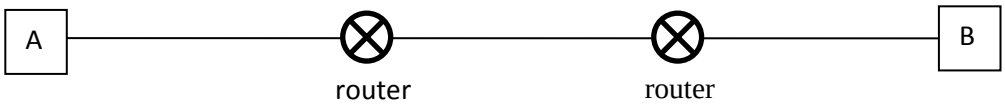
IS 504 – Exercise 1

1. Consider the following network. Assume that:
   - Length of each link is x meters,
   - Data transfer rate on each link is r bits/sec,
   - Signal propagation speed in the medium is c meters/sec,
   - Each packet consists of m bit data and h bit header,
   - Processing and queuing delays are negligible,
   - Links are reliable (no loss, no corruption) and reliable data transfer protocol is not needed/used.
   - No other traffic is present in the network.



   a. Suppose n packets will be sent by A to B and transmission will start at time 0. When will all packets be delivered to B? (derive a formula in terms of n, x, r, c, m, h)
   b. Assume that h=25 bytes, x=1000 km, c=$2*10^8$ m/sec, r=1Mbps ($1*10^6$ bits/sec) and a 1 Mbyte ($1*10^6$ byte) message is to be transferred from A to B. How long does it take to deliver entire file to B when
      i. m=1 Mbytes (i.e. the message is transferred in a single packet)?
      ii. m=250 Kbytes?
      iii. m=25 bytes?

Solution

1-a)

Propagation delay on each link = $d_{prop} = \frac{x}{c}$

Packet length = $L = h + m$

Packet transmission delay = $d_{trans} = \frac{L}{r} = \frac{h+m}{r}$

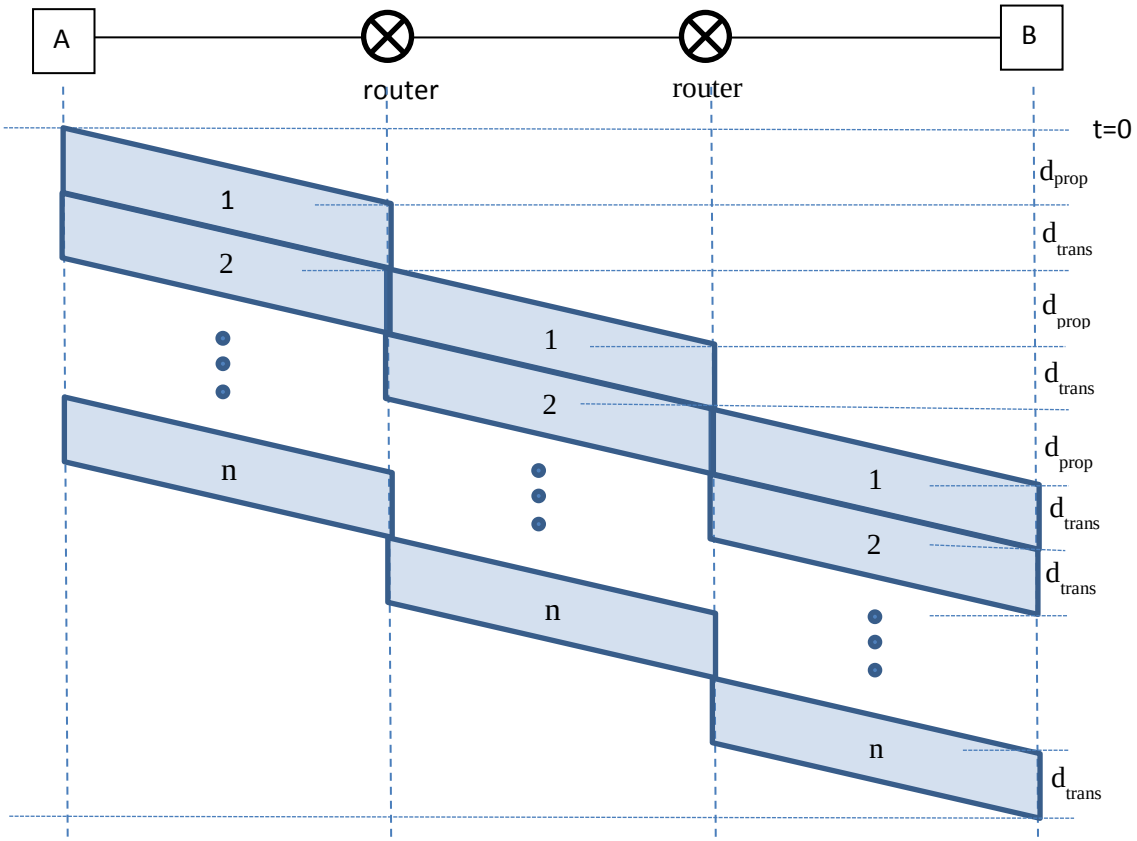
As it can be shown from the following time-space diagram the packets will be delivered to B at:

$$d = d_{prop} + d_{trans} + d_{prop} + d_{trans} + d_{prop} + n * d_{trans}$$

By rearranging the terms:

$$d = 3 * d_{prop} + (n + 2) * d_{trans}$$

$$d = 3 * \frac{x}{c} + (n + 2) * \frac{h + m}{r}$$



1-b-i)

m=1000000 bytes = 1000000*8 bits = $8*10^6$ bits

h = 25 bytes = 25 * 8 bits = 200 bits

x = 1000 km = $1 * 10^6$ m

r = 1 Mbps = $1 * 10^6$ bits/sec

n = $1 * 10^6$ byte/1000000 bytes = 1 packet

Therefore total delay can be found as:

$$d = 3 * \frac{1 * 10^6}{2 * 10^8} + (1 + 2) * \frac{200 + 8 * 10^6}{1 * 10^6} = 24.0156\ sec$$

1-b-ii)

m=250000 bytes = 250000*8 bits = $2*10^6$ bits

h = 25 bytes = 25 * 8 bits = 200 bits

x = 1000 km = $1 * 10^6$ m

r = 1 Mbps = $1 * 10^6$ bits/sec

n = $1 * 10^6$ byte/250000 bytes = 4 packets

Therefore total delay can be found as:

$$d = 3 * \frac{1 * 10^6}{2 * 10^8} + (4 + 2) * \frac{200 + 2 * 10^6}{1 * 10^6} = 12.0162\ sec$$

1-b-iii)

m=25 bytes = 25*8 bits = 200 bits

h = 25 bytes = 25 * 8 bits = 200 bits

x = 1000 km = $1 * 10^6$ m

r = 1 Mbps = $1 * 10^6$ bits/sec

n = $1 * 10^6$ byte/25 bytes = $4 * 10^4$ packets

Therefore total delay can be found as:

$$d = 3 * \frac{1 * 10^6}{2 * 10^8} + (4 * 10^4 + 2) * \frac{200 + 200}{1 * 10^6} = 16.0158\ sec$$