Introduction to Computer Networks

Homework #1 Solutions

[1] (a) List the delay components in the end-to-end delay of sending a packet from a source to a destination host over a packet-switched network over the same route.

**The delay components are processing delays, transmission delays, propagation delays, and queuing delays.**

1. Which of these delays are constant and which are variable over the same route for packets with the same length?

**All of these delays can be thought of as fixed, except for the queuing delays.**

[2].Suppose Host A wants to send a large packet to Host B over a datagram switching network. The path from Host A to Host B has three links, of rates R1 = 250 kbps, R2 = 2 Mbps, and R3 = 500 kbps. Assume the propagation delays on R1, R2, and R3 are 0.

1. **(1.5 points)** Assuming no other traffic in the network, what is the throughput for the file transfer?

**250 kbps**

1. **(1.5 points)** Assuming no other traffic in the network and suppose the packet size is 1000 bytes. Roughly, how long will it take to transfer the packet to Host B, assume the maximum allowed packet size over all links is 1500B?

Queuing delays and propagation delays are 0

🡪ttotal = ttrans-R1 + ttrans-R2 + ttrans-R3

= 1000x8/250kbps + 1000x8/2Mkbps + 1000x8/500kbps = 52ms

[3]. 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. (*dprop* = propagation delay, *dtrans* = transmission delay)

1. (0.5 point) Express the propagation delay, *dprop*, in terms of *m* and *s*.

 seconds.

1. **(0.5 point)** Determine the transmission time of the packet, *dtrans*, in terms of *L* and *R*.

 seconds.

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

 seconds.

1. **(1.5 points)** Suppose Host A begins to transmit the packet at time *t* = 0. At time *t* = *dtrans*, where is the last bit of the packet?

**The bit is just leaving host A.**

1. **(1.5 points)** Suppose *s* = 250,000,000 meters/sec, *L* = 1000 bits, and *R* = 1 Mbps. Find the distance m so that *dprop = dtrans*.

km.

[4].Which OSI layer is responsible for the following?

(a) Determining the best path to route packets.

**The network layer is concerned with the selection of paths across the network.**

(b) Providing process-to-process communications with reliable service.

**The transport layer is concerned with providing reliable service on a process-to-process basis across the network.**

1. Providing communications between adjacent nodes with reliable service.

**The data link layer provides for the reliable transfer of information between adjacent nodes in a network.**

[5]. **(2 points)** 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. What is the average queuing delay for the N packets?

**Answer: The queuing delay is 0 for the first transmitted packet, *L/R* for the second transmitted packet, and generally, *(n-1)L/R* for the *nth* transmitted packet. Thus, the average delay for the *N* packets is**

***(L/R + 2L/R + ....... + (N-1)L/R)/N = L/RN(1 + 2 + ..... + (N-1)) = LN(N-1)/(2RN)***

***= (N-1)L/(2R)***

**Note that here we used the well-known fact that**

***1 + 2 + ....... + N = N(N+1)/2***