EE450 Introduction to Computer Networks - Fall 2019 - HW 2

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September 10, 2019

1 Reading Assignment:

Chapter 1

2 Problems to be solved:

2.1 Chapter 1, Page 69: R19 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 $R_1 = 500$ Kbps, $R_2 = 2$ Mbps, and $R_3 = 1$ Mbps.

2.1.1 Assuming no other traffic in the network, what is the throughput for the file transfer?

$$Throughput = \min(R_1, R_2, R_3) = 500 \text{ Kbps}. \tag{1}$$

2.1.2 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?

$$Time = \frac{4 \text{ million bytes} \times 8\text{bits}}{500 \text{ Kbps}} = 64\ s. \tag{2}$$

2.1.3 Repeat (a) and (b), but now with R2 reduced to 100 kbps.

$$Throughput^{'} = 100 \text{ Kbps}. \tag{3}$$

$$Time^{'} = \frac{4 \text{ million bytes} \times 8\text{bits}}{100 \text{ Kbps}} = 320\ s. \tag{4}$$

2.2 Chapter 1, Page 69: R23 What are the five layers in the Internet protocol stack? What are the principal responsibilities of each of these layers?

Top-down:

- Application Layer: supporting network applications
- Transport Layer: process-process data transfer
- Network Layer: routing of datagrams from source to destination
- Link Layer: data transfer between neighboring network elements
- Physical Layer: bits ”on the wire”

2.3 Chapter 1, Page 71: P5 Review the car-caravan analogy in Section 1.4. Assume a propagation speed of 100 km/hour.

2.3.1 Suppose the caravan travels 150 km, beginning in from one tollbooth, passing through a second tollbooth, and finishing just after a third tollbooth. What is the end-to-end delay?

The caravan is comprised of 10 cars. Each tollbooth are 75 km apart, cars' speed are 100 km/h, tollbooths service cars at a rate of one car per every 12 seconds.

Tollbooth operation time: 10×0.2=2 min.

Propagation time: $75/100$=0.75 h=45 min.

Total time: $2 \times 3 + 45 \times 2$=96 min.

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

Tollbooth operation time is now: 8×0.2=1.6 min.

Total time: 94.8 min

2.4 Chapter 1, Page 72: P10

Total end-to-end delay:

$$\frac{d_1}{s_1} + \frac{L}{R_1} + d_{proc} + \frac{d_2}{s_2} + \frac{L}{R_2} + d_{proc} + \frac{d_3}{s_3} + \frac{L}{R_3} = 2d_{proc} + \frac{d_1}{s_1} + \frac{d_2}{s_2} + \frac{d_3}{s_3} + L\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) \quad (5)$$

applying real values: Total delay = 64 msec.

2.5 Chapter 1, Page 75: P24 Suppose you would like to urgently deliver 40 terabytes data from Boston to Los Angeles. You have available a 100 Mbps dedicated link for data transfer. Would you prefer to transmit the data via this link or instead use FedEx overnight delivery? Explain.

40 Terabytes = $40 \times 10^{12} \times 8 = 3.2 \times 10^{14}$ bits. Total time will be $3.2 \times 10^{14}\, bits / 100\ Mbps = 3.2 \times 10^6$ s = 8.9×10^2 h=37 days.

But with FedEx, data can be guaranteed to be delivered in one day. So I choose FedEx.