COMPUTER NETWORKS ASSIGNMENT 4

NS3-BASED SIMULATION OF A COMPUTER NETWORK

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OVERVIEW

Key Objectives:

- **Brief description of the network simulation task.**
- **Objective: Evaluate network performance using NS3.**
- **Simulation done by 4 routers and 7 end devices.**

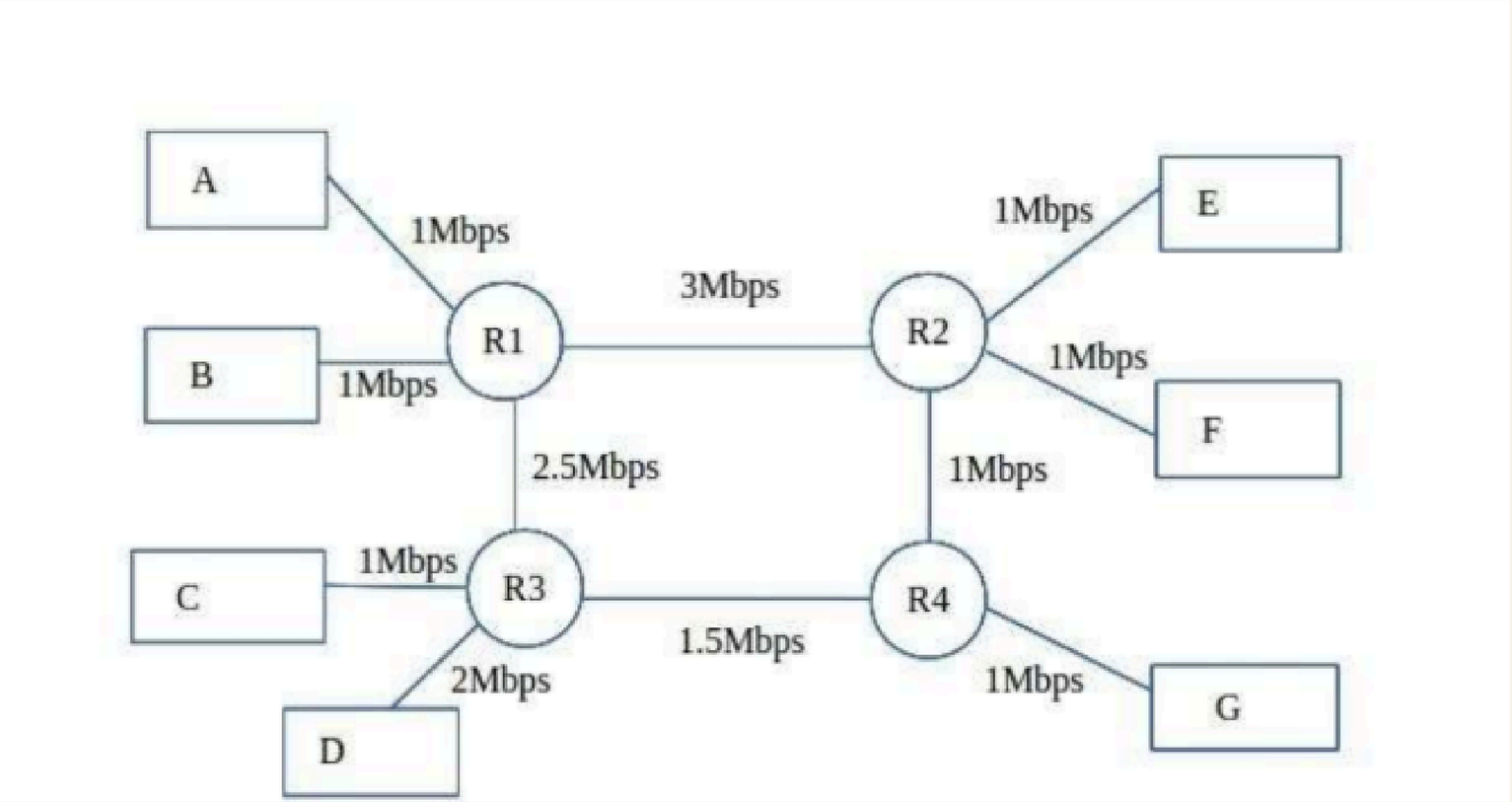
ASSUMPTIONS

- 11 nodes: 4 routers, 7 workstations/servers.
- Packets generated follow Poisson distribution based on the traffic matrix.
- Packet size: 2048 bits.
- Propagation delay: 1 ms for all links.
- Packet drop rate: 1%.
- Static, predefined routes.
- Simulation time: 60 seconds.

NETWORK TOPOLOGY

Description of topology:

- **4 routers interconnected via point-to-point links.**
- **7 end devices connected to routers.**



NS3 CONFIGURATION

Simulation Configuration

Programming language: C++ (.cc files).

./ns3 run scratch/scratch-simulator.cc

Initialization parameters:

Traffic matrix, packet size (2048 bits),

drop rate (1%), simulation time (60 seconds).

TRAFFIC

```
const int trafficMatrix[7][7] = {
    {0, 40, 50, 204, 44, 29, 67},
    {33, 0, 40, 50, 34, 44, 29},
    {29, 78, 0, 100, 54, 98, 26},
    {120, 19, 144, 0, 67, 95, 65},
    {34, 88, 91, 54, 0, 23, 11},
    {40, 50, 34, 44, 29, 0, 45},
    {34, 70, 13, 88, 89, 65, 0}
};
```

RESULTS – END-TO-END DELAY

- **High Delays for Specific Destinations:**

Destination G consistently shows higher average delays across all source nodes (e.g., A->G: 595.45 ms, B->G: 654.33 ms, etc.). This suggests that paths leading to G may have higher traffic or longer routes.

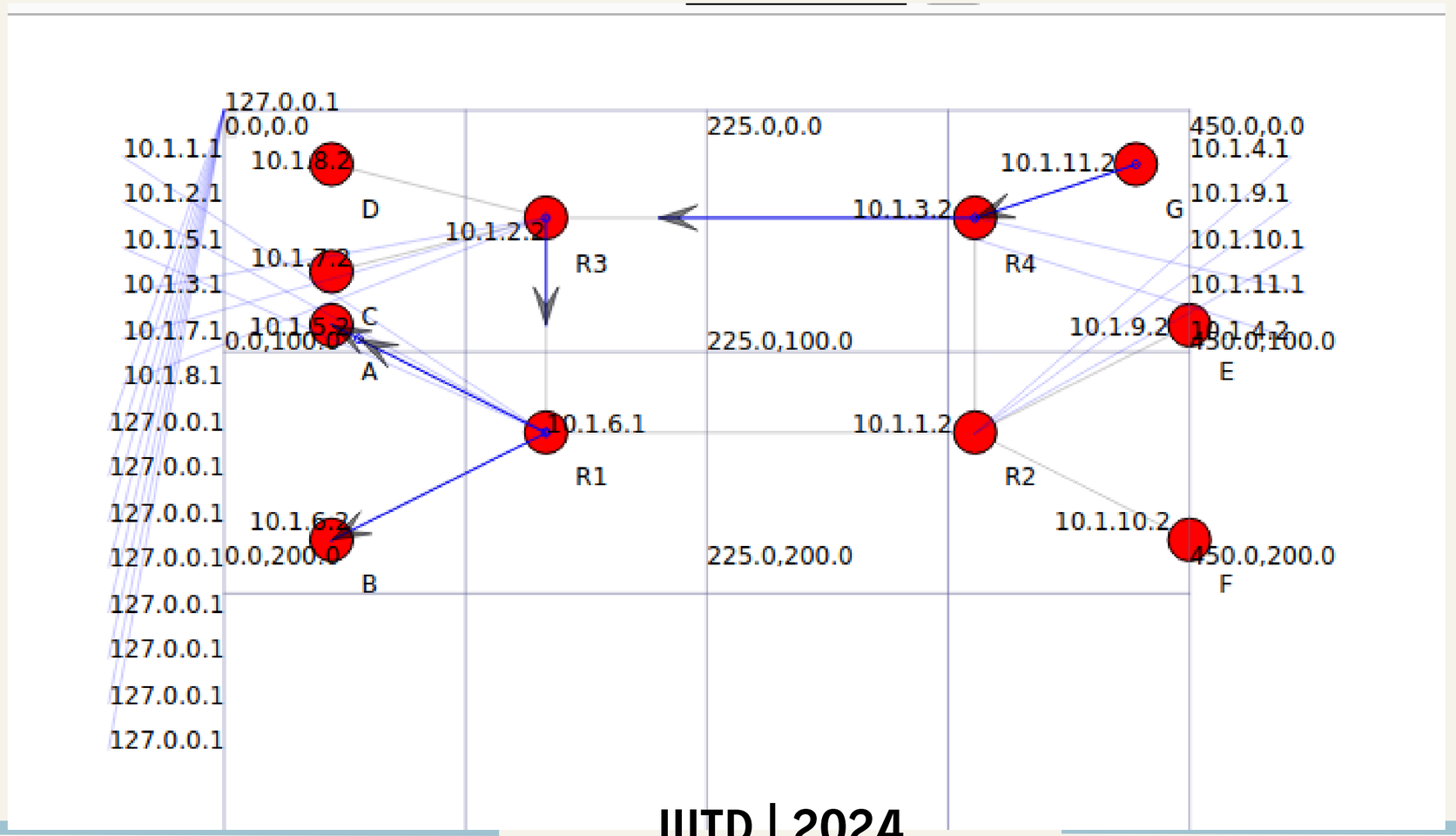
Similarly, F shows lower average delays for certain sources, such as E->F (347.62 ms) and F->E (348.70 ms), indicating potentially shorter or less congested paths.

Source/Dest	A	B	C	D	E	F	G
A	NaN	339.77	452.96	425.92	443.80	435.54	595.45
B	328.80	NaN	444.09	501.27	434.81	495.53	654.33
C	429.15	427.51	NaN	333.42	534.23	523.45	601.50
D	466.97	556.62	353.68	NaN	525.30	522.09	477.82
E	417.71	452.61	526.21	526.94	NaN	348.70	552.13
F	440.47	463.04	571.47	586.15	347.62	NaN	513.13
G	567.27	564.85	487.92	468.12	501.53	536.79	NaN

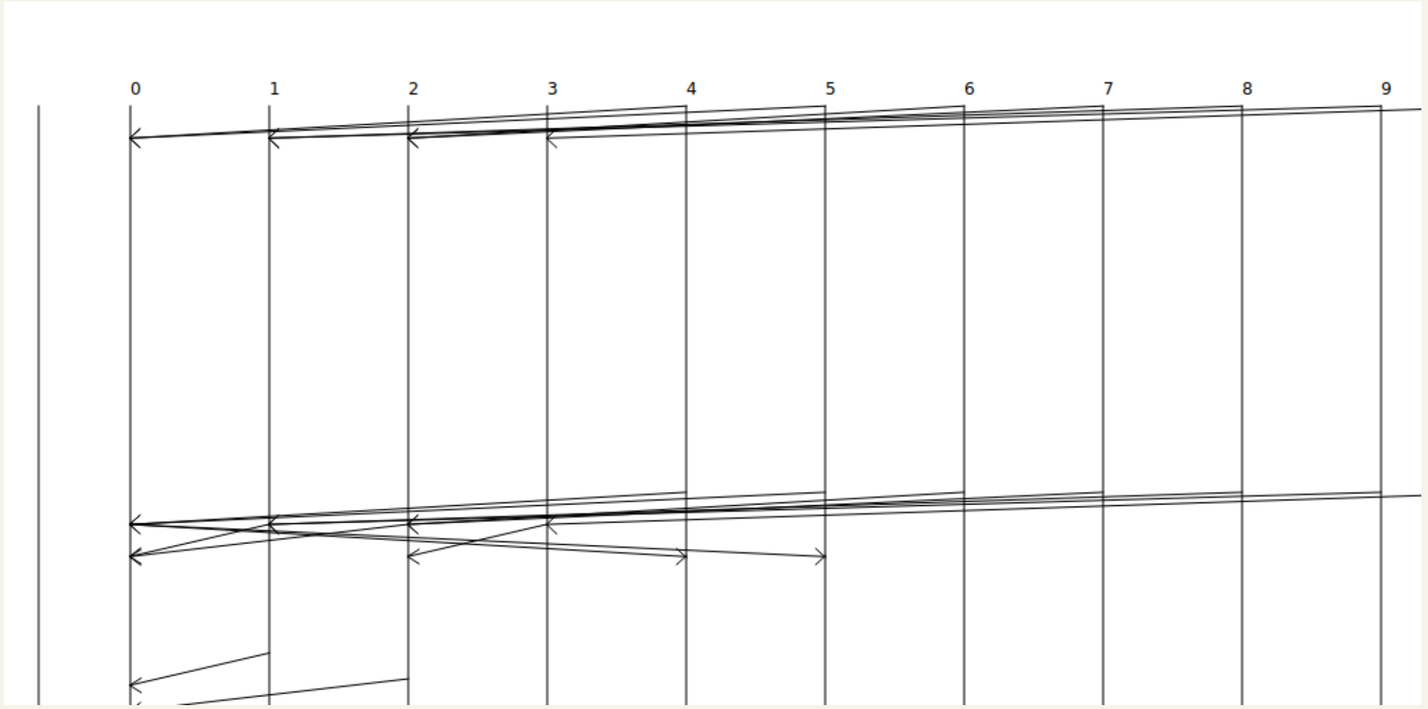
- **Self-Loops:**

The diagonal of the delay matrix (A->A, B->B, etc.) is marked as "NaN," indicating no self-loop delay is measured, as expected.

NETANIM VISUALIZATION



NETANIM



	From Id	To Id	Tx	Meta
1	4	0	1	
2	5	0	1	
3	6	2	1	
4	7	2	1	
5	8	1	1	
6	9	1	1	
7	10	3	1	
8	4	0	1.01202	
9	5	0	1.01202	
10	6	2	1.01202	
11	7	2	1.01202	
12	8	1	1.01202	
13	9	1	1.01202	
14	10	3	1.01202	
15	0	5	1.01302	
16	0	4	1.01302	
17	2	0	1.01302	
18	1	0	1.01302	
19	3	2	1.01302	
20	1	0	1.01702	
21	2	0	1.01782	
22	4	0	1.0209	
23	5	0	1.0209	
24	6	2	1.0209	
25	7	2	1.0209	
26	8	1	1.0209	

ROUTING TABLE

Source	A	B	C	D	E	F	G	R1	R2	R3	R4
A	-	R1	R1	R1	R1	R1	R1				
B	R1	-	R1	R1	R1	R1	R1				
C	R3	R3	-	R3	R3	R3	R3				
D	R3	R3	R3	-	R3	R3	R3				
E	R2	R2	R2	R2	-	R2	R2				
F	R2	R2	R2	R2	R2	-	R2				
G	R4	R4	R4	R4	R4	R4	-				
R1	A	B	R3	R3	R2	R2	R2	-	R2	R3	R2
R2	R1	R1	R1	R1	E	F	R4	R1	-	R1	R4
R3	R1	R1	C	D	R1	R1	R4	R1	R1	-	R4
R4	R2	R2	R3	R3	R2	R2	G	R2	R2	R3	-

PACKET DROP RATE

Source \ Destination	A	B	C	D	E	F	G
A	0	4	6	22	5	3	7
B	3	0	5	6	4	5	3
C	3	8	0	10	6	9	2
D	13	2	15	0	7	10	7
E	4	9	10	6	0	3	1
F	5	5	4	5	3	0	5
G	4	7	1	9	9	6	0

Table 4: Packet Drop Matrix

ANALYSIS AND CONCLUSION

- DELAYS: HIGHER DELAYS OBSERVED FOR PATHS TO DESTINATION G (E.G., B→G: 654.33 MS). SHORTER DELAYS FOR STABLE ROUTES LIKE E→F (~348 MS).
- JITTER: MAXIMUM JITTER SEEN FOR B→G (92.71 MS). STABLE ROUTES LIKE E→F AND A→D SHOW MINIMAL JITTER.
- QUEUE LENGTHS: ROUTERS 0 AND 3 EXPERIENCE THE HIGHEST MAXIMUM QUEUE SIZES (306 PACKETS), INDICATING POTENTIAL BOTTLENECKS.

ANALYSIS AND CONCLUSION

- The network performs well under the given configuration, but bottlenecks (e.g., G, routers 0 and 3) could affect performance.
- Stable routes exhibit efficient traffic handling with minimal delay and jitter.
- Future improvements: Dynamic routing and adaptive traffic management to mitigate congestion.

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THANK YOU