CS 118 - Homework 1

Jahan Kuruvilla Cherian UID: 104436427

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1 Problem 1

1a

To calculate the propagation delay, we take into account the propagation speed and the length of each link. Since the length of each link is the same at $3 \times 10^3 m$, along with the propagation speed at $2.5 \times 10^8 m/s$, the propagation speed for each link is the same, at

$$d_{prop} = \frac{distance}{speed} = \frac{3 \times 10^6}{2.5 \times 10^8} = 12msec$$

1b

The bandwidth-delay product calculates the amount of data we can pack in each pipe. Because $bandwidth - delay\ product = R \times d_{prop}$, we see that each link has its own bandwidth-delay product, as follows:

$$H_1 \to R_1 = 2 \times 10^6 \cdot 1.2 \times\ 10^{-2} = 24Kb$$

$$R_1 \to R_2 = 4 \times 10^6 \cdot 1.2 \times 10^{-2} = 48Kb$$

$$R_2 \to H_2 = 1 \times 10^6 \cdot 1.2 \times 10^{-2} = 12Kb$$

1c

We know that $d_{transmission} = L/R$ wherein we have to calculaye the packet length L in bits. Since 1 byte = 8 bits, each packet of 1500 bytes is 12×10^3 bits. Since we are also dependent on the transmission rates, we have the following tranmission times for each link:

$$H_1 \to R_1 = \frac{12 \times 10^3}{2 \times 10^6} = 6msec$$

$$R_1 \to R_2 = \frac{12 \times 10^3}{4 \times 10^6} = 3msec$$

$$R_2 \to H_2 = \frac{12 \times 10^3}{1 \times 10^6} = 12msec$$

1d

Let us consider each link individually. We notice that because for the first link, we have no form of delay or extra time, and thus for the first link we have the maximum number of bits as:

$$H_1 \to R_1 = 2 \times 10^6 \cdot 1.2 \times\ 10^{-2} = 24Kb$$

The trick comes in second link. Because we are going from a smaller bandwidth to a higher bandwidth, we now have a gap between each packet. We can calculate this by seeing the difference between when a start packet leaves R_1 and when an end packet reaches R_2. This is seen as $6 + 12 + 3 = 21ms$ for the first packet to leave R_1 and then $6 + 6 + 12 = 24ms$, with the difference being $3ms$. Thus we notice that because the transmisson time within this secondary link is $3ms$, and so with an additional gap of $3ms$, then we have basically have to divide our overall bandwidth-delay product by 2. This can also be seen by the fact that the length of the two links are the same, but the first link is half the bandwidth of the second link, which means that we can only fit half of the bandwidth-delay product in the secondary link.

$$R_1 \rightarrow R_2 = 4 \times 10^6 \cdot 1.2 \times 10^{-2} = 48 \div 2 \rightarrow 24Kb$$

As we will find out later, the tertiary link, there is a queueing delay because we have to wait for different packets, and this is obvious as we are going from a higher bandwidth to a lower bandwidth, and so the maximum we can hold in the last link is the bandwidth-delay product.

$$R_2 \rightarrow H_2 = 1 \times 10^6 \cdot 1.2 \times 10^{-2} = 12Kb$$

1e

So we notice that the time for the last bit of a packet to reach the end of link is the $d_{transmission} + d_{propagation}$, and that in order to see if we need to queue, we look at the difference in bandwidth between each link. We notice that between $H_1 \rightarrow R_1$ and $R_1 \rightarrow R_2$ the bandwidth difference is an increase. Thus we do not need to queue within the R_1 router, but because of this we have a gap of an additive factor of $3ms$ between each packet. Thus when we get to the final router R_2, we are jumping from a larger bandwidth to a lower bandwidth, that is from $4Mbps$ to $1Mbps$. Looking at primarily the first packet, we notice the following calculation for the time it takes for the last bit of the packet to leave R_2: $((6+12)+3)+(12+12) = 45ms$ and then for the secondary packet's last bit to enter R_2: $(6+6+12)+(3+12) = 39ms$. This leaves us with an additive difference of $6ms$ as a queueing delay for each packet. Thus we would have to account for a total of $(80 \cdot 6) - 6 = 474ms$ delay. Using the bandwidth in in the final link, we see that this equates to

$$474 \times 10^{-3} \cdot 1 \times 10^6 = 474Kb \rightarrow 59.25KB$$

This is the minimum buffer size. Another way of seeing this is applying the formula $(v_2 - v_1) \cdot (t_2 - t_1)$, wherein $v_2 - v_1$ is the difference in overall speed of the packets from the first 2/3 of the link to the final section of the link which in this case would be $2Mbps - 1Mbps$, and $t_2 - t_1$ is the difference between when the last bit of the first packet leaves R_2 and the last bit of the very last packet enters R_2 which is $79 \cdot 6$.

1f

We notice that we don't even need to take into account the queueing delay time because by the time we have the first packet leave R_2 to get to H_2 all packets will follow sequentially, and so we have the total time as

$$79 \cdot 12 + 45(time for first packet to leave) + 12(propagation of last packet) = 1005ms$$

for the total time from the start of the first bit from H_1 to the last bit to H_2.

2 Problem 2

2a

The URL for the requested file comes right after the method type in the GET response header, which in this case is **gaia.cs.ucla.edu/cs118/index.html**.

2b

The version of HTTP in this instance is **HTTP/1.1**.

2c

Noticing the Connection type as **Keep-Alive**, we notice that the browser is requesting a persistent connection. This is only possible because the browser is running HTTP/1.1.

2d

Looking at the User-Agent, we see that the browser that initiated the request was a **Netscape 7.2** browser running on Mozilla 5.0 on a Windows based machine.

3 Problem 3

1

HTTP status code **200 OK**. This means that the get request was suceeded and the requested object was later defined in the message.

2

HTTP status code **301 Moved Permanently**. This means the requested object was moved to a different location that is specified in the message later.

3

HTTP status code **404 Not Found**. This means that the requested object was not found on the server we tried to get from.

4

Leaving out the Host specifier results in a HTTP status code of **400 Bad Request** which means the GET request itself was not correctly established.