Homework #1	CS 372	Rhea Mae Edwards

Review Questions

90/100

R11) R_1 = Transmission Rate Between the Sending Host and the Switch

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R_2 = Transmission Rate Between the Switch and the Receiving Host (bps)

- Exactly one Packet Switch
- Store and Forward Packet Switching

d_{trans} = Total end-to-end delay to send a packet = ?

L = length of packet (bits)

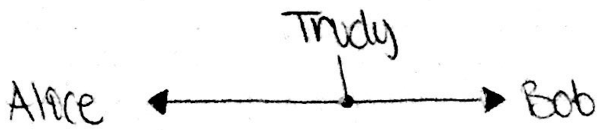
$d_{trans} = \frac{L}{R}$ (definition)

$d_{trans} = \frac{L}{R_1} + \frac{L}{R_2} = \boxed{\frac{L(R_1+R_2)}{R_1R_2}}$ ✓

delay through the first transmission + delay through the second transmission = delay through the entire process/transmission occuring

R28)

10/10



✓

- Trudy able to capture what is being sent and she can send whatever she wants

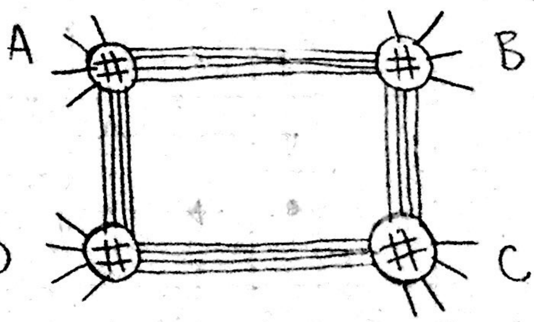
Malicious Things Trudy Can Do:

- IP Spoofing: Send packets with false addresses
- Packet "Sniffing": Broadcast media, Reads/Record all packets passing by/being sent ✓

Problems

P4) Circuit-Switched Network (Figure 1.13)

15/15



- A simple circuit-switched network consisting of four switches and four links

a) 4 links between each pair of switches, so 4 links for each 4 pairs of switches...

Movement in one direction through the network here

4×4 = $\boxed{\text{16 Maximum Simultaneous Connections}}$ ✓

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b) 4 Connections from A → B → C
And another...
4 Connections from A → D → C
4 + 4 = $\boxed{\text{8 Maximum Simultaneous Connections}}$ ✓

c) Yes, we can route these calls: ✓

- 4 connections between A and C
- 4 connections between B and D

through the four links to accommodate all eight connections.

For between switches A and C:

2 connections from A → B
2 connections from B → C ✓
and...
2 connections from A → D
2 connections from D → C

For between switches B and D:

2 connections from B → A
2 connections from A → D ✓
and...
2 connections from B → C
2 connections from C → D

So when combined for the overview of what's happening/connected...

2 connection from A → B
4 connections from A → D
4 connections from B → C
2 connections from B → A
2 connections from D → C
2 connections from C → D

P8) 3 Mbps Link
150 Kbps Transmitting

Each user only transmits 10% of the time

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a) $\frac{3 \text{ Mbps}}{150 \text{ Kbps}} = \frac{3000 \text{ Kbps}}{150 \text{ Kbps}} = \boxed{20 \text{ users}}$ ✓ when circuit-switching is used

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b) "Each user transmits only 10 percent of the time"

$\boxed{P(\text{Given user is transmitting}) = 0.1}$ ✓

c) $n = 120$ users $\quad p = 0.1$

Binomial Distribution:

$$P(x) = \left(\frac{n!}{x!\,(n-x)!}\right) p^x \cdot (1-p)^{n-x}$$

$$P(x=n) = \left(\frac{120!}{n!\,(120-n)!}\right) (0.1)^n \cdot (1-0.1)^{120-n}$$

$$\boxed{P(x=n) = \left(\frac{120!}{n!\,(120-n)!}\right) (0.1)^n\,(0.9)^{120-n}}$$ ✓

d) $P(x \geq 21) = ?$ → $P(x=21) + P(x=22) + \cdots + P(x=120)$ (2)

$$P(x=21) = \left(\frac{120!}{21!\,(120-21)!}\right) (0.1)^{21}\,(0.9)^{120-21}$$

$$P(x=21) = \left(\frac{120!}{21!\,(99)!}\right) (0.1)^{21}\,(0.9)^{99}$$

$$P(x=21) = 0.00414$$

So..

$\boxed{P(x \geq 21) \text{ less than or equal to } 0.00414}$

P10) Packet of Length = L

10/10

End System A $\xrightarrow{\text{3 Links}}$ Destination End System

Connected by 2 packet switches

Length = d_i

Propagation Speed = s_i

Transmission Rate of Link i = R_i $\quad i = 1, 2, 3$

Packet Switch Delays Each Packet = d_{proc}

No Queuing Delays

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Total End-to-End Delay for the Packet?

$d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$

$d_{trans} = \frac{L}{R}$

$d_{prop} = \frac{d}{s}$

$d_{trans_1} + d_{prop_1} + d_{proc} + d_{trans_2} + d_{prop_2} + d_{proc} + d_{trans_3} + d_{prop_3} = d_{total}$

$d_{total} = \frac{L}{R_1} + \frac{d_1}{s_1} + d_{proc} + \frac{L}{R_2} + \frac{d_2}{s_2} + d_{proc} + \frac{L}{d_3} + \frac{d_3}{s_3}$

$$\boxed{d_{total} = 2d_{proc} + L\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) + \frac{d_1}{s_1} + \frac{d_2}{s_2} + \frac{d_3}{s_3}}$$ ✓

$L = 1500 \text{ bytes} = 12000 \text{ bits}$

$s = 2.5 \times 10^8 \text{ m/s}$

$R = 2 \text{ Mbps} = 2 \times 10^6 \text{ bps}$

$d_{proc} = 3 \text{ msec} = 3 \times 10^{-3} \text{ s}$

$d_1 = 5 \times 10^6 \text{ m}$

$d_2 = 4 \times 10^6 \text{ m}$

$d_3 = 1 \times 10^6 \text{ m}$

$d_{total} = 2(3 \times 10^{-3}) + (12000)(3)\left(\frac{1}{2 \times 10^6}\right) + \left(\frac{1}{2.5 \times 10^8}\right)(5+4+1)(10^6)$

$\boxed{d_{total} = 0.064 \text{ s}}$ ✓

P33) F bits

R = R bps

20/20

Host A → Host B

→ Segments of S bits each

+ 80 bits

Packets → L = 80 + S bits

- 3 Links
- 2 Switches
- No Queuing Delays (d_{queue}) ✓
- Disregard Propagation Delay (d_{prop}) ✓

S = ? bits to minimize the delay of the moving file

Number of Packets = $\frac{F}{S}$ $L = 80 + S$ bits

First calculating the overall delay.

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To get the first packet through along with the idea that every packet after the first reaches to Host B every $\frac{S+80}{R}$ seconds:

$$3\left(\frac{L}{R}\right)+\left(\frac{F}{S}-1\right)\left(\frac{L}{R}\right) = \text{Total Delay}$$

$$3\left(\frac{80+S}{R}\right)+\left(\frac{F}{S}-1\right)\left(\frac{80+S}{R}\right)$$

$$\left(\frac{80+S}{R}\right)\left(3+\left(\frac{F}{S}-1\right)\right)$$

✓ $$\left(\frac{80+S}{R}\right)\left(\frac{F}{S}+2\right)$$ → Now use this delay formula in order to find where on its graph the value of the equation is the smallest

- So one way, is where the slope = 0, by making the derivate of the equation equal to zero in terms of S.

$$\frac{d(\text{total delay})}{dS} = \frac{80F}{SR}+\frac{\cancel{S}F}{\cancel{S}R}+\frac{160}{R}+\frac{2S}{R}$$

$$=\left(\frac{80F}{R}\right)\left(\frac{1}{S}\right)+\frac{F}{R}+\frac{160}{R}+\left(\frac{2}{R}\right)(S)$$

$$=\left(\frac{80F}{R}\right)(S)^{-1}+0+0+\left(\frac{2}{R}\right)(S)$$

$$\frac{\cancel{+}\left(\frac{2}{R}\right)}{\cancel{+}\left(\frac{80F}{R}\right)} = \frac{-\cancel{\left(\frac{80F}{R}\right)}(S)^{-2}}{-\cancel{\left(\frac{80F}{R}\right)}} + \frac{\cancel{\left(\frac{2}{R}\right)}}{-\cancel{\left(\frac{2}{R}\right)}}$$

$$\frac{2\cancel{R}}{80F\cancel{R}} = (S)^{-2} \rightarrow \frac{1}{S^2}=\frac{2}{80F} \rightarrow \frac{1}{S^2}=\frac{1}{40F}$$

$$\sqrt{S^2}=\sqrt{40F} \qquad \boxed{S=\sqrt{40F}} \text{ (bits)}$$ ✓

Additional Questions

R = R bps Packet Arrival Rate = A packets/s

L = L bits Traffic Intensity = I = $\frac{L \cdot A}{R}$

12/20

a) $d_{queue.average}$ = ? when I > 1 and I ≤ I

R = Rbps $\left(\frac{\text{bits ahead}}{\text{rate}}\right)$ = queueing delay

L = L bits

$I = \frac{L \cdot A}{R}$

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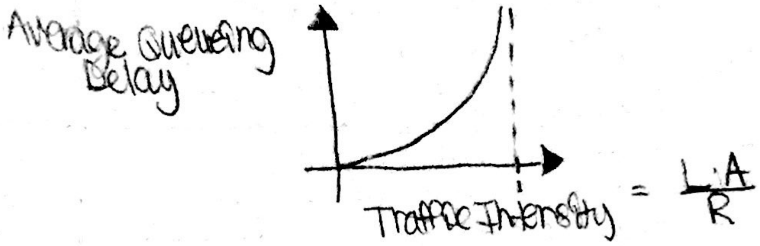
$\frac{L \cdot A}{R} \to 1$: delay become large → we can calculate it (-8)

$\frac{L \cdot A}{R} > 1$: more "work" arriving than can be serviced, average delay infinite!



b) $d_{total.average} = d_{queue.average} + d_{trans.average}$

$d_{trans} = \frac{L}{R}$

$d_{total\ average} = d_{queue\ average} + \frac{L}{R}$