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ECE 545 HW1

Due Date: 1/29/23

Problems to be submitted.
Review Questions: R#
Problem Questions: P#

R#13 a) When the circuit is used, 2 users can be supported since each user would require half of the link bandwidth.

b) If two or fewer users transmit at the same time using packet switching, there will be essentially no queuing delay before the link because of the available brandwidth (2Mbps) can handle the incoming traffic. However, if three users transmit at the same time, the incoming traffic exceeds the link's capacity and packets will have to wait in a queue before being transmitted, resulting in a queuing delay.

c) The probability that a given user is transmitting is 0.2 or 20% (Since each user transmits only 20% of the time).

d) If there are 3 users, the probability that all 3 users are transmitting simultaneously: $\binom{3}{3}p^3(1-p)^{3-3}$

$$= (0.2)^3$$
$$= 0.008 \text{ or } 0.8\%$$

∴ Since the queue grows when all the users are transmitting, the fraction of time during which the queue grows is 0.8%.

R#18 Transmission delay $= L/R$
$= 8$ bits/byte $*$ 1000 bytes /2,000,000 bps
$= 4$ ms

Propagation delay $= d/s$
$= 2500/2.5\times 105$

$= 10ms$

$\therefore$ The total time $= 4ms + 10ms$

$= 14 ms.$

The delay depending on packet length is not true and the delay depending on transmission rate is also not true.

R#19 According to the given data:

a) $R1 = 500$ kbps, $R2 = 2$ Mbps, and $R3 = 1$ Mbps.

$\therefore$ The throughput for the file transfer is minimum of R1, R2, R3.

$\therefore$ file transfer $= \min(500 \text{ kbps}, 2 \text{Mbps}, 1 \text{Mbps})$

$= 500 \text{ kbps}$ //

b) The file size is 4 million bytes and when converted to bits its 32,000,000 bits.

Using throughput from (a), the time taken to transfer is $= \dfrac{32{,}000{,}000 \text{ bits}}{500 \text{ kbps}}$

$= \dfrac{32{,}000{,}000}{500000}$ sec

$= 64$ seconds //

c) Using the data from (a) & (b), with the modification of $R2 = 100$ kbps.

The throughput for file transfer $= \min(R1, R2, R3)$

$= \min(500 \text{ kbps}, 100 \text{kbps}, 1 \text{Mbps})$

$\therefore$ Throughput $= 100$ kbps //

And time taken $= \dfrac{32{,}000{,}000 \text{ bits}}{100 \text{ kbps}}$

$= \dfrac{32{,}000{,}000}{100000}$ sec

$= 320$ seconds //

P#7 For Host A to convert the analog voice to a digital 64 kbps bit stream on the fly. Host A groups the bits in 56 byte packets. If the transmission rate is 2 Mbps & propagation delay is 10 msec:

Elapsed Time = $\frac{\text{Total number of packets}}{\text{Conversion of analog to digital}}$ + Transfer packet time + propogation delay

$$= \left(\frac{56 \times 8}{64 \times 10^3} + \frac{56 \times 8}{2 \times 10^6} + 0.01\right) \text{ seconds}$$

$$= (0.007 + 0.000224 + 0.01) \text{ seconds}$$

$$= 0.017224 \text{ seconds} //$$

P#13 a) 1^{st} packet queuing delay = 0

2^{nd} packet queuing delay = L/R

3^{rd} packet queuing delay = $2(L/R)$ and similar progression can be seen.

∴ For the N^{th} packet queuing delay = $(N-1)\,L/R$

∴ The average queuing delay for N^{th} packet = $\frac{L}{RN} \sum_{x=1}^{N-1} x$

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

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

b) In order to transmit N batches, it takes $\frac{LN}{R}$ seconds.

With a new batch, the queue is empty each time.

∴ The average delay of a packet across all batches is the average delay within one batch.

∴ The average queuing delay of a packet = $(N-1)\frac{L}{2R}$ //

P#31 a) To send message from source host to 1^{st} packet switch.

1) Time $= \frac{8\times10^6}{2\times10^6}$ sec

$= 4$ seconds//

2) With store and forward switching, the total time to move message from source host to destination host

$= 4$ sec $\times 3$ hops

$= 12$ seconds//

b) To send 1^{st} packet from the souce host to 1^{st} packet switch

1) Time $= \frac{1\times10^4}{2\times10^6}$ sec

$= 5$ m.seconds//

2) For the 2^{nd} packet is received at the 1^{st} switch = time at which 1^{st} packet is received at the 2^{nd} switch.

Time $= 2 \times 5$ msec

$= 10$ m.sec//

c) i) For the 1^{st} packet to be received at the destination host

$= 5$ msec $\times$ 3 hops $= 15$ m.sec.

After this, every 5 msec one packet will be received.

$\therefore$ Time at 800^{th} packet is received $= 15$m.sec $+ 799 \times 5$m.sec

$= 4.01$ sec//

2) The delay in using message segmentation is significantly less.

d) i) Without message segmentation, if bit errors are not tolerated, the entire message must be resent if there is a single bit errors, rather than just a single packet.

ii) Without message segmentation, large packets are sent into the network, causing routers to struggle to accommodate them. As a result, smaller packets are forced to wait behind larger ones, leading to unfair delays.

e) i) Packets must be reassembled in the correct order at the destination.

ii) Message segmentation results in many smaller packets. However, since the header size is usually the same for all packets regardless of their size, the total amount of header bytes is increased with message segmentation.