CS542 HW 5 **CWID: 20402686**

1. Answer below:

(1) How long does it take a packet of length 1,000 bytes to propagate over a link of distance 2,500 Km, propagation speed of guided medium, and transmission rate 2Mbps?

Transmission delay = L/R
Where, L = length of packet and R = transmission rate
Here, L = 1000 bytes = 8000 bits and R = 2Mbps
Transmission delay = L/R
= 8000 / (2 * $10^{6)}$
= 0.004 sec

Propagation delay = d/s
Where d = distance and s = speed of guided medium = 2 * 10^8 m/s = 2 * 10^5 km/s
Propagation delay = d/s
= 2500 / (2 * 10^5)
= 1250 * 10^{-5}
= 0.0125 sec

As we know, total delay = Transmission delay + Propagation delay
= 0.004 + 0.0125
= 0.0165 sec

Total delay = 16.5 milliseconds

(2) How long does it take a packet of length L to propagate over a link of distance D, propagation speed S, and transmission rate R bps?

Length of packet = L
Transmission rate = R

Transmission delay = Length of packet/ Transmission rate = /L/R

Distance = D
Propagation speed = S

Propagation delay = Distance / Propagation speed = D/S

Total delay = Transmission delay + Propagation delay
Total delay = (L/R) + (D/S)

(3) Does this delay depend on packet length?
Yes, total delay depends on packet length as transmission delay depends on packet length.

(4) Does this delay depend on transmission rate?
Yes, total delay depends on transmission rate as transmission delay depends on transmission rate.

2. **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 R1 = 500 kbps, R2 = 4 Mbps, and R3 = 2 Mbps.**

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

Here, R1 = 500 kbps, R2 = 4 Mbps, and R3 = 2 Mbps
Throughput = min (R1,R2,R3)
Hence **throughput = 500 kbps**

(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? (Do not count any overhead bytes such as layer headers at this time)

File size = 4 million bytes = $4 * 10^6$ = $32 * 10^6$ bits
Dividing the file size by the throughput, Time required for file transfer from A to B=
$(32 * 10^6) / (500 * 10^3)$ bits per seconds = **64 seconds**

(3) Repeat above 1 and 2, but now with R2 reduced to 100 kbps.

Now R2 = 100kbps
Hence, **throughput = min (500kbps, 100kbps, 2Mbps) = 100kbps**

Time required for file transfer from A to B = $(32 * 10^6) / (100 * 10^3)$ bits per seconds
Time required for file transfer from A to B = 320 seconds

3. **Review the car-caravan analogy in textbook Section 1.4 or lecture 1 slide 68 and related slides. Assume a propagation speed of 100 km/hour.**

(1) Suppose the caravan travels 150 km, beginning in front of one tollbooth, passing through a second tollbooth, and finishing just after a third toll-booth. What is the end-to-end delay?

Total distance = 150km
Propagation speed = 100 km/h
Total cars in caravan = 10
Transmission time for each car = 12seconds
Transmission time for all 10 cars = 2 minutes

Travelling time = 150km /100 km per hour
= 1.5 hours
= 90 minutes

For 2 tollbooths, total processing time for all cars = 4 minutes

Total end-to-end delay = Travelling time + Transmission time
Total end-to-end delay = 90 + 4
Total end-to-end delay = 94 minutes

(2) Repeat (1), now assuming that there are eight cars in the caravan instead of ten.

As there are only 8 cars in the caravan,

Transmission time for single tollbooth = 8 * 12 seconds = 96 seconds

Hence, Transmission time for 2 tollbooths = 96 * 2 = 192 seconds

Transmission time for 2 tollbooths = 3 minutes 12 seconds

Total end-to-end delay = Travelling time + Transmission time
Total end-to-end delay = 90 minutes + (3 minutes 12 seconds)
Total end-to-end delay = 93 minutes 12 seconds

4. **This problem begins to explore propagation delay and transmission delay, two central concepts in data networking. 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.**

(1) Express the propagation delay, dprop, in terms of m and s.
Propagation delay = Distance / Speed
D_{prop} = m/s seconds

(2) Determine the transmission time of the packet, dtrans, in terms of L and R.
Transmission rate = Length of packet / transmission rate
D_{trans} = L/R seconds

(3) Ignoring processing and queueing delays, obtain an expression for the end-to-end delay.
End-to-end delay = (m/s) + (L/R) seconds

(4) Suppose Host A begins to transmit the packet at time t = 0. At time t = dtrans where is the last bit of the packet?
Last bit of packet would be just leaving the Host A.

(5) Suppose dprop is greater than dtrans. At time t = dtrans, where is the first bit of the packet?

First bit of packet would be on the link to the host B but not at host B.

(6) Suppose dprop is less than dtrans. At time t = dtrans, where is the first bit of the packet?

First bit of packet would be at Host B.

(7) Suppose s= speed of guided medium, L = 120 bits, and R = 56 kbps. Find the distance m so that dprop = dtrans.

L = 120 bits
Speed of guided medium = $2 * 10^8$ m/s
R = 56kbps
$d_{trans} = d_{prop}$ …………..(transmission delay = propagation delay)
therefore, L/R = m/s
m = L/R * s
= $(120/ 56 * 10^3) * 2 * 10^8$ meters
= $4.2857 * 10^5$ meters
m = 428.57 km = $4.2857 * 10^5$ meters

5. **We assume a VOIP over packet switched network problem. Host A converts analog voice to a digital 64 kbps bit stream on the fly. Host A then groups the bits into 56 byte packets. There is one link between Host A and B; its transmission rate is 2 Mbps and its propagation delay is 10 msec. As soon as Host A gathers a packet, it sends it to Host B. As soon as Host B receives an entire packet, it converts the packet's bits to an analog signal. How much time elapses from the time a bit is created (from the original analog signal at Host A) until the bit is decoded (as part of the analog signal at Host B)? Do not consider any overhead bytes of the layer headers and processing delay of analog to digital, digital to analog.**

Transmission rate = 2Mbps

Propagation delay = 10milliseconds

Conversion rate = 64kbps

Number of bytes = 56 = 448 bits

Conversion time = Number of bits / conversion rate

= $448 / 64 * 10^3$ seconds

Conversion time = 7 milliseconds

Transmission delay = Number of bits (L) / transmission rate (R)

= $56 *8 / 2 *10^6$ seconds

Transmission delay = 0.224 milliseconds

Propagation delay = 10 milliseconds

Total time elapsed = Conversion time + Transmission delay + Propagation delay

= 7 + 0.224 + 10

Total time elapsed = 17.224 milliseconds