LAB-04
Computer Networks
Group-18

200101086 Ravipati Swarna
220123041 Nelapati Meghana
220101049 Kasani Keerthi Sarika
220123029 Kavuri Veda Varsha

[README]
[Algorithms File Link]

Q1:

Round Robin Scheduling algorithm:
Implementation of algorithm in different traffic conditions and comparison.
Uniform Traffic:

```
Input Port Priorities:
Port 0: 1 7 4 6 2 3 5 0
Port 1: 4 5 3 2 0 6 7 1
Port 2: 1 7 3 0 5 6 4 2
Port 3: 0 1 3 7 4 5 6 2
Port 4: 0 3 7 2 5 6 1 4
Port 5: 5 1 0 6 7 4 3 2
Port 6: 4 0 5 2 1 3 7 6
Port 7: 0 7 1 5 4 2 3 6
Output Port Priorities:
Port 0: 3 5 6 7 2 0 4 1
Port 1: 2 1 0 6 7 4 5 3
Port 2: 4 1 2 0 3 7 5 6
Port 3: 1 2 4 6 5 3 7 0
Port 4: 2 7 6 4 0 1 3 5
Port 5: 4 3 5 6 2 0 1 7
Port 6: 3 6 0 7 5 4 1 2
Port 7: 7 6 2 0 5 4 3 1
```

Randomly generated the input and output port priorities for each other.

```
Granting access to Input Port 5 from Output Port 2
Packet 8 from Input Port 0 processed and sent to Output Port 7 at time 1 ms
Granting access to Input Port 0 from Output Port 7
Packet 14 from Input Port 6 processed and sent to Output Port 6 at time 1 ms
Granting access to Input Port 6 from Output Port 6
Packet 11 from Input Port 3 processed and sent to Output Port 2 at time 1 ms
Granting access to Input Port 3 from Output Port 2
Packet 10 from Input Port 2 processed and sent to Output Port 3 at time 1 ms
Granting access to Input Port 2 from Output Port 3
Packet 9 from Input Port 1 processed and sent to Output Port 5 at time 1 ms
Granting access to Input Port 1 from Output Port 5
Packet 15 from Input Port 7 processed and sent to Output Port 5 at time 1 ms
Granting access to Input Port 7 from Output Port 5
Packet 13 sent from Output Port 2 at time 1 ms
Packet 1 sent from Output Port 3 at time 1 ms
Packet 9 sent from Output Port 5 at time 1 ms
Packet 7 sent from Output Port 6 at time 1 ms
Packet 8 sent from Output Port 7 at time 1 ms
Packet 16 arrived at Input Port 0 at time 2 ms (Total Packets: 17)
Packet 17 arrived at Input Port 1 at time 2 ms (Total Packets: 18)
Packet 18 arrived at Input Port 2 at time 2 ms (Total Packets: 19)
Packet 19 arrived at Input Port 3 at time 2 ms (Total Packets: 20)
Packet 20 arrived at Input Port 4 at time 2 ms (Total Packets: 21)
Packet 21 arrived at Input Port 5 at time 2 ms (Total Packets: 22)
Packet 22 arrived at Input Port 6 at time 2 ms (Total Packets: 23)
Packet 23 arrived at Input Port 7 at time 2 ms (Total Packets: 24)
Time 2 ms:
Input Port Priorities:
Port 0: 1 7 4 6 2 3 5 0
Port 1: 4 5 3 2 0 6 7 1
Port 2: 1 7 3 0 5 6 4 2
Port 3: 0 1 3 7 4 5 6 2
Port 4: 0 3 7 2 5 6 1 4
Port 5: 5 1 0 6 7 4 3 2
Port 6: 4 0 5 2 1 3 7 6
Port 7: 0 7 1 5 4 2 3 6
Output Port Priorities:
Port 0: 3 5 6 7 2 0 1 4
Port 1: 1 0 6 7 4 5 3 2
Port 2: 4 1 2 0 7 6 5 3
Port 3: 4 6 5 7 0 3 1 2
Port 4: 2 7 6 4 0 1 3 5
Port 5: 4 3 5 6 2 0 1 7
Port 6: 3 0 4 1 2 5 7 6
Port 7: 7 6 2 5 4 3 1 0
Packet 21 from Input Port 5 processed and sent to Output Port 4 at time 2 ms
```

Initially, the output port 7 priority is:
7 6 2 0 5 4 3 1
Access to Input port 0 was granted first to output port 7 making the priority order:
7 6 2 5 4 3 1 0
As is observed in the final output port priority order.
These are the packets generated to simulate uniform traffic

Observed metrics.

```
--- Round Robin Performance Metrics ---
Traffic Type: Uniform
Packet Loss: 7
Throughput: 92%
Average Turnaround Time: 22.5
Average Waiting Time: 20
-----------------------
Traffic Type: Non-Uniform
Packet Loss: 15
Throughput: 75%
Average Turnaround Time: 30
Average Waiting Time: 27
-----------------------
Traffic Type: Bursty
Packet Loss: 23
Throughput: 60%
Average Turnaround Time: 42
Average Waiting Time: 39.5
-----------------------
```

Comparing Round Robin Performance for the three cases
Packet Loss: Uniform < Non-Uniform < Bursty
Throughtput: Uniform > Non-Uniform > Bursty
Avg TAT: Uniform < Non-Uniform < Bursty
Avg Waiting Time: Uniform < Non-Uniform < Bursty

Weighted Fair Queue (WFQ) Scheduling :

```
Packet 30 arrived at Queue 0
Packet 31 arrived at Queue 1
Packet 32 arrived at Queue 2
Packet 34 arrived at Queue 2
Packet 36 arrived at Queue 2
Packet 38 arrived at Queue 2

Initial Queue States:
Queue 0 (Weight: 1) contains 13 packets
Queue 1 (Weight: 2) contains 13 packets
Queue 2 (Weight: 3) contains 13 packets

Processing packets with Request, Grant, Accept Logic:
Packet 1 from Queue 2 granted and accepted with priority 3
Packet 11 from Queue 2 granted and accepted with priority 2
Packet 13 from Queue 2 granted and accepted with priority 1
Packet 0 from Queue 1 granted and accepted with priority 2
Packet 3 from Queue 1 granted and accepted with priority 2
Packet 2 from Queue 0 granted and accepted with priority 3
Packet 15 from Queue 2 granted and accepted with priority 2
Packet 20 from Queue 2 granted and accepted with priority 1
Packet 21 from Queue 2 granted and accepted with priority 2
Packet 4 from Queue 1 granted and accepted with priority 1
Packet 6 from Queue 1 granted and accepted with priority 1
Packet 5 from Queue 0 granted and accepted with priority 2
Packet 25 from Queue 2 granted and accepted with priority 1
Packet 29 from Queue 2 granted and accepted with priority 3
Packet 32 from Queue 2 granted and accepted with priority 1
Packet 8 from Queue 1 granted and accepted with priority 2
Packet 10 from Queue 1 granted and accepted with priority 3
Packet 7 from Queue 0 granted and accepted with priority 1
Packet 34 from Queue 2 granted and accepted with priority 2
Packet 36 from Queue 2 granted and accepted with priority 3
Packet 38 from Queue 2 granted and accepted with priority 1
Packet 16 from Queue 1 granted and accepted with priority 1
Packet 18 from Queue 1 granted and accepted with priority 2
Packet 9 from Queue 0 granted and accepted with priority 3
Packet 39 from Queue 2 granted and accepted with priority 2
Packet 23 from Queue 1 granted and accepted with priority 1
Packet 26 from Queue 1 granted and accepted with priority 3
Packet 12 from Queue 0 granted and accepted with priority 2
Packet 28 from Queue 1 granted and accepted with priority 3
Packet 31 from Queue 1 granted and accepted with priority 2
Packet 14 from Queue 0 granted and accepted with priority 3
Packet 35 from Queue 1 granted and accepted with priority 3
Packet 17 from Queue 0 granted and accepted with priority 1
Packet 19 from Queue 0 granted and accepted with priority 2
Packet 22 from Queue 0 granted and accepted with priority 1
Packet 24 from Queue 0 granted and accepted with priority 2
Packet 27 from Queue 0 granted and accepted with priority 1
Packet 30 from Queue 0 granted and accepted with priority 3
Packet 33 from Queue 0 granted and accepted with priority 3

Processed Packets:
```

```
Packet 1 from Queue 2 processed
Packet 11 from Queue 2 processed
Packet 13 from Queue 2 processed
Packet 0 from Queue 1 processed
Packet 3 from Queue 1 processed
Packet 2 from Queue 0 processed
Packet 15 from Queue 2 processed
Packet 20 from Queue 2 processed
Packet 21 from Queue 2 processed
Packet 4 from Queue 1 processed
Packet 6 from Queue 1 processed
Packet 5 from Queue 0 processed
Packet 25 from Queue 2 processed
Packet 29 from Queue 2 processed
Packet 32 from Queue 2 processed
Packet 8 from Queue 1 processed
Packet 10 from Queue 1 processed
Packet 7 from Queue 0 processed
Packet 34 from Queue 2 processed
Packet 36 from Queue 2 processed
Packet 38 from Queue 2 processed
Packet 16 from Queue 1 processed
Packet 18 from Queue 1 processed
Packet 9 from Queue 0 processed
Packet 39 from Queue 2 processed
Packet 23 from Queue 1 processed
Packet 26 from Queue 1 processed
Packet 12 from Queue 0 processed
Packet 28 from Queue 1 processed
Packet 31 from Queue 1 processed
Packet 14 from Queue 0 processed
Packet 35 from Queue 1 processed
Packet 17 from Queue 0 processed
Packet 19 from Queue 0 processed
Packet 22 from Queue 0 processed
Packet 24 from Queue 0 processed
Packet 27 from Queue 0 processed
Packet 30 from Queue 0 processed
Packet 33 from Queue 0 processed
Queue 0 dropped 2 packets
Queue 1 dropped 4 packets
Queue 2 dropped 5 packets

Total Packet Loss: 11

Metrics:
Total Packets Arrived: 50
Total Packets Processed: 39
Total Packet Loss: 11
Packet Loss Percentage: 22.00%
Throughput Percentage: 78.00%

Average Turnaround Time: 29.95
Average Waiting Time: 27.97
```

Working of algorithm:

Arrival:

Packet 1 arrives in **Queue 2**, the highest-weighted queue (weight = 3), allowing more frequent processing.

Queue Check:

The system checks if Queue 2 has room; Packet 1 isn't dropped and enters the queue.

Processing:

Due to Queue 2's high weight, it gets prioritised. Packet 1 is granted and accepted for processing early on, as reflected by:

```
Processing packets with Request, Grant, Accept Logic:
Packet 1 from Queue 2 granted and accepted with priority 3
```

Metrics:

```
--- Weighted Fair Queuing Performance Metrics ---
Traffic Type: Uniform
Packet Loss: 5
Throughput: 95%
Average Turnaround Time: 20
Average Waiting Time: 18
-----------------------
Traffic Type: Non-Uniform
Packet Loss: 11
Throughput: 78%
Average Turnaround Time: 29.95
Average Waiting Time: 27.97
-----------------------
Traffic Type: Bursty
Packet Loss: 18
Throughput: 65%
Average Turnaround Time: 40
Average Waiting Time: 37.5
-----------------------
```

Comparing **Weighted Fair Queuing** for three **different types of traffic patterns**:
Packet Loss: Uniform < Non-Uniform < Bursty
Throughput: Uniform > Non-Uniform > Bursty
Average Turnaround Time (TAT): Uniform < Non-Uniform < Bursty
Average Waiting Time: Uniform < Non-Uniform < Bursty

Priority Scheduling Algorithm:

We generated packets with an associated priority, along with other attributes like arrival time, processing time, and the intended output port.
A priority queue is maintained to manage packets.
The packet with the highest priority among all input ports is selected first for processing.
Once the highest priority packet is identified, the output port grants access from the corresponding input queue.
The system records the waiting time and turnaround time for that packet and then enqueues it into the appropriate output queue.

```
Enter traffic type (uniform, non-uniform, bursty): uniform
Packet 0 (Priority: 3) arrived at Input Port 0 at time 0 ms (Total Packets: 1)
Packet 1 (Priority: 8) arrived at Input Port 1 at time 0 ms (Total Packets: 2)
Packet 2 (Priority: 5) arrived at Input Port 2 at time 0 ms (Total Packets: 3)
Packet 3 (Priority: 4) arrived at Input Port 3 at time 0 ms (Total Packets: 4)
Packet 4 (Priority: 5) arrived at Input Port 4 at time 0 ms (Total Packets: 5)
Packet 5 (Priority: 3) arrived at Input Port 5 at time 0 ms (Total Packets: 6)
Packet 6 lost at Input Port 6 at time 0 ms
Packet 7 (Priority: 9) arrived at Input Port 7 at time 0 ms (Total Packets: 8)
Granting access to Packet 7 (Priority: 9) from Input Port 7 processed and sent to O
utput Port 0 at time 0 ms
Granting access to Packet 1 (Priority: 8) from Input Port 1 processed and sent to O
utput Port 1 at time 0 ms
Granting access to Packet 2 (Priority: 5) from Input Port 2 processed and sent to O
utput Port 0 at time 0 ms
Granting access to Packet 4 (Priority: 5) from Input Port 4 processed and sent to O
utput Port 3 at time 0 ms
Granting access to Packet 3 (Priority: 4) from Input Port 3 processed and sent to O
utput Port 5 at time 0 ms
Granting access to Packet 0 (Priority: 3) from Input Port 0 processed and sent to O
utput Port 1 at time 0 ms
Granting access to Packet 5 (Priority: 3) from Input Port 5 processed and sent to O
utput Port 2 at time 0 ms
Packet 7 sent from Output Port 0 at time 0 ms
Packet 1 sent from Output Port 1 at time 0 ms
Packet 5 sent from Output Port 2 at time 0 ms
Packet 4 sent from Output Port 3 at time 0 ms
Packet 3 sent from Output Port 5 at time 0 ms
Packet 8 (Priority: 3) arrived at Input Port 0 at time 1 ms (Total Packets: 9)
Packet 9 (Priority: 6) arrived at Input Port 1 at time 1 ms (Total Packets: 10)
Packet 10 (Priority: 6) arrived at Input Port 2 at time 1 ms (Total Packets: 11)
Packet 11 (Priority: 3) arrived at Input Port 3 at time 1 ms (Total Packets: 12)
Packet 12 (Priority: 9) arrived at Input Port 4 at time 1 ms (Total Packets: 13)
Packet 13 lost at Input Port 5 at time 1 ms
Packet 14 (Priority: 7) arrived at Input Port 6 at time 1 ms (Total Packets: 15)
Packet 15 (Priority: 4) arrived at Input Port 7 at time 1 ms (Total Packets: 16)
```

In this uniform traffic type, the packets arriving are assigned a priority order.
Priority Order: pkt 1

```
Enter traffic type (uniform, non-uniform, bursty): bursty
Packet 0 (Priority: 2) arrived at Input Port 0 at time 0 ms (Total Packets: 1)
Packet 1 lost at Input Port 1 at time 0 ms
Granting access to Packet 0 (Priority: 2) from Input Port 0 processed and sent to O
utput Port 5 at time 0 ms
Packet 0 sent from Output Port 5 at time 0 ms
Packet 2 lost at Input Port 0 at time 1 ms
Packet 3 lost at Input Port 1 at time 1 ms
Packet 4 (Priority: 9) arrived at Input Port 0 at time 2 ms (Total Packets: 5)
Packet 5 lost at Input Port 1 at time 2 ms
Granting access to Packet 4 (Priority: 9) from Input Port 0 processed and sent to O
utput Port 5 at time 2 ms
Packet 4 sent from Output Port 5 at time 2 ms
Packet 6 (Priority: 8) arrived at Input Port 0 at time 3 ms (Total Packets: 7)
Packet 7 (Priority: 1) arrived at Input Port 1 at time 3 ms (Total Packets: 8)
Granting access to Packet 6 (Priority: 8) from Input Port 0 processed and sent to O
utput Port 6 at time 3 ms
Granting access to Packet 7 (Priority: 1) from Input Port 1 processed and sent to O
utput Port 5 at time 3 ms
Packet 7 sent from Output Port 5 at time 3 ms
Packet 6 sent from Output Port 6 at time 3 ms
Packet 8 lost at Input Port 0 at time 4 ms
Packet 9 (Priority: 3) arrived at Input Port 1 at time 4 ms (Total Packets: 10)
Granting access to Packet 9 (Priority: 3) from Input Port 1 processed and sent to O
utput Port 5 at time 4 ms
Packet 9 sent from Output Port 5 at time 4 ms
Packet 10 (Priority: 9) arrived at Input Port 0 at time 5 ms (Total Packets: 11)
Packet 11 lost at Input Port 1 at time 5 ms
Granting access to Packet 10 (Priority: 9) from Input Port 0 processed and sent to
Output Port 1 at time 5 ms
Packet 10 sent from Output Port 1 at time 5 ms
Packet 12 lost at Input Port 0 at time 6 ms
Packet 13 lost at Input Port 1 at time 6 ms
Packet 14 (Priority: 1) arrived at Input Port 0 at time 7 ms (Total Packets: 15)
Packet 15 lost at Input Port 1 at time 7 ms
Granting access to Packet 14 (Priority: 1) from Input Port 0 processed and sent to
Output Port 6 at time 7 ms
Packet 14 sent from Output Port 6 at time 7 ms
Packet 16 lost at Input Port 0 at time 8 ms
```

Metrics:

```
--- Priority Scheduling Performance Metrics ---
Traffic Type: Uniform
Packet Loss: 8
Throughput: 90%
Average Turnaround Time: 23
Average Waiting Time: 21
-----------------------
Traffic Type: Non-Uniform
Packet Loss: 17
Throughput: 73%
Average Turnaround Time: 31
Average Waiting Time: 29
-----------------------
Traffic Type: Bursty
Packet Loss: 25
Throughput: 57%
Average Turnaround Time: 44
Average Waiting Time: 41
-----------------------
```

Comparing **Priority algorithm** for three **different types of traffic patterns**:

Packet Loss: Uniform < Non-Uniform < Bursty
Throughput: Uniform > Non-Uniform > Bursty
Average Turnaround Time (TAT): Uniform < Non-Uniform < Bursty
Average Waiting Time: Uniform < Non-Uniform < Bursty

iSLIP Algorithm:

```
Generated Packet 72 at input port 0 destined for output port 6
Generated Packet 73 at input port 1 destined for output port 0
Generated Packet 74 at input port 2 destined for output port 2
Generated Packet 75 at input port 3 destined for output port 2
Generated Packet 76 at input port 4 destined for output port 5
Generated Packet 77 at input port 5 destined for output port 0
Generated Packet 78 at input port 6 destined for output port 5
Generated Packet 79 at input port 7 destined for output port 7
Input Queues:
Input port 0: [56 64 72 ] (Size: 3)
Input port 1: [73 ] (Size: 1)
Input port 2: [74 ] (Size: 1)
Input port 3: [75 ] (Size: 1)
Input port 4: [76 ] (Size: 1)
Input port 5: [69 77 ] (Size: 2)
Input port 6: [70 78 ] (Size: 2)
Input port 7: [79 ] (Size: 1)
```

Initially generated packets destined for specific output ports, then printed the input queues based on generated packets.

```
Requests sent by input ports:
Output port 0 gets requests from: 0
Output port 1 gets requests from: 5
Output port 2 gets requests from: 2
Output port 3 gets requests from:
Output port 4 gets requests from:
Output port 5 gets requests from: 4
Output port 6 gets requests from:
Output port 7 gets requests from: 7
Grants made by output ports:
Output port 0 grants input port 0
Output port 1 grants input port 5
Output port 2 grants input port 2
Output port 5 grants input port 4
Output port 7 grants input port 7
```

Then requests are being sent from input ports to respective output ports, according to the output port’s priorities, they grant the requests

```
Matching and accepting packets:
Accepted Packet 56 from Input Port 0 to Output Port 0
Accepted Packet 69 from Input Port 5 to Output Port 1
Accepted Packet 74 from Input Port 2 to Output Port 2
Accepted Packet 76 from Input Port 4 to Output Port 5
Accepted Packet 79 from Input Port 7 to Output Port 7
Updating priorities after matches:
Updated priorities for Output Port 0: 1 4 3 5 6 2 7 0
Updated priorities for Output Port 1: 3 4 7 2 1 6 0 5
Updated priorities for Output Port 2: 0 5 6 7 1 3 4 2
Updated priorities for Output Port 5: 0 2 5 6 7 1 3 4
Updated priorities for Output Port 7: 0 3 6 4 2 5 1 7
Packet transmission:
Packet 64 sent from input port 0 to output port 0
Packet 77 sent from input port 5 to output port 1
```

When the grants sent to input ports by output ports, the input ports only accept the grants according to their priority list.

Here matching and accepts are printed along with packet transmissions

```
Output Queues:
Output port 0: [11 19 37 42 46 50 71 56 ] (Size: 8)
Output port 1: [5 6 17 25 34 41 24 62 40 69 ] (Size: 10)
Output port 2: [1 2 28 36 27 68 74 ] (Size: 7)
Output port 3: [7 21 22 39 47 44 53 66 ] (Size: 8)
Output port 4: [29 33 43 55 ] (Size: 4)
Output port 5: [3 9 60 59 76 ] (Size: 5)
Output port 6: [0 13 15 31 38 8 49 ] (Size: 7)
Output port 7: [4 12 20 18 45 57 65 79 ] (Size: 8)
Output Port Priorities:
Output port 0: 1 4 3 5 6 2 7 0
Output port 1: 3 4 7 2 1 6 0 5
Output port 2: 0 5 6 7 1 3 4 2
Output port 3: 0 1 3 6 7 4 5 2
Output port 4: 0 2 4 6 5 1 3 7
Output port 5: 0 2 5 6 7 1 3 4
Output port 6: 2 3 4 5 7 6 0 1
Output port 7: 0 3 6 4 2 5 1 7
```

Then the output queues are updated along with the output port priorities

To explain them in detail:

```
Output Port Priorities:
Output port 0: 0 1 4 3 5 6 2 7
Output port 1: 3 4 7 5 2 1 6 0
Output port 2: 0 5 6 7 1 2 3 4
Output port 3: 0 1 3 6 7 4 5 2
Output port 4: 0 2 4 6 5 1 3 7
Output port 5: 0 2 5 6 7 1 4 3
Output port 6: 2 3 4 5 7 6 0 1
Output port 7: 0 3 6 7 4 2 5 1
```

These are the output port priorities before the packets were sent i.e before match and accept

```
Matching and accepting packets:
Accepted Packet 56 from Input Port 0 to Output Port 0
Accepted Packet 69 from Input Port 5 to Output Port 1
Accepted Packet 74 from Input Port 2 to Output Port 2
Accepted Packet 76 from Input Port 4 to Output Port 5
Accepted Packet 79 from Input Port 7 to Output Port 7
```

These are the packets accepted

```
Output Port Priorities:
Output port 0: 1 4 3 5 6 2 7 0
Output port 1: 3 4 7 2 1 6 0 5
Output port 2: 0 5 6 7 1 3 4 2
Output port 3: 0 1 3 6 7 4 5 2
Output port 4: 0 2 4 6 5 1 3 7
Output port 5: 0 2 5 6 7 1 3 4
Output port 6: 2 3 4 5 7 6 0 1
Output port 7: 0 3 6 4 2 5 1 7
```

If seen clearly, output port 0 accepts packet from input port 0, so the output port 0's priority is updated as: priority of 0th packet is now put at the end

Similarly for output port 1, 5th input port goes to the end, similarly for the rest too

And for the unchanged, the priorities remain unchanged.

Metrics:

```
--- iSLIP Performance Metrics ---
Traffic Type: Uniform
Packet Loss: 6
Throughput: 94%
Average Turnaround Time: 21
Average Waiting Time: 19
-----------------------
Traffic Type: Non-Uniform
Packet Loss: 13
Throughput: 80%
Average Turnaround Time: 28
Average Waiting Time: 25.5
-----------------------
Traffic Type: Bursty
Packet Loss: 19
Throughput: 68%
Average Turnaround Time: 38
Average Waiting Time: 36
-----------------------
```

Comparing **iSLIP algorithm** for three **different types of traffic patterns**:

Packet Loss: Uniform < Non-Uniform < Bursty
Throughput: Uniform > Non-Uniform > Bursty
Average Turnaround Time (TAT): Uniform < Non-Uniform < Bursty
Average Waiting Time: Uniform < Non-Uniform < Bursty

Q:
Which algorithm achieves the lowest packet delay and why?
Weighted Fair Queuing (WFQ) achieves the **lowest packet delay** by allocating bandwidth based on the importance of each queue, allowing **packets in a more weighted queue** to be processed more frequently without neglecting lower-priority ones. This balancing reduces both **average waiting time** and **turnaround time** for packets. WFQ's adaptability to changing traffic conditions minimises **congestion**, unlike Round Robin, which can introduce delays due to fixed time slots, and Priority Scheduling, which may prolong wait times for lower-priority packets.

Q: Handling high-priority traffic versus low-priority traffic?
In **Round Robin**, all packets are treated equally, which can delay high-priority packets if low-priority ones are in the queue. **Weighted Fair Queuing (WFQ)** is smarter; it gives high-priority traffic more bandwidth while still allowing lower-priority packets a fair chance. **Priority Scheduling** goes a step further by always serving high-priority packets first, but this can leave lower-priority ones waiting a long time. The **iSLIP algorithm** strikes a balance, ensuring high-priority traffic gets attention while still being fair to lower-priority packets, so everyone gets a chance without excessive delays.

Q: Which algorithm provides the highest fairness and how does the iSLIP algorithm improve
performance over traditional round-robin methods?
iSLIP offers the highest fairness among the scheduling algorithms by dynamically adjusting the service rates based on traffic conditions. Unlike traditional **Round Robin**, which can favour packets that are simply next in line, iSLIP allocates bandwidth proportionally to the number of requests while minimising the waiting time for all packets. It uses a request/grant mechanism that ensures each flow gets its fair share of resources, reducing the chances of starvation for lower-priority traffic. This fairness helps maintain consistent performance across different traffic types, making iSLIP more efficient in managing high-priority and low-priority packets simultaneously, ultimately improving overall system throughput and reducing latency compared to Round Robin.

Comparison of Scheduling Algorithms Based on Performance Metrics

In evaluating the performance of various scheduling algorithms—**Round Robin (RR)**, **Weighted Fair Queuing (WFQ)**, **iSLIP**, and **Priority Scheduling**—under different traffic patterns (uniform, non-uniform, and bursty), several key performance metrics were analysed:

1. **Packet Loss**:
    - **Uniform Traffic**: All algorithms perform better, with lower packet loss.
    - **Non-Uniform Traffic**: Increased packet loss is observed, particularly in **RR** and **Priority Scheduling**, which struggle to manage varying flow rates.
    - **Bursty Traffic**: The highest packet loss occurs, especially in **RR** and **Priority Scheduling**, as these cannot efficiently allocate resources during traffic spikes.
2. **Throughput**:
    - **Uniform Traffic**: **WFQ** exhibits the highest throughput, effectively distributing bandwidth.

    - **Non-Uniform Traffic**: **iSLIP** and **WFQ** maintain higher throughput by accommodating different priorities better than **RR** and **Priority Scheduling**.
    - **Bursty Traffic**: All algorithms experience reduced throughput, but **iSLIP** still performs relatively well due to its adaptive nature.
3. **Average Turnaround Time (TAT)**:
    - **Uniform Traffic**: **WFQ** achieves the lowest average TAT as it processes packets evenly.
    - **Non-Uniform Traffic**: **iSLIP** shows a slight advantage over **Priority Scheduling**, minimising delays for lower-priority packets.
    - **Bursty Traffic**: All algorithms exhibit increased TAT, with **RR** struggling the most due to its simplistic approach.
4. **Average Waiting Time**:
    - **Uniform Traffic**: **WFQ** has the lowest average waiting time, providing efficient service to all packets.
    - **Non-Uniform Traffic**: **iSLIP** manages waiting times effectively, ensuring fairness even for lower-priority packets.
    - **Bursty Traffic**: All algorithms see increased waiting times, but **iSLIP** mitigates delays better than others.

Performance Metrics	Round Robin (RR)	Weighted Fair Queuing (WFQ)	iSLIP	Priority Scheduling
Packet Loss	High in Non-Uniform & Bursty	Low in Uniform, Moderate in Non-Uniform	Moderate in Non-Uniform & Bursty	Highest in Bursty
Throughput	Moderate	Highest in Uniform	High in Non-Uniform	Moderate
Average Turnaround Time (TAT)	Highest in Bursty	Lowest in Uniform	Slightly higher than WFQ in Non-Uniform	High
Average Waiting Time	High in Bursty	Lowest in Uniform	Better than RR in Non-Uniform	Higher for low-priority
High-Priority Traffic Handling	Limited, can starve low-priority	Fair allocation	Fair handling	Prioritized, can starve low-priority
Low-Priority Traffic Handling	Starved under load	Fair allocation	Fair handling	Starved under load
Overall Fairness	Low	High	High	Moderate