COMP 431 - Problem Set 2

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1.

a) $\frac{(8(F+h))}{R} \times N$, seconds

b) $\frac{(8M(P+h))}{R} + \frac{8(N-1)(P+h)}{R}$, seconds

c) $T_s + \frac{(8M(P+\frac{h}{2}))}{R} + \frac{8(N-1)(P+\frac{h}{2})}{R}$, seconds

d) $T_s + \frac{(8(F+\frac{h}{2}))}{R}$, seconds

e) Packet switching is faster than pure circuit switching when $\frac{8Mh}{R} + \frac{8(N-1)(P+h)}{R} < \frac{4h}{R} + T_s$.

2.

a) 1.5 Mbps $\times .02$ seconds $= .03$ Mb or 30kb of data on the wire at any given instant.

b) Because 450,000 bits exceeds 30kb, we know that the most that will ever be on the wire at a given time is 30kb.

c) One knows the maximum amount of data that can be held on the link at any instant of time.

d) $.02 + \frac{.45}{1.5} = .32$ seconds.

e) 50 $\times$ (.02 + (.006) + .02) - .02 = 2.28 seconds. We subtract off the last .02 because the last frame does not need to be acknowledged.

f) The largest value of m such that an ACK frame for 1 will arrive while m is being transmitted is $m = 8$. The sender will be able to send frame $m + 1 = 9sa$, 0.048 seconds after sending the first frame. The sender will be able to send frame $2m = 16$, .09 seconds after sending the first frame. Because this setting of m results in no wait time, the total time for transmission is again $.02 + \frac{.45}{1.5} = .32$ seconds.

3.

a) 600 Mbps $\times .02$ seconds $= 12$ Mb of data on the wire at any given instant.

b) Because 450,000 bits is less than 12 Mb, we know that the most that will ever be on the wire at a given time is all 450,000 bits.

d) $.02 + \frac{.45}{600} = .02075$ seconds.

e) $50 \times (.02 + (.000015) + .02)$ - $.02 = 1.98075$ seconds. We subtract off the last .02 because the last frame does not need to be acknowledged.

f) The largest value of m such that an ACK frame for 1 will arrive while m is being transmitted is $m = 2668$. The sender will be able to send frame $m + 1 = 2669$, 0.04002 seconds after sending the first frame. The sender will be able to send frame $2m = 5336$, 0.080025 seconds after sending the first frame. Because this setting of m results in no wait time, the total time for transmission is again $.02 + \frac{.45}{600} = .02075$ seconds.

4.

a) The ping is the distance between the nodes divided by the speed of transmission, so $\frac{3.6\times10^7}{2.4\times10^8} = 0.15$ seconds, and each image is 37 megabits, and our link has a rate of 10 megabits per second, so we found a given image to be sent and acknowledged takes $\frac{37}{10} + 2 \times (0.15) = 4$ seconds, which means we can send 15 images per minute.

b) We want to find a value for the size of the file (in megabits), call it x, such that it can be transmitted and acknowledged in exactly 1 second (as exactly 1 second will lead to the largest value for the size of the file), so we have

$$\frac{x}{10} + 2 \times (0.15) = 1 \Rightarrow x = 7$$

So we have it that the maximum file size possible is 7 megabits.

c) We must solve this equation again but instead where our transmission speed is 100, so

$$\frac{x}{100} + 2 \times (0.15) = 1 \Rightarrow x = 70$$

So our maximum file size is 70 megabits.

5.

a) The intensity for a given link is simply the average number of bits being transmitted on the link over the transmission capacity of the link, so we know that $I = (10,000 \times 90,000)/10^9 = .9$, which means on average the number of packets in queue when a new packet arrives is $q = .9/(1 - .9) = 9$. So the amount of delay that this packet is subject to is $(9 \times 10,000)/10^9 = .00009$ seconds.

b) This is simply our queuing delay .00009 plus the transmission delay of the frame .00001, so the total delay is .0001 seconds.

c) Our new average number of packets in the queue when a new packet arrives is $q = .09/(1 - .09) = 0.098$, which means that in fact this new packet is arriving just as the previous packet is about to finish sending. So the queuing delay is very small, .0000000989, and the transmission delay is .000001, so our total delay is .0000010989.