Q9

Video Link: https://www.youtube.com/watch?v=n6BU_7FjhJ8

Suppose N packets arrive simultaneously at a link at which no packets are currently being transmitted or queued. Each packet is of length L and the link has transmission rate R. What is the average queuing delay for the N packets? Simplify your answer.

We know that the queuing delay for the first packet is 0.

For the second packet, it's $\frac{L}{R}$ because of the first packet.

For the third packet, it's $2 * \frac{L}{R}$ because of the first and second packet.

For the fourth packet, it's $3 * \frac{L}{R}$ because of the first, second, and third packet.

In general, the kth packet has $(k-1)(\frac{L}{R})$ delay, so the total delay of N packets is

$$T_{total} = \sum_{k=1}^{N}(k-1)\frac{L}{R}$$

, and the average delay of the N packet is

$$T_{avg} = \frac{1}{N}\sum_{k=1}^{N}(k-1)\frac{L}{R}$$

$$\implies \frac{L}{NR}\sum_{k=1}^{N}(k-1)$$

$$\implies \frac{L}{NR}(\sum_{k=1}^{N}k-\sum_{k=1}^{N}1)$$

$$\implies \frac{L}{NR}(\sum_{k=1}^{N}k-N)$$

$$\implies \frac{L}{NR}(\frac{N(N+1)}{2}-N)$$

$$\implies \frac{L}{R}(\frac{(N+1)}{2}-1)$$

$$\implies \frac{L}{2R}(N-1)$$

$$T_{avg}=\frac{L}{2R}(N-1)$$