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6 This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits toHost B

a. Express the propagation delay, d , in terms of m and s.

dprop= m/s

b. Determine the transmission time of the packet, d , in terms of L and R.

dtrans=L/R

c. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.

End To End Delay = m/s + L/R

d. Suppose Host A begins to transmit the packet at time T=0 . At time dtrans ,where is the last bit of the packet?

It's in the transmission medium aka communication link and has left the host A and entered the transmission medium aka link

e.) Suppose d is greater than d . At time , where is the first bit of the packet?

It will still be in the transmission medium since it takes more time to propagate it than the time it takes for Host A to push bits onto the medium so it will still be in transit

f. Suppose d is less than d . At time , where is the first bit of the packet?

It will be towards the host B since it takes a shorter time to travel across the the transmission medium so by the time the last bits are being transmitted the first one would have reached already due to high speed.

g)Suppose and Find the distance m so that d equals m so that d equals

s=2.5.108,

L=120

R=56kbps

dtrans=L/R

dtrans = 120/56*10^3

m=120/56*10^3*(2.5*10^8)

7. In this problem, we consider sending real-time voice from Host A to Host B over a packet-switched network (VoIP). Host A converts analog voice to a digital 64 kbps bit

stream on the fly.Host A then groups the bits into 56-byte packets. There is one link between Hosts A and B; its transmission rate is 2 Mbps and its propagation delay is 10 msec. As soon as Host A gathers a packet, it sends it to Host B. As soon as Host B receives an entire packet, it converts the packet's bits to an analog signal. How much time elapses from the time a bit is created (from the original analog signal at Host A) until the bit is decoded (as part of the analog signal at Host B)?

dtrans=2Mbs

dprop=10m/sec

Time it takes to convert analog voice to digital = 1/64,000

56 bytes have to be converted to bits as they are sent in bits

1 byte is 8 bits

=56*8 = 448 bits

Calculating transmission delay using transmission rate

dtrans= Packet length = 448 = 0.224m/sec

Transmission rate 2000000

If it takes the host 64kpbs(64,000bits) to create a packet of bit.

What of just one bit

Then 1 bit= 1/64000

How long it takes to gather bits for 448 bits

1/64000*448=7msec

Total delay time = 7msec+0.224+10 = **17.224msec**

This shows that it takes 17.224msec time from creation to decoding the signals with propagation delay,transmission delay and the time it takes to transfer bits for 1 packer is 7 leaving total delay at 17.224

8. Suppose users share a 3 Mbps link. Also suppose each user requires 150 kbps when transmitting, but each user transmits only 10 percent of the time. (See the discussion of packet switching versus circuit switching in Section 1.3 .)

a. When circuit switching is used, how many users can be supported?

3/150.Only 20 users can be supported simultaneously since its circuit switching and users have to be supported all the time

b*. For the remainder of this problem, suppose packet switching is used. Find the probability that a given user is transmitting.*

Probability is 0.1(10 percent for a given user)

c. *Suppose there are 120 users. Find the probability that at any given time, exactly n users are transmitting simultaneously. (Hint: Use the binomial distribution.)*

N =120

p=0.1

n=20

prob=binom.cdf(20,120,0.1)

print(prob)= `0.007825579711977095`

`0.0078255`

d. *Find the probability that there are 21 or more users transmitting simultaneously.*

Using binomial distribution

N =120

p=0.1

n=20

prob=binom.cdf(20,120,0.1)

1-prob

Due to the complementary rule of calculating less than 21

=0.00794

12. A packet switch receives a packet and determines the outbound link to which the packet should be forwarded. When the packet arrives, one other packet is halfway done being transmitted on this outbound link and four other packets are waiting to be transmitted. Packets are transmitted in order of arrival. Suppose all packets are 1,500

bytes and the link rate is 2Mbps. What is the queuing delay for the packet? More generally, what is the queuing delay when all packets have length L, the transmission rate is R, x bits of the currently-being-transmitted packet have been transmitted, and n packets are already in the queue?

dqueue= L/R

Transmission rate for each packet $= \frac{1500*8}{(2*10^6)}$

$= \frac{12000}{(2*10^6)}$

=0.006 seconds

One of the packets is already halfway

Since its halfway done= 6/2 = 3 milliseconds traveled

Time for the 4 packets to travel full swing= 6 * 4=24

Queuing delay = time for current packets + time for packets waiting to be queued

= 24 +3

= 27 milliseconds.

23 Consider Figure 1.19(a) . Assume that we know the bottleneck link along the path from the server to the client is the first link with rate R bits/sec. Suppose we send a pair of packets back to back from the server to the client, and there is no other traffic on this path. Assume each packet of size L bits, and both links have the same propagation delay d .a. What is the packet inter-arrival time at the destination? That is, how much time elapses from when the last bit of the first packet arrives until the last bit of the second packet arrives?

dtrans=L/R

First packet transmission= dtrans + dprop(propagation delay)

Second packet transmission= 2dtrans + dprop(propagation delay)

Inter arrival time = second packet transmission-first packet transmission

= dtrans

b. Now assume that the second link is the bottleneck link (i.e.,). Is it possible that the second packet queues at the input queue of the second link? Explain. Now suppose that the server sends the second packet T seconds after sending the first packet. How large must T be to ensure no queuing before the second link? Explain.

Yes its possible for the second packet to queue at the input queue of the second link.

How large T has to be depends on the transmission delay between when first packet propagates as it shud be ensure it is fully propagated and that the delay is just enough before the second packet is sent.This ensures that first packet has completely arrived before sending them at the same time.

Suppose there is a 10 Mbps microwave link between a geostationary satellite and its base station on Earth. Every minute the satellite takes a digital photo and sends it to the base station.

Assume a propagation speed of 2.4.108 meters/sec.

a. What is the propagation delay of the link?

dprop= d/s

dprop=<u>36,000,000</u>

2.4 * 10(^8)

= 0.15 seconds

b. What is the bandwidth-delay product, ?

Transmission_rate* dprop

10 (^7) * 0.15

=1.5 *10(^6) bits

c. Let x denote the size of the photo. What is the minimum value of x for the microwave link to be continuously transmitting?

Transmission rate * time

(10^7) * 60

600,000,000 bits