P5

Suppose N packets arrive simultaneously to 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?

Answer:

When N packets arrive simultaneously, the first packet experiences no queuing delay, the second packet experiences a delay equal to the transmission time of the first packet, the third packet experiences a delay equal to the transmission time of the first two packets, and so on.

The transmission time for one packet is L/R

The total queuing delay for all N packets is: 0 + L/R + 2(L/R) + ... + (N-1)(L/R)

This is an arithmetic series with the sum: L/R * (0 + 1 + 2 + ... + (N-1)) = L/R * (N-1) * N / 2

The average queuing delay is the total delay divided by the number of packets: (L/R * (N-1) * N / 2) / N = L/R * (N-1) / 2

So, the average queuing delay for the N packets is: L * (N-1) / (2*R)