Vidun Jayakody - Assignment 1

1. 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 $R_1 = 400Kbps$, $R_2 = 1.6Mbps$, and $R_3 = 800Kbps$

   (a) (5 points) Assuming no other traffic in the network, what is the throughput for the file transfer?

   The throughput would be the slowest of the three links, or $400Kbps$.

   (b) (5 points) Suppose the file is 5 million bytes (not bits). Dividing the file size by the through-put, roughly how long will it take to transfer the file to Host B?

   To convert 5 million bytes into bits we first multiply by 8 (since there are 8 bits in a byte):

$$5,000,000\ bytes \times 8\ bits = 40,000\ Kb$$

   To find the transfer time let's then divide this by the throughput:

$$\frac{40,000\ bits}{400\ Kbps} = 100 \text{ seconds}$$

   So a 5 million byte file would take about 100 seconds to transfer with a throughput of 400 $Kbps$.

   (c) (5 points) Repeat (a) and (b), but now with R2 reduced to 100 $Kbps$.

   This would just be replacing the denominator with 100 $Kbps$.

$$\frac{40,000\ bits}{100\ Kbps} = 400 \text{ seconds}$$

   So a 5 million byte file would take about 400 seconds to transfer with a throughput of 100 $Kbps$.

2. Review the car-caravan analogy in Section 1.4 of the textbook (Fig.1.17). Assume a propagation speed of 130 $km/hour$.

   (a) (5 points) Suppose the caravan travels 120km, beginning in front of one tollbooth, passing through a second tollbooth, and finishing just after a third tollbooth. What is the end-to-end delay?

   The end-to-end delay is the sum of the transmission delay and propagation delay. We know from the question that the transmission delay is:

$$\frac{10 \text{ cars}}{5 \text{ cars a minute}} = 2 \text{ minutes}$$

   Multiplied by the 2 links, this means that the total transmission delay is 4 minutes. Next we find the propogation delay, which is:

$$\frac{\text{distance}}{\text{speed}} = \frac{120\ km}{130\ km/hr} \approx 0.923 \text{ hours} \times\ 60 \text{ minutes/hour} \approx 55.38 \text{ minutes}$$

   This means the total end-to-end delay is:

$$\begin{aligned} d_{\text{end-to-end}} &= d_{\text{transmission}} + d_{\text{propagation}} \\ &= 4 \text{ minutes} + 55.38 \text{ minutes} \\ &= 59.38 \text{ minutes} \end{aligned}$$

   Note: This answer assumes that the caravan starts at the first tollbooth, gets serviced there, then passes through the second tollbooth, and is serviced again just after the third tollbooth. This is a reasonable assumption since the analogy mentions there is no other traffic (or network congestion) and so the second router should be able to immediately forward the packet.

   (b) (5 points) Repeat (a), now assuming that there are seven cars in the caravan instead of ten.

   We continue the same calculation as above, but with a packet length of 7 instead:

$$d_{\text{ transmission}} = 2 \cdot \frac{7 \text{ cars}}{5 \text{ cars a minute}} = 2.8 \text{ minutes}$$

   Our propagation delay remains the same. Our total end-to-end delay is then:

$$\begin{aligned} d_{\text{end-to-end}} &= d_{\text{transmission}} + d_{\text{propagation}} \\ &= 2.8 \text{ minutes} + 55.38 \text{ minutes} \\ &= 58.18 \text{ minutes} \end{aligned}$$