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Assignment - 1
Computer Networks and Internet of Things.

Q1

Calculate the Average queuing delay:

The first packet queuing delay $=0$

The second packet queuing delay $= \frac{L}{R}$

The third packet queuing delay $= 2\frac{L}{R}$ and so on

The Nth packet queuing delay $= (N-1)\frac{L}{R}$

Therefore, the average queuing delay of Nth Packet =

$$\frac{\left[\frac{L}{R} + 2\frac{L}{R} + 3\frac{L}{R} + \ldots + (N-1)\frac{L}{R}\right]}{N}$$

$$= \frac{L}{(RN)} \sum_{i-1}^{N-1} i$$

$$= \left[\frac{L}{(RN)}\right] \frac{N(N-1)}{2}$$

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

To transmit N such batches, it takes LN/R seconds. Therefore empty each time. Thus, the average delay of a packet across batch.

Hence, the average queuing delay of a packet =

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

Q2 Consider the given data:

Packet length = L

Transmission rate = R

Currently transmitted Packet = x bits

Waiting queue = n packets

Formula for queuing delay:

$$\text{Queuing delay} = \frac{[nL + (L-x)]}{R}$$

Given data:

$L = 1500$ bytes

$R = 2$ Mbps or 2×10^6 bps

$$x = \frac{1500}{2} = 750$$

$n = 4$

Calculation:

$$[nL + (\cancel{L}-x)] = (4 \times 1500) + (1500 - 750)$$
$$= 6000 + 750$$
$$= 6750 \text{ bytes}$$

Packets are transmitted at 2Mbps,

$$= 6750 \times 2 \times 4$$
$$= 54000$$

The queuing delay for packet is calculated as follows:

$$\text{Queuing Delay} = \frac{54000}{2 \times 106}$$
$$= 0.027 \text{ sec.}$$

Thus the queuing delay = 0.027 seconds

Q.3 We will count the transfer as completed when the last data bit arrives at its destination.

a) 1.5 MB = 12,582,912 bits

~~2 iti~~ 2 initial RTT's (160 ms) + $\frac{12,582,912}{10,000,000}$ bps

transmit + RTT/2 (propagation) ≈ 1.458 sec.

b) Number of packets required = 1.5MB/1KB = 1,536.
To the above we add the time for 1,536 RTTs (the number of RTTs between when packet 1 arrives and packet 1,536 arrives), for a total of 1.458 + 122.8 = 124.258 seconds.

c) Dividing the 1,536 packets by 20 gives 76.8. This will take 76.5 RTTs (half an RTT for the first batch and the 77^{th} partial batch), plus the initial 2 RTTs, for 6.28 seconds

d) Right after handshaking is done we send one packet. One RTT after the handshaking we send 2 pakets. At n RTTs past the initial handshaking we have sent 1+2+4+...+2n = 2n+1-1 pakets. At n = 10 we have thus been able to send all 1,536 pakets; the last batch arrives 0.5 RTT later. Total time is 2+10.5RTTs or 1 second

Q.4 a)

1) Time to send message from source

$\frac{8 \times 10^6}{2 \times 10^6}$ sec = 4 sec

2) With store-and-forward switching, the total time from source host to destination host = 4 sec × 3 hops = 12 sec

b) 1) Time to send 1st packet from source host to first switch

$\frac{1 \times 10^4}{2 \times 10^6}$ sec = 5m sec

2) Time at which 2nd packet is received at the ~~first~~ 1st switch = time at which ~~1st~~ 2nd switch = ~~2nd~~ 1st Packet is received at the ~~second~~ 2nd switch =

2× 5 m sec = 10 m sec

c) Time at which 1st packet is received at the destination host = 5 m sec × 3 hops = 15 msec

After this every 5msec one paket will be received;

Thus time at which last (800th) packet received = 15 m sec + 799 × 5 m sec = 4.01 sec

It can be seen that delay in using message segmentation is significantly less (almost 1/3rd)

d) i) Without message segmentation, if bit errors are not tolerated, if there is single bit error, the whole message has to be retransmitted (rather than a single packet)

ii) Without message segmentation, huge pakets (containing in HD videos, for example) are sent into the network. Routers have to accommodate these huge packets. Smaller pakets have to queue behind enormous pakets and suffer unfair delays.