Second Semester 2005/ 2006
CPE 0907422 Computer Networks
Monday, April 3, 2006 **Midterm Exam** **75 Minutes**

Student Name: _______________Sample Solution_____________________
Student No.:____

There are 4 problems in the exam. The exam is out of 60 points.

Show all work and reasoning, writing both work and solution legibly. *You must box all answers*. *If I cannot read a solution, no credit will be given.* Good luck!

Problem 1 (15 points)
This question considers a sliding window implementation across a full-duplex point-to-point link. The link has a bandwidth of 327 kbps in each direction and a one-way propagation delay of 100 milliseconds. All packets sent across the link are 1,024 bytes long, including all headers and trailers.

a) How much data is required to fill the pipe for a round-trip delay on the network?

327 *.2= **65.4 Kilobits** **=** **66,969 Bits**

b) What send window size (*SWS*) is necessary to fully utilize the network?

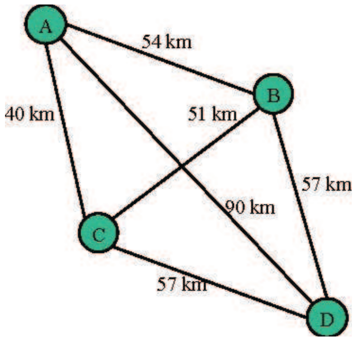
65.4/8 = 8.17 Packet. Hence *SWS* should be greater or equal to **9**

c) For *RWS*= $\lfloor SWS/2 \rfloor$, construct an example demonstrating that *SWS* +2 sequence numbers (e.g., from 0 to *SWS* +1, where *SWS* is your answer to part (b)) are not enough to guarantee correct operation of the sliding window algorithm)

***RWS* = 4; *SWS* = 9; Sequence #'s space is {0, 1, 2… 9, 10}**
Assume that packets 0, 1, 2, 3, 4, 5, 6, 8 are sent
Receiver receives 0, 1, 2, 3; sends acknowledgements and expects packets 4, 5, 6, 7
Packets 4, 5, 6, 7 are received; acknowledgements are sent
New packets with the sequence #'s 8, 9, 10, 0 are expected
All acknowledgments are lost.
Old packets with sequence #'s 0, 1, 2, 3, 4, 5, 6, 7, 8 are retransmitted.
Receiver buffers the packet with sequence 0 as new data >>> operation of the sliding window algorithm is not correct

Problem 2 (10 points)

This question concerns medium access control on a microwave network using carrier sense multiple access with collision detection (CSMA/CD, the algorithm used with Ethernet). The network consists of four hosts distributed as shown in the figure below. The microwaves are broadcast, and the signal travels directly along a line of sight from sender to all receivers. Assume that the signals propagate at the speed of light in a vacuum, 3×10^8 m/sec.



If a transmitter sends at 1 Mbps, how long must packets be to guarantee collision detection by the transmitter?

The maximum distance between any two nodes is 90 KM (A – D).
Hence the maximum RTT = $(2 * 90 * 10^3) / (3 * 10^8)$ = 600 µsec
To guarantee collision detection a packet must be at least

(1 Mbits/second)* (600 µsec) = 600bits

Problem 3 (20 points)

Consider a token ring with latency of 500 μsec. Answer for both a single active host and for “many” active hosts. For the latter, assume that there are sufficiently many hosts transmitting that the time spent advancing the token can be ignored. Assume a packet size of 1500 Byte

a) Assuming that the delayed token release strategy is used, what is the effective throughput rate that can be achieved if the ring has a bandwidth of 3 Mbps?

i. **Single Active Host:**

1 Frame is transmitted every
(1500*8)/3 + 500 (frame rotation time) + 500 (token rotation time) = 5000 μsec

Hence the effective throughput rate is (1500*8)/5000 = 2.4 Mbps

ii. **Many Active Hosts:**

1 Frame is transmitted every approximately
(1500*8)/3 + 500 (frame rotation time) = 4500 μsec

Hence the effective throughput rate is (1500*8)/4500 = 2.67 Mbps

b) Assuming that the immediate token release strategy is used, what is the effective throughput rate that can be achieved if the ring has a bandwidth of 3 Mbps?

i. **Single Active Host:**

1 Frame is transmitted every
(1500*8)/3 + 500 (frame & token rotation time) = 4500 μsec

Hence the effective throughput rate is (1500*8)/4500 = 2.67 Mbps

ii. **Many Active Hosts:**

1 Frame is transmitted every approximately
(1500*8)/3 = 4000 μsec and the effective throughput rate is 3 Mbps

c) With delayed release, what is the effective throughout rate that can be achieved if the ring has a bandwidth of 100 Mbps?

i. **Single Active Host:**

1 Frame is transmitted every
(1500*8)/100 + 500 (frame rotation time) + 500 (token rotation time) = 1120 μsec

Hence the effective throughput rate is (1500*8)/1120 = 10.7 Mbps

ii. **Many Active Hosts:**

1 Frame is transmitted every approximately
(1500*8)/100 + 500 (frame rotation time) = 620 μsec

Hence the effective throughput rate is (1500*8)/620 = 19.4 Mbps

d) With immediate release, what is the effective throughout rate that can be achieved if the ring has a bandwidth of 100 Mbps?

i. **Single Active Host:**

1 Frame is transmitted every
(1500*8)/100 + 500 (frame & token rotation time) = 620 μsec

Hence the effective throughput rate is (1500*8)/ 620 = 19.4 Mbps

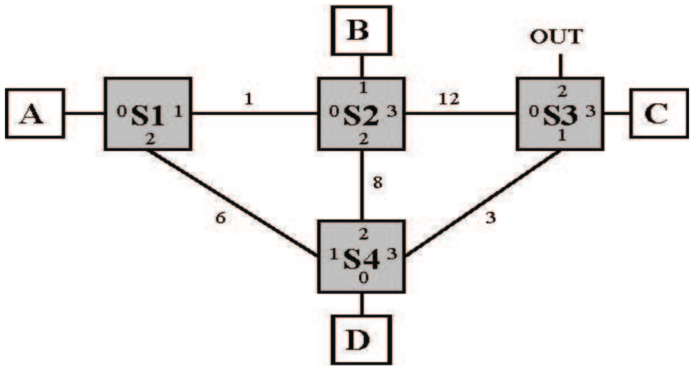
ii. **Many Active Hosts:**

1 Frame is transmitted every approximately
(1500*8)/100 = 120 μsec and the effective throughput rate is 100 Mbps

Second Semester 2005/ 2006
CPE 0907422 Computer Networks
Monday, April 3, 2006 **Midterm Exam** **75 Minutes**

Problem 4 (15 points)

Consider the network shown in the figure below. The links are labeled with relative costs. The three parts of this problem deal with datagram forwarding, circuit-switched forwarding, and source-routed forwarding, respectively



a) **(4 points)** Give the datagram routing table at switch S2, assuming least-cost paths are used. Your table should consist of one row for each possible destination (including the default destination, OUT) consisting of the destination ID, output port, and distance

Destination ID	Output Port	Distance
A	0	1
B	1	0
C	0	10
D	0	7
OUT	1	-

b) **(6 points)** Suppose virtual circuit forwarding is used for the network shown above with the routing tables show below.

S1:	$port_{in}$	VCI_{in}	$port_{out}$	VCI_{out}
	0	0	2	0
	0	1	1	0
	2	0	1	1

S3:	$port_{in}$	VCI_{in}	$port_{out}$	VCI_{out}
	0	0	3	0
	0	1	2	1
	3	0	0	0

S2:	$port_{in}$	VCI_{in}	$port_{out}$	VCI_{out}
	0	0	2	0
	0	1	3	1
	2	0	3	0
	2	2	1	0
	3	0	1	1

S4:	$port_{in}$	VCI_{in}	$port_{out}$	VCI_{out}
	0	0	2	0
	0	2	1	0
	1	0	2	2
	2	0	0	0

When setting up a new virtual circuit on a given output port, a switch should assign the smallest unused virtual circuit identifier for that port. Indicate how the routing tables change after the following two (cumulative) events: (i) The circuit beginning with (port,VCI)=(0,0) at switch S1 is torn down, and (ii) subsequently, a new circuit is set up from host D to host B using a least-cost path.

After event (i) the tables are as follows:

S1:	$port_{in}$	VCI_{in}	$port_{out}$	VCI_{out}
	-------	-------	-------	-------
	0	1	1	0
	2	0	1	1

S3:	$port_{in}$	VCI_{in}	$port_{out}$	VCI_{out}
	0	0	3	0
	0	1	2	1
	3	0	0	0

S2:	$port_{in}$	VCI_{in}	$port_{out}$	VCI_{out}
	0	0	2	0
	0	1	3	1
	2	0	3	0
	-------	-------	-------	-------
	3	0	1	1

S4:	$port_{in}$	VCI_{in}	$port_{out}$	VCI_{out}
	0	0	2	0
	0	2	1	0
	-------	-------	-------	-------
	2	0	0	0

After the two (cumulative) events (i) & (ii) the tables are the following:

S1:	$port_{in}$	VCI_{in}	$port_{out}$	VCI_{out}
	2	1	1	2
	0	1	1	0
	2	0	1	1

S3:	$port_{in}$	VCI_{in}	$port_{out}$	VCI_{out}
	0	0	3	0
	0	1	2	1
	3	0	0	0

S2:	$port_{in}$	VCI_{in}	$port_{out}$	VCI_{out}
	0	2	1	0
	0	0	2	0
	0	1	3	1
	2	0	3	0
	3	0	1	1

S4:	$port_{in}$	VCI_{in}	$port_{out}$	VCI_{out}
	0	1	1	1
	0	0	2	0
	0	2	1	0
	2	0	0	0

c) **(5 points)** Now assume the use of source routing for the network. Indicate the sequence of absolute port identifiers to be found in a packet header for a packet sent by host B destined for host C along the least-cost path. (Assume that the sequence of port identifiers in the header is transmitted in the order written, from left to right.)

0, 2, 3, 3