

## Assignment 1

**Covered Topics:-**  
Network Delays

### Problem 1

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.

- Express the propagation delay  $d_{\text{prop}}$  in terms of  $m$  and  $s$ .
- Express the transmission delay  $d_{\text{trans}}$  in terms of  $L$  and  $R$ .
- Ignoring processing and queuing delays, what will be the total end-to-end delay?
- Suppose  $s = 2.5 \times 10^8$  m/s,  $L = 1500$  bits, and  $R = 28$  Kbps. Find the distance  $m$  so that  $d_{\text{prop}}$  equals  $d_{\text{trans}}$ .

### Problem 2

Consider a point-to-point link 100 km in length. The propagation speed of bits in this link is  $2 \times 10^8$  m/s. At what bandwidth will propagation delay equal transmission delay for a 100 bytes packets?

### Problem 3

Host A wants to send a 1Mbyte packet to Host B. The propagation speed of bits is  $2 \times 10^8$  m/sec. Assume that A and B are connected via a router R. Link AR connects A to R, and link RB connects R to B. Link AR is 1Km long and link RB is 2Km long. Suppose that the capacity of each of the 2 links is 10 Mbytes/sec and the processing delay in the Router (R) is 10 msec. Find after how long will host B receive the packet. Note the Router (R) must receive the whole packet before being able to forward it.

#### **Problem 4**

A system has an n-layer protocol hierarchy. Applications generate messages of length M bytes. At each of the layers an h-byte header is added. What fraction of the network bandwidth is filled with headers?

#### **Problem 5**

Host A needs to ping Server B to make sure that it is connected, assuming that the distance between Host A and Server B is 5 KMs, the speed of bits in the wire is  $2 \times 10^8$  m/s, and the bandwidth is 20 Mbps, assuming that an Echo Request message is 80 MBytes and an Echo Response is 100 MBytes, then how long would each message take to be sent and received by Host A.