NATIONAL UNIVERSITY OF SINGAPORE

EXAMINATION FOR THE DEGREE OF B.ENG. (ELECTRICAL)

(Semester I: 2001/2002)

EE3204 – COMPUTER COMMUNICATION NETWORKS I

October / November 2001 - Time Allowed: 2 Hours

INSTRUCTIONS TO CANDIDATES:

1. This paper contains **SIX** (6) questions and comprises **SIX** (6) printed pages.
2. Answer any **FOUR** (4) questions.
3. All questions carry equal marks.

(a) This is a CLOSED BOOK examination.

Q.1 (a) Calculate the latency (from first bit sent by the sender and the last bit received by the receiver) for each of the following cases: (15 marks)

(i) A packet of 5000 bits is sent over a 10 Mbps Ethernet from node A to node B through four intermediate store-and-forward switches. Assume that each link introduces a propagation delay of 10 μs, and that the switch begins retransmitting immediately after it has finished receiving the packet.

(ii) Same as (i), but assume the switch implements “cut-through” switching: It is able to begin retransmitting the packet immediately after receiving the first 200 bits.

(iii) Same as (i), but 5000 bits are sent in 5 packets each carrying 1000 bits.

(b) Suppose that a certain communication protocol involves a per-packet overhead of 100 bytes for headers and framing. We send 1 million bytes of DATA using this protocol; however, one data byte is corrupted and the entire packet containing it is thus lost. Give the total number of overhead+loss bytes for packet data sizes of 5000 and 20000 bytes. Determine the optimal packet data size. (10 marks)

Q.2. (a) Node A transmits 1000-bit frames to node C through node B. The link A-B is 4000km long and link B-C is 1000 km long. The frame error probability is 0.1 for link A-B and 0.2 for link B-C. The propagation delay is 5μs/km for each of the links. Between A and B, selective-repeat ARQ with a window size of 3 is used. Between B and C, stop-and-wait ARQ is used. The transmission time of ACK frames is negligible. Node A transmits at the rate of 100 kbps.

(a) How many (original) frames are transferred by node A on link A-B in one second? (5 marks)

(b) Calculate the utilization on link A-B. (5 marks)

(c) Determine the minimum transmission rate required by B so that the buffers of node B are not flooded. [***Hint:*** 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.] (8 marks)

(b) Suppose that host A transmits 1000-byte frames using stop-and-wait ARQ through a 1 Mbps link with the propagation speed of 2×10^{8} m/s. For what range of link lengths, at least 50% link utilization is achieved when the frame error probability is 0.1? (7 marks)

Q.3 (a) Two hosts A and B attempt to transmit on an Ethernet. Each host has a steady queue of frames ready to send; A's frames are numbered A1, A2, and so on, and B's frames are numbered B1, B2, and so on. Suppose that A and B simultaneously attempt to send frame 1 (A1 and B1, respectively) and collide. When they try again to transmit their frame using exponential backoff algorithm, host A wins. We say that Host A wins backoff race-1. The above procedure repeates and suppose that Host A wins and host B loses all the first 3 backoff races (i.e. race-1, 2, and 3). Now, A and B collide again and enter into race-4. Given this,

(i) What is the minimum and maximum number of slots, host A waits before attempting transmission during race-4? (3 marks)

(ii) What is the minimum and maximum number of slots, host B waits before attempting transmission during race-4? (3 marks)

(iii) What is the probability that Host A wins race-4? (6 marks)

(iv) With what probability, Host A wins race-4 and all the remaining backoff races? You can give a reasonably approximate value for this probability. (8 marks)

(b) For a 100-Mbps token ring with a token rotation time of 200 μs which allows each station to transmit one 1 KB packet each time it possesses the token, calculate the maximum effective throughput rate that any one host can achieve, assuming "immediate release". (5 marks)

Q.4 (a) Consider the ATM network shown in Fig. Q.4a. with four hosts A, B, C, and D and four switches 1, 2, 3, and 4. ATM connections are routed between each of the node-pairs <A,B>, <C,D>, <D,A>, <A,D>, and <B,C> . Show the VCI table at each of the switches indicating the VCIs in the input and output ports. **The routing is carried out in the order in which the above node-pairs are listed and VCIs are assigned starting from 1.** (13 marks)

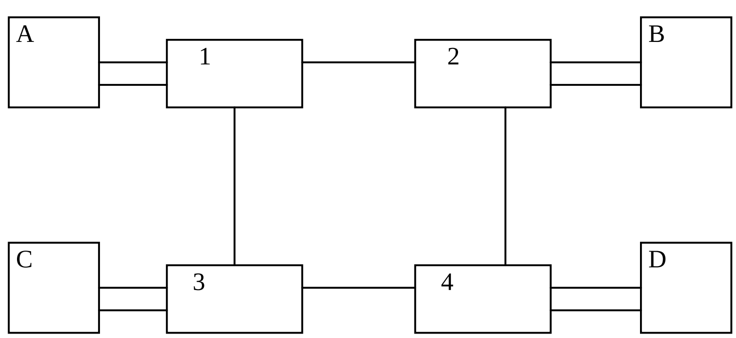

Fig Q.4 a

Q.4 continues on page 4

(a) Consider hosts X, Y, Z, W and learning bridges B1, B2, B3, with initially empty forwarding tables as shown in Fig. Q.4b. (12 marks)

(i) Suppose X sends a packet to Z. Which bridges learn where X is? Does Y's network interface see this packet?

(ii) Suppose Z now sends a packet to X. Which bridges learn where Z is? Does Y's network interface see this packet?

(iii) Suppose Y now sends a packet to X. Which bridges learn where Y is? Does Z's network interface see this packet?

(iv) Suppose Z now sends a packet to Y. Which bridges learn where Z is? Does W's network interface see this packet?

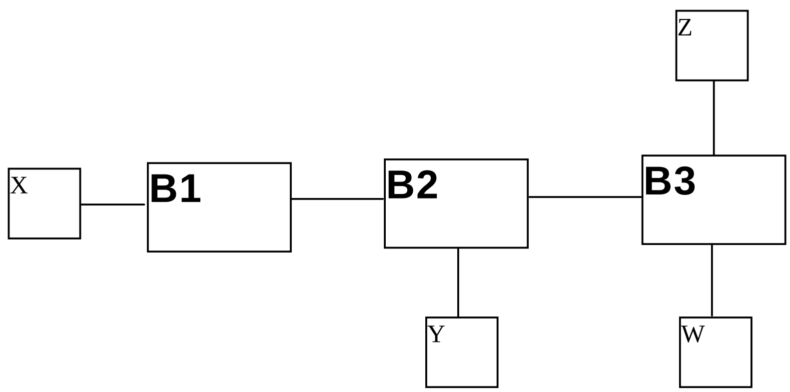

Fig Q.4 b

Q.5(a) Suppose that an IP packet is fragmented into 10 fragments, each with a 0.01 probability of loss (independent of others). What is the probability of net loss of the packet if the packet is transmitted twice, assuming any given fragment may have been part of either transmission? (13 marks)

(b) For the network shown in Fig. Q.5b, show the contents of the global distance-vector tables at time t=0, t=T, and t=2T. Assume that initially (t=0) every node knows only the distances to its immediate neighbors and at the interval of every T time units a node reports its information to its immediate neighbors. Assume that the links are bi-directional. (12 marks)

Q.5 continues on page 5

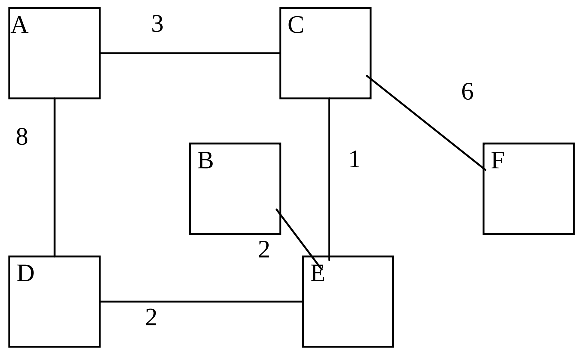

Fig. Q.5b

Q.6 (a) Suppose hosts A and B have been assigned the same IP address on the same Ethernet, on which ARP is used. B starts up after A. What will happen to A's existing connections? Explain how "self-ARP" (querying the network on start-up for one's own IP address) might help with this problem. (6 marks)

(b) A router R1 has built up a routing table as shown in Table Q.6b given below. The router can deliver packets directly over interfaces 0 and 1, or it can forward packets to routers R2, R3, or R4. Describe what the router R1 does with a packet addressed to each of the following destinations: (i) 128.96.39.10, (ii) 128.96.40.151, and (iii) 192.4.153.17 (9 marks)

SubnetNumber	SubnetMask	NextHop
128.96.39.0	255.255.255.128	Interface 0
128.96.39.128	255.255.255.128	Interface 1
128.96.40.0	255.255.255.128	R2
192.4.153.0	255.255.255.192	R3
(default)		R4

Table Q.6b

Q.6 continues on page 6

(c) Suppose hosts A and B are on an Ethernet LAN with class C IP network address 200.0.0. It is desired to attach a host C to the network via a direct connection to B as shown in Fig.Q.6c. One way to solve the routing problem is to use proxy ARP; B agrees to route traffic to and from C, and also answers ARP queries for C received over the Ethernet.

(10 marks)

(i) List down all packets sent with physical addresses, as A uses ARP to locate and then send one packet to C.

(ii) List down

(iii) B's routing table. What "special feature" must this routing table contain?

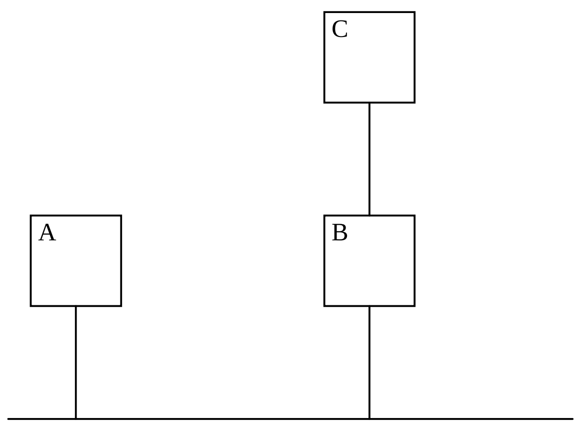

Fig . Q.6c

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