1. Compute the total time required to transfer a file of 2.5 MB assuming RTT of 55ms and the packet size is 2KB and an initial delay of one RTT of handshaking before the data is sent on the line. If the link bandwidth is 20Mbps, and after sending every data packet we have wait one RTT before sending the next, compute the total time taken to transfer the complete file.

   Ans. wait one RTT before sending the next:

   Initial Handshaking = 1 * R.T.T. = 1*55 ms = 55 ms

   Inter packet gap = 1 R.T.T. = 55 ms

   Total number of packets= 2.5MB/2KB=1250 PACKETS

   time to send 1 packet is 2KB / 20 Mbps = 0.8 ms

   Total Time = **T Initial Handshaking time +1250 packets T.T.+ 1249 * R.T.T. (waiting time)**

   = 55+1250*0.8 + 1249*55 =55+125+68695=69750 **ms** =69.75sec

2. Calculate the bandwidth*delay product for the following links. Use one-way delay, measured from first bit sent to first bit received.

   a.100Mbps Ethernet with a delay of 10µsec.

   b.10MbpsEthernet with a single store-and-forward switch in the path, and packet size of 50000 bits. Assume that each link introduces a propagation delay of 10 µsec and each switch is retransmitting immediately after it has finished receiving the packet.

   c.2 Mbps T1 link, with a transcontinental on-way delay of 50ms.

   Ans. a. The b x w product is 100 x 10^6 bits/sec x 10 x 10^-6 secs = 1000 bits = 125 bytes

   b. The first-bit delay is 5020 microsecs through the store-and-forward switch. The bandwidth x delay product is thus 10 Mbps x 5020 microsecs = 50200 bits (Alternatively, you can think of it as each link can hold 100 bits and the switch can hold 50000 bits.)

   c. 2 x 10^6 bits/sec x 50 x 10^-3 sec = 1,00,000 bits = 12500 bytes

3. What is the total delay (Latency) for a frame of size 5million bits that is being on the sent on a link with 10 routers each having a queuing time of 2 µsec and a processing time of 1µsec. The link has a bandwidth of 5Mbps. Which component if the total delay is dominant? Which one is negligible? Assume The length of the link is 2000 Km. The speed of light inside the link is 2 x 10^8 m/s

Ans. Propagation time = distance / propagation speed= 2000 Km / 2 x 10^8 m/s = 10 ms

Transmission time = Message size / Bandwidth = 5 x 10^6 bits/ 5 Mbps = 1 s

Queuing time = 10 routers * 2 us = 20 us

Processing Delay = 10 routers * 1 us = 10 us

Total delay (latency) = 10 ms + 1 s + 20 us + 10 us= 1010.03 ms = 1.01003 s / 1 s

4. Compute two-dimensional parity for the given data word 1100 1111 0110 0011 1110 0001 0011 01101000 (four bits at a time) using even parity. Introduce error in two different bit positions and correct the errors.

Ans.

1100	0
1111	0
0110	0
0011	0
1110	1
0001	1
0011	0
0110	0
1000	1
0100	1

Introduce error in two different bit positions and repeat the same process.

Note: two-dimensional parity catches all 2-bit errors. If the 2 bits that have been altered are not in the same column, then the column parity bits will be incorrect, and if they are not in the same row, the row parity bits will be incorrect. Two positions cannot simultaneously be in the same row and same column; hence the error can be detected.

5. A network with pure ALOHA transmits 250 bits per frame on a shared channel of 500 kbps. Compute the time required to make the transmission collision free?

Ans. Average Frame Transmission time T_{fr} is 250 bits/500 kbps or 0.5 ms.

The vulnerable time is 2 X 0.5ms= 1ms.

This means no station should send later than 0.5 ms before this station starts transmission and no station should start sending during the one 0.5- ms period that this station is sending.

6. Compute total time delay for transmitting a file of 5MB file on link in 50Mbps line of length of 12000km where the signal travel with a velocity of 2.8*10^8 m/sec.

   Ans. Propagation time= 12000 x 1000/2.4x10^8 = 50ms

   Transmission time= 5MX8 bits /50Mbs=0.8sec

   Total time= Propagation time+ Transmission time=50ms+800ms=850ms

7. Consider the message sender wants to send is1010001101, and the generator polynomial is x^5+x^4+x^2+1. Find the message transmitted by the sender. If the receiver receives the message, check if the receiver receives the correct message or not.

   Ans.

8. An image of 1024*768 pixels with 3bytes/pixel. Assume the image is uncompressed. How long does it take to transmit it over a 56kbps modem channel? Over a 1-Mbps cable modem? Over a 10Mbps ethernet? over 100Mbps ethernet

   Ans. The image is 1024*768*3 bytes or 2,359,296 bytes. This is 18,874,368 bits.

   At 56,000 bits/sec, it takes about 337.042 sec.

   At 1,000,000 bits/sec, it takes about 18.874 sec.

   At 10,000,000 bits/sec, it takes about 1.887 sec.

   At 100,000,000 bits/sec, it takes about 0.01887 sec.

9. Consider a source computer S transmitting a file of size 10^6 bits to a destination computer D over a network of two routers R1 and R2 and three links L1, L2 and L3. L1 connects between S and R1; L2 connects R1 and R2, and L3 connects R2 and D. Let length of each link be 100Km and signal travels at a speed of 10^8m/sec. If the file broken into 1000 packets each of size 1000bits. Find the total sum of transmission and propagation delays in transmitting the file form S to D. Assume the bandwidth of the channel is 1Mbps.

   Ans.

Data:

Number of packets = n =1000

Size of each Packet = L = 1000 bits

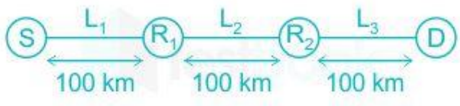
The link bandwidth on each link is = BW = 1Mbps =10^6 bits/s

Each link be of length = d= 100 km

Signals travel over each link at a speed = v= 10^8m/s

Transmission delay = T

Propagation delay = P



Formula:

$T = \frac{L}{BW}$

$P = \frac{d}{v}$

Propagation delay to travel from S to R1 (P) = (Distance) / (Link Speed) = 10^5/10^8 = 1ms

Total prorogation delay to travel from S to D = 3*1 ms = 3ms

Total Transmission delay for 3 packets (T) = 3 * (Number of Bits) / Bandwidth = 3*(1000/10^6) = 3ms.

So, the total time taken to transmit the first packet from source to destination is P+T= 3+3 ms=6ms

The first packet will take 6ms to reach D.

While first packet was reaching D, other packets must have been processing in parallel. So, D will receive remaining packets 1 packet per 1 ms from R2. So, remaining 999 packets will take 999 ms. And total time will be 999 + 6 = 1005 ms

10. Calculate the latency (from first bit sent to last bit received) for the following: (a) 10-Mbps Ethernet with a single store-and-forward switch in the path, and a packet size of 5000 bits. Assume that each link introduces a propagation delay of 10 μs and that the switch begins retransmitting immediately after it has finished receiving the packet. (b) Same as (a) but with three switches.

Ans. a) transmission time=5000/10*10^6= 500 us

packet reaches at switch=500+10=510us

then from switch to destination=510us

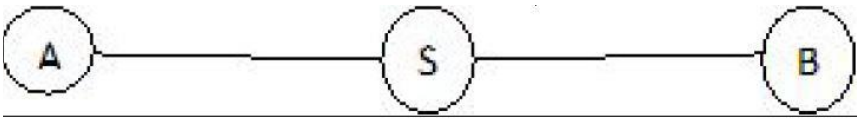
so total latency=1020us

b) for 3 switches =510*4=2040 us (as packet must go over 4 links)

11. Suppose the following block of 32 bits is to be sent using checksum 8 bits 11100101011010111000111101011011 and check your answer for the receiver receives 11100101111010111000111101011011.

    Ans.

12. Hosts A and B are each connected to a switch S via 10-Mbps links as in shown in figure below. The propagation delay on each link is 20 μs. S is a store-and forward device; it begins retransmitting a received packet 35 μs after it has finished receiving it. Calculate the total time required to transmit 10,000 bits from A to B. (a) as a single packet (b) as two 5000-bit packets sent one right after the other b) Illustrate networking devices?



Ans. (i) Given t_{prop} = 20 microseconds. We compute t_{trans} =10000/10*10^6 = 1000 microseconds.

The packet reaches the switch at t_{trans} + t_{prop} = 1020 micro sec.

The packet is retransmitted after 35 microseconds.

After 1055 micro sec., the packet starts transmitting from the switch.

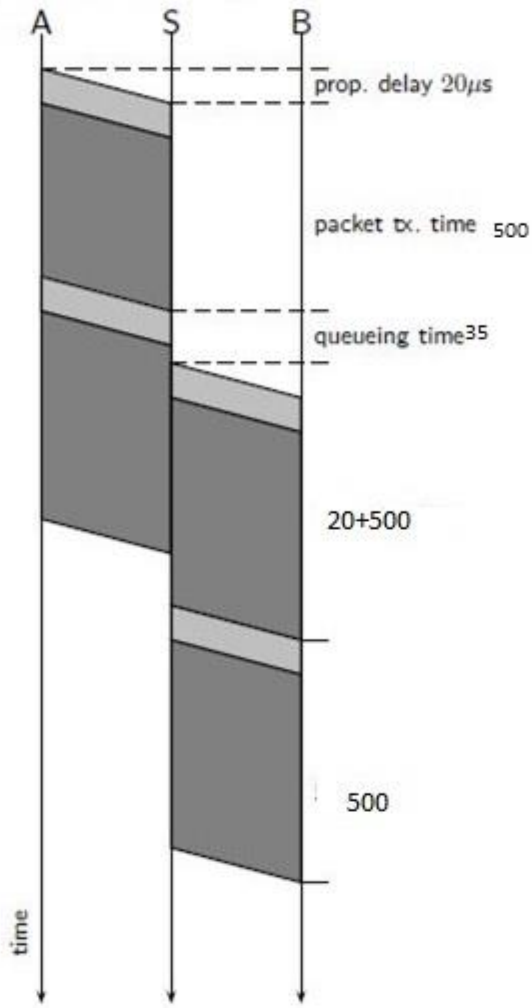
The packet reaches B after 1055 micro sec + t_{trans} + t_{prop} = 1055 + 1000 + 20 = 2075 micro sec.

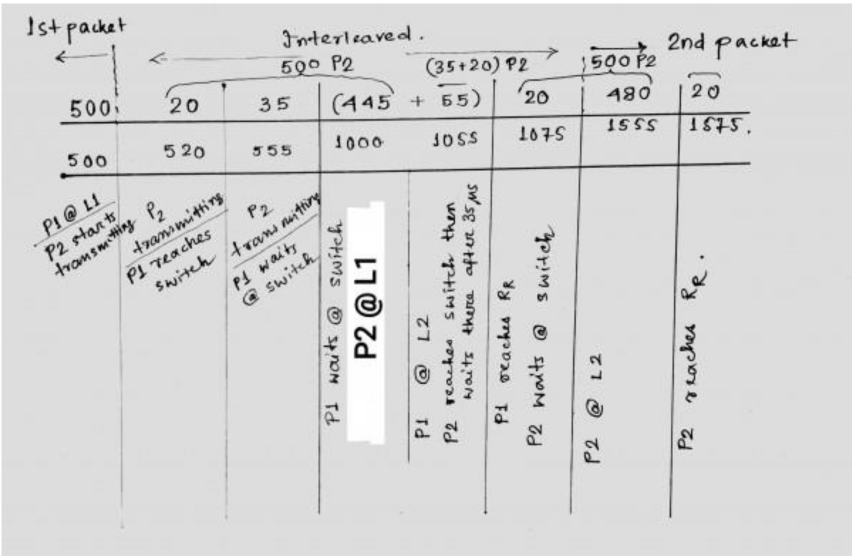
(ii) We compute t_{trans} = 5000/10*10^6 = 500 micro sec.

The First packet reaches the switch in 520 micro sec. After 35 micro sec. of switch delay, the switch retransmits packet 1 which reaches B at 520 + 35 + 520 = 1075 micro sec.

Immediately after the transmission of the first packet, A sends the second packet which reaches the switch at 520 micro sec. After 520 micro sec, the switch can start receiving the second packet and at 520+500=1020 micro sec, second frame is completely received by the switch (we don't need to add propagation time here as packet 2 can just follow packet 1).

So, at 1055 micro sec from the start the switch starts sending the second packet and this will be received at destination after another 520 micro sec (1055+520) that is 1575 micro sec. Since we added transmission time, this ensures that the last bit of data is received at the sender. Therefore, at 1055 + 520 = 1575 micro sec., Packet 2 is received at B. The transmission is complete at 1575 micro sec.


A
S
B
prop. delay 20μs
packet tx. time 500
queueing time35
20+500
500
time


1st packet
Interleaved.
500 P2
(35+20) P2
500 P2
2nd packet
500
20
35
(445 + 55)
20
480
20
500
520
555
1000
1055
1075
1555
1575.
P1 @ L1
P2 starts transmitting
P2 transmitting
P1 reaches switch
P2 transmitting
P1 waits @ switch
P1 waits @ switch
P2 @ L1
P1 @ L2
P2 reaches switch then waits there after 35μs
P1 reaches RR
P2 waits @ switch
P2 @ L2
P2 reaches RR.

General definitions

Latency (Delay)

- The latency or delay defines how long it takes for an entire message to completely arrive at the destination from the time the first bit is sent out from the source.
- Latency = propagation time +transmission time +queuing time + processing delay
- Propagation Time
  - The time required for a bit to travel from the source to the destination.

    Propagation time = Distance/Propagation speed
- The propagation speed of electromagnetic signals depends on the medium and on the frequency of the signal. For example, in a vacuum, light is propagated with a speed of 3 × 108 m/s. It is lower in air; it is much lower in cable.