Homework 2 Solution

Problem 1.2

a) A circuit-switched network would be well suited to the application described, because the application involves long sessions with predictable smooth bandwidth requirements.
Since the transmission rate is known and not bursty, bandwidth can be reserved for each application session circuit with no significant waste. In addition, we need not worry greatly about the overhead costs of setting up and tearing down a circuit connection, which are amortized over the lengthy duration of a typical application session.

b) Given such generous link capacities, the network needs no congestion control mechanism. In the worst (most potentially congested) case, all the applications simultaneously transmit over one or more particular network links. However, since each link offers sufficient bandwidth to handle the sum of all of the applications' data rates, no congestion (very little queueing) will occur.

Problem 1.5

a) The time to transmit one packet onto a link is $\frac{F+h}{R}$. The time to deliver the packet over Q links is Q$\frac{F+h}{R}$. Since we need t_s to set up the circuit, therefore, the total latency is $t_s + \frac{F+h}{R}Q$

b) The transmission on each link will take $\frac{F+2h}{R}$. Thus, the total time of transmission is Q$\frac{F+2h}{R}$.

c) Because there is no store-and-forward delay at the links, Since we need t_s to set up the circuit . The total delay from starting time till the last bit received is

$$t_s + \frac{F+h}{R}Q$$

Problem 1.8

a) 1Mbps/100kbps = 10 users can be supported because each user requires one tenth of the bandwidth.
b) The probability of one user transmitting is p =0.1.
c) We can assume that each user is independent from other users, thus each transmission can be

modeled as binomial distribution. Thus for a given total N, P(n) = $\binom{N}{n} p^n (1-p)^{N-n}$ In this problem, N=40 and p=0.1, so the probability is $\binom{40}{n} p^n (1-p)^{40-n}$

d) 1-$\sum_{n=0}^{9} \binom{40}{n} p^n (1-p)^{40-n}$

We use the central limit theorem to approximate this probability. Let j X be independent random variables such that P(X j = 1) = p.

$$P(\text{ “11 or more users” }) = 1-P\left(\sum_{j=1}^{40} Xj \le 10\right)$$

$$P\left(\sum_{j=1}^{40} Xj \le 10\right) = P\left(\frac{\sum_{j=1}^{40} Xj - 4}{\sqrt{40 \times 0.1 \times 0.9}}\right) \le \frac{6}{\sqrt{40 \times 0.1 \times 0.9}}$$

$$= P\left(Z \le \frac{6}{\sqrt{3.6}}\right) = P(Z \le 3.16) = 0.999$$

when Z is a standard normal r.v. Thus, P(“10 or more users”) = 0.001.

Problem 1.13

Traceroute to a domestic host:
The command:
traceroute 64.233.167.99

EST	Avg. RTT (ms)	RTT STD	# hops	# ISPs
8 am	9.322	0.224	10	2
3 pm	16.431	4.452	10	2
2 am	8.084	0.124	10	2

Traceroute to a foreign host:
The command:
traceroute 61.172.201.195

EST	Avg. RTT (ms)	RTT STD	# hops	# ISPs
8 am	470.438	4.424	22	4
3 pm	481.212	9.562	22	4
2 am	402.339	5.435	22	4

The delay increases during the working hour and has more obvious impact on the domestic delay. The largest delay to foreign country appears inside one AS (savvis), which is very likely to be across continent links.

Problem 18.

a) The geostationary orbit is 36,000km. The propagation delay is $\frac{36000000m}{2.4\times 10^8 m/s}$ =150msec

b) The bandwidth-delay product is $10\times 0.15=$ 1,500,000 bits

c) If the size of the photo x is larger than the amount of information transmitted in one minute, then in one minute the satellite transmits 600,000,000 bits

Chapter 4

Problem 4.4

a) There is no VC number that can be assigned to the new VC, as all 4 of the possible link numbers are in use at some link on the path.

b) There are two possibilities at each of the four links, implying 2^4=16 different combinations of VC numbers.

Problem 4.7.

a)

Prefix Match	Link Interface
11100000	0
11100001 00000000	1
11100001	2
otherwise	3

b) Prefix match for first address is 4th entry -> link interface 3

Prefix match for second address is 2nd entry -> link interface 1

Prefix match for first address is 3rd entry -> link interface 2

Problem 4.21.

Step	N’	D(s), p(s)	D(t), p(t)	D(u), p(u)	D(v), p(v)	D(w), p(w)	D(y), p(y)	D(z), p(z)
0	x	∞	∞	∞	3,x	1,x	6,x	∞

1	xw	∞	∞	4,w	2,w		6,x	∞
2	xwv	∞	11,v	3,v			3,v	∞
3	xwvu	7,u	5,u				3,v	∞
4	xwvuy	7,u	5,u					17,y
5	xwvuyt	6,t						7,t
6	xwvuyts							7,t

Problem 4.25

a. The distance table in X is:

Before the information exchanged,

x	Via neighbor	To w	To y	To u
	Y	unknown	4	10
	w	1	Unknown	6

There is not unknown cost in the table. This is because the cost from w to y and y to w is not given in the question.

b)

To determine the cost to u, because the cost of the path via w is smaller, a change in the link cost c(x,w) will cause x to inform its neighbors of a new minimum cost path to u. To be more specific, if the cost of c(x,w) increases but smaller than 6, the path still goes through w but with larger cost. x will inform its neighbor. If the cost increases larger or equal to 6, the path changes to go through y and again, x will inform its neighbor.

c) No matter c(x,y) becomes larger or smaller, the cost path from x to u will be no less than 6 via w. So, a change in the link cost c(x,y) will not cause x to inform its neighbors of a new minimum cost path to u.