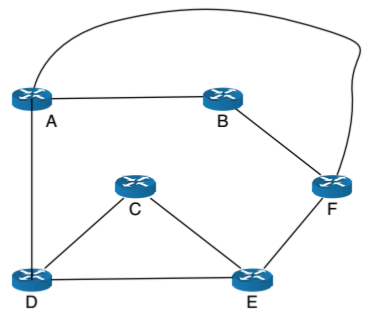
Problem 1

Consider a network of 6 routers shown in the figure below. The network is running OSPF routing protocol and the cost of each link is 10. Each router is announcing a single unique prefix, in total 6 prefixes are announced (prefix A, prefix B, ... prefix F). Propagation delay for each link is 10msec. When a router has to choose between two or more equal cost paths to the same destination, it breaks the tie by picking the path whose next hop has smallest name (A < B < C < D < E < F). The network has been up and running for a long time. However, at time T=100 min, link A-F fails.



1. How do node A and node F discover this link failure?

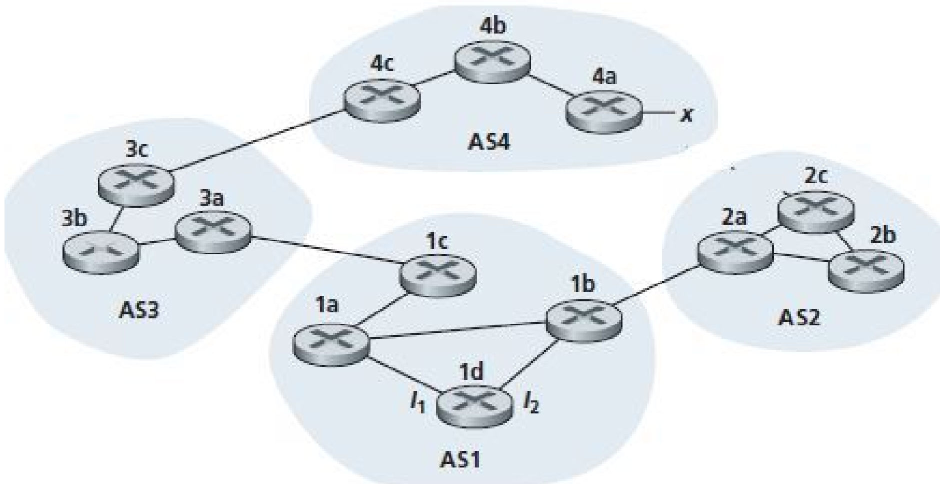
Since A and F are direct neighbors, they would know immediately when the connection is lost, and the change will shown in their link-state packets.

2. Will node C learn about this link failure? If so, does knowing this failure affect C's forwarding table?

Since OSPF requires each node to broadcast their information immediately when there is change to the link status, node C will know by receiving the broadcast message from A and F.

Problem 2

Consider the network shown below. Suppose all ASes (AS 1 – AS 4) are running OSPF for their intra-AS routing protocol. Suppose BGP is used for the inter-AS routing protocol (and iBGP is used inside each AS).



At some time T, the prefix x appears in AS4, adjacent to the router 4a. From which routing protocol (OSPF, eBGP, or iBGP):

1. Router 1c learns about prefix x?
2. Router 3b learns about prefix x?
3. Router 4a learns about prefix x?

1. 1c is not in the same AS as x, its AS is also not directly connected to the AS x is in. So it will only learn about x through eBGP fist to find out which AS x is in, using eBGP to first get to AS3, then use eBGP to get to AS4 from AS3, then it will use OSPF to find the specific route to get to x.

2. The AS 3b is in is directly adjacent from the AS x is in, so they can are connected by eBGP session. 3b will use eBGP to set a session with AS4 to find out x is in AS4, then use OSPF to know the specific path.

3. 4a is in the same AS as x, so they are connected by iBGP, which is for connection inside a specific AS. 4c will then use iBGP to set a session with x directly, without using eBGP. It will also use OSPF to know the specific physical distance.

Problem 3

1. How does BGP detect loops in paths?
2. Why does a BGP router not always choose routes with the shortest AS-path length?

1. Since BGP relies on message exchanging between neighbor routers, they don't have information about the global picture. Routers will advertise the full path, so this way the receiving router will easily detect loops by finding itself occurring in the path already.

2. In general BGP will choose the shortest path without loops because the length of the path is easy to detect in incoming messages, and it is also easy to detect loops. However, since routers want to only advertise the clients it is connected to, it will not advertise other routers or their clients, even if they might have a shorter path. It is the "no valley policy."

Problem 4

Suppose four active nodesnodes A, B, C and Dare 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.

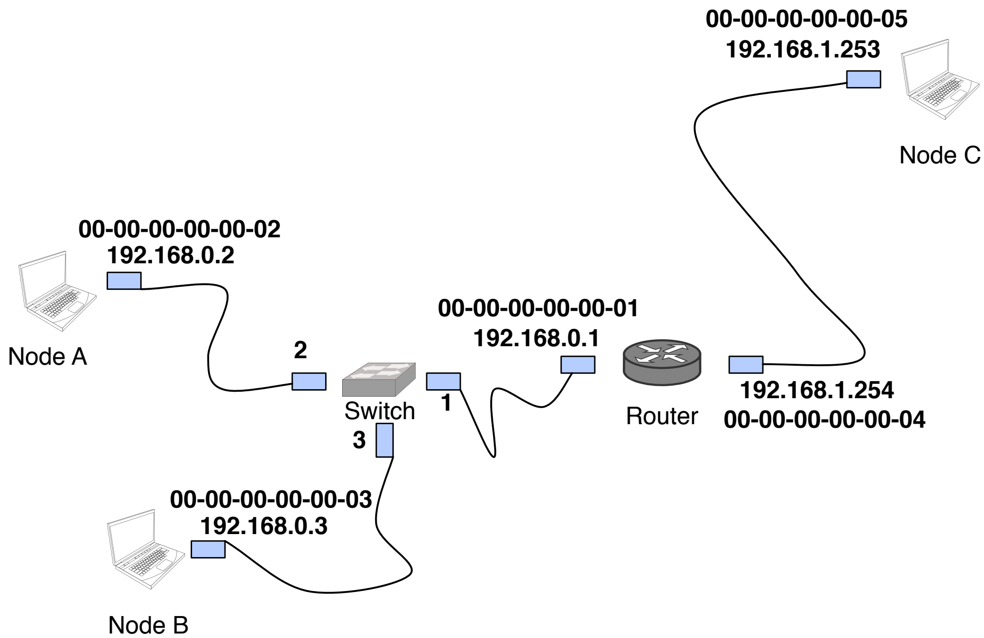
1. What is the probability that node A succeeds for the first time in slot 5?
2. What is the probability that any node (either A, B,C or D) succeeds in slot 4?

1.
let pA denote the probability that A succeeds in a specific time.
p(A first time in 5th) = p(A failed first four times) * p(A succeeds in 5th time) = $(1 - pA)^4$ * pA
pA = p(B,C,D all failed) * p(A succeeds) = $(1 - p)^3$ * p
p(A first time in 5th) = $(1 - p(1 - p)^3)^4 * (1 - p)^3 * p$

2.
p(A succeeds in slot 4) = $(1 - p)^3$ * p
p(B succeeds in slot 4) = $(1 - p)^3$ * p
p(C succeeds in slot 4) = $(1 - p)^3$ * p
p(D succeeds in slot 4) = $(1 - p)^3$ * p
p(either A, B,C or D)succeeds in slot 4) = 4 p$(1 - p)^3$
(because these events are mutually exclusive)

Problem 5

Consider the following network topology with specified MAC addresses for network interfaces and the configured IP addresses:



Assume the network mask for both subnetworks is 255.255.255.0.

1. Assume that routing tables are properly configured and the network just started (i.e., all caches are empty), fill the following table to enumerate Ethernet frames (in chronological order) needed for node B to send an IP packet to 192.168.0.2 and receive a response back.

frame #	dst MAC addr	src MAC addr	device(s) that can get the frame, excluding the sender	new entries added into the switch's table (if any)
1	...02	...03	switch,node A, node B, router	node B
2	...03	...02	switch,node A, node B, router	node A

Problem 5 continued on next page. . .

2. Assume that the previous operation is done, fill the following table to enumerate Ethernet frames (in chronological order) for node B to send a packet to 192.168.1.253 and receive a reply.

frame #	dst MAC addr	src MAC addr	device(s) that can get the frame, excluding the sender	new entries added into the switch's table (if any)
1	...05	92.168.1.253	switch,router,node A	
2	...05	...03	switch,router,node A	
3	...05	...03	switch,router,node A, node C	
4	...03	...05	router,switch	node C
5	...03	...05	router, switch, node B, node A	