COSC 4377 – Networking - Kevin B Long

# interlocking-uh-m-186.eps

Homework #1

Due 11:59am, Sunday, 9 June 2019

Multiple submissions accepted.

1. (10 pts) Do the Intro Wireshark lab found in the Wireshark folder on the class drive. Paste your answers either here or in a separate Wireshark document.
2. (15 pts) Complete the second Wireshark lab on HTTP. A note: if you have trouble seeing the packets you need on your network to complete your exercise (if Wireshark is working but they’re just not there), then you can revert back to a “pcap” file from the author that has all the packets you need that you can open with Wireshark. I’ve added a folder of those to the google drive.
3. (4 pts) Visit the Transmission Versus Propagation Delay applet reachable from this page: <http://wps.pearsoned.com/ecs_kurose_compnetw_6/216/55463/14198700.cw/index.html>.
   1. Among the rates, propagation delay, and packet sizes available, find a combination for which the sender finishes transmitting before the first bit of the packet reaches the receiver. **Take a snapshot and paste it here**.
   2. Find another combination for which the first bit of the packet reaches the receiver before the sender finishes transmitting. **Take a snapshot and paste it here**.
4. (6 pts) How long does it take a packet of length 1,000 bytes to propagate over a link of distance 2,500 km, propagation speed 2.5⋅108 m/s, and transmission rate 2 Mbps?
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More generally, how long does it take a packet of length *L* to propagate over a link of distance *d*, propagation speed *s*, and transmission rate *R* bps?

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Does this delay depend on packet length? Does this delay depend on transmission rate?

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1. (6 pts) Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates R1=500 kbps, R2=2 Mbps, and R3=1 Mbps.
   1. Assuming no other traffic in the network, what is the throughput for the file transfer?

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* 1. Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?

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* 1. Repeat (a) and (b), but now with *R*2 reduced to 100 kbps.

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1. (8 pts 4x2) Visit the Queuing and Loss applet at the companion Web site.
   1. What is the maximum emission rate and the minimum transmission rate? With those rates, what is the traffic intensity?

Max emission: \_\_\_\_\_\_\_\_; Min transmission: \_\_\_\_\_\_\_;

Traffic Intensity: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Run the applet with these rates and determine how long it takes for packet loss to occur. Then repeat the experiment a second time and determine again how long it takes for packet loss to occur.

* 1. Are the values different? Why or why not?

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1. (3 pts) (P2) Equation 1.1 gives a formula for the end-to-end delay of sending one packet of length *L* over *N* links of transmission rate *R*.

Generalize this formula for sending *P* such packets back-to-back over the *N* links.

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1. (4 pts) (P5) Review the car-caravan analogy in section 1.4. Assume a propagation speed of 100 km/hour.
2. Suppose the caravan travels 150 km, beginning in front of one tollbooth, passing through a second tollbooth, and finishing just after a third tollbooth. What is the end-to-end delay?

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1. Repeat (a), now assuming that there are eight cars in the caravan instead of ten.

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1. (14 pts) P6. This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate *R* bps. Suppose that the two hosts are separated by *m* meters, and suppose the propagation speed along the link is *s* meters/sec. Host A is to send a packet of size *L* bits to Host B.
2. Express the propagation delay, *d*prop, in terms of *m* and *s*.

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1. Determine the transmission time of the packet, *d*trans, in terms of *L* and *R*.

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1. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.

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1. Suppose Host A begins to transmit the packet at time t=0. At time t= *d*trans, where is the last bit of the packet?

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1. Suppose *d*prop is greater than *d*trans. At time *t=dtrans*, where is the first bit of the packet?

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1. Suppose *d*prop is less than *d*trans. At time *t=dtrans*, where is the first bit of the packet?

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1. Suppose s=2.5⋅108, L=120 bits, and R=56kbps. Find the distance *m* so that *d*prop equals *d*trans.

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1. (4 pts) P10. Consider a packet of length *L* that begins at end system A and travels over three links to a destination end system. These three links are connected by two packet switches. Let *di*, *si*, and *Ri* denote the length, propagation speed, and the transmission rate of link *i,* for i=1,2,3. The packet switch delays each packet by *d*proc.
   1. Assuming no queuing delays, in terms of *di*, *si*, *Ri*, (i=1,2,3), and *L,* what is the total end-to-end delay for the packet?
   2. Suppose now the packet is 1,500 bytes, the propagation speed on all three links is 2.5⋅108m/s, the transmission rates of all three links are 2 Mbps, the packet switch processing delay is 3 msec, the length of the first link is 5,000 km, the length of the second link is 4,000 km, and the length of the last link is 1,000 km. For these values, what is the end-to-end delay?
2. (4 pts) P11. In the above problem, suppose *R1=R2=R3=R* and *dproc=0*. Further suppose the packet switch does not store-and-forward packets but instead immediately transmits each bit it receives before waiting for the entire packet to arrive. What is the end-to-end delay?
3. (6 pts) P12. A packet switch receives a packet and determines the outbound link to which the packet should be forwarded. When the packet arrives, one other packet is halfway done being transmitted on this outbound link and four other packets are waiting to be transmitted. Packets are transmitted in order of arrival. Suppose all packets are 1,500 bytes and the link rate is 2 Mbps.
   1. What is the queuing delay for the packet?

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* 1. More generally, what is the queuing delay when all packets have length *L*, the transmission rate is *R*, *x* bits of the currently-being-transmitted packet have been transmitted, and *n* packets are already in the queue?

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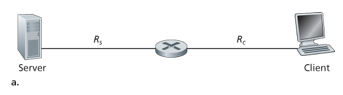
1. (4 pts) P13. Suppose *N* packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length *L* and the link has transmission rate *R*.
2. What is the average queuing delay for the *N* packets?

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1. Now suppose that *N* such packets arrive to the link every *LN/R* seconds. What is the average queuing delay of a packet?

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1. (4 pts) (P23) Consider Figure 1.19a:



Assume that we know the bottleneck link along the path from the server to the client is the first link with rate *Rs*bits/sec. Suppose we send a pair of packets back to back from the server to the client, and there is no other traffic on this path. Assume each packet of size *L* bits, and both links have the same propagation delay *d*prop.

1. What is the packet inter-arrival time at the destination? That is, how much time elapses from when the last bit of the first packet arrives until the last bit of the second packet arrives?

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1. Now assume that the second link is the bottleneck link (i.e., Rc<Rs). Is it possible that the second packet queues at the input queue of the second link? Explain. Now suppose that the server sends the second packet *T* seconds after sending the first packet. How large must *T* be to ensure no queuing before the second link?

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1. (8 pts) P25. Suppose two hosts, A and B, are separated by 20,000 kilometers and are connected by a direct link of R=2 Mbps. Suppose the propagation speed over the link is 2.5⋅108 meters/sec.
2. Calculate the bandwidth-delay product, R⋅dprop.

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1. Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?

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1. What is the width (in meters) of a bit in the link? Is it longer than a ­football field?

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1. Derive a general expression for the width of a bit in terms of the propagation speed *s,* the transmission rate *R,* and the length of the link *m*.

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