Computer Networks - CS132/EECS148 - Spring 2013
Instructor: Karim El Defrawy
Assignment 4
Deadline : May 23rd – 9:30pm (hard and soft copies required)

Problem 1 (Chapter 4, Problem 27, 10 points) - Consider the network shown in Problem 26 in your book. Using Dijkstra's algorithm, and showing your work using a table similar to Table 4.3, do the followings:
a. Compute the shortest path from t to all network nodes.
b. Compute the shortest path from u to all network nodes.
b. Compute the shortest path from v to all network nodes.
b. Compute the shortest path from w to all network nodes.
b. Compute the shortest path from y to all network nodes.
b. Compute the shortest path from z to all network nodes.

a)

Step	*N'*	*D(x), p(x)*	*D(u),p(u)*	*D(v),p(v)*	*D(w),p(w)*	*D(y),p(y)*	*D(z),p(z)*
0	t	∞	2,t	4,t	∞	7,t	∞
1	tu	∞	2,t	4,t	5,u	7,t	∞
2	tuv	7,v	2,t	4,t	5,u	7,t	∞
3	tuvw	7,v	2,t	4,t	5,u	7,t	∞
4	tuvwx	7,v	2,t	4,t	5,u	7,t	15,x
5	tuvwxy	7,v	2,t	4,t	5,u	7,t	15,x
6	tuvwxyz	7,v	2,t	4,t	5,u	7,t	15,x

b)

Step	*N'*	*D(x), p(x)*	*D(t),p(t)*	*D(v),p(v)*	*D(w),p(w)*	*D(y),p(y)*	*D(z),p(z)*
	u	∞	2,u	3,u	3,u	∞	∞

	ut	∞	2,u	3,u	3,u	9,t	∞
	utv	6,v	2,u	3,u	3,u	9,t	∞
	utvw	6,v	2,u	3,u	3,u	9,t	∞
	utvwx	6,v	2,u	3,u	3,u	9,t	14,x
	utvwxy	6,v	2,u	3,u	3,u	9,t	14,x
	utvwxyz	6,v	2,u	3,u	3,u	9,t	14,x

c)

Step	*N’*	*D(x), p(x)*	*D(u),p(u)*	*D(t),pt)*	*D(w),p(w)*	*D(y),p(y)*	*D(z),p(z)*
	v	3,v	3,v	4,v	4,v	8,v	∞
	vx	3,v	3,v	4,v	4,v	8,v	11,x
	vxu	3,v	3,v	4,v	4,v	8,v	11,x
	vxut	3,v	3,v	4,v	4,v	8,v	11,x
	vxutw	3,v	3,v	4,v	4,v	8,v	11,x
	vxutwy	3,v	3,v	4,v	4,v	8,v	11,x
	vxutwyz	3,v	3,v	4,v	4,v	8,v	11,x

d)

Step	*N’*	*D(x), p(x)*	*D(u),p(u)*	*D(v),p(v)*	*D(t),p(t)*	*D(y),p(y)*	*D(z),p(z)*
	w	6,w	3,w	4,w	∞	∞	∞
	wu	6,w	3,w	4,w	5,u	∞	∞
	wuv	6,w	3,w	4,w	5,u	12,v	∞
	wuvt	6,w	3,w	4,w	5,u	12,v	∞

wuvtx	6,w	3,w	4,w	5,u	12,v	14,x
wuvtxy	6,w	3,w	4,w	5,u	12,v	14,x
wuvtxyz	6,w	3,w	4,w	5,u	12,v	14,x

e)

Step	*N'*	*D(x), p(x)*	*D(u),p(u)*	*D(v),p(v)*	*D(w),p(w)*	*D(t),p(t)*	*D(z),p(z)*
	y	6,y	∞	8,y	∞	7,y	12,y
	yx	6,y	∞	8,y	12,x	7,y	12,y
	yxt	6,y	9,t	8,y	12,x	7,y	12,y
	yxtv	6,y	9,t	8,y	12,x	7,y	12,y
	yxtvu	6,y	**9,t**	8,y	12,x	7,y	12,y
	yxtvuw	6,y	9,t	8,y	12,x	7,y	12,y
	yxtvuwz	6,y	9,t	8,y	12,x	7,y	12,y

f)

Step	*N'*	*D(x), p(x)*	*D(u),p(u)*	*D(v),p(v)*	*D(w),p(w)*	*D(y),p(y)*	*D(t),p(t)*
	z	8,z	∞	∞	∞	12,z	∞
	zx	8,z	∞	11,x	14,x	12,z	∞
	zxv	8,z	14,v	**11,x**	14,x	12,z	15,v
	zxvy	8,z	14,v	11,x	14,x	**12,z**	15,v
	zxvyu	8,z	**14,v**	11,x	14,x	12,z	15,v
	zxvyuw	8,z	14,v	11,x	**14,x**	12,z	15,v
	zxvyuwt	8,z	14,v	11,x	**14,x**	12,z	15,v

Problem 2 (Chapter 4, Problem 28, 10 points) - Consider the network shown under problem 28, chapter 4 in your book, and assume that each node initially knows the costs to each of its neighbors. Consider the distance vector algorithm and show the distance table entries at node z.

		Cost to				
		u	v	x	y	z
	v	∞	∞	∞	∞	∞
From	x	∞	∞	∞	∞	∞
	z	∞	6	2	∞	0

		Cost to				
		u	v	x	y	z
	v	1	0	3	∞	6
From	x	∞	3	0	3	2
	z	7	5	2	5	0

		Cost to				
		u	v	x	y	z
	v	1	0	3	3	5
From	x	4	3	0	3	2
	z	6	5	2	5	0

		Cost to				
		u	v	x	y	z
	v	1	0	3	3	5
From	x	4	3	0	3	2
	z	6	5	2	5	0

Problem 3 (Chapter 5, Problem 4, 5 points) - Consider Problem 3, Chapter 5. Instead, suppose these 10 bytes contain

a. the binary representation of the numbers 1 through 10.
b. the ASCII representation if the letters B through K (uppercase).
c. the ASCII representation if the letters b through k (uppercase).

Compute the Internet checksum for this data.

a. To compute the Internet checksum, we add up the values at 16-bit quantities:

00000001 00000010

00000011 00000100

00000101 00000110

00000111 00001000

00001001 00001010

00011001 00011110

The one's complement of the sum is 11100110 11100001.

a. To compute the Internet checksum, we add up the values at 16-bit quantities:

01000010 01000011
01000100 01000101
01000110 01000111
01001000 01001001
01001010 01001011

10011111 10100100

The one's complement of the sum is 01100000 01011011

a. To compute the Internet checksum, we add up the values at 16-bit quantities:

01100010 01100011
01100100 01100101
01100110 01100111

01101000 01101001
01101010 01101011

00000000 00000101

The one's complement of the sum is 11111111 11111010.

Problem 4 (Chapter 5, Problem 5, 5 points) - Consider the 5-bit generator, G=10011, and suppose that D has the value 1010101010. What is the value of R?

If we divide 10011 into 1010101010 0000, we get 1011011100, with a remainder of R=0100. Note that, G=10011 is CRC-4-ITU standard.

Problem 5 (Chapter 5, Problem 11, 10 points) - Suppose four active nodes-- nodes A,B,C, and D -- are competing for access to a channel using slotted ALOHA. Assume each node has an infinite number of packets to send. Each node attempts to transmit in each slot with probability p. The first slot is numbered slot 1. The second slot is numbered slot 2, and so on.

a. What is the probability that node A succeeds for the first time in slot 5?
b. What is the probability that some node (either A,B,C or D) succeeds in slot 4?
c. What is the probability that the first success occurs on slot 3?
d. What is the efficiency of this four node system?

a. $(1 – p(A))^4 p(A)$
where, p(A) = probability that A succeeds in a slot
p(A) = p(A transmits and B does not and C does not and D does not)
= p(A transmits) p(B does not transmit) p(C does not transmit) p(D does not transmit)
$= p(1 – p) (1 – p)(1-p) = p(1 – p)^3$

Hence, p(A succeeds for first time in slot 5)
$= (1 – p(A))^4 p(A) = (1 – p(1 – p)^3)^4 p(1 – p)^3$

a. $p(\text{A succeeds in slot 4}) = p(1-p)^3$
$p(\text{B succeeds in slot 4}) = p(1-p)^3$
$p(\text{C succeeds in slot 4}) = p(1-p)^3$
$p(\text{D succeeds in slot 4}) = p(1-p)^3$

$p(\text{either A or B or C or D succeeds in slot 4}) = 4 p(1-p)^3$
(because these events are mutually exclusive)

a. $p(\text{some node succeeds in a slot}) = 4 p(1-p)^3$
$p(\text{no node succeeds in a slot}) = 1 - 4 p(1-p)^3$

Hence, p(first success occurs in slot 3) = p(no node succeeds in first 2 slots) p(some node succeeds in 3rd slot) = (1 - 4 p(1-p)3)2 4 p(1-p)3

a. efficiency = p(success in a slot) =4 p(1-p)3

Problem 6 (Chapter 6, Problem 1, 10 points) - Consider the single sender CDMA example in figure 6.5 of your book. What would be the sender's output (for the 2 data bits shown) if the sender's CDMA code were (1,-1,1,-1,1,-1,1,-1) ?

Output corresponding to bit d_1 = [-1,1,-1,1,-1,1,-1,1]
Output corresponding to bit d_0 = [1,-1,1,-1,1,-1,1,-1]

Problem 7 (Chapter 6, Problem 8, 10 points) - Consider the scenario shown in Figure 6.33 in your book, in which there are four wireless nodes A, B, C and D. The radio coverage of the four nodes is shown via the shaded ovals; all nodes share the same frequency. When A transmits it can only be heard/received by B; when C transmits both B and D can head/receive from C; when D transmits only C can hear/receive from D.
Suppose now that each node has an infinite supply of messages that it wants to send to each of the other nodes. If a message's destination is not an immediate neighbor, then the message must be relayed. If A wants to send to D, a message from A must first be sent to B, which then sends the message to C, which then sends the message to D. Time is slotted, with a message transmission time taking exactly one time slot, e.g. as in slotted ALOHA. During a slot, a node can do one of the following:
i) send a message; ii) receive a message (if exactly one message is being sent to it) iii) remain silent. As always, if a node hears two or more transmissions, a collision occurs and none of the messages are received successfully. You can assume here that there are no bit-level errors, and thus if exactly one message is sent it will be received correctly by those within the transmission radius of the sender.

a. Suppose now that an omniscient controller (i.e. a controller that nodes the state of every node in the network.) can command each node to do whatever it (the omniscient controller) wishes, i.e. to send or receive a message or to remain silent. Given this omniscient controller, what is the maximum rate at which a data message can be transferred from C to A, given that there are no other messages between any other source/destination pairs?

b. Suppose now that A sends messages to B and D sends messages to C. What's the combined maximum rate at which data messages can flow from A to B and from D to C?

c. b. Suppose now that A sends messages to B and C sends messages to D. What's the combined maximum rate at which data messages can flow from A to B and from C to D?

d. Now suppose we are again in the wireless scenario, and that for every data message sent from source to destination, the destination will send an ACK back to the source (e.g. as in TCP). Also suppose that each ACK message takes up one slot. Repeat questions a through c above for the scenario.

a. 1 message/ 2 slots
b. 2 messages/slot
c. 1 message/slot

a. i) 1 message/slot
ii) 2 messages/slot
iii) 2 messages/slot

a. i) 1 message/4 slots
ii) slot 1: Message A B, message D C
slot 2: Ack B A
slot 3: Ack C D
= 2 messages/ 3 slots

iii)
slot 1: Message C D
slot 2: Ack DC, message A B
Repeat

slot 3: Ack B A

= 2 messages/3 slots