

Computer Network

NS3 Simulator

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Building Custom Topology Network

To simulate a computer network using the NS-3 simulator and evaluate its performance. The network consists of multiple nodes, which include workstations, servers, and intermediate routers. Data packets are routed through the network, and links may have different capacities, delays, and noise levels.

Topology

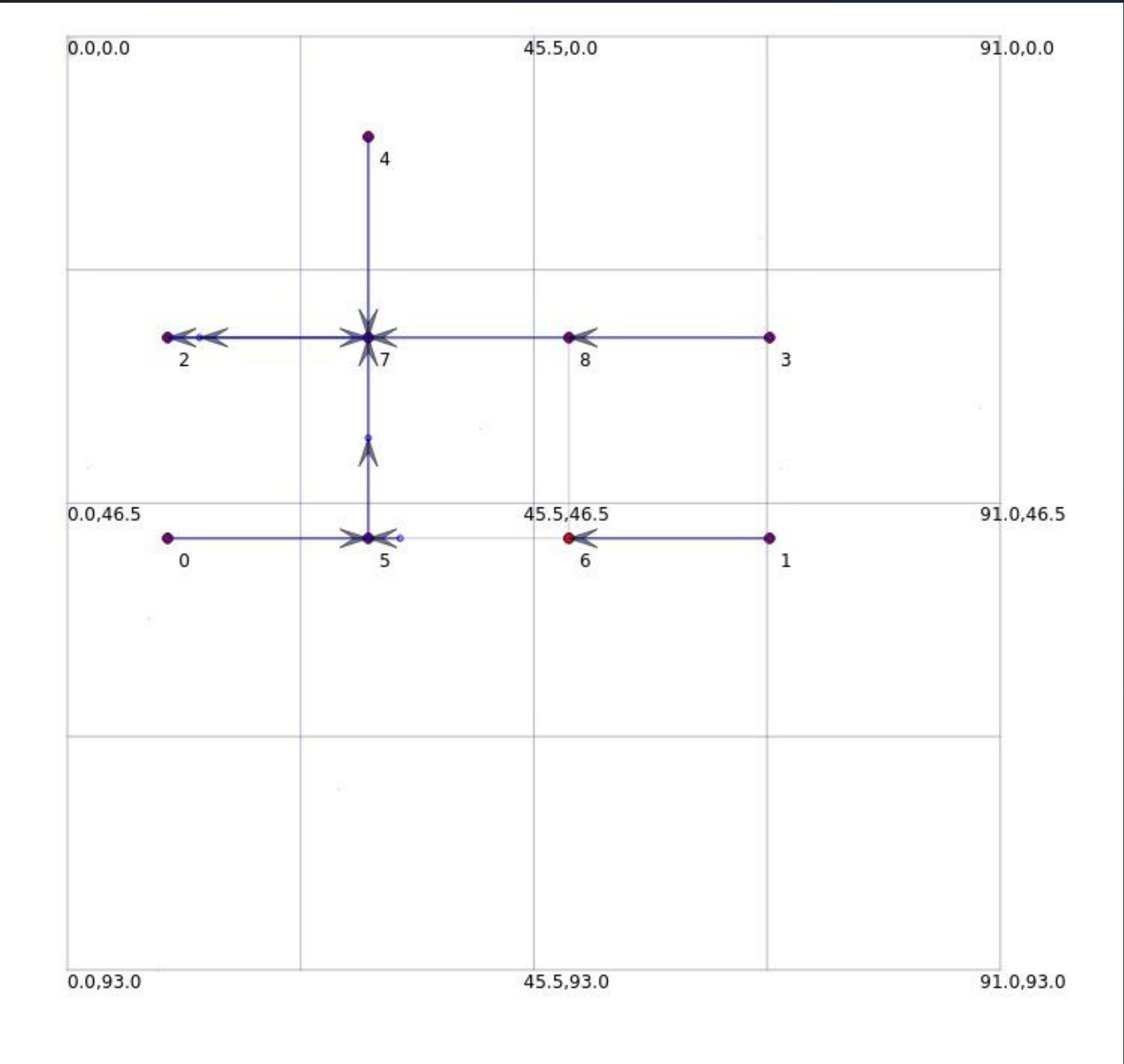
The network consists of:

- 5 Workstations/Servers (N1, N2, N3, N4, N5)
- 4 Routers (R1, R2, R3, R4)
- Point-to-point links with varying capacities and delays

topology simulation

Source	N1	N2	N3	N4	N5	R1	R2	R3	R4
N1	—	R1	R1	R1	R1	—	—	—	—
N2	R2	—	R2	R2	R2	—	—	—	—
N3	R3	R3	—	R3	R3	—	—	—	—
N4	R4	R4	R4	—	R4	—	—	—	—
N5	R3	R3	R3	R3	—	—	—	—	—
R1	N1	R2	R3	R2	R3	—	R2	R3	R2
R2	R1	N2	R4	N4	R4	R1	—	R1	R4
R3	R1	R4	N3	R4	N5	R1	R1	—	R4
R4	R2	R2	R3	N4	R5	R3	R2	R3	—

Routing table



From	To	Traffic Rate (Mbps)
N1	N2	120
N1	N3	132
N1	N4	144
N1	N5	160
N2	N1	100
N2	N3	190
N2	N4	111
N2	N5	154
N3	N1	101
N3	N2	100
N3	N4	199
N3	N5	108
N4	N1	150
N4	N2	156
N4	N3	262
N4	N5	159
N5	N1	140
N5	N2	188
N5	N3	285
N5	N4	171

Table 1: Traffic Matrix between Nodes

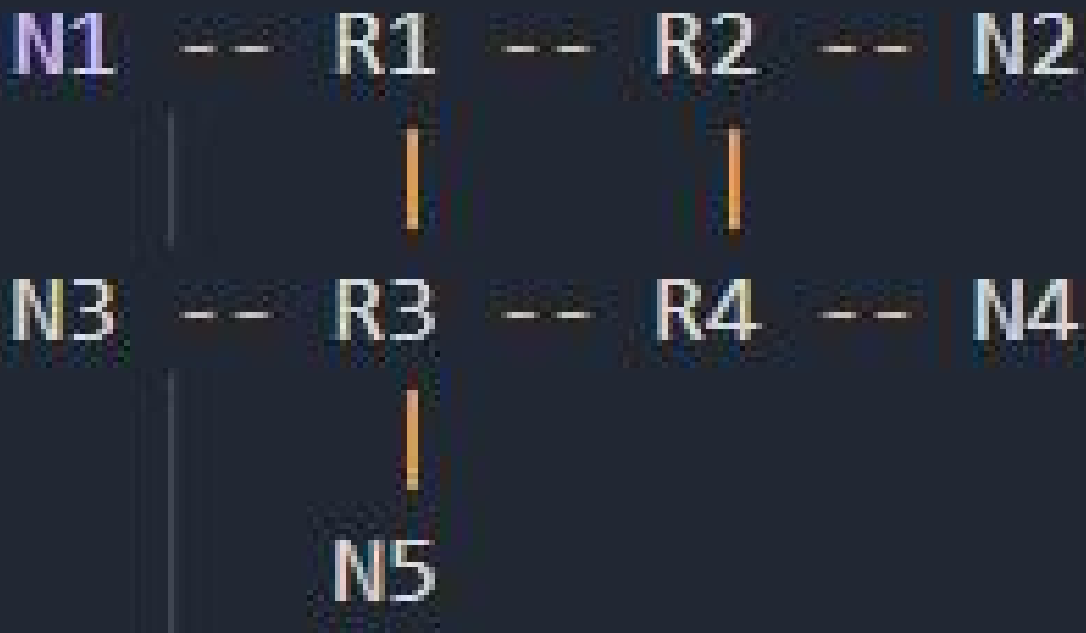
Node	Node Number	Type
N1	0	Client/Server
N2	1	Client/Server
N3	2	Client/Server
N4	3	Client/Server
N5	4	Client/Server
R1	5	Router
R2	6	Router
R3	7	Router
R4	8	Router

Table 2: Node Details and Classification

Link	Link Capacity
N1 – R1	1 Mbps
N2 – R2	1 Mbps
N3 – R3	3 Mbps
N4 – R4	1 Mbps
N5 – R3	1 Mbps
R1 – R2	3 Mbps
R1 – R3	2.5 Mbps
R2 – R4	1 Mbps
R3 – R4	1.5 Mbps

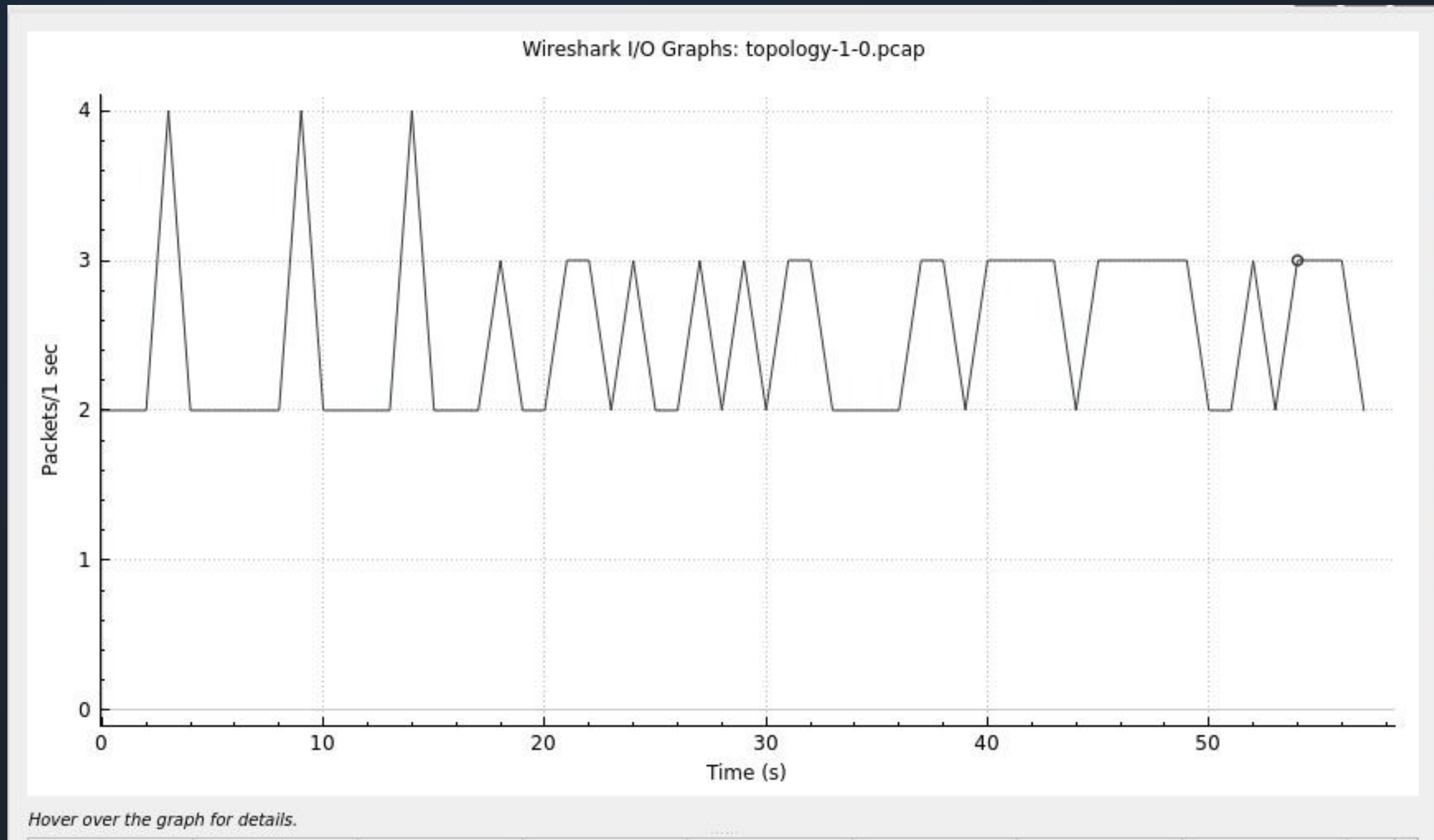
	N1	N2	N3	N4	N5
N1	0	120	132	144	160
N2	100	0	190	111	154
N3	101	100	0	199	108
N4	150	156	262	0	159
N5	140	188	285	171	0

traffic matrix



topology

Simulation Parameters and Assumptions



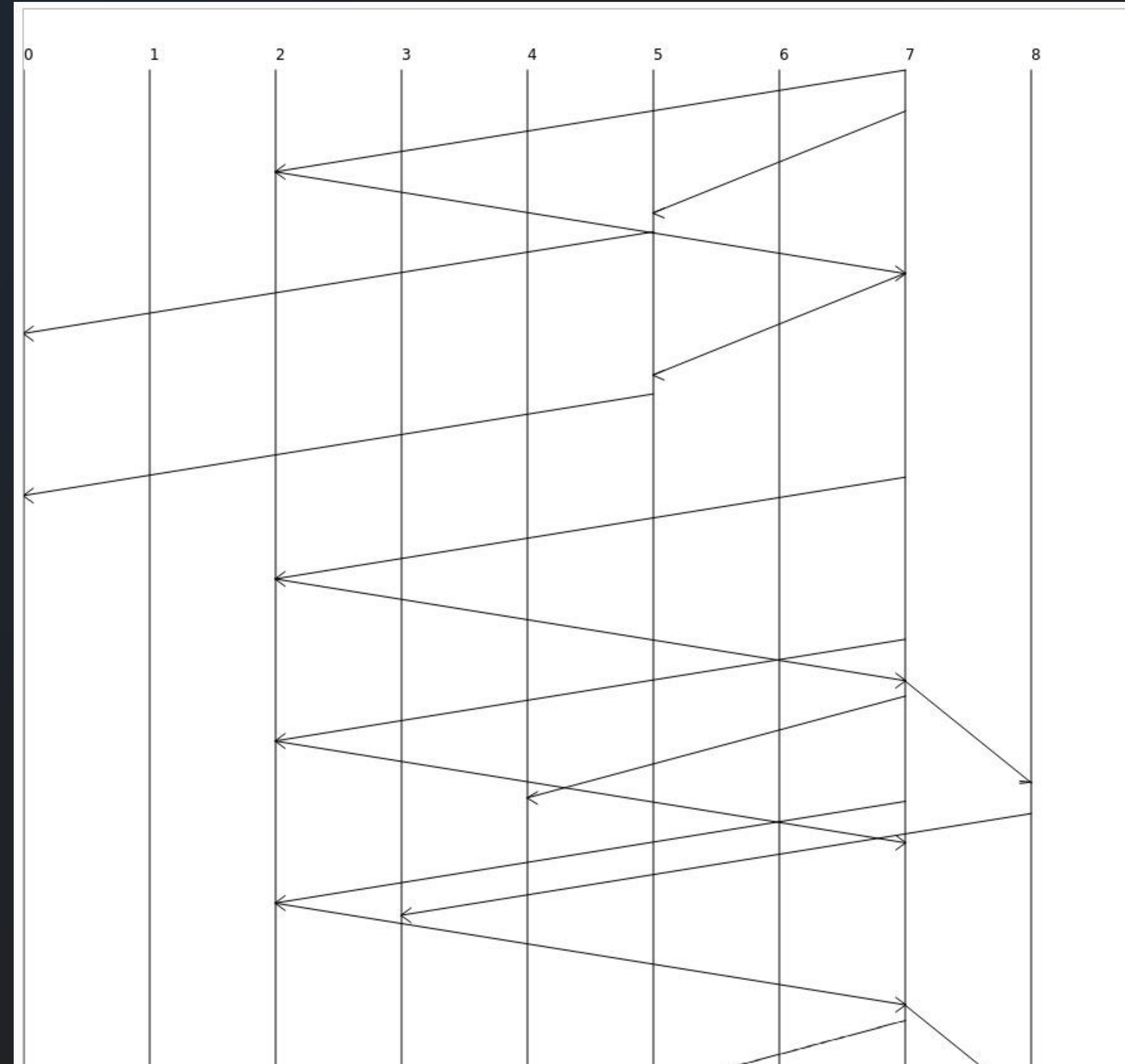
```
double dropProbability = 0.005; // 0.5% drop rate
if (UniformRandomVariable().GetValue(0.0, 1.0) < dropProbability) {
    // Drop the packet
}
```

**Setting Packet Drop probability
0.5%– 1%**

```
ExponentialRandomVariable expRandomVariable;
double interArrivalTime = expRandomVariable.GetValue(meanArrivalRate);
```

Poisson distribution

Export Table				
	From Id	To Id	Tx	Meta
889	7	2	21.2002	
890	7	5	21.2006	
891	2	7	21.2012	
892	5	0	21.2018	
893	7	5	21.2022	
894	5	0	21.2034	
895	7	2	21.2042	
896	2	7	21.2052	
897	7	2	21.2058	
898	7	8	21.2062	
899	7	4	21.2064	
900	2	7	21.2068	
901	7	2	21.2074	
902	8	3	21.2075	
903	2	7	21.2084	
904	7	8	21.2094	
905	7	4	21.2095	
906	8	3	21.2107	
907	7	2	21.2114	
908	2	7	21.2124	
909	7	2	21.213	
910	7	5	21.2136	
911	2	7	21.214	
912	5	6	21.2147	
913	7	5	21.2151	
914	6	1	21.2159	
915	5	6	21.2163	
916	7	2	21.217	
917	6	1	21.2175	
918	2	7	21.218	
919	7	2	21.221	
920	2	7	21.222	
921	7	2	21.2226	
922	7	2	21.2242	
923	2	7	21.226	
924	2	7	21.2276	
925	7	2	21.2282	
926	2	7	21.2292	
927	7	2	21.2298	
928	2	7	21.2332	
929	7	2	21.2338	



Reading .pcap files in wireshark

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	10.1.3.1	10.1.4.0	IPv4	1502	Fragmented IP protocol (proto=UDP 17, off=0, ID=0000) [Reassembled in #3]
2	0.012016	10.1.5.1	10.1.4.0	IPv4	1502	Fragmented IP protocol (proto=UDP 17, off=0, ID=0000) [Reassembled in #4]
3	0.024032	10.1.3.1	10.1.4.0	UDP	598	49153 → 9 Len=2048
4	0.028816	10.1.5.1	10.1.4.0	UDP	598	49153 → 9 Len=2048
5	1.000000	10.1.3.1	10.1.4.0	IPv4	1502	Fragmented IP protocol (proto=UDP 17, off=0, ID=0001) [Reassembled in #7]
6	1.012016	10.1.5.1	10.1.4.0	IPv4	1502	Fragmented IP protocol (proto=UDP 17, off=0, ID=0001) [Reassembled in #8]
7	1.024032	10.1.3.1	10.1.4.0	UDP	598	49153 → 9 Len=2048
8	1.028816	10.1.5.1	10.1.4.0	UDP	598	49153 → 9 Len=2048
9	2.000000	10.1.3.1	10.1.4.0	IPv4	1502	Fragmented IP protocol (proto=UDP 17, off=0, ID=0002) [Reassembled in #11]
10	2.012016	10.1.5.1	10.1.4.0	IPv4	1502	Fragmented IP protocol (proto=UDP 17, off=0, ID=0002) [Reassembled in #12]
11	2.024032	10.1.3.1	10.1.4.0	UDP	598	49153 → 9 Len=2048
12	2.028816	10.1.5.1	10.1.4.0	UDP	598	49153 → 9 Len=2048
13	3.000000	10.1.3.1	10.1.4.0	IPv4	1502	Fragmented IP protocol (proto=UDP 17, off=0, ID=0003) [Reassembled in #15]
14	3.012016	10.1.5.1	10.1.4.0	IPv4	1502	Fragmented IP protocol (proto=UDP 17, off=0, ID=0003) [Reassembled in #16]
15	3.024032	10.1.3.1	10.1.4.0	UDP	598	49153 → 9 Len=2048
16	3.028816	10.1.5.1	10.1.4.0	UDP	598	49153 → 9 Len=2048
17	3.681328	10.1.9.2	10.1.3.1	ICMP	58	Time-to-live exceeded (Time to live exceeded in transit)
18	3.722160	10.1.9.2	10.1.5.1	ICMP	58	Time-to-live exceeded (Time to live exceeded in transit)

▶ Frame 1: 1502 bytes on wire (12016 bits), 1502 bytes captured (12016 bits)
 ▶ Point-to-Point Protocol
 ▶ Internet Protocol Version 4, Src: 10.1.3.1, Dst: 10.1.4.0
 ▶ Data (1480 bytes)

```

0000  00 21 45 00 05 dc 00 00 20 00 3f 11 00 00 0a 01  -!E-....-?.....
0010  03 01 0a 01 04 00 c0 01 00 09 08 08 00 00 00 00  .....
0020  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
0030  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
0040  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
0050  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
0060  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
0070  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
0080  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
0090  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
00a0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
00b0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
00c0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
00d0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
00e0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
00f0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
0100  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
0110  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
0120  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
0130  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
  
```

topology-7-3.pcap
 Packets: 2

```

1 Node: 0, Time: +1s, Local time: +1s, Ipv4ListRouting table
2 | Priority: 0 Protocol: ns3::Ipv4StaticRouting
3 Node: 0, Time: +1s, Local time: +1s, Ipv4StaticRouting table
4 Destination      Gateway      Genmask      Flags Metric Ref    Use Iface
5 127.0.0.0         0.0.0.0      255.0.0.0    U      0      -     -    0
6 10.1.1.0          0.0.0.0      255.255.255.0 U      0      -     -    1
7
8 | Priority: -10 Protocol: ns3::Ipv4GlobalRouting
9 Node: 0, Time: +1s, Local time: +1s, Ipv4GlobalRouting table
10 Destination      Gateway      Genmask      Flags Metric Ref    Use Iface
11 0.0.0.0           10.1.1.2     0.0.0.0      UG     -      -     -    1
12
13 Node: 1, Time: +1s, Local time: +1s, Ipv4ListRouting table
14 | Priority: 0 Protocol: ns3::Ipv4StaticRouting
15 Node: 1, Time: +1s, Local time: +1s, Ipv4StaticRouting table
16 Destination      Gateway      Genmask      Flags Metric Ref    Use Iface
17 127.0.0.0         0.0.0.0      255.0.0.0    U      0      -     -    0
18 10.1.2.0          0.0.0.0      255.255.255.0 U      0      -     -    1
19
20 | Priority: -10 Protocol: ns3::Ipv4GlobalRouting
21 Node: 1, Time: +1s, Local time: +1s, Ipv4GlobalRouting table
22 Destination      Gateway      Genmask      Flags Metric Ref    Use Iface
23 0.0.0.0           10.1.2.2     0.0.0.0      UG     -      -     -    1
24
25 Node: 2, Time: +1s, Local time: +1s, Ipv4ListRouting table
26 | Priority: 0 Protocol: ns3::Ipv4StaticRouting
27 Node: 2, Time: +1s, Local time: +1s, Ipv4StaticRouting table
28 Destination      Gateway      Genmask      Flags Metric Ref    Use Iface
29 127.0.0.0         0.0.0.0      255.0.0.0    U      0      -     -    0
30 10.1.3.0          0.0.0.0      255.255.255.0 U      0      -     -    1
31
32 | Priority: -10 Protocol: ns3::Ipv4GlobalRouting
33 Node: 2, Time: +1s, Local time: +1s, Ipv4GlobalRouting table
34 Destination      Gateway      Genmask      Flags Metric Ref    Use Iface
35 0.0.0.0           10.1.3.2     0.0.0.0      UG     -      -     -    1
36

```

Routing Table from populating Routing Tables

Performance metrics

Average Delay and Variance of Delay

Queue length statistics

1837	Router 1	|	Time: 42.5336	|	Queue Length: 35
1838	Router 3	|	Time: 42.5336	|	Queue Length: 35
1839	Router 0	|	Time: 42.5346	|	Queue Length: 35
1840	Router 0	|	Time: 42.5346	|	Queue Length: 36
1841	Router 0	|	Time: 42.5346	|	Queue Length: 35
1842	Router 1	|	Time: 42.5346	|	Queue Length: 35
1843	Router 3	|	Time: 42.5346	|	Queue Length: 35
1844	Router 4	|	Time: 42.5346	|	Queue Length: 35
1845	Router 0	|	Time: 42.5375	|	Queue Length: 35
1846	Router 0	|	Time: 42.5456	|	Queue Length: 35
1847	Router 1	|	Time: 42.5456	|	Queue Length: 35
1848	Router 3	|	Time: 42.5456	|	Queue Length: 35
1849	Router 0	|	Time: 42.5466	|	Queue Length: 35
1850	Router 1	|	Time: 42.5466	|	Queue Length: 35
1851	Router 3	|	Time: 42.5466	|	Queue Length: 35
1852	Router 0	|	Time: 42.5504	|	Queue Length: 35
1853	Router 1	|	Time: 42.5504	|	Queue Length: 35
1854	Router 3	|	Time: 42.5504	|	Queue Length: 35
1855	Router 0	|	Time: 42.5514	|	Queue Length: 35
1856	Router 1	|	Time: 42.5514	|	Queue Length: 35
1857	Router 3	|	Time: 42.5514	|	Queue Length: 35
1858	Router 0	|	Time: 42.5624	|	Queue Length: 35
1859	Router 1	|	Time: 42.5624	|	Queue Length: 35
1860	Router 3	|	Time: 42.5624	|	Queue Length: 35

End-to-End One-Way Delay (Average):

[	0.	0.	0.	26.01973335	0.]
[	0.	0.	0.	34.04157524	0.]
[	0.	0.	0.	28.04718949	0.]
[	0.	0.	0.	25.62627662	0.]
[	0.	0.	0.	28.50852131	0.]]

End-to-End One-Way Delay (Variance):

[	0.	0.	0.	5.33771062	0.]
[	0.	0.	0.	5.9550409	0.]
[	0.	0.	0.	8.09655645	0.]
[	0.	0.	0.	8.60188499	0.]
[	0.	0.	0.	6.00644237	0.]]

Packet Drops:

[	0.	0.	270.	0.	0.]
[	0.	0.	280.	0.	0.]
[	0.	0.	0.	0.	0.]
[	0.	0.	275.	0.	0.]
[	0.	0.	250.	0.	0.]]

Packet drop rate matrix