ELEC 5220/6220 Solution 1

R16. The delay components are processing delays, transmission delays, propagation delays, and queueing delays. All of these delays are fixed, except for the queuing delays, which are variable.

R18. 10msec; d/s; no; no

R19. a) 500 kbps
b) 64 seconds
c) 100kbps; 320 seconds

R26. a) Virus
Requires some form of human interaction to spread. Classic example: E-mail viruses.
b) Worms
No user replication needed. Worm in infected host scans IP addresses and port numbers, looking for vulnerable processes to infect.

Problem 2

At time N*(L/R) the first packet has reached the destination, the second packet is stored in the last router, the third packet is stored in the next-to-last router, etc. At time N*(L/R) + L/R, the second packet has reached the destination, the third packet is stored in the last router, etc. Continuing with this logic, we see that at time N*(L/R) + (P-1)*(L/R) = (N+P-1)*(L/R) all packets have reached the destination.

Problem 3

a) A circuit-switched network would be well suited to the application, 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 without significant waste. In addition, the overhead costs of setting up and tearing down connections are amortized over the lengthy duration of a typical application session.

b) In the worst case, all the applications simultaneously transmit over one or more network links. However, since each link has sufficient bandwidth to handle the sum of all of the applications' data rates, no congestion (very little queuing) will occur. Given such generous link capacities, the network does not need congestion control mechanisms.

Problem 6

a) $d_{prop} = m / s$ seconds.

b) $d_{trans} = L / R$ seconds.

c) $d_{end-to-end} = (m / s + L / R)$ seconds.

d) The bit is just leaving Host A.
e) The first bit is in the link and has not reached Host B.
f) The first bit has reached Host B.
g) Want

$$m = \frac{L}{R} s = \frac{120}{56 \times 10^3} \left(2.5 \times 10^8\right) = 536 \text{ km}$$

Problem 10

The first end system requires L/R_1 to transmit the packet onto the first link; the packet propagates over the first link in d_1/s_1; the packet switch adds a processing delay of d_{proc}; after receiving the entire packet, the packet switch connecting the first and the second link requires L/R_2 to transmit the packet onto the second link; the packet propagates over the second link in d_2/s_2. Similarly, we can find the delay caused by the second switch and the third link: L/R_3, d_{proc}, and d_3/s_3.

Adding these five delays gives

$$d_{end\text{-}end} = L/R_1 + L/R_2 + L/R_3 + d_1/s_1 + d_2/s_2 + d_3/s_3 + d_{proc} + d_{proc}$$

To answer the second question, we simply plug the values into the equation to get 6 + 6 + 6 + 20+16 + 4 + 3 + 3 = 64 msec.

Problem 31

a) Time to send message from source host to first packet switch = $\frac{8\times10^6}{2\times10^6}\sec = 4\sec$ With store-and-forward switching, the total time to move message from source host to destination host = $4\sec\times 3\,hops = 12\sec$

b) Time to send 1st packet from source host to first packet switch = . $\frac{1\times10^4}{2\times10^6}\sec = 5\,m\sec$. Time at which 2nd packet is received at the first switch = time at which 1st packet is received at the second switch = $2\times 5m\sec = 10\,m\sec$

c) Time at which 1st packet is received at the destination host = $5\,m\sec\times 3\,hops = 15\,m\sec$. After this, every 5msec one packet will be received; thus time at which last (800th) packet is received = $15\,m\sec + 799 * 5m\sec = 4.01\sec$. 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 a single bit error, the whole message has to be retransmitted (rather than a single packet).

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

e)

i. Packets have to be put in sequence at the destination.

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

Problem 33

There are *F/S* packets. Each packet is (S+80) bits. Time at which the last packet is received at the first router is $\frac{S+80}{R}\times\frac{F}{S}$ sec. At this time, the first F/S-2 packets are at the destination, and the F/S-1 packet is at the second router. The last packet must then be transmitted by the first router and the second router, with each transmission taking $\frac{S+80}{R}$ sec. Thus delay in sending the whole file is $delay = \frac{S+80}{R}\times(\frac{F}{S}+2)$

To calculate the value of S which leads to the minimum delay,

$$\frac{d}{dS}delay = 0 \Rightarrow S = \sqrt{40F}$$

Problem 34

The circuit-switched telephone networks and the Internet are connected together at "gateways". When a Skype user (connected to the Internet) calls an ordinary telephone, a circuit is established between a gateway and the telephone user over the circuit switched network. The skype user's voice is sent in packets over the Internet to the gateway. At the gateway, the voice signal is reconstructed and then sent over the circuit. In the other direction, the voice signal is sent over the circuit switched network to the gateway. The gateway packetizes the voice signal and sends the voice packets to the Skype user.