**Packet Queue Simulation Project Report**

**1. Simulator Implementation**

The Packet Queue Simulation was developed in Java, using an object-oriented approach for simplicity and modularity. At the core, the `PacketQueueSimulation` class simulates the router's packet queuing system. Each instance of this class represents a unique combination of packet arrival rate (λ), packet departure rate (μ), and buffer size (n).

Events (packet arrival or departure) are simulated by generating a random number to decide if the event corresponds to an arrival or departure, based on the given rates. Depending on the event type, the state of the queue (number of packets in queue and number of dropped packets) is updated.

The `Main` class sets up different simulation scenarios, runs them, and logs the results for each scenario into respective files.

**2. Simulation Results Analysis**

Upon executing the simulation for various scenarios, we observed patterns in how the number of packets in the queue and the number of dropped packets change with increasing simulated events.

***For Constant Rates:***

For different combinations of λ, μ, and n, the number of packets in the queue tends to stabilize as events increase, given that both the arrival and departure rates are constant. When λ > μ, the queue fills up faster and, after reaching the maximum buffer size, packets start getting dropped. Conversely, when μ > λ, the number of packets in the queue decreases, and the drop rate is generally low.

***For Variable Input Rate:***

When the input rate varies, the behavior is a bit more unpredictable. At times when λ is significantly higher than μ, the queue quickly fills up, and many packets are dropped. When the rates are closer or λ is lower than μ, the queue begins to clear, and fewer packets are dropped.

Based on our class discussions, this behavior is expected. The router's queue system operates optimally when the input and output rates are balanced. However, when the system is overloaded (λ much higher than μ), the finite buffer size leads to packet drops. These drops can lead to network congestion, increased latency, and reduced throughput.