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CptS 455 - Fall 2018

HW 2

1. What is the propagation time over a link of length 5,000km if the propagation speed is 2*10^8 m/s? (the notation 10^8 means 10 to the 8th power).
   $(5 * 10^6) \div (2 * 10^8)$ = 0.025 sec
2. What is the transmission time for a packet of length 2000 MB on a link with data rate 10Mb/s? Note the conventions: B stands for byte (8 bits); b stands for bit (1 bit); M stands for decimal Mega (10^6).
   L = $2000\ MB\ *\ (8 * 10^6)\ bits$ = $1.6 * 10^{10}\ bits$
   R = $10\ Mb/s\ * (1\ *\ 10^6)\ =\ 1\ *\ 10^7\ b/s$
   $L\ \div R\ =\ (1.6 * 10^{10})\ \div (1\ *\ 10^7)\ =\ 1600\ sec$
3. Give a formula for the width w of a bit on a link in terms of the data rate R and the propagation speed s.
   w = $d/(R * t_{prop})\ = d/(R\ *\ (d/s))\ =\ s/R$
   Where d = length of the link and t_{prop} = propagation time
4. Give a formula of how many bits of width w will be "in-flight" at the same time on a link of length d?
   bandwidth-delay product = R * t_{prop} = R * (d/s)
5. What is the delay x bandwidth product for a link of with the propagation time from Problem 1 and throughput from Problem 2?
   bandwidth-delay product = R * t_{prop} = $(1\ *\ 10^7\ b/s)$ * 0.025 = 250,000 bits
6. What is the total delay associated with sending a 2000 B packet on a 1,000km link with a propagation speed of 2*10^8 m/s and a transmission rate of 10Mb/s? (Ignoring queueing and processing delays)
   L = $2000\ B\ *\ 8\ bits$ = $16000\ bits$
   R = $10\ Mb/s\ * (1\ *\ 10^6)\ =\ 1\ *\ 10^7\ b/s$
   t_{prop} = $(1 * 10^6) \div (2 * 10^8)$ = 0.005 sec
   t_{tran} = $16000\ \div (1\ *\ 10^7)\ =\ 0.0016\ sec$
   t_{total} = t_{prop} + t_{tran} = 0.0066 sec

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7. Now suppose instead of a single 1,000km link there are three 500km links connected by store-and-front routers. Assuming the propagation speed and transmission rate are the same as before what is the total delay for a 2000 B packet? The picture looks like this (S is the source, D is the destination, and R1 and R2 are the two routers.)
   S → R1 → R2 → D
   $t_{prop} = (5 * 10^5) \div (2 * 10^8)$ = 0.0025 sec
   $t_{tran} = 16000 \div (1 * 10^7) = 0.0016\, sec$

S	→	R1	→	R2	→	D
	Propagation		Propagation		Propagation	
	0.0025	+	0.0025	+	0.0025	+
		Transmission		Transmission		
		0.0016	+	0.0016		

   = 3(0.0025) + 2(0.0016) = 0.0107 sec

8. Now suppose a second source S2 sends to R1 over a separate link having the same speed as the S → R1 link. The packets from S2 are also destined for D. How will the delay change relative to question 7? Why? What assumption do you have to make to ensure that no packets are lost?
   By adding another packet to R1, a queueing delay affect whichever package gets there last since it will have to wait until the previous transmission is complete. To ensure no packages are lost, we must assume that the destination can be able to queue subsequent packages.