CS4850/7850 Homework 1 Due: Tuesday, September 9, at beginning of class

From the Computer Networks book (by L. Peterson and B. Davis, 5th edition):

Chapter 1, Ex. 3, 10, 16, 18, 26, 36, 37

Notes:
A store-and-forward switch holds bits while receiving the entire packet, before transmitting the (first bit of the) packet to the downlink.

Be careful when converting bit or byte values (e.g. MB to KB) vs. converting bandwidth (e.g., Mbps to Kbps); Remember: 1 MB = 1024 KB; 1 Mbps = 1000 Kbps

For 3(c) and 3(d) assume that the first packet will be sent right after the 2*RTT handshake delay.
For 18(a) assume sender sends a continuous bit stream
For 18(b) assume sender sends individual 12,000 bit packets
For 26(d) assume each black-and-white pixel is represented by 1 bit

3. Calculate the total time required to transfer a 1000-KB file in the following cases, assuming an RTT of 50 ms, a packet size of 1 KB data, and an initial 2×RTT of "handshaking" before data is sent:

(a) The bandwidth is 1.5 Mbps, and data packets can be sent continuously.

(b) The bandwidth is 1.5 Mbps, but after we finish sending each data packet we must wait one RTT before sending the next.

(c) The bandwidth is "infinite," meaning that we take transmit time to be zero, and up to 20 packets can be sent per RTT.

(d) The bandwidth is infinite, and during the first RTT we can send one packet (2^(1–1)), during the second RTT we can send two packets (2^(2–1)), during the third we can send four (2^(3–1)), and so on. (A justification for such an exponential increase will be given in Chapter 6.)

10. What differences in traffic patterns account for the fact that STDM is a cost-effective form of multiplexing for a voice telephone network and FDM is a cost-effective form of multiplexing for television and radio networks, yet we reject both as not being cost effective for a general-purpose computer network?

16. Calculate the latency (from first bit sent to last bit received) for the following:

(a) 100-Mbps Ethernet with a single store-and-forward switch in the path and a packet size of 12,000 bits. Assume that each link introduces a propagation delay of 10 μs and that the switch begins retransmitting immediately after it has finished receiving the packet.

(b) Same as (a) but with three switches.

(c) Same as (a), but assume the switch implements "cut through" switching; it is able to begin retransmitting the packet after the first 200 bits have been received.

18. Calculate the effective bandwidth for the following cases. For (a) and (b) assume there is a steady supply of data to send; for (c) simply calculate the average over 12 hours.

(a) 100-Mbps Ethernet through three store-and-forward switches as in Exercise 16(b). Switches can send on one link while receiving on the other.

(b) Same as (a) but with the sender having to wait for a 50-byte acknowledgment packet after sending each 12,000-bit data packet.

(c) Overnight (12-hour) shipment of 100 DVDs that hold 4.7 GB each.

26. For the following, assume that no data compression is done, although in practice this would almost never be the case. For (a) to (c), calculate the bandwidth necessary for transmitting in real time:

(a) Video at a resolution of 640×480, 3 bytes/pixel, 30 frames/second.

(b) Video at a resolution of 160×120, 1 byte/pixel, 5 frames/second.

(c) CD-ROM music, assuming one CD holds 75 minutes' worth and takes 650 MB.

(d) Assume a fax transmits an 8×10-inch black-and-white image at a resolution of 72 pixels per inch. How long would this take over a 14.4-kbps modem?

36. The Unix utility ping can be used to find the RTT to various Internet hosts. Read the man page for ping, and use it to find the RTT to www.cs.princeton.edu in New Jersey and www.cisco.com in California. Measure the RTT values at different times of day, and compare the results. What do you think accounts for the differences?

37. The Unix utility traceroute, or its Windows equivalent tracert, can be used to find the sequence of routers through which a message is routed. Use this to find the path from your site to some others. How well does the number of hops correlate with the RTT times from ping? How well does the number of hops correlate with geographical distance?

Bonus. Consider a point-to-point link 50 km in length. At what bandwidth would propagation delay (at a speed of 2×10^8m/s) equal transmit delay for 100-byte packets? What about 512-byte packets?

** Provide a 1 sentence explanation at each step of your answer
** Submit to Canvas by 11:59pm 8/30/2017 and receive 10 pts
** Turn the answer in with your homework and receive 2 bonus pts