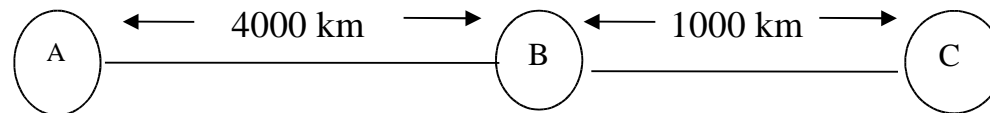# EXAMPLES AND PROBLEMS

Example 1

- In following figure frames are generated at node A and sent to node C through node B. Determine the minimum transmission rate required between nodes B and C so that the buffers at node B are not flooded, based on the following:

- The data rate between A and B is 100 kbps.

- The propagation delay is 5 µsec/km for both lines

- There are full-duplex, error-free lines between the nodes.

- All data frames are 1000 bits long; ACK frames are separate frames of negligible length.

- Between A and B, a sliding-window protocol is used, with a window size of 3 (three).

- Between B and C, stop and wait is used.

Example 1 - Solution

In order not to flood the buffers of B, the average number of frames entering and leaving B must be the same over a long interval.

A -> B: Propagation time = 4000* 5 µsec = 20 msec

Transmission time per frame = $1000/(100*10^3)$ = 10 msec.

B -> C: Propagation time = 1000* 5 µsec = 5 msec

Transmission time per frame = x = 1000/R

R = data rate between B and C (unknown)

Example 1 - Solution

A can transmit three frames to B and then must wait for the acknowledgement of he first frame before transmitting additional frames. The first frame takes 10 msec to transmit; the last bit of the first frame arrives at B 20 msec after it was transmitted and therefore 30 msec after the frame transmission began. It will take an additional 20 msec for B's ack to return to A. Thus A can transmit three frames in 50 msec.

B can transmit one frame to C at a time. It takes 5 + x msec for the frame to be received at C and an additional 5 msec for C's acknowledgement to return to A. Thus, B an transmit one frame every 10 + x msec, or three frames every 30 + 3x msec. Thus:

30+3x=50   x= 6.66 msec and R = 1000/x = 150 kbps.

Example 2 -

A 4Mbps token ring has a token holding time value of 10msec. What is the longest frame that can be sent on this ring?

Example 2 - Solution

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Data rate = 4-Mbps

 · Token holding time = 10msec

 · Frame length = $4*10^6*10*10^{-3} = 40000$ bits

 · The longest frame that can be send on this ring is 40000 bits or 5000 bytes

Example 3

Assume CSMA/CD protocol. Find the minimum frame length for a 1Mbps bit rate and maximum network span of 10 kilometers with no repeaters. Assume a medium propagation delay of 4.5 nanoseconds per meter. Is CSMA/CD a reasonable protocol for a network of this span and bitrate

Example 3

- Minimum frame size for CSMA/CD is 2 * Tpr.
- Propogation Delay :
    - Tpr = $(4.5 * 10^{-9})*(10 * 10^{3}) = 4.5 * 10^{-5}$ sec.
- Thus, $(1.0 * 10^{6}) * (9.0 * 10^{-5}) = 11.25$ bytes.
- CSMA/CD would be a very reasonable protocol

    for a network of this span and speed since the minimum frame size is not " excessive" (e.g., larger than 64 bytes

Example 4

Assume a 100Mbps link of 10,000meters in length with 5 nanoseconds per meter propagation delay. Assume constant length 400 byte data frames, 64 byte ACK frames, 10 microsecond of processing delay for each data frame, and 5 microseconds of processing time for each ACK. The sender always has data to send. Solve for link utilization (U) between a sender and a receiver assuming a stop and wait protocol

Example 4

$t\_pr = 10,000 * 5e^9 = 50$ s

$t\_fr = 8 * 400 / 100e^6 = 32$ s

Ack Delay : $t\_ack = 8 * 64 / 100e^6 = 5.12$ s

We note that the processing delays are not negligible compared to these values so we must include them in our calculation of U...

$U = t\_fr / (t\_pr + t\_fr + t\_proc + t\_ack + t\_proc) = 21\%$

If we neglected t_ack and t_proc our result would have been U = 24% which is more than 10% "off" from the real result confirming that to ignore these values would not have been correct to do

Example 5

For a Gigabit Ethernet the minimum packet length is 512 bytes, for 100 Mbps the minimum packet length is 64 bytes. Compute media (or wire) speed for Gigabit and 100Mbps Ethernet for minimum length packets. What conclusion can you draw

Example 5

1.0e9 / (8 * (512 + 12 + 8)) = 234,962 pkts/sec for Gigabit

1.0e8 / (8 * (64 + 12 + 8)) = 148,819 pkts/sec for 100Mbps

The "8" is for preamble and the "12" is for interframe gap. The media speed for Gigabit is less than double that of 100Mbps for minimum size packets. To get the full gain of Gigabit, you must use large payloads

Example 6

Consider building a IEEE 802.3 network at 1-Gbps over a 1-km cable with no repeaters. What is the minimum frame size? ,

(Assume the signal speed in the cable is 200,000Km/sec).

Example 6 - Solution

In order to detect collisions, the station must be still transmitting when the first bit reaches the far end of the cable.

For a 1Km cable, the one-way propagation time is $\tau=5\mu\text{sec}$ so $2\tau=10\mu\text{sec}$ (RTT).

At 1 Gbps all frames shorter than 10,000 bits can be completely transmitted in under 10micro-sec. Thus the minimum frame size is 10,000 bits or 1250 bytes.

Example 7

How many bps can the modem achieve at 1200 baud?

Example 7

Soln.

There are 4 legal values per baud, or, in other words, each signal change represents *2 bits*. Thus the bit rate is twice the baud rate. At 1200 baud, the bit rate is *2400 bps*.

Example 8

Imagine 2 LAN bridges, both connecting a pair of 802.4 networks. The first bridge is faced with 100 512-byte frames per seconds that must be forwarded. The second is faced with 200 4096-byte frame per second. Which bridge do you think will need the faster CPU? Discuss.

Example 8

The 100 frames/sec bridge would need a faster CPU. Although the other one has a higher throughput, the 100 frames/sec bridge has more interrupts, more process switches, more frames passed and more of everything that needs the CPU.

Example 9

- Consider a 200-meter 4Mbps token ring containing 20 stations, each transmitting with equal priority. Suppose no station is allowed to transmit more than 5000 data octets before giving up the token. Once a station gives up a token how long will it take (in the worst case) for that station to get the token again?

- Designate the station in question by A. The worst case scenario occurs if each of the other 19 stations also has 5000 bytes to send.

- Assume speed of signal: 200meters/μsec. Token is 24 bytes/μsec.

- Let t_{5000} is the time to transmit 5000 bytes and t_{token} the time to transmit the token (for the nineteen stations plus A).

- With data rate 4Mbps:

- T_{5000}=5000*8*250nsec=10000μsec.

- t_{token}=24*250nsec=6μsec.

- Once the last bit is transmitted, it requires 20 micro-sec(i micr sec to cover 200 m+19 microsec internal delay). Once the last frame bit has circulated the ring, station can send the token.

- Thus the time between sending the first bit and first token bit is 10020 micro-sec (since stations are 10 m apart, the propagation time of the token between adjacent stations is 0.05 micro second(negligible). Time required to send one frame followed by one token is 10020+6 micr-sec

- Time A has to wait:19*10026micro-sec+6(this is 1st token)=190500 micro-sec.

Example 10

Ethernet frames must be at least 64 bytes long to ensure that the transmitter can detect collisions. A faster Ethernet has the same minimum frame size but can transmit 10 times faster. How is it possible to still detect collisions?

Example 10

Soln. In order to detect collisions, the station must be still transmitting when the first bit reaches the far end of the cable. As the network speed goes up, the minimum frame length must go up or the maximum cable length must come down proportionally.

Indeed, let: u=speed of signal, l = length of the cable, and s=data rate (bps)

Then the minimum frame size is: x=s*l/u.

Thus, since x is the same for both Ethernet and Fast Ethernet, and s in Fast Ethernet is 10 times as much as in Ethernet, l, the wire length, must be 1/10 as long as in Ethernet.

Example 11

A group of N stations share a 56-kbps pure ALOHA channel. Each station outputs a 1000-bit frame on an average of once every 100 sec, even if the previous one has not yet been send (e.g. the stations are buffered). What is the maximum value of N ?

Example 11

Soln.

Recall that ALOHA achieves an average throughput of appr 18%, when operating at reasonable load. In an ALOHA network with channel capacity 56 kbps, only 18% of this capacity will be used to deliver meaningful data.

With pure ALOHA the usable bandwidth is 0.184 * 56-kbps = 10.3-kbps. This 10 kbps must be divided among N hosts, each of which is transmitting an average of 1000 bits every 100 seconds. This corresponds to a transmission rate of 10 bits per second per host. If the channel can support 10 kbps of data, then it can support up to N users, each transmitting at 10 bps

Each station requires 10 bps (1000-bit/100-sec), so

N = 10300 /10 = *1030 stations*.

Example 12

Ten thousand airline reservation stations are coming for the use of a single slotted ALOHA channel. The average station makes 18 request/hour. A slot is 125 μsec. What is the approximate total channel load.

Example 12

Average requests for 10000 stations
= 10^4 x 18 / (60 x 60) =
50 requests/sec
Average slots number = 1 / (125 x
10^{-6}) = 8000 slots/sec.
Total channel load = average
requests / average slots number
= 50 / 8000 = 0.0625
Hence, the total channel load is
0.0625 request/slot.