Handout #3 — CS 471

Jared Dyreson
California State University, Fullerton

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1 Questions

1. What are nodal, queueing, transmission, processing, and propagation delays?

   - Nodal (d_{proc}): the time that a node spends processing a packet
   - Queueing: the sum of the delays encountered by a packet between the time of insertion into the network and the time of delivery to the destination.
   - Transmission: the amount of time required to push all the packet's bits through a wire
   - Processing: the time it takes routers to process the packet header.
   - Propagation: measure of the time required for a signal to propagate from one end of the circuit to the other.

2. What is the difference between transmission and propagation delays?

   - Transmission delays refer to the entire packet being delivered when the propagation delay is in reference to an individual bit sent through the circuit.

3. Two systems are connected by a router. Both systems and the router have transmission rates of 1,000 BPS. Each link has a propagation delay of 10ms. Also, it takes the router 2ms to process the packet. Suppose the first system want to send a 10,000 bit packet to the second system. How long will it take before the receiver system obtain the entire packet?

   - Regardless of delays, it will take at least 10 seconds (10000 milliseconds) to transmit each way. Each way will also have a delay of 10 milliseconds along with an additional 2 milliseconds for processing. Therefore it will take:

     $$20 + 0.2 + 0.002 = 20.022$$

     seconds for the packet to be sent in this ecosystem.

4. 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 links is s meters/second. Host A is to send a packet of size L bits to host B.

   - Express the propagation delay, d_{prop}, in terms of m and s.
     - $d_{prop} = \frac{m}{s}$
   - Determine the transmission time of the packet, d_{trans} in terms of L and R
     - $d_{trans} = \frac{L \text{ (bits)}}{R \text{ (bits/second)}}$
   - Ignoring processing and queueing delays, obtain an expression for the end-to-end delay
     - Originally, d_{nodal} can be expressed using the following: $d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$
     - Therefore, in this instance d_{nodal} can be written as: $d_{nodal} = d_{trans} + d_{prop} \implies d_{nodal} = L + R$

- Suppose host A begins to transmit the packet at $t = 0$. At $t = d_{trans}$, where is the last bit of the packet?
  - The last bit of the packet has already been sent to the destination node
- Suppose $d_{prop} > d_{trans}$. At $t = d_{trans}$, where is the first bit of the packet?
  - Host A has already finished transmitting the last bit of the packet but since the initial condition says the destination has not yet received the first bit.
- Suppose $d_{prop} < d_{trans}$. At $t = d_{trans}$, where is the first bit of the packet?
  - The first bit of the packet has reached the destination node.
- Suppose $s = 2.5 \times 10^8$, $L = 120$ bits , and $R = 56$ kbps $\implies$ 56000 bps . Find the distance m so that $d_{prop} = d_{trans}$:

$$\frac{L}{R} = \frac{m}{s}$$

$$\frac{120}{56000} = \frac{m}{2.5 \times 10^8}$$

$$m = (\frac{120}{56000} \times (2.5 \times 10^8)) \div 1000$$

$$m \cong 535.714 \text{ km}$$