Introduction to Computer Networks (S17) June 23 2017

- Please put your name and student ID on your answer sheets.
- Total score: 100 points
- Final exam time: 2:20-5:30pm
- Please turn in your answer sheets together with your exam sheet when you are done.

1. (5%) Please determine the CRC code for data message 10011101101 with generator 1101 and give the bit sequence to transmit. Suppose that the third bit counting from the left (i.e., from the most significant bit) is inverted during transmission. Show how this error is detected at the receiver side.

2. (5%) Consider a router that interconnects three subnets: Subnet 1, Subnet 2, and Subnet 3. Suppose all the interfaces in each of these three subnets are required to have the prefix 223.1.17/24. Also suppose that Subnet 1 is required to support up to 62 interfaces, Subnet 2 is to support up to 106 interfaces, and Subnet 3 is to support up to 15 interfaces. Provide three network addresses (of the form *a.b.c.d/x*) that satisfy these constraints.

3. (5%. 1 point each) Ethernet switch: true or false, why and why not.

   (a) A layer-2 device with IEEE 802.3 protocol (b) Allow plug-and-play and traffic isolation (c) Implement binary exponential backoff among hosts connecting to different ports for collision resolutions (d) Ensure error correction with CRC (e) Suffer from traffic concentration but avoid the count-to-infinity problem due to its optimal routing

4. (30%, 10 points each) Routing

   (a) Consider the network shown in Fig. 1. Please give 1) the least number of iterations required before the distributed algorithm converges, and 2) the forwarding table of node D (indicating destination, next hop, and cost for each entry), based on a synchronous version of the distance-vector algorithm. Please do show how you determine to indicate your answer.

   (b) Consider the network in Fig. 1 again. Please show how the link-state algorithm determines the forwarding table (indicating destination, previous node, and cost for each entry) for node D.

   (c) Suppose that we have the forwarding tables shown in Fig. 2 for nodes A and F in a network where all links have cost 1. Give the smallest network (i.e., with least number of links) consistent with these tables.

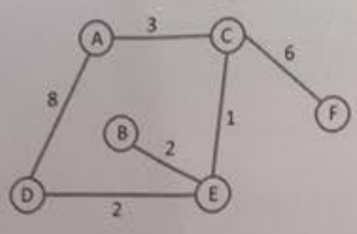


Fig. 1: The network topology for Prob. 4

A

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

F

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

Fig. 2: The two forwarding tables for Prob. 4 (c)

5. (15%) Consider Fig. 3, where A, B, C, W, X, and Y are ASs; A, B, C are provider networks, and W, X, Y are customer networks. Assume that A, B, C directly send traffic to each other and provide full BGP information to their customer networks. W, X, Y are stub networks so that traffic to or from each network are either destined for or originated from that network. Consider the path information that reaches stub networks W, X, and Y. Based on the path information available at W and X, what are their respective views of the network topology? Please justify your answer. The topology view at Y is shown below as Fig. 4.

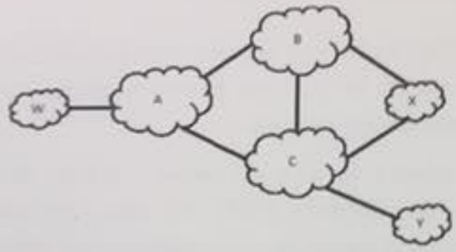


Fig. 3 The network topology for Prob. 5

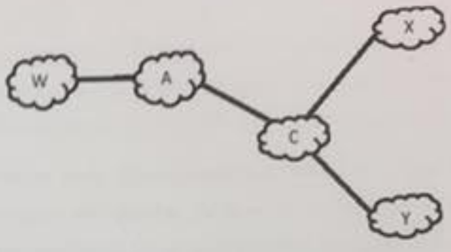


Fig. 4. The topology view at Y

6. (15%) Pure ALOHA

(a) (5%) Please show the maximum efficiency of pure ALOHA is 1/(2e).

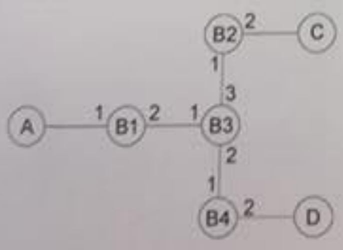
(b) (10%) Now consider the case that there are only two nodes in the system now, say node A and node B, contenting for the channel with pure ALOHA. Suppose that node A has more data to send than node B, and node A's retransmission probability Pa is greater than node B's retransmission probability Pb. What is the total efficiency of the protocol with these two nodes?

7. (10%) Suppose nodes A and B are on the same 100Mbps broadcast channel, and the propagation delay between the two nodes are 245 bit times. Suppose that CSMA/CD and Ethernet frames are used for this channel. Suppose that node A begins transmitting a frame and before it finishes, node B begins transmitting a frame. Can node A finish transmitting before it detects that node B has transmitted? Why or why not?

8. (15%) Consider the arrangement of self-learning switches shown in Fig. 5 (a). Assume that all are initially empty. Give the switch tables for each of the switches B1-B4 after the following three transmissions:

A sends to D, A moves to B2 (with interface B2), C sends to A, and D sends to C.

The switch table format is shown in Fig. 5 (b). Please use MA to denote Host A's MAC address, and MB1 for Switch B1's MAC address. Please also give the data flow in the network for each event.



(a) Network topology

MAC address	Interface

(b) Switch table format

Fig. 5: Self-learning switches

Final Solution

1.

寫出 CRC 運算 (2%)

R=010 (1%)

寫出如何 detect error (2%)

2. (reference answer)

1: 223.1.17.0/26

2: 223.1.17.128/25

3: 223.1.17.192/28

錯一個扣 2 分

3.

(a) T

(b) T

(c) F, no collisions among different ports

(d) F, ~~error correction~~ → error detection

(e) F, no optimal-routing

4.

(a)

(1)2 or 3 iterations

5% wrong 1 -2%

Initial	A	B	C	D	E	F
A	0	∞	3	8	∞	∞
B	∞	0	∞	∞	2	∞
C	3	∞	0	∞	1	6
D	8	∞	∞	0	2	∞
E	∞	2	1	2	0	∞
F	∞	∞	6	∞	∞	0

1st	A	B	C	D	E	F
A	0	∞	3	8	4	9
B	∞	0	3	4	2	∞
C	3	3	0	3	1	6
D	8	4	3	0	2	∞
E	4	2	1	2	0	7
F	9	∞	6	∞	7	0

(b)10%

	A	B	C	E	F
D	8,D	∞	∞	2,D	∞
DE	8,D	4,E	3,E		∞
DEC	6,C	4,E			9,C
DECB	6,C				9,C
DECBA					9,C
DECBAF					

Destination	Previous node	cost
A	C	6
B	E	4
C	E	3
E	D	2
F	C	9

(c)10%

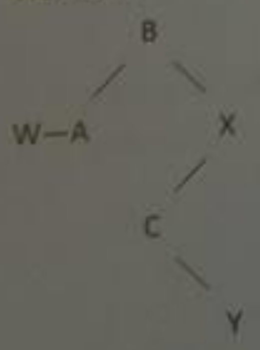
A—B—C

| | |

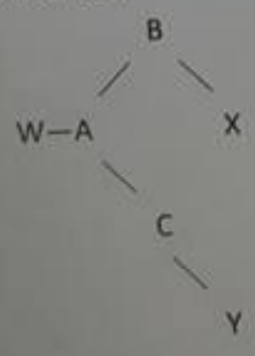
D—E—F

5. 5% each, justify 5%

View at x



View at W



6.

(a)5%

$$E(p) = Np(1-p)^{2(N-1)}$$
$$E'(p) = N(1-p)^{2(N-2)} - Np2(N-1)(1-p)^{2(N-3)}$$
$$= N(1-p)^{2(N-3)}((1-p) - p2(N-1))$$

$$E'(p) = 0 \Rightarrow p^* = \frac{1}{2N-1}$$

$$E(p^*) = \frac{N}{2N-1}(1 - \frac{1}{2N-1})^{2(N-1)}$$

$$\lim_{N\to\infty} E(p^*) = \frac{1}{2}\cdot\frac{1}{e} = \frac{1}{2e}$$

(b)10%

Total efficiency is $pA(1-pB)^2 + pB(1-pA)^2$

7. 10%

No, in the worst case, B begins transmitting at time 244, which is the time right before the first bit of A's frame arrives at B. At time t=244+245=489 B's first bit arrives at A. Because 489< 576(Ethernet min packet), A cannot finish transmitting before it detects that B has transmitted.

2nd	A	B	C	D	E	F
A	0	6	3	8	4	9
B	6	0	3	4	2	9
C	3	3	0	3	1	6
D	8	4	3	0	2	9
E	4	2	1	2	0	7
F	9	9	6	9	7	0

3rd (or 2nd)	A	B	C	D	E	F
A	0	6	3	6	4	9
B	6	0	3	4	2	9
C	3	3	0	3	1	6
D	6	4	3	0	2	9
E	4	2	1	2	0	7
F	9	9	6	9	7	0

(2) 5%

Destination	Next hop	cost
A	E	6
B	E	4
C	E	3
E	E	2
F	E	9

8. 3% each table

B1:

Mac address	Interface
MA	1
MC	2

B2:

Mac address	Interface
MA	1
MC	2
MD	1

B3:

Mac address	Interface
MA	1
MC	3
MD	2

B4:

Mac address	Interface
MA	1
MD	2

3% each

A sends to D: A-B1-B3-B2-C
└B4-D

C sends to A: C-B2-B3-B1-A

D sends to C: D-B4-B3-B2-C