1. How long does it take a packet of length 1000 bytes to propagate over a link of distance 2,500 km, propagation speed 2.5x10^8 m/s, and transmission rate 2 Mbps? More generally, 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? Does this delay depend on packet length? Does this delay depend on transmission rate?

   Answer: t_{prop} = d/s = $2500x10^3/(2.5x10^8)$ = 10.00 msec; no; no

2. Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has 3 links, of rates R1 = 500 kbps, R2 = 2 Mbps and R3 = 1 Mbps.

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

      Answer: The min throughput available = 500 kbps

   b) 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?

      Answer: File size/throughput = $4x10^6x8 / (500x10^3)$ = 64 s

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

      Answer: 100kbps; 320 seconds

3. Review the car-caravan analogy in Section 1.4. Assume a propagation speed of 100 km/hour.

a. Suppose the caravan travels 150 km, 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?

ans: total distance = 150 kms

speed = 100 km/hr

hence, total propagation delay = 150/100 = 1.5 hrs

time taken by each toll booth to service a single car = 12 sec

therefore, time taken to service 10 cars = 120 sec or 2 min

time taken by three toll booth to service 10 cars = 6 min

end-to-end delay = 1.5 hrs + 6 min = 1 hr 36 min

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

answer : total transmission delay = 150/100 = 1.5 hrs

time taken by each toll booth to service a single car = 12 sec

time taken to service 8 cars = 8 x 12 = 96 sec

time taken by three toll booth to service 8 cars = 3 x 96 = 288 sec

end-to-end delay = 1.5 hrs + 4 min 48 sec

so, for end to end delay for 8 cars = 1 hr 34 min 48 sec

Question 4

Suppose two hosts, A and B, are separated by 20,000 kilometres and are connected by a direct link of R = 2 Mbps. Suppose the propagation speed over the link is 2.5 108 meters/sec.

a. Calculate the bandwidth-delay product, R d(prop).

ans: Propagation delay = Distance/speed = 2 x 10^7 / 2.5 x 10^8 = 0.08 sec

Transmission rate = 2 Mbps

So, bandwidth delay product = R x dprop = 2 x 10^6 x .08 = 16 x 10^4 bits

b. Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?

ans:

If the file is sent continuously as one message, a link can have the maximum number of bit at the same as band width delay product.
So the maximum number of bits at a given time will be 16 x 10^4 bits

c. What is the width (in meters) of a bit in the link? Is it longer than a football field?

ans:

The width of each bit is the length of the link divided by the number of bits it can carry,

20000km= $2x10^7$ meter

So, length of 1 bit is= $(2x10^7)$ / (16 x 10^4 bits)=125 meter

e. Derive a general expression for the width of a bit in terms of the propagation

speed s, the transmission rate R, and the length of the link m .

ans: the width of a bit is related with the propagation speed per bandwidth

than general expression for the width of bit is = s/R