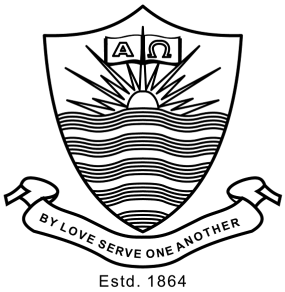

FORMAN CHRISTIAN COLLEGE

(A CHARTERED UNIVERSITY)

Problem Set # 1

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Course: COMP 311 – Computer Networks

Section: B

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1. How long does it take a packet of length 15,000 bytes to propagate over a link of distance 1,200 km, propagation speed 3×10^8 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 the transmission rate?

Ans.
L= 15000 bytes × 8 = 120,000 bits
R = 2 Mbps × 1×10^6 = 2×10^6 bps

Transmission delay: $\frac{L}{R} = \frac{120{,}000\ bits}{2\times10^6\ bps} = 0.06$ sec

0.06 sec × 1000 = 60 ms

d = 1200 km

s = $\frac{3\times10^8\ m/s}{1000} = 3\times10^5$ km/s

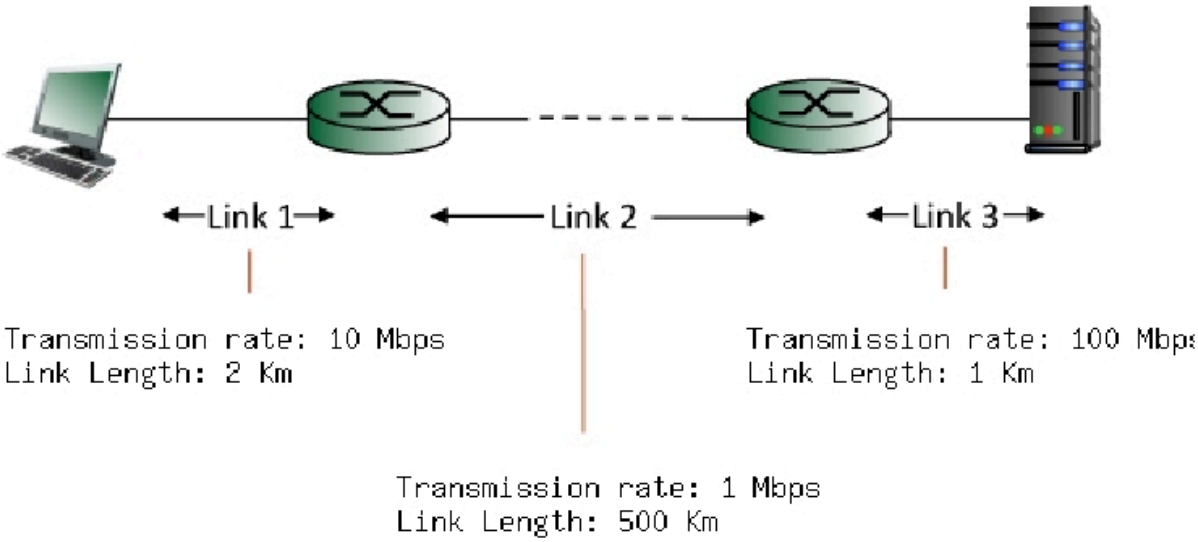
Propagation delay: $\frac{d}{s} = \frac{1200\ km}{3\times10^5\ km/s} = 4\times10^{-3}$ sec

4×10^{-3} sec × 1000 = 4ms

Total delay: $d_{trans} + d_{prop}$ = 4ms + 60ms = 64ms

Therefore, the total delay depends on the packet length and the transmission rate. The total delay is the sum of the propagation and transmission delays. The propagation delay does not depend on the packet length or the transmission rate, but the transmission delay does. Therefore, the longer the packet or the lower the transmission rate, the higher the transmission delay and the total delay.

Q. Consider the figure below, with three links, each with the specified transmission rate and link length.



Find the end-to-end delay (including the transmission delays and propagation delays on each of the three links, but ignoring queueing delays and processing delays) from when the left host begins transmitting the first bit of a packet to the time when the last bit of that packet is received at the server at the right. The speed of light propagation delay on each link is $2.5x10^8$ m/sec. Note that the transmission rates are in Mbps and the link distances are in Km. Assume a packet length of 12,000 bits. Give your answer in milliseconds.

Ans:

s = $\frac{2.5\times10^8\ m/s}{1000}$ = 250000 km/s

L = 12000 bits

Link1:

R = 10 Mbps × 1×10^6 = 1×10^7 bps

d_{trans}: $\frac{L}{R} = \frac{12000\ bits}{1\times10^7\ bps}$ = 1.2×10^{-3} sec = 1.2ms

d_{prop}: $\frac{d}{s} = \frac{2\ km}{250000\ km/s}$ = 8×10^{-6} sec = 8×10^{-3} ms

Link2:

R = 1 Mbps × 1×10^6 = 1×10^6 bps

d_{trans}: $\frac{L}{R} = \frac{12000\ bits}{1\times10^6\ bps}$ = 0.012 sec = 12ms

d_{prop}: $\frac{d}{s} = \frac{500\ km}{250000\ km/s}$ = 2×10^{-3} sec = 2 ms

Link3:

R = 100 Mbps × 1×10^6 = 1×10^8 bps

d_{trans}: $\frac{L}{R} = \frac{12000\ bits}{1\times10^8\ bps}$ = 1.2×10^{-4} sec = 0.12ms

d_{prop}: $\frac{d}{s} = \frac{1\ km}{250000\ km/s}$ = 4×10^{-6} sec = 4×10^{-3} ms

End-to-end delay including transmission delays and propagation delays on each of the three links

= 1.2 + 8×10^{-3} + 12 + 2 + 0.12 + 4×10^{-3} = 15.332 ms