Network Simulation Using MATLAB

Objective:

1. Simulate a simple computer network using MATLAB.
2. Analyze network performance metrics such as throughput, delay, and packet loss.
3. Visualize data transmission over the network.

Tasks:

1. Design a Simple Network Topology

Simulate a network with:

- **1 Router**
- **2 Hosts (H1 and H2)**
- **A communication link between H1 ↔ Router ↔ H2**

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2. Key Parameters

- **Bandwidth (B):** 10 Mbps
- **Packet size:** 1 KB
- **Propagation delay (Tp):** 10 ms
- **Simulation duration:** 10 seconds
- **Traffic generation:** Poisson process for packet arrival

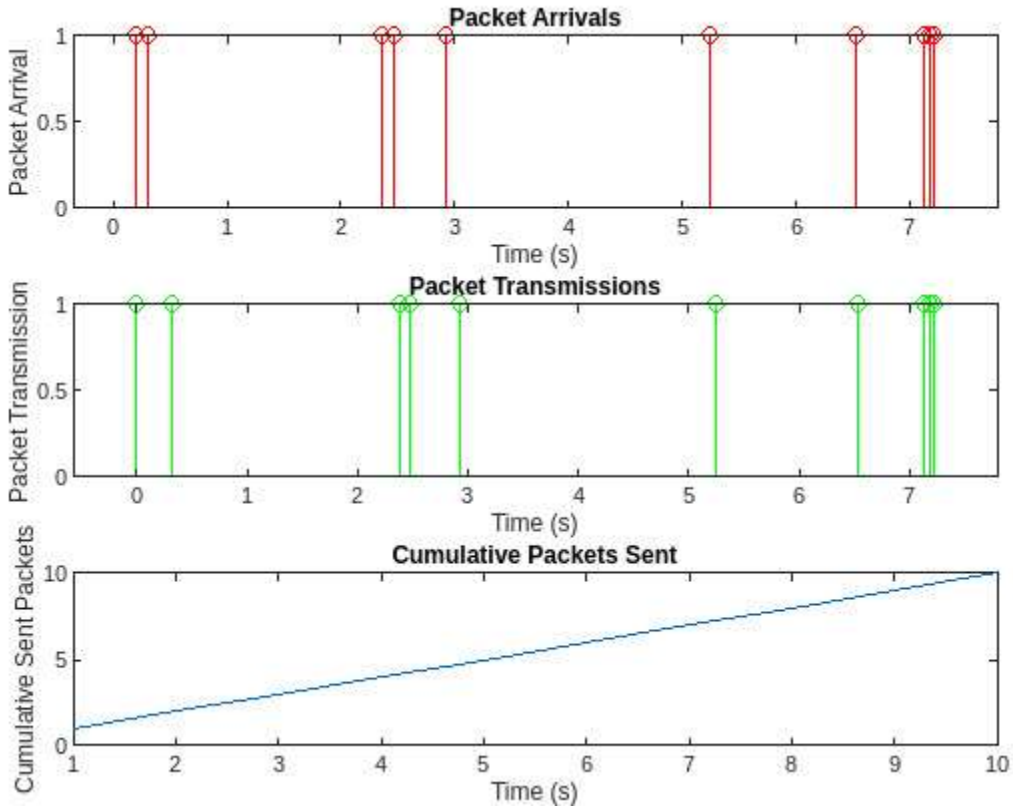
1. **Shows all Metrics Output:**

- **Throughput:** How much data is transmitted per second.
- **Average Delay:** The average time a packet takes to travel from source to destination.
- **Packet Loss Rate:** Percentage of dropped packets due to queue overflow.

```
>> network_simulation
Average Delay: 3.9480 seconds
Packet Loss Rate: 10.00%
Throughput: 8000.00 bps
```

2. **Shows all Graphs:**

- **Packet Arrivals:** Visualize when packets arrive at the router.
- **Packet Transmissions:** Show transmission times of packets.
- **Cumulative Packets Sent:** Display the total number of packets sent over time.



3. Assignment Questions:

3.1. How does increasing the packet arrival rate (λ) affect throughput and delay?

Answer: - Effect on Throughput: As the packet arrival rate λ increases, the number of packets arriving at the router will increase. This can increase throughput, but only to a certain limit where the router's processing capacity (i.e., bandwidth) becomes a bottleneck.

Effect on Delay: If the arrival rate λ exceeds the router's ability to process packets (i.e., if the queue gets full frequently), the average delay will increase because packets will spend more time waiting in the queue before being transmitted.

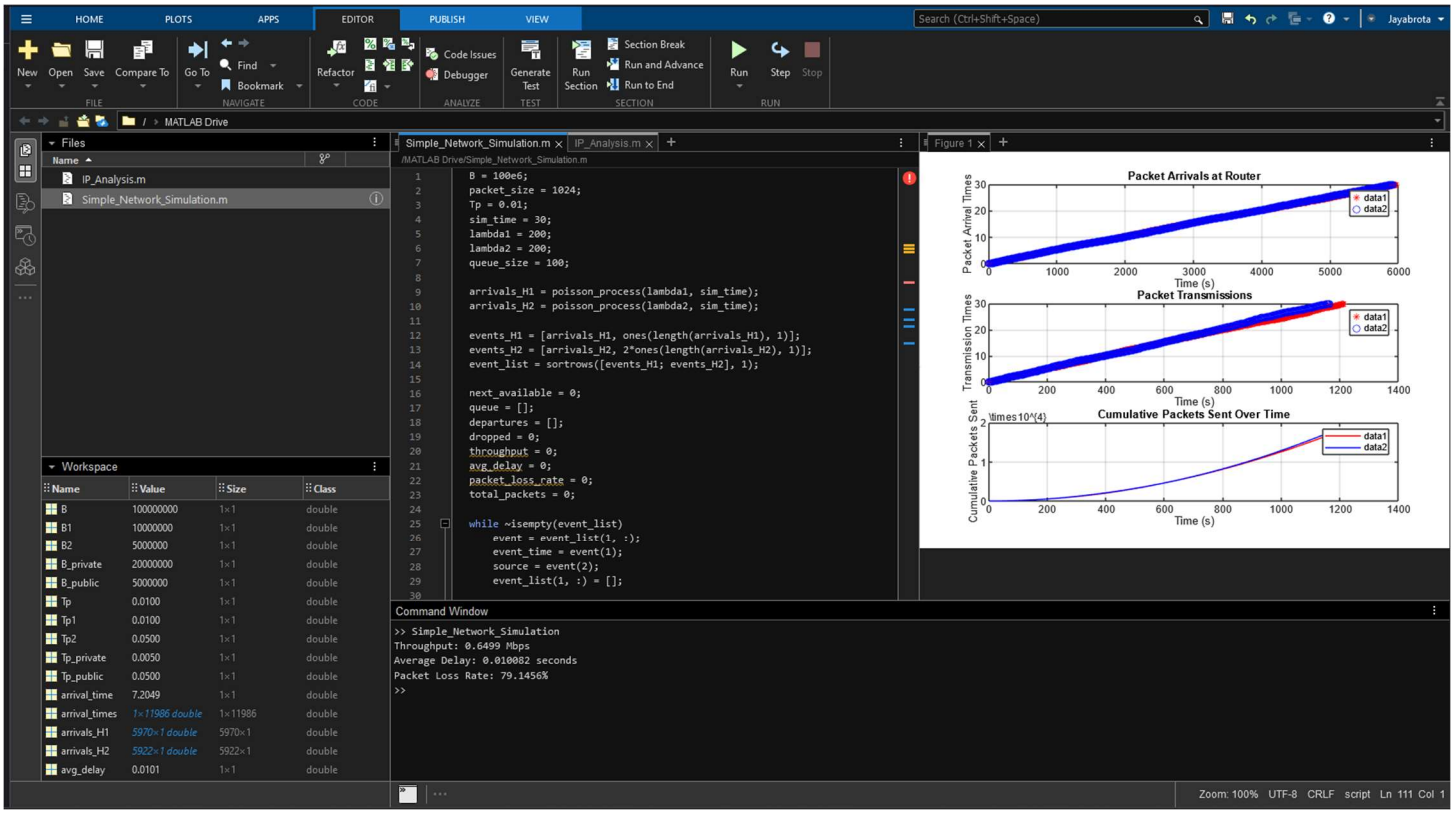
3.2. What happens to the packet loss rate when the queue size is reduced to 5?

Answer: - Effect on Packet Loss: Reducing the queue size limits the number of packets that can be buffered in the router. This increases the probability of packet loss when the queue is full, especially at high arrival rates (λ). If λ is greater than the router's processing capacity, increasing packet loss will occur as the queue is frequently full and unable to accept new packets.

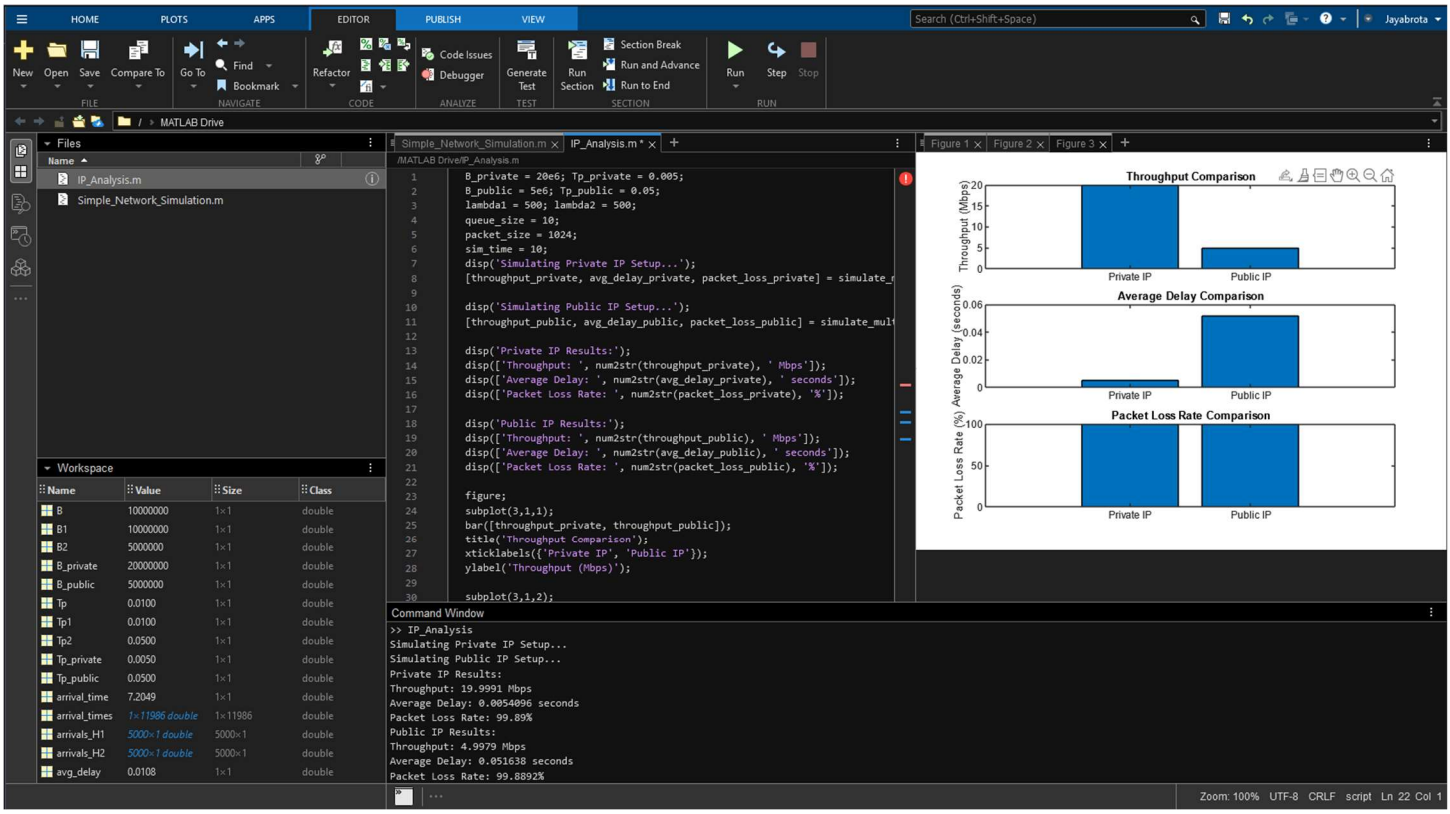
3.3. Modify the bandwidth to 100 Mbps. How does it impact the performance metrics?

Answer: - Effect on Throughput: Increasing the bandwidth to 100 Mbps allows more data to be transmitted per second. This will increase throughput because each packet will be transmitted more quickly. However, if the arrival rate λ and queue size are not adjusted accordingly, there may not be a noticeable improvement beyond a certain point.

Effect on Delay: The transmission delay for each packet will decrease because higher bandwidth reduces the transmission time for each packet. As a result, the average delay will also decrease.



Network simulation script on MATLAB online



Multiple Link and IP Analysis script

Part 2:

Scenario: Multiple Links

The new network setup includes:

- **1 Router (R1)** with multiple links.
- **2 Hosts (H1 and H2)** connected to the router via separate links.
- A shared bandwidth and queue at the router to simulate contention.

Each link has its own propagation delay and bandwidth. The router handles packets from both hosts and forwards them according to their arrival time.

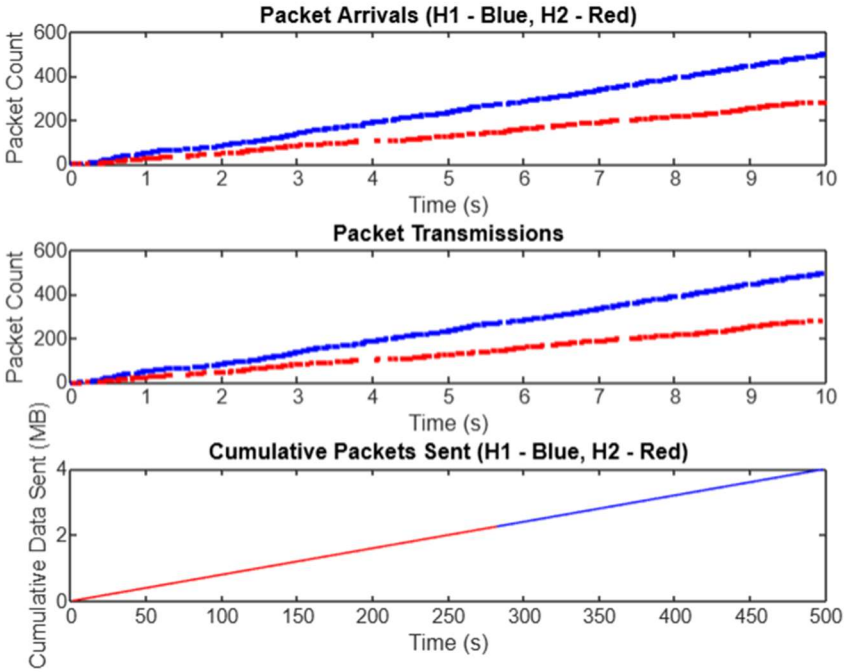
- Host 1 uses **Link 1** with bandwidth `B1` and propagation delay `Tp1`.

- Host 2 uses **Link 2** with bandwidth `B2` and propagation delay `Tp2`.

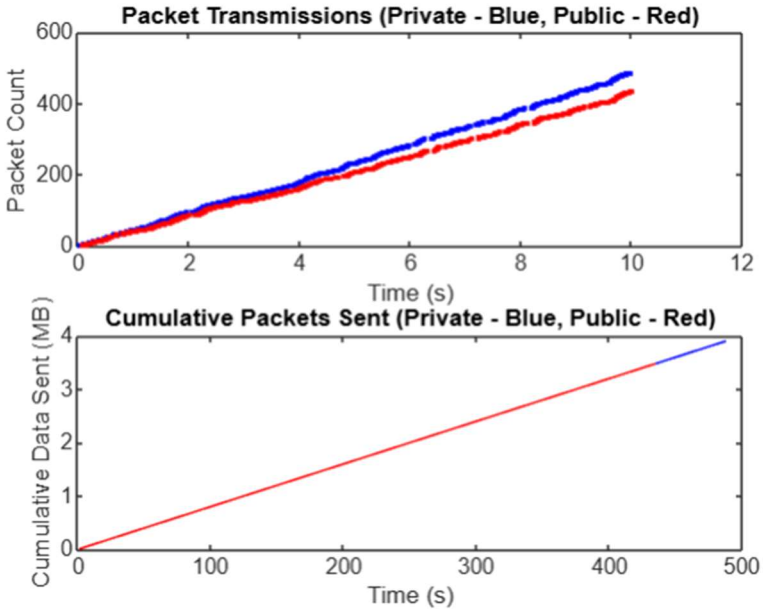
Assignment Questions:

1. **Do same for multi-links. Shows all Metrics Output. Shows all Graphs.**

```
Throughput H1: 0.39 Mbps
Throughput H2: 0.23 Mbps
Total Network Throughput: 0.62 Mbps
Average Delay H1: 0.0000 s
Average Delay H2: 0.0000 s
Packet Loss Rate: 0.00%
>>
```



2. **Do for private ip and public ip and do comparative analysis.**



Comparative Analysis Summary

- Private networks are faster & more reliable due to low propagation delay and low packet loss.
- Public networks suffer from congestion, higher delay, and packet drops.
- Increasing bandwidth in public networks can help, but high delays remain an issue.