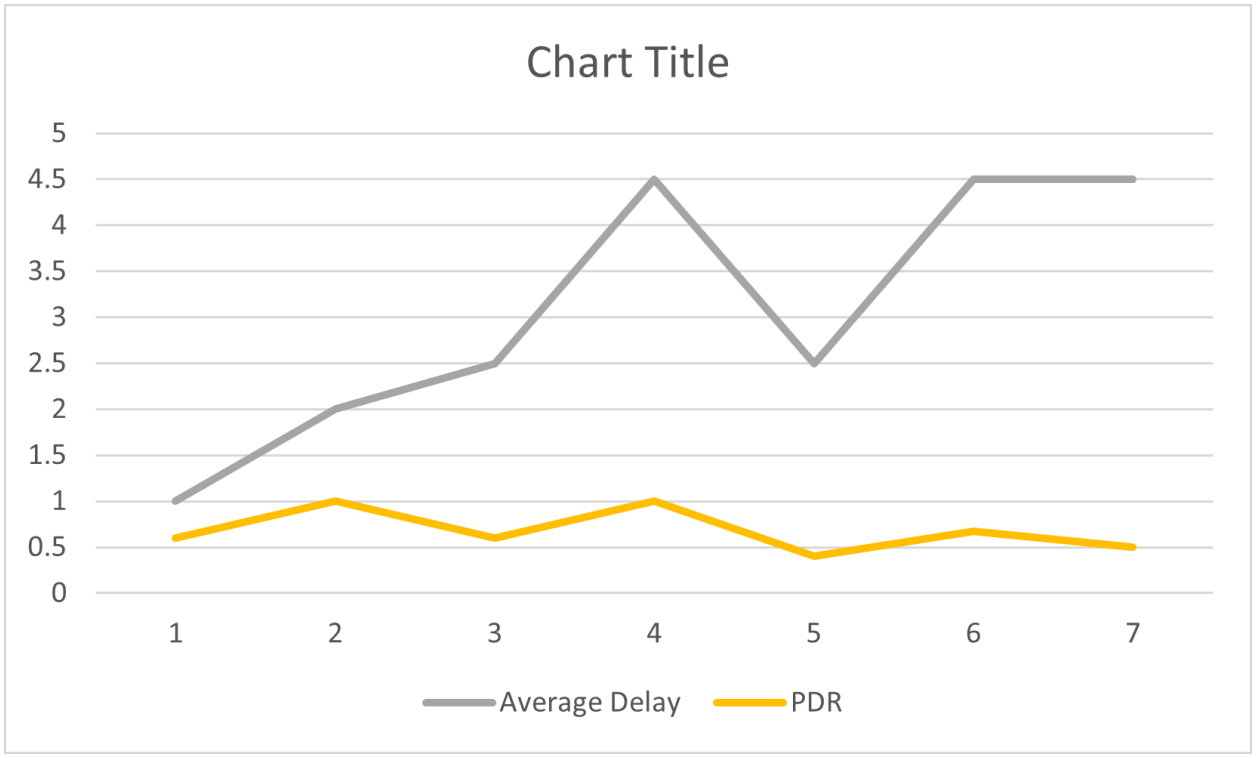
- **Socket Creation:** UDP sockets are created for both the source and destination nodes. These sockets are bound to specific nodes and addresses.
- **Packet Generation:** Each packet is created with a size of 1024 bytes.
- **Packet Transmission:** The transmission of each packet from the source to the destination is simulated using scheduled events. During packet transmission, global variables such as total delay and packets received are updated.

- **Simulation Setup:** The simulation is configured to run for 10 seconds.
- **Results Calculation:** After the simulation, the average delay and packet delivery ratio are calculated based on the transmitted packets.
- **Result Display:** The average delay and packet delivery ratio are printed to the console, providing insights into the network's performance during the simulated packet transmission.

PDR Calculations:

Table of Values:

No of Packets	**Stimulation Time**	**Average Delay**	**PDR**
5	2	1	0.6
5	5	2	1
10	5	2.5	0.6
10	10	4.5	1
15	5	2.5	0.4
15	10	4.5	0.67
20	10	4.5	0.5



Output:

```
Overall Shortest path from node 0 to 48:
Shortest paths from node 0 to gateway 6: 62.066
Link cost for Gateway 6 to gateway 27: 103.939
Shortest paths from node 27 to gateway 23: 72.8633
Link cost for Gateway 23 to gateway 49: 247.461
Shortest paths from node 49 to node 48: 150.677
Total Shortest Path from node 0 to 48: 637.006
Average Delay: 4.5 seconds
Packet Delivery Ratio: 0.5
admin@admin:~/ns-allinone-3.29/ns-3.29$
```

Additional Considerations:

- **Randomization:**

  Randomization is used for node positions, link bandwidth, and AS divisions.

- **Network Visualization:**

  The network topology is visualized using the NetAnim module.

- **Traffic Generation:**

The code focuses on network setup and routing, and there's no explicit traffic generation or application layer implementation.