Computer Network

NS3 Simulator

Ritika Thakur(2022408) Swarnima Prasad (2022525)

Building Custom Topology Network

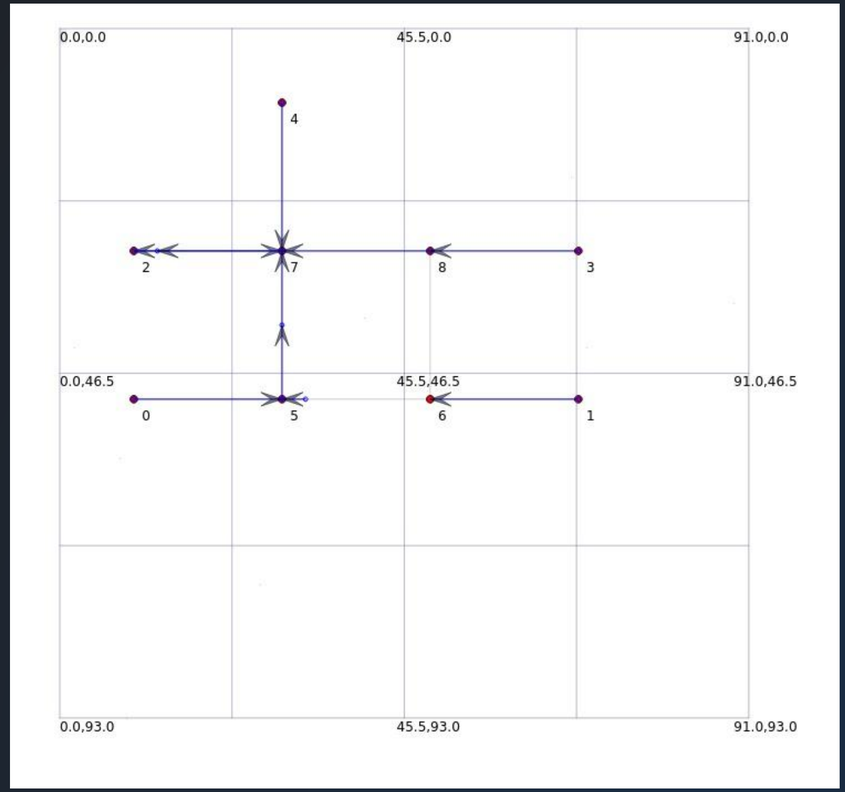
To simulate a computer network using the NS-3 simulator and evaluate its performance. The network consists of
multiple nodes, which include workstations, servers, and intermediate routers. Data packets are routed through
the network, and links may have different capacities, delays, and noise levels.

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

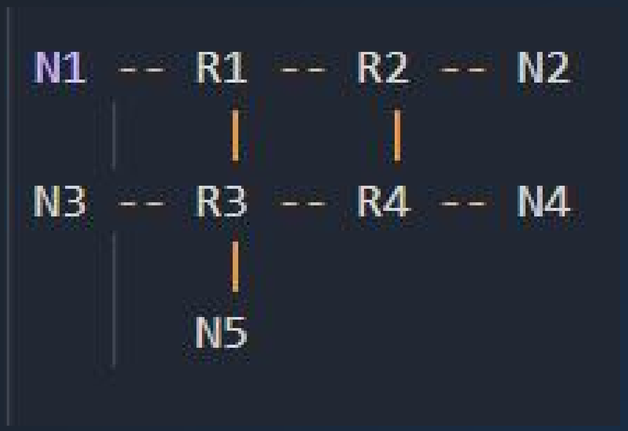
Node	Node Number	Type
N1	0	Client/Server
N2	1	Client/Server
N3	2	Client/Server
N4	3	Client/Server
N5	4	Client/Server
R1	5	Router
R2	6	Router
R3	7	Router
R4	8	Router

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

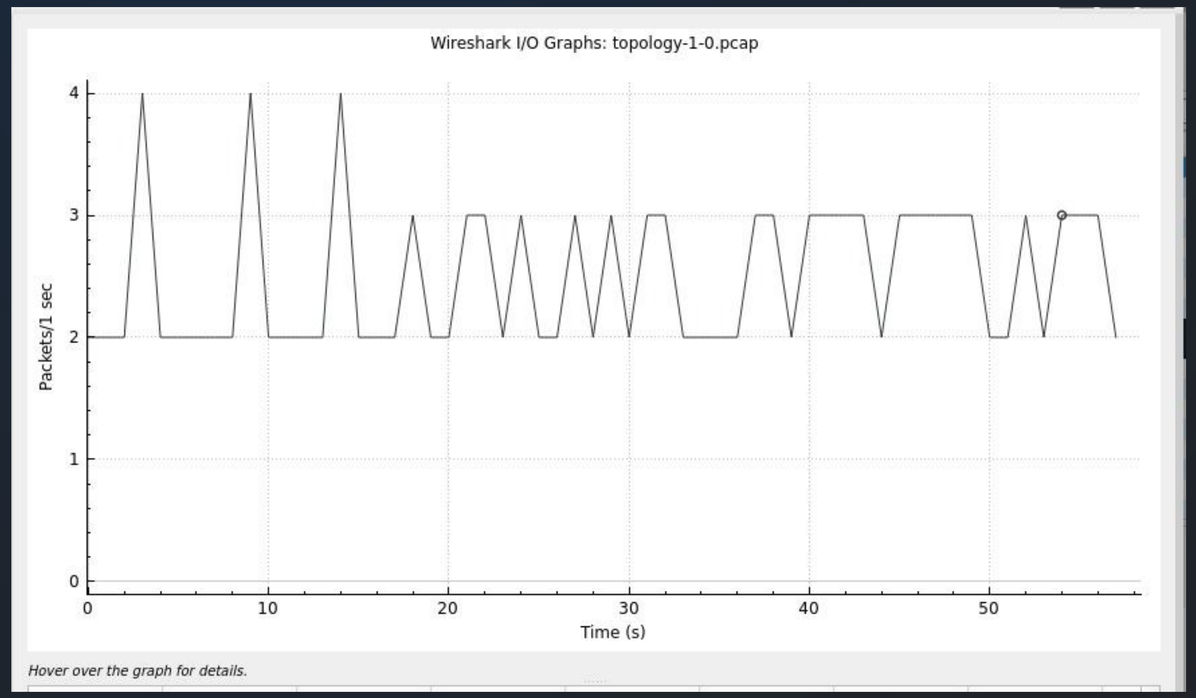
	$N1$	$N2$	$N3$	$N4$	$N5$
$N1$	0	120	132	144	160
$N2$	100	0	190	111	154
$N3$	101	100	0	199	108
$N4$	150	156	262	0	159
$N5$	140	188	285	171	0

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

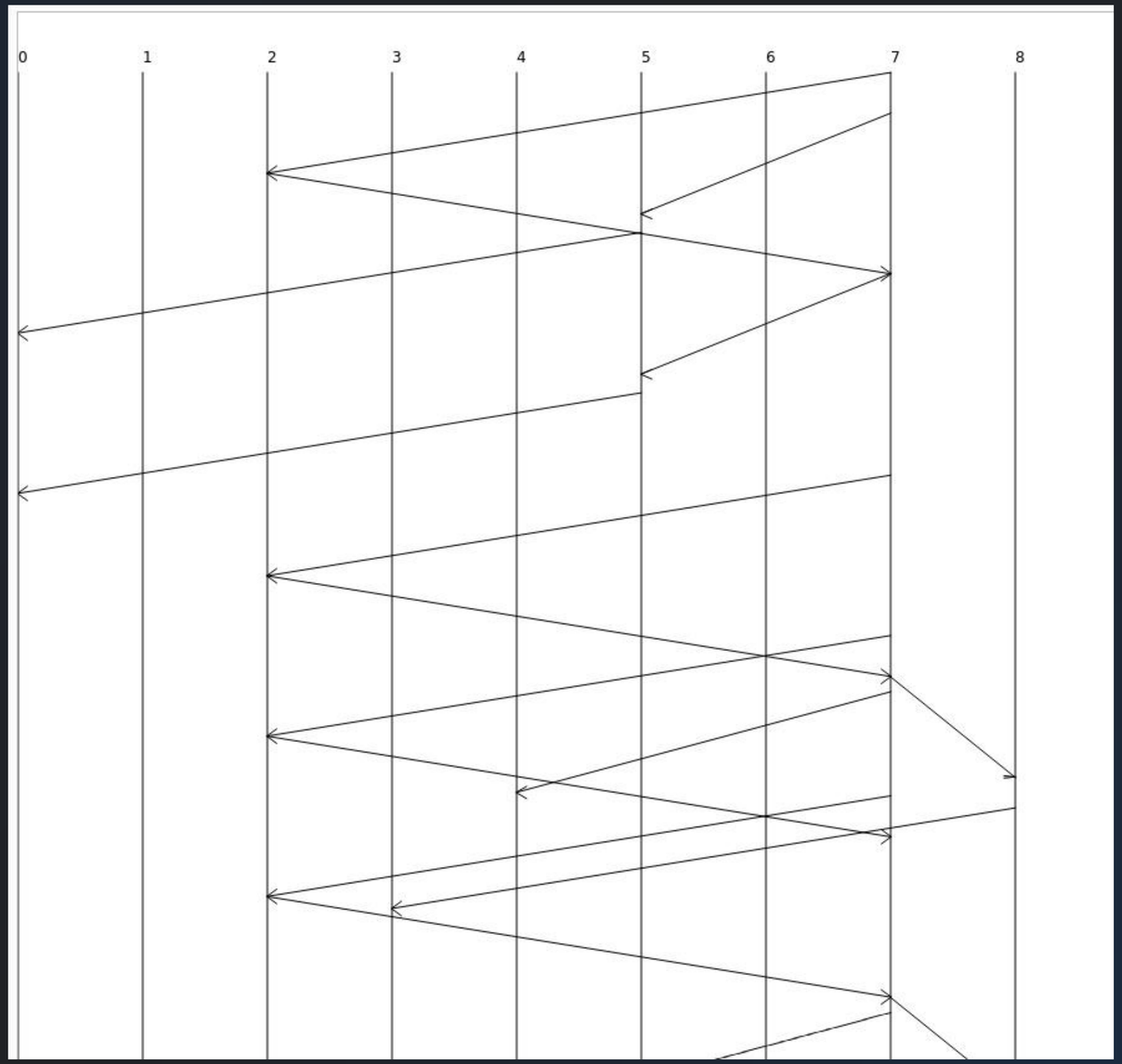
0.5%- 1%

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

Poisson distribution

Export Table

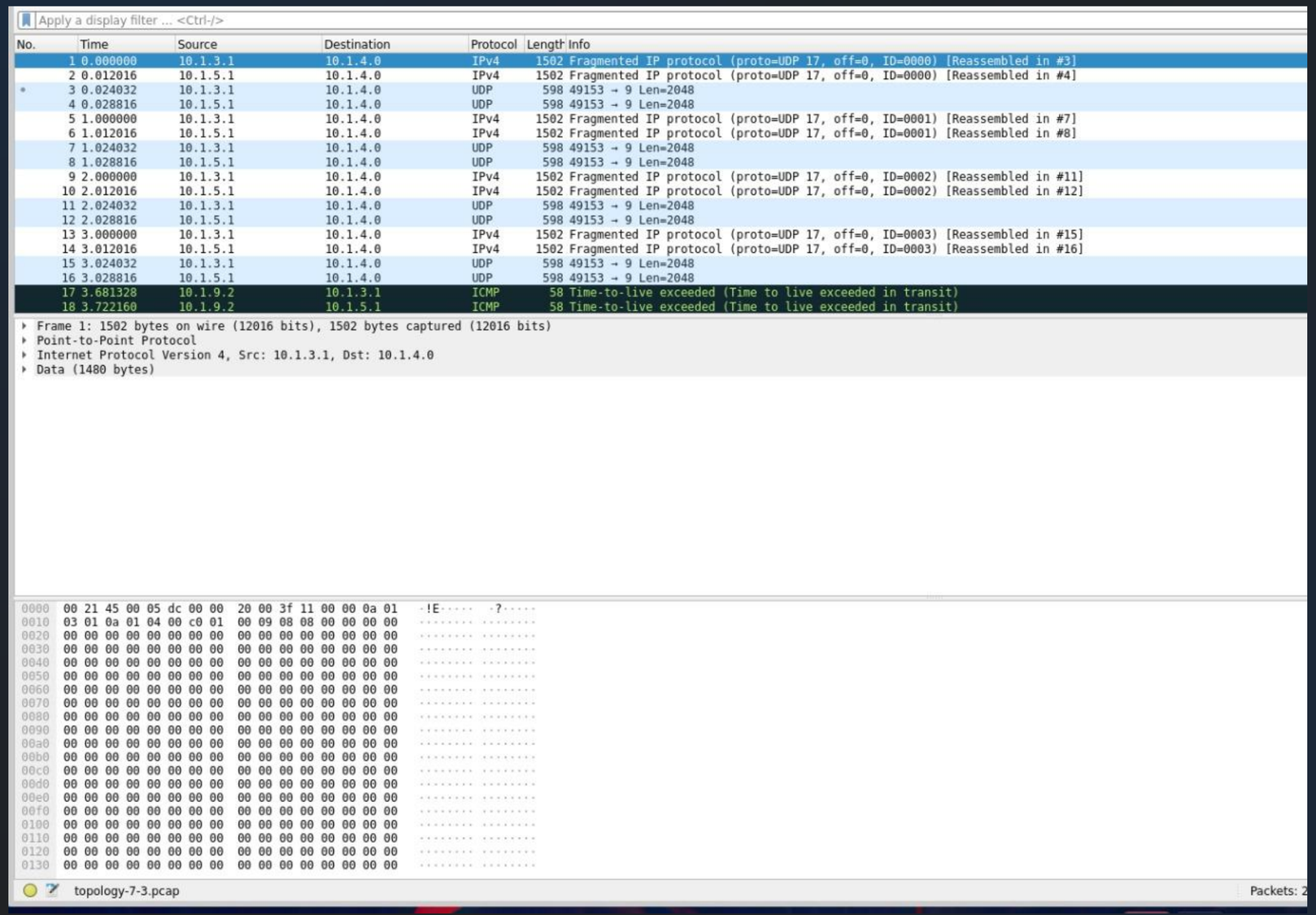
	From Id	To Id	Tx	Meta
889	7	2	21.2002	
890	7	5	21.2006	
891	2	7	21.2012	
892	5	0	21.2018	
893	7	5	21.2022	
894	5	0	21.2034	
895	7	2	21.2042	
896	2	7	21.2052	
897	7	2	21.2058	
898	7	8	21.2062	
899	7	4	21.2064	
900	2	7	21.2068	
901	7	2	21.2074	
902	8	3	21.2075	
903	2	7	21.2084	
904	7	8	21.2094	
905	7	4	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	



Communication Log Table

Sequence Diagram

Reading .pcap files in wireshark



```
Node: 0, Time: +1s, Local time: +1s, Ipv4ListRouting table
  Priority: 0 Protocol: ns3::Ipv4StaticRouting
Node: 0, Time: +1s, Local time: +1s, Ipv4StaticRouting table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
127.0.0.0       0.0.0.0         255.0.0.0       U     0      -      -   0
10.1.1.0        0.0.0.0         255.255.255.0   U     0      -      -   1

  Priority: -10 Protocol: ns3::Ipv4GlobalRouting
Node: 0, Time: +1s, Local time: +1s, Ipv4GlobalRouting table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         10.1.1.2        0.0.0.0         UG    -      -      -   1

Node: 1, Time: +1s, Local time: +1s, Ipv4ListRouting table
  Priority: 0 Protocol: ns3::Ipv4StaticRouting
Node: 1, Time: +1s, Local time: +1s, Ipv4StaticRouting table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
127.0.0.0       0.0.0.0         255.0.0.0       U     0      -      -   0
10.1.2.0        0.0.0.0         255.255.255.0   U     0      -      -   1

  Priority: -10 Protocol: ns3::Ipv4GlobalRouting
Node: 1, Time: +1s, Local time: +1s, Ipv4GlobalRouting table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         10.1.2.2        0.0.0.0         UG    -      -      -   1

Node: 2, Time: +1s, Local time: +1s, Ipv4ListRouting table
  Priority: 0 Protocol: ns3::Ipv4StaticRouting
Node: 2, Time: +1s, Local time: +1s, Ipv4StaticRouting table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
127.0.0.0       0.0.0.0         255.0.0.0       U     0      -      -   0
10.1.3.0        0.0.0.0         255.255.255.0   U     0      -      -   1

  Priority: -10 Protocol: ns3::Ipv4GlobalRouting
Node: 2, Time: +1s, Local time: +1s, Ipv4GlobalRouting table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         10.1.3.2        0.0.0.0         UG    -      -      -   1

```

Routing Table from populating Routing Tables

Performance metrics

Average Delay and Variance of Delay

```
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.        ]]
```

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
```

```
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