Propagation & Transmission Delay

Propagation & Transmission delay

- **Propagation speed** - speed at which a bit travels though the medium from source to destination.
- **Transmission speed** - the speed at which all the bits in a message arrive at the destination. (difference in arrival time of first and last bit)

Propagation and Transmission Delay

- Propagation Delay = Distance/Propagation speed
- Transmission Delay = Message size/bandwidth bps
- **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.
- We can say that latency is made of four components: ***propagation time, transmission time, queuing time*** and ***processing delay***.
- Latency = Propagation delay + Transmission delay + Queueing time + Processing time

Example 1

What are the propagation time and the transmission time for a 2.5-kbyte message (an e-mail) if the bandwidth of the network is 1 Gbps? Assume that the distance between the sender and the receiver is 12,000 km and that light travels at 2.4 × 108 m/s.

Solution

We can calculate the propagation and transmission time as shown on the next slide:

Example 1 (continued)

$$\text{Propagation time} = \frac{12{,}000 \times 1000}{2.4 \times 10^8} = 50 \text{ ms}$$

$$\text{Transmission time} = \frac{2500 \times 8}{10^9} = 0.020 \text{ ms}$$

Note that in this case, because the message is short and the bandwidth is high, the dominant factor is the propagation time, not the transmission time. The transmission time can be ignored.

Example 2

What are the propagation time and the transmission time for a 5-Mbyte message (an image) if the bandwidth of the network is 1 Mbps? Assume that the distance between the sender and the receiver is 12,000 km and that light travels at 2.4×10^8 m/s.

Solution

We can calculate the propagation and transmission times as shown on the next slide.

Example 2 (continued)

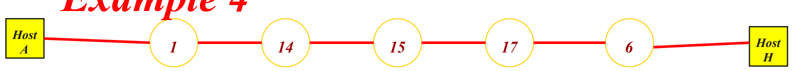
$$\text{Propagation time} = \frac{12{,}000 \times 1000}{2.4 \times 10^8} = 50 \text{ ms}$$

$$\text{Transmission time} = \frac{5{,}000{,}000 \times 8}{10^6} = 40 \text{ s}$$

Note that in this case, because the message is very long and the bandwidth is not very high, the dominant factor is the transmission time, not the propagation time. The propagation time can be ignored.

4.7

Example 4



1. What is the end-to-end packet latency in this store-and-forward subnet from router 1 to router 6 ?

Assume: All links: 2.5 km; C = 100Mbps; propagation speed = 200m/microsec.

queuing delay = processing delay =0; packet size = 1000 bytes

Solution:

end-to-end packet delay = 4 (equal hops) x link delay

link delay = PROC +QD + TRANS + PROP = 0 + 0 + transmission time + propagation delay

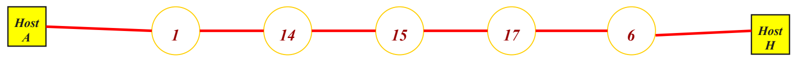
$$\text{transmission time} = \frac{1000 \text{ bytes}}{100 \text{ Mbps}} = \frac{8 \times 10^3 \text{ bits}}{10^8 \text{ bps}} = 8 \times 10^{-5} = 80 \text{ microseconds.}$$

$$\text{prop delay} = \frac{2500 \text{ m}}{200 \text{ m/ microsec}} = 12.5 \text{ microseconds}$$

link delay = 92.5 microseconds

end-to-end subnet delay = 4 x 92.5 = 370 microseconds

8



2. What is the end-to-end packet delay in this store-and-forward subnet from router 1 to router 6 under the scenario that when a packet from router 1 arrives at router 15 there are three packets enqueued for the link to router 17?

Assume: All links: 2.5 km; C = 100Mbps; propagation speed = 200m/microsec.

processing delay =0; all packet sizes = 1000 bytes

Implied Assumption: queues at 1, 14, and 17 are empty when the packet arrives at node 15.

Required Insight: there will be no queuing delay at 17 even if all three queued packets are going to 6.

Solution:

end-to-end packet delay = 4 (equal hops) x link delay + queuing delay at node 15.

link delay = PROC +QD + TRANS + PROP = 0 + 0 + transmission time + propagation delay

transmission time $= \dfrac{1000 \text{ bytes}}{100 \text{ Mbps}} = \dfrac{8 \times 10^3 \text{ bits}}{10^8 \text{ bps}} = 8 \times 10^{-5}$ = 80 microseconds.

prop delay $= \dfrac{2500 \text{ m}}{200 \text{ m/ microsec}}$ = 12.5 microseconds

link delay = 92.5 microseconds

queueing delay at node 15 = 3 packets * transmission time = 3* 80 microseconds = 240 microseconds

end-to-end subnet delay = 4 x 92.5 + 240 = 610 microseconds

9

Example 6

We are sending a 30 Mbit MP3 file from a source host to a destination host. All links in the path between source and destination have a transmission rate of 10 Mbps. Assume that the propagation speed is $2 * 10^8$ meters/sec, and the distance of the each link is 10,000 km. the processing time of the router is 0.01 sec

a) Suppose there is only one link between source and destination. Find the latency?

b)Suppose there is three links between source and destination. The router is found between each two links Find the latency?

Sol:

a) a) To find the latency for a single link between the source and destination, we can calculate the time it takes for a packet to travel from the source to the destination without considering any processing or queuing delays.

Latency = Transmission delay + Propagation delay

To convert Mbps (megabits per second) to bps (bits per second), you can use the following conversion:

1 Mbps = 1,000,000 bps

Therefore, to convert 10 Mbps to bps:

10 Mbps * 1,000,000 bps/Mbps = 10,000,000 bps

So, 10 Mbps is equal to 10,000,000 bps.

$$=30 * 10^6/10^7 + 10^7/(2 * 10^8) = 0.05 \text{ sec}$$

b)Latency = 3*Transmission delay +3*Propagation delay + 2* Processing time (waiting time)

$$=3*(30 * 10^6/10^7)+ 3*(10^7 /(2 * 10^8))+2*0.01=3*4.05+2*0.01=9.17$$

CLASS EXERCISE

A data packet of 1000 bits is being transmitted over a network with a transmission rate of 1 Mbps. Calculate the transmission delay.

. If a signal travels through a medium at a speed of 2.5 x 10^8 meters per second and the distance between sender and receiver is 500 meters, calculate the propagation delay.

If the transmission rate of a network is 10 Mbps and the length of a packet is 2000 bits, calculate the transmission delay.

How long does it take a packet of length 1,500 bytes to propagate over a link of distance 500 km, propagation speed $2.5\text{x}10^8$ m/s, and transmission rate 2 Mbps?

1. A data packet of 1000 bits is being transmitted over a network with a transmission rate of 1 Mbps. Calculate the transmission delay.

Solution:

Transmission delay (Dtrans) can be calculated using the formula:

Dtrans =L/R

where =L is the length of the packet in bits and R is the transmission rate in bits per second.

Given: L=1000 bits, R=1 Mbps = 1×106 bits per second Dtrans $=1000/1\times10^{6}$ = 0.001 seconds

So, the transmission delay is 0.001 seconds.1.

2. If a signal travels through a medium at a speed of 2.5 x 10^8 meters per second and the distance between sender and receiver is 500 meters, calculate the propagation delay.

Solution:

Propagation delay (Dprop) can be calculated using the formula:

Dprop=S/D, where =D is the distance and S is the speed of the signal propagation medium. Given: =500 meters, S=2.5×108S=2.5×10^{8} meters per second Dprop=500/2.5×108=2×10−6 seconds So, the propagation delay is 2×10−62×10−6 seconds.

3. If the transmission rate of a network is 10 Mbps and the length of a packet is 2000 bits, calculate the transmission delay.

Solution:

Transmission delay (Dtrans) can be calculated using the formula: Dtrans=RL.

Given: L=2000 bits, R=10 Mbps = 10×10^{6} bits per second Dtrans=2000/10×10^{6}=0.0002 seconds

So, the transmission delay is 0.0002 seconds.

4. How long does it take a packet of length 1,500 bytes to propagate over a link of distance 500 km, propagation speed $2.5\text{x}10^{8}$ m/s, and transmission rate 2 Mbps?

Solution

Transmission delay (Dtrans) can be calculated using the formula: Dtrans =RL. Given: L=800 bits, R=100 Kbps = 100×10^{3} bits per second Dtrans=800/100×10^{3} = 0.008 seconds

So, the transmission delay is 0.008 seconds.