ELEC 3120: Computer Communication Networks

Prof. Shen, Shanpu
(Fall 2021)

Department of Electronic and Computer Engineering
The Hong Kong University of Science and Technology

Homework 4
Due: December 6 (Monday) 9:00 a.m.
Full marks: 60

Notes:
1) This assignment contains six problems, each with several parts. Answer them as clearly and concisely as possible and show how you obtain the answers. Solely giving the final numerical result without showing the procedure on how it is obtained will lead to a deduction of most of your points in the corresponding problem even if the numerical result is correct.
2) You may discuss ideas with others in the class, but your solutions and presentations must be your own. Do not look at anyone else's solutions or copy them from anywhere.
3) Please upload a scanned copy of your solutions to the Canvas System on the due date. No late submission will be accepted.

P1. (12 pts.) Suppose node C receives the following link-state packets from other nodes as in the following table. Answer the following questions.

Link-State packet from	Neighbor nodes (Link Cost)					
A	B(8)	G(1)	H(5)			
B	A(8)	F(3)				
D	C(4)	E(4)	F(4)	H(2)		
E	C(3)	D(4)				
F	B(3)	D(4)				
G	A(1)	C(9)				
H	A(5)	C(8)	D(2)			

a. Construct the topology of the network from the Link-State packets given in the table. (4 pts)

b. Use Dijkstra's shortest-path algorithm to compute the shortest path from node C to all network nodes. Fill the table below and you can add more rows if you need. (4 pts)

N'	D(A), p (A)	D(B), p (B)	D(C), p (C)	D(D), p (D)	D(E), p (E)	D(F), p (F)	D(G), p (G)	D(H), p (H)

c. Based on the results in b), fill in the following forwarding table for node C. Note that the "shortest path cost" column refers to the cost from node C to all destination nodes. (4 pts)

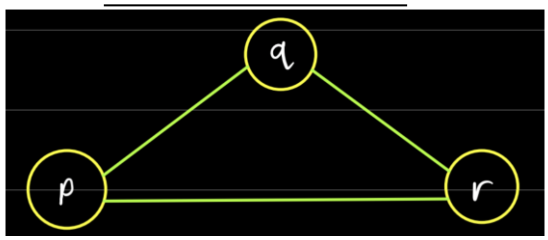
Destination	Next Hop	Shortest path cost
A		
B		
C		
D		
E		
F		
G		
H		

P2 (10 pts.) Consider the three-node topology shown below. The link costs are c(p,q) = 1, c(q,r) = 2, c(r,p) = 3. The DV routing algorithm runs in the following way. Nodes are synchronized. In every second, nodes exchange link cost information. Afterwards, each node computes its distance vector locally.

Compute the distance tables for node p, q, and r:

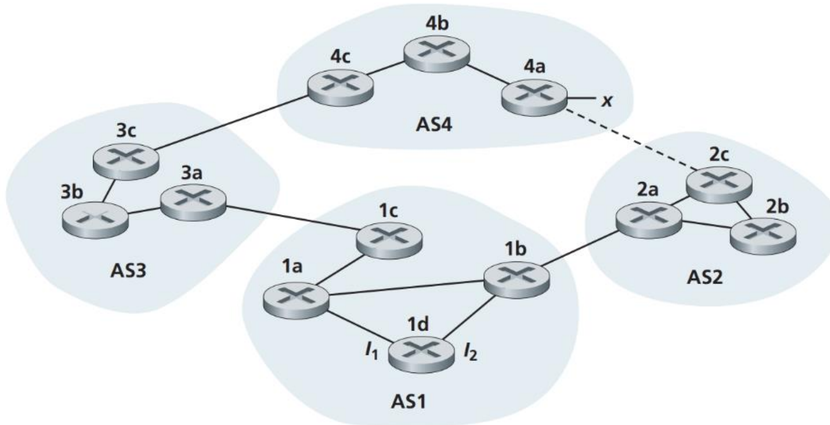
a) after the initialization step

b) after each iteration of the distance-vector algorithm



P3 (8 pts.) Consider the network shown below. Suppose AS3 and AS2 are running OSPF for their intra-AS routing protocol. Suppose AS1 and AS4 are running RIP for their intra-AS routing protocol. Suppose eBGP and iBGP are used for the inter-AS routing protocol. Initially suppose there is no physical link between AS2 and AS4.

a. Router 3c learns about prefix x from which routing protocol: OSPF, RIP, eBGP, or iBGP? (2 pts)
b. Router 3a learns about x from which routing protocol? (2 pts)
c. Router 1c learns about x from which routing protocol? (2 pts)
d. Router 1d learns about x from which routing protocol? (2 pts)



P4. (10 pts.) In slotted ALOHA systems, we assume there are N active nodes and recall that the efficiency of slotted ALOHA is $Np(1-p)^{N-1}$.

(a) Find the optimal value of p that can maximize the efficiency of slotted ALOHA. Please show the derivation. (3 pts)

(b) With the optimal value of p found in (a), find the efficiency of slotted ALOHA by letting N approach infinity. Please show the derivation. (3 pts)

(c) Show that the maximum efficiency of pure ALOHA systems is $1/2e$. Please show the derivation. (4 pts)

P5. (8 pts.) Consider the cyclic redundancy check. Assume the generator is given by G = 1010. What is the value of R for the following value of D?

a. D = 11000111010. (2 pts)

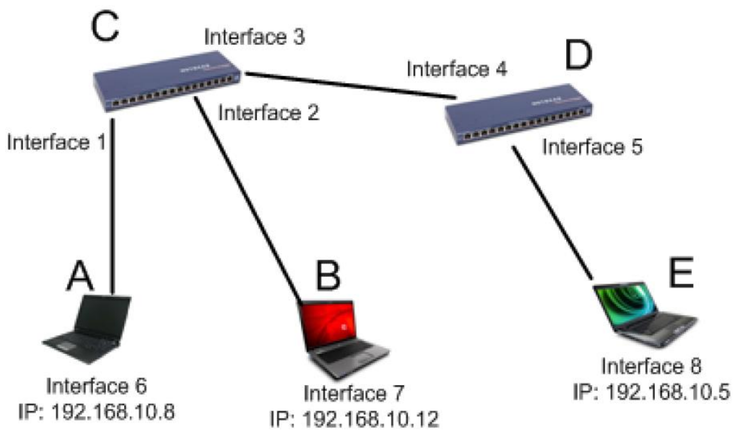
b. D = 01101010101. (2 pts)

c. D = 11111011111. (2 pts)

d. D = 10001110001. (2 pts)

P6. (12 pts.) Consider a network topology shown in the following figure that consists of three notebooks and two routers. The IP addresses of the notebooks are shown in the figure and the MAC addresses for the corresponding interfaces are shown in the following table. Answer the following questions.

Note: table filling problems will be graded on a row basis. A row is correct if and only if all the units of this row are correctly filled in. A student will get points for a correct row.



Interface	MAC
1	EE-F3-56-FC-26-12
2	42-73-BB-0A-06-87
3	2B-3D-84-6F-DC-28
4	3F-4E-CB-66-16-7D
5	90-27-CA-CB-0B-7E
6	A0-43-5B-CC-06-7D
7	13-05-32-EF-DD-02
8	7D-51-12-F3-EE-06

a. Suppose host A wants to send a packet to host B. In describing how this packet is sent from host A to host B through C. Please fill out the table below. You may add more rows if needed. (2 pts)

Path	Source MAC	Destination MAC	Source IP	Destination IP
From A to C				

b. Suppose now devices C and D are switches. Assume that the ARP tables in all the notebooks and the switch tables in all switches are initially empty. After host A sends an ARP query packet to learn the MAC address of host B, will host E receive the ARP query packet sent by host A? Justify your answer. (2 pts)

c. Based on assumption in sub-problem b, fill out the switch table below for switch C after host A receives reply from host B. You may add more rows if needed. (2 pts)

MAC Address	Interface

d. After host A has successfully sent a data packet to host B, host E tries to send a data packet to host B. Does host E need to issue an ARP query packet to learn the MAC address of host B? Why? If yes, will host A receive the ARP query packet sent by host E? Why? (3 pts)

e. Fill out the following switch table for switch C after host E has successfully sent a data packet to host B. You may add more rows if needed. (3 pts)

MAC Address	Interface