Introduction to Computer Networks – Final Exam (S04)

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(1) CLOSE BOOK.

(2) Please put your name and student ID on your answer sheets.

(3) 100 points in total.

(4) Exam: 2:30~5:30pm 06/15/2004 in EEB Rm104、106

(5) Good luck!

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1. (10%) Suppose we want to transmit a message 11100111 and protect it from errors using Cyclic Redundancy Check (CRC) generator 1001. Please determine the message that should be transmitted. 11100111000

2. (30%) Suppose nodes A and B are attached to opposite ends of a 900 m cable, and that they each have one frame of 1000 bits (including all headers and preambles) to send to each other. Both nodes attempt to transmit at ~~time t=0~~. Suppose there are four repeaters between A and B, each inserting a 20-bit delay. Assume the transmission rate is 10Mbps, and CSMA/CD with backoff intervals of multiple of 512 bits is used. After the first collision, A draws K=0, and B draws K=1 in the exponential backoff protocol. Ignore the jam signal.

   (a) (10%) What is the one-way propagation delay (including repeater delays) between A an B in seconds? Assume that the signal propagation speed is 2x10^8 m/sec. ~~13.5 μs~~ 12.5 μs 137.5 μs

   (b) (10%) At what time (in seconds) is A's packet completely delivered to B? 150 μs

   (c) (10%) Repeat (b), but now suppose that only A has a packet to send and that the repeaters are replaced with bridges. Suppose that each bridge has a 20-bit processing delay in addition to a store-and-forward delay. At what time (in seconds) is A's packet delivered at B?

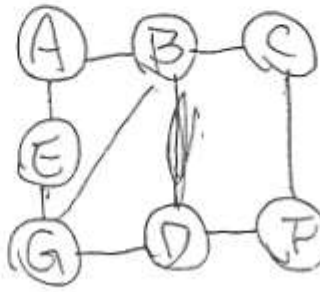
3. (15%) Suppose we have the forwarding tables below for nodes A and F, in a network where all links have cost 1. Give a diagram of the smallest network consistent with these tables.

Node	Cost	Next Hop
B	1	B
C	2	B
D	2	B
E	1	E
F	3	B
G	2	E

Node A's table

Node	Cost	Next Hop
A	3	C
B	2	C
C	1	C
D	1	D
E	4	D
G	3	D

Node ~~B~~ F's table



4. (10%) Consider a simple network below, in which A and B exchange distance vector routing information. All links have cost 1. Suppose the A-E link fails. Give a sequence of routing table updates that leads to a routing loop between A and B.

(E) —— (A) —— (B)

5. (20%) TCP

(a) (10%) What is the fastest line speed at which a host can blast out 1500-byte TCP payloads with a 120-sec maximum packet lifetime without having the sequence numbers wrap around? Take TCP (20 bytes), IP (20 bytes), and Ethernet (26 bytes) overhead into consideration. Assume that Ethernet frames may be sent continuously.

4 byte

(b) (10%) Consider the effect of using slow start on a line with a 10-msec round-trip time and no congestion. The receive window is 24KB and the maximum segment size is 2KB. How long does it take before the first full window can be sent?

55 msec.

6. (15%) Consider a simple application-level protocol built on top of UDP that allows a client to retrieve a file from a remote server residing at a well-known address. The client first sends a request with file name, and the server responds with a sequence of data packets containing different parts of the requested file. To ensure reliability and sequenced delivery, client and server use a stop-and-wait protocol. Ignore the obvious performance issue. Do you see a problem with this protocol? Note: think carefully about the possibility of processes crashing.

65535.

1566 byte

2^{32} packet

65536 個 P

10ms 20ms 30ms 40ms

2 . 4 . 8 . 16 24

10ms RTT.

$$\frac{2^{32} \times 1566 \times 8}{120} =$$

M

15 G

4.48×10^{11} bps =

1. 11100111000

If you calculate the long division correctly but not include 3 CRC bits, you get **5 points**.

2.

a)

$$\frac{900m}{2\cdot 10^{8}\, m/\sec} + 4\cdot\frac{20bits}{10\times 10^{6}\, bps}$$
$$= (4.5\times 10^{-6} + 8\times 10^{-6})\sec$$
$$= 12.5\mu\sec$$

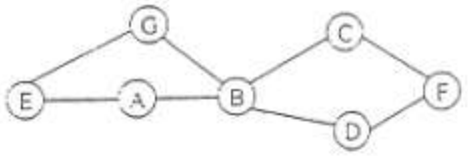
b)

- At time $t=0$, both A and B transmit.
- At time $t = 12.5\mu\sec$, A detects a collision.
- At time $t = 25\mu\sec$ last bit of B's aborted transmission arrives at A.
- At time $t = 37.5\mu\sec$ first bit of A's retransmission arrives at B.
- At time $t = 37.5\mu\sec + \dfrac{1000bits}{10\times 10^{6}\, bps} = 137.5\mu\sec$ A's packet is completely delivered at B.

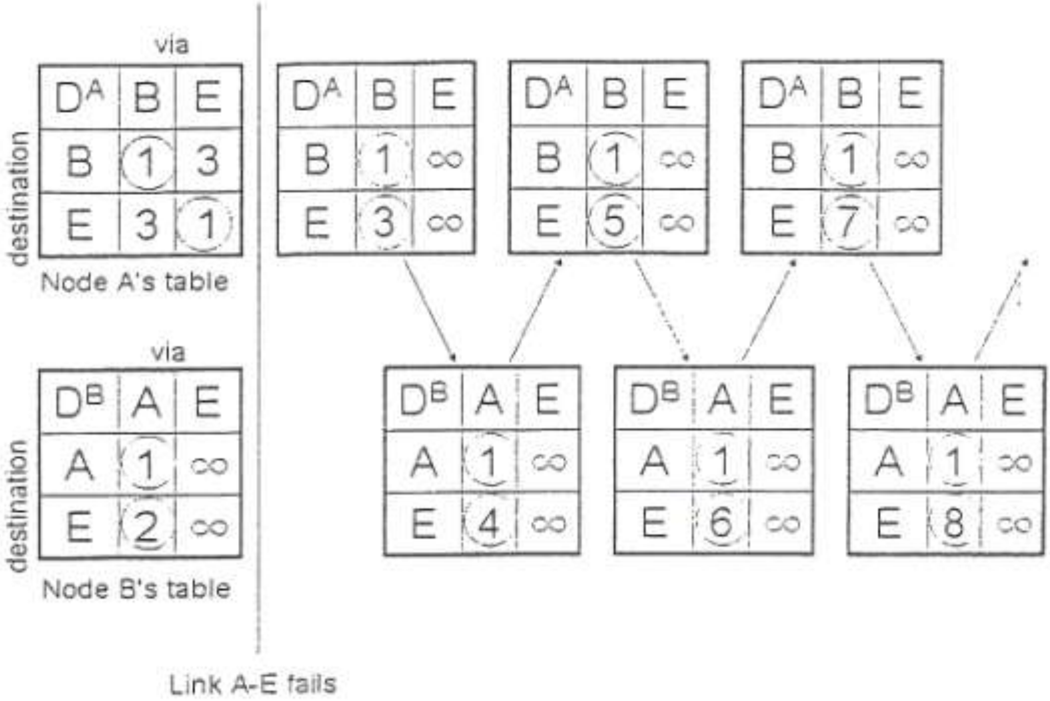
c) $12.5\mu\sec + 5\cdot 100\mu\sec = 512.5\mu\sec$

For each minor mistake, you may lose **1 or 2 points**.

3.



4. A necessary and sufficient condition for the routing loop to form is that B reports to A the networks B believes it can currently reach E, after A discovers the problem with the A—E link, but before A has communicated to B that A no longer can reach E.



For each minor mistake, you may lose 1 **or 2 points**.

5. TCP

(a) The goal is to send 2^32 bytes per 120 sec or 35,791,394 payload bytes/sec. This is 23,860 1500-byte frame/sec. The TCP overhead is 20 bytes. The IP overhead is 20 bytes. The Ethernet overhead is 26 bytes. This means that for 1500 bytes of payload, 1566 bytes must be sent. If we are to send 23,860 frames of 1566 bytes every second, we need a line of 299 Mbps. With anything faster than this we run the risk of two different TCP segments having the same sequence number at the same time.

If you misunderstand TCP's sequence number as the number over the series of transmitted segments but not the number over the stream of transmitted bytes, you can get 4 **points**. In this case, your answer should be $\dfrac{2^{32}\ frame \times 1566 bytes\,/\,frame \times 8 bits\,/\,byte}{120\text{sec}} \cong 448Gbps$.

If you misunderstand TCP's sequence number as the number over the stream of transmitted bit, you can get 4 **points**. In this case, your answer should be

$$\frac{\left\lfloor \dfrac{2^{32}\ bits}{1500 byte\,/\,frame \times 8 bits\,/\,byte} \right\rfloor \times 1566 bytes\,/\,frame \times 8 bits\,/\,byte}{120\text{sec}} \cong 37Mbps.$$

(b) The first bursts contain 2KB, 4KB, 8KB, and 16KB, respectively. The next one is 24KB and occurs after 40 msec.

If you misunderstand the meaning of "full window" and answer the time for the TCP sender to send cumulative 24KB, you can get **2 points**. In this case, your answer should be 35 msec.
For each minor mistake, you may lose **1 or 2 points**.

6. It is possible that a client may get a wrong file. Suppose client A sends a request for file F1 and then crashes. Another client B then uses the same protocol to request another file F2. Suppose client B, running on the same machine as A (with the same IP address), binds its UDP socket to the same port that A was using earlier. Furthermore, suppose B's request is lost. When the server's reply (to A's request) arrives, client B will receive it and assume that it is a reply its own request.

If you answer client may continue sending ACK if process on sender crashes, or sender may continue sending DATA if process on client crashes, you can get **5 points**.