CECS 474 - Midterm Exam

Solution

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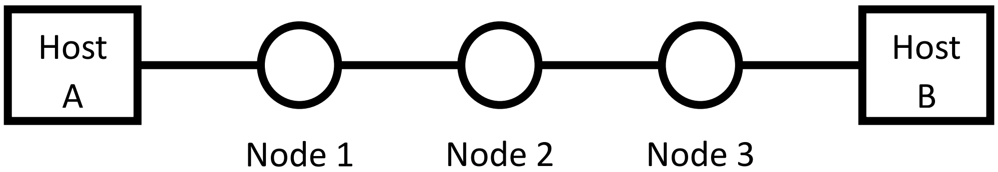
Question 1:

Consider two hosts A and B separated by 3 nodes (switches or routers), host A wants to send a file of size M = 20 Mbits over to host B. Each link has the same data rate C = 2 Mb/s.



(a) Assume message switching (transmitting the whole file as one packet) and ignore the propagation delay, queuing delay, and processing delay. How long would it take for the whole file to be received by host B? (**2 marks**)

(b) Assume packet switching and that all packets have the same size L=1000 bits. Also, assume the propagation delay, queuing delay, and processing delay are negligible. How long would it take for the whole file to be received by host B? (**4 marks**)

Answers:

(a) If message switching, then each node will only send the whole file to the next node after it has completely received it. Hence the total time needed to send the file from host A to host B is:

$$t_{Total} = 4 \times \frac{M}{C} \text{ seconds} = 4 * 10 \text{ seconds} = 40 \text{ seconds}$$

(b) If the message is divided into L=1000 bits per packet, we will have M/L = (20 * 10^6)/ 1000 = 20000 packets.

When the first packet leaves A, B needs to wait for $t_{First} = 4 \times \frac{L}{C}$ seconds to get it.

After the first packet was received, B will get one packet every $\frac{L}{C}$ second (parallelism effect) and there are still M/L-1 = 19999 packets to send, therefore the total time taken to receive the whole file completely is:

$$t_{Total} = 4 \times \left(\frac{L}{C}\right) + \left(\frac{M}{L} - 1\right) \times \frac{L}{C} = \left(\frac{M}{L} + 3\right) \times \frac{L}{C} \text{ seconds} = 20003 * 0.5 \text{ ms} = 10.0015 \text{ seconds}$$

Question 2:

Suppose two hosts, A and B, are separated by 5,000 kilometers and are connected by a direct link of R = 8 Mbps. Suppose the propagation speed over the link is $2.5 * 10^8$ meters/sec.

(a) Calculate the bandwidth-delay product (i.e., $R*d_{prop}$, d_{prop} is the propagation delay.) **(2 marks)**

(b) Consider sending a file of 400,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time? **(1 mark)**

(c) How long does it take to send the file of 400,000 bits? (Assuming the file is sent continuously, and the queuing delay and processing delay are negligible) **(2 marks)**

Answers:

(a) R = 8 Mbps = 8*10^6 pbs

Propagation delay: d_{prop} = (5000*10^3 meters) / (2.5 * 10^8 meters/sec) = 0.02 secs

Thus, $R*d_{prop}$ = (8*10^6 bps) * (0.02 secs) = 160,000 bits

(b) Since 400,000 bits > 160,000 bits, the maximum number of bits that will be in the link at any given time is 160,000 bits.

(c) Propagation delay: d_{prop} = (5000*10^3 meters) / (2.5 * 10^8 meters/sec) = 0.02 secs

Transmission delay: d_{trans} = (400,000 bits) / (8 * 10^6 bps) = 0.05 secs

Thus, $d_{end\text{-}to\text{-}end} = d_{prop} + d_{trans}$ = 0.02 + 0.05 = 0.07 secs

Question 3:

(a) What is the difference in the service offered to applications by the TCP and UDP protocols? **(3 marks)**

(b) For each of the following applications determine whether you would use TCP or UDP and **briefly explain** the reasons for your choice. **(4 marks)**

1. File transfer

2. Watching a real time streamed video

3. Web browsing

4. A Voice Over IP (VoIP) telephone conversation

(c) Briefly explain the difference between persistent and non-persistent HTTP. **(1 mark)**

Answers:

(a) Shown in Page 2-15 of course slides "Chapter2_Week4-5-6".

(b)

1. File transfer: TCP; Reason, requiring reliable data transfer

2. Watching a real time streamed video: UDP; Reason, it is data loss tolerant but rate sensitive

3. Web browsing: TCP; Reason, requiring reliable data transfer

4. A Voice Over IP (VoIP) telephone conversation: UDP (but use TCP as a backup);

Reason: Because VoIP can often tolerate some loss but require a minimal rate to be effective, developers of VoIP usually prefer to run this application over UDP, thereby circumventing TCP's congestion control mechanism and packet overheads. But because many firewalls are configured to block (most types of) UDP traffic, VoIP often is designed to use TCP as a backup if UDP communication fails.

(c) Shown in Page 2-21 of course slides "Chapter2_Week4-5-6".

Question 4:

UDP and TCP use 1s complement for their checksums. Suppose you have the following three 8-bit bytes: 01010111, 01100110, 01110100.

(a) What is the 1s complement of the sum of these 8-bit bytes? (Note that although UDP and TCP use 16-bit words in computing the checksum, for this problem you are being asked to consider 8-bit sums.) Show all work. **(3 marks)**

(b) Why is it that UDP takes the 1s complement of the sum; that is, why not just use the sum? With the 1s complement scheme, how does the receiver detect errors? **(2 marks)**

(c) Is it possible that a 1-bit error will go undetected? How about a 2-bit error? **(1 marks)**

Answer:

(a)

Note, wrap around if overflow.

0 1 0 1 0 1 1 1

\+ 0 1 1 0 0 1 1 0

= 1 0 1 1 1 1 0 1

\+ 0 1 1 1 0 1 0 0

=1 0 0 1 1 0 0 0 1

\+ 0 0 0 0 0 0 0 1

= 0 0 1 1 0 0 1 0

One's complement of the sum = 11001101.

(b) From question (a), we can see that, the checksum is 11001101. To detect errors, the receiver adds the four words (the three original words and the checksum). From this example, we can see that, the sum of the three original words 01010111, 01100110, 01110100, and the checksum 11001101, is

0 1 0 1 0 1 1 1

\+ 0 1 1 0 0 1 1 0

= 1 0 1 1 1 1 0 1

\+ 0 1 1 1 0 1 0 0

=1 0 0 1 1 0 0 0 1

\+ 1 1 0 0 1 1 0 1

=1 1 1 1 1 1 1 1 0

+ 0 0 0 0 0 0 0 1

= 1 1 1 1 1 1 1 1

The one's complement of the sum then is 00000000 (the calculated checksum by the receiver). From the above discussion, we can see, without errors, the checksum calculated by the receiver will be all zeroes. And, if there is a one-bit error during the transmission, the recalculated checksum by the receiver will be with this bit to be 0 and all the other bits to be 1. Such that, the receiver then can easily know there has been an error. Thus, UDP takes the 1s complement of the sum instead of just using the sum.

(c) All one-bit errors will be detected, but two-bit errors can be undetected (e.g., if the last digit of the first word is converted to a 0 and the last digit of the second word is converted to a 1).