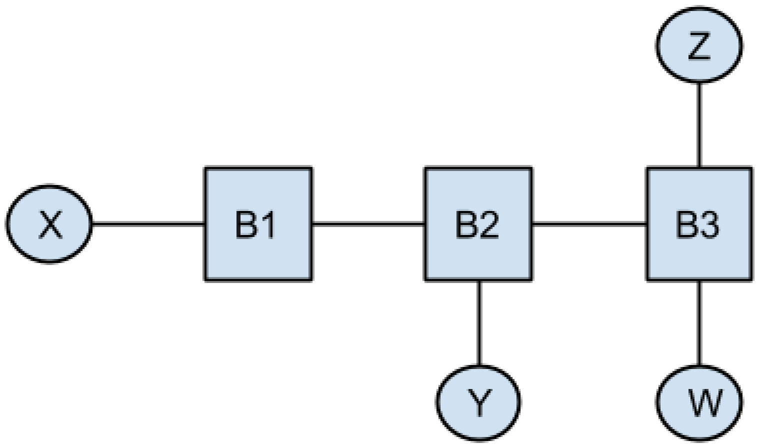
CSE 123: Computer Networks

Homework 3 Solutions

1. Learning Bridges



Consider the hosts W, X, Y, Z and the learning bridges B1, B2, B3. Assume, that they have empty forwarding tables to begin with and keep on adding entries based on the events.

a. Suppose host X sends a packet to W. Which bridges learn the location of host X (i.e., which of the bridge's interfaces should traffic destined to X be directed)? Also, does host Y see this packet? Also, which bridges learn the location of host W?

   `Bridges B1, B2, B3 learn of the location of host X. Yes, the host Y will see this packet since each of the bridges will flood this packet since they do not know the location of W. No, the bridges do not learn the location of W since the bridges flood the packet but do not know flooding on which interface made W get the packet.`

b. Now, suppose host Z sends to X. Which bridges learn the location of host Z? Also, does host Y see this packet? Also, which bridges learn the location of host X from this transmission?

   `Bridges B1, B2, B3 will learn the location of Z. No, host Y will not see this packet since the bridges already know the location of host X and hence do not need to flood the packet. As before, this transmission does not tell us anything about the host that receives the packet.`

c. Now, suppose host Y sends to X. Which bridges learn the location of host Y? Also, does host Z see this packet? Also, which bridges learn the location of host X from this transmission?

`Bridge B1, B2 will learn the location of Y. No, host Z will not see this packet. As before, this transmission does not tell us anything about the host that receives the packet.`

d. Now, finally host W sends to Y. Which bridges learn the location of host W? Does host Z see this packet? Also, which bridges learn the location of host Y from this transmission?

`Bridges B2, B3 will learn of the location of W. Yes, host Z will see this packet.As before, this transmission does not tell us anything about the host that receives the packet.`

2. IP Forwarding

Consider the forwarding and (partial) ARP tables below take from a router connected to four different networks. The router uses the IP addresses 192.168.32.2, 192.168.0.3, 192.168.6.1, and 192.168.7.1, on each of those networks, respectively.

Destination	Next Hop	Interface
127.0.0.1/32	127.0.0.1	lo0
default	192.168.32.1	eth0
192.168.0.0/16		eth0
192.168.0.0/21		eth1
192.168.4.0/22	192.168.0.4	eth1
192.168.6.0/24		eth2
192.168.7.0/24		eth3

IP Address	MAC Address
192.168.32.1	00:21:56:4a:38:00
192.168.32.2	ba:e8:56:24:88:00

192.168.0.4	78:31:c1:c5:7c:48
192.168.0.3	00:50:56:c0:00:01
192.168.6.1	00:50:56:c0:01:F1
192.168.6.255	FF:FF:FF:FF:FF:FF
192.168.7.1	0:50:56:c0:73:d8

a. Suppose the following Ethernet frame arrived at a router with the tables above. (Only a subset of the header fields are shown.) Which entry in the forwarding table would it match?

Eth Src	Eth Dst	IP Src	IP Dst	Payload
00:21:56:4a:38:00	ba:e8:56:24:88:00	10.1.17.23	192.168.5.137	...

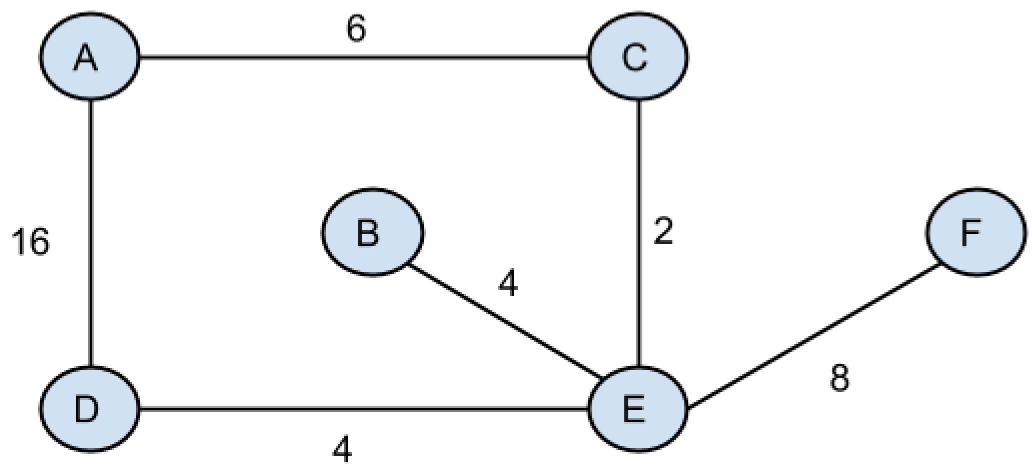
`The following entry will be used in the forwarding table.`

`192.168.4.0/22`	`192.168.0.4`	`eth1`

b. Assume that the packet is forwarded according to the tables above. What would the following fields of the frame contain as it leaves the router?

Eth Src	Eth Dst	IP Src	IP Dst	Payload
`00:50:56:c0:00:01`	`78:31:c1:c5:7c:48`	`10.1.17.23`	`192.168.5.137`	`...`

3. Link State Routing (OSPF)



Build the routing table for ***node A*** in the network shown above using the Link State Routing Algorithm. *(Show all the steps as shown in Table 3.14 in the textbook)*

No	**Confirmed**	**Tentative**
1	(A,0,-)	
2	(A,0,-)	(C,6,C),(D,16,D)
3	(A,0,-), (C,6,C)	(E,8,C),(D,16,D)
4	(A,0,-), (C,6,C), (E,8,C)	(B,12,C),(D,12,C),(F,16,C)
5	(A,0,-), (C,6,C), (E,8,C),(B,12,C)	(D,12,C),(F,16,C)
6	(A,0,-), (C,6,C), (E,8,C),(B,12,C),(D,12,C)	(F,16,C)
7	(A,0,-), (C,6,C), (E,8,C),(B,12,C),(D,12,C), (F,16,C)	

4. Distance Vector Routing

For the network given above, give the global distance-vector tables when using Distance Vector Routing Algorithm for the following three instances

a. Each node knows only the distances to its immediate neighbors.

Info @	A	B	C	D	E	F
A	0	∞	6	16	∞	∞
B	∞	0	∞	∞	4	∞
C	6	∞	0	∞	2	∞
D	16	∞	∞	0	4	∞
E	∞	4	2	4	0	8
F	∞	∞	∞	∞	8	0

b. Each node has reported the information it had in the preceding step to its immediate neighbors.

Info @	A	B	C	D	E	F
A	0	∞	6	16	8	∞
B	∞	0	6	8	4	12
C	6	6	0	6	2	10
D	16	8	6	0	4	12
E	8	4	2	4	0	8
F	∞	12	10	12	8	0

c. Step (b) happens a second time.

(Refer to Table 3.10 in the textbook for how the global distance-vector tables should look like!)

Info @	A	B	C	D	E	F
A	0	12	6	12	8	16
B	12	0	6	8	4	12

C	6	6	0	6	2	10
D	12	8	6	0	4	12
E	8	4	2	4	0	8
F	16	12	10	12	8	0

5. **Distance Vector Routing vs Link State Routing**

What characteristic of the updates in distance-vector routing help it scale better than link-state routing?

In the distance vector routing the updates are only sent to the immediate neighbors while in the link state routing the updates are sent out to all the nodes. Thus, if the network has a lot of nodes the updates might take a really long time in link-state routing. Hence, distance-vector routing scales better than link-state routing.

6. **Routing Protocols**

   a. Give an example of an intradomain and an interdomain routing protocol.

   Intradomain - OSPF, RIP
   Interdomain - BGP

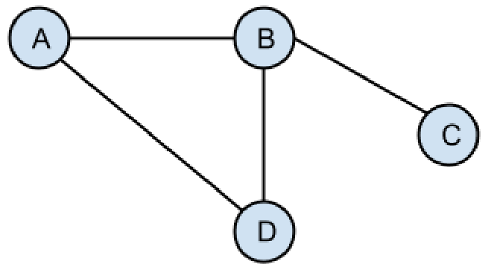
   b. The Internet uses different protocols for inter and intra domain routing. Give one reason why we do not use an intra-domain routing protocol for inter-domain routing.

   Intradomain protocols try to be as responsive as possible by leveraging knowledge of the entire network. However, some ASes do not wish to reveal/expose the internal topology of their network to other ASes. Hence, intradomain routing protocols aren't used in interdomain routing.

   c. In BGP, what is the difference between a customer/provider and peer AS relationship? In each of the relationships, who typically pays whom?

   In a customer/provider relationship the customer pays the provider for access to everyone via the provider while not acting as a transit for the provider. On the other hand peer relationships are more of an equal relationship in which ASes provide transit for each others' customers to their own customers, and vice versa.

7. Split Horizon and Poison Reverse



All of the links in the above network have weight 1. All entries in the routing table are timed, ie. if node fails to receive an update for the particular entry for more than a certain time interval, then the entry is marked invalid and discarded.

a. Now suppose that after the link between B and C fails, the following events occur in order given below:
   Event 1: B sends a route update saying the cost to reach C is infinite. *(Note: Though the route update is sent the other nodes do not receive the update right away and will* ***receive*** *the route update only in later events!)*
   Event 2: Simultaneously both A and D send updates saying that each can reach C with a cost of 2.
   Event 3: Now, A gets an update from B and D at the same time. The update from B is what was sent at *Event 1* while the update from D was sent at *Event 2*. After getting these two updates, A updates its routing table to say that it can reach C via D with a cost of 3.
   Event 4: Similarly, D will make a similar update after getting the update from B and A. That is, D updates its routing table to say that it can reach C via A with a cost of 3.

   Given the state of the network above, briefly explain how this scenario would continue if the network were to, from this point on, implement
   i. Split horizon
   ii. Split Horizon with Poison Reverse.

i. In Split Horizon, both A and D will not advertise to each other since they learn about the path from each other. After B chooses one of them to be its parent it will advertise a route to C with cost 4. However, both A and D have routes with cost 3 via each other. Hence, neither A and D will use the update that B sent. Eventually, all the entries will time out!

ii. If Split Horizon with Poison Reverse is added, then the count to infinity will end immediately, since A and D will send each others saying that the distance to C for them is ∞, since they learnt it from each other.

Note: Your points depend on how well you have explained what happens. Points have been allocated based on explanation if you've listed another possible scenario.

b. Now again suppose that if in the network above, the link between B and C goes down, list *a* sequence of events in which Split Horizon with Poison Reverse will fail to prevent a loop? *(Assuming we use Split Horizon with Poison Reverse from the start)* Use the following notation to describe the events ie. the messages sent by the nodes.
Notation: `[(X->Y, #) to Z]` *denotes that X can reach Y in a distance # and the update is sent to Z.*

1. [(B->C, ∞) to D]
2. [(A->C, 2) to D]
3. [(B->C, ∞) to A]
4. [(D->C, 3) to B]
5. [(A->C, ∞) to D]
6. [(B->C, 4) to A]
7. [(D->C, ∞) to B]
8. [(A->C, 5) to D]
9. [(B->C, ∞) to A]
10. [(D->C, 6) to B]

And the oscillations will continue and count to infinity.