50.012 Networks (2021 Term 6)

Homework 4

Link Layer Overview

Hand-out: 30 Nov

Due: 9 Dec 23:59

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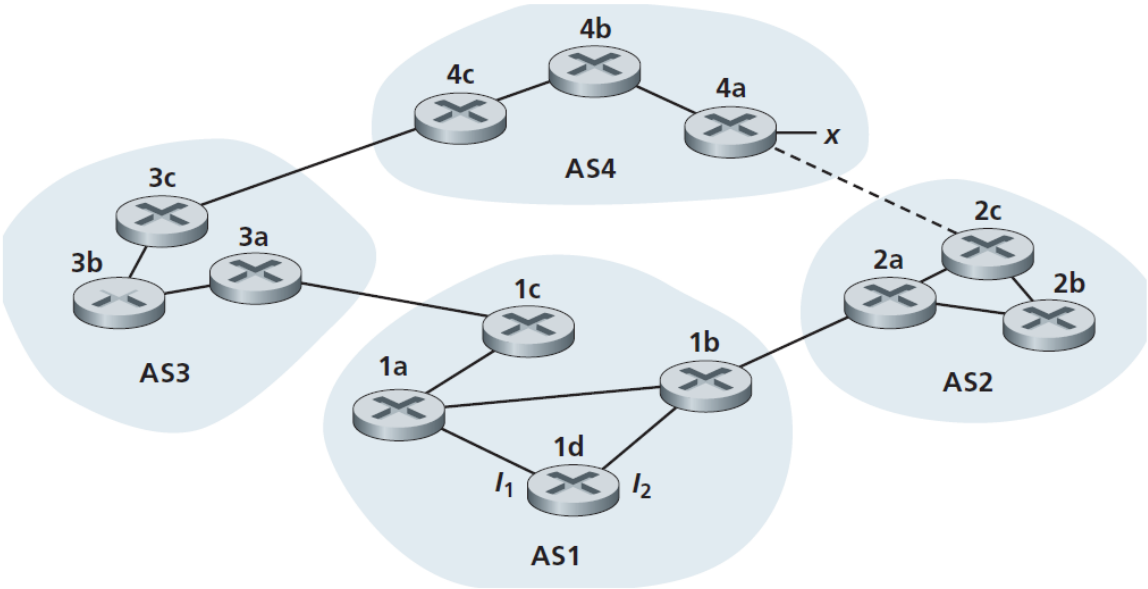
1. (textbook chapter 5, adapted from problem P14 and P15): Consider the network shown below. Suppose all the four ASes are running OSPF for their intra-AS routing protocol and assume the cost for every link in the graph is 1. Suppose eBGP and iBGP are used for the inter-AS routing protocol. Initially suppose there is no physical link between AS2 and AS4.



a. Router 3c learns about prefix x from which routing protocol: OSPF, eBGP, or iBGP?

Answer: eBGP.

b. Router 3a learns about x from which routing protocol?

Answer: iBGP.

c. Router 1c learns about x from which routing protocol?

Answer: eBGP.

d. Router 1d learns about x from which routing protocol?

Answer: iBGP.

e. Once router 1d learns about x it will put an entry (x, I) in its forwarding table. Will I be equal to I_1 or I_2 for this entry? Explain why in one sentence.

Answer: I_1. Since every link has the same cost of 1, using the I_1 interface has a lower overall least path cost of 2 from 1d to the gateway router 1c, while I_2 has a higher overall least path cost of 3.

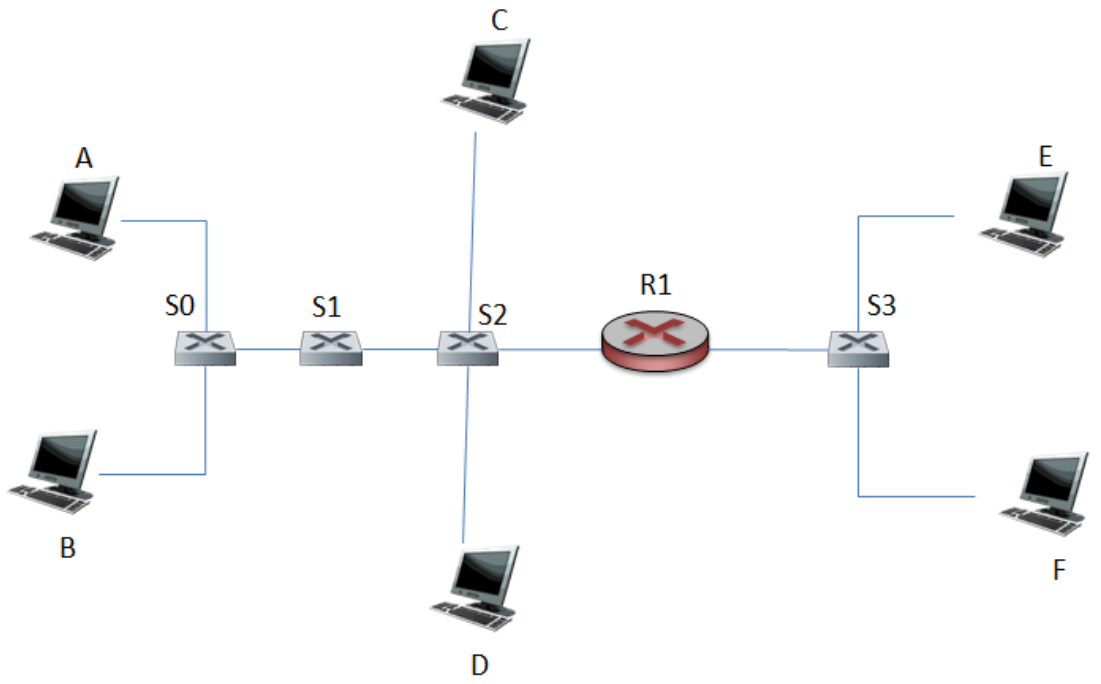
f. Now suppose that there is a physical link between AS2 and AS4, shown by the dotted line. Suppose router 1d learns that x is accessible via AS2 as well as via AS3. Will I be set to I_1 or I_2? Explain why in one sentence.

Answer: I_2. Both routes have an equal shortest AS-PATH length of 2, but due to hot potato routing, 1b is the closest NEXT-HOP router with the least intra-domain cost compared to 1a.

g. Now suppose there is another AS, called AS5, which lies on the path between AS2 and AS4 (not shown in diagram). Suppose router 1d learns that x is accessible via AS2 AS5 AS4 as well as via AS3 AS4. Will I be set to I_1 or I_2? Explain why in one sentence.

Answer: I_1. This is because it begins the path that has the shortest AS-PATH of 2.

2. (textbook chapter 6, adapted from problem P15): Consider the following network:



Where S0, S1, S2, and S3 are switches and R1 is a router. Note that the hosts at different side of R1 belong to different subnets.

a. Consider sending an IP datagram from Host E to Host F. Will Host E ask router R1 to help forward the datagram? Why? In the Ethernet frame containing the IP datagram, what are the source and destination IP and MAC addresses?

Answer: No. Host E would be able to check the subnet prefix of Host F's IP address and would realize/know that Host F is on the same LAN. Hence, E will not send the packet to the default router R1.

In the Ethernet frame from E to F:

- Source IP Address: E's IP address
- Destination IP Address: F's IP address
- Source MAC Address: E's MAC address
- Destination MAC Address: F's MAC address

b. Suppose host E would like to send an IP datagram to host B and assume that E's ARP cache does not contain B's MAC address. Will E perform an ARP query to find B's MAC address? Why? In the Ethernet frame (containing the IP

datagram destined to B) that is delivered to router R1, what are the source and destination IP and MAC addresses?

Answer: No, since after checking Host B's IP address, E would find out and learn that E and B are not within the same LAN.

In the Ethernet frame from E to R1:

- Source IP Address: E's IP address
- Destination IP Address: B's IP address
- Source MAC Address: E's MAC address
- Destination MAC Address: The MAC address of the router R1's interface connected to the switch S3

c. Suppose Host A would like to send an IP datagram to Host B, and neither A's ARP cache contains B's MAC address, nor does B's ARP cache contain A's MAC address. Further suppose that the switch S1's forwarding table contains entries for Host B and router R1 only. Thus, A will broadcast an ARP request message. What actions will switch S1 perform once it receives the ARP request message? Will router R1 also receive this ARP request message? If so, will R1 forward the message? Once Host B receives this ARP request message, it will send back to Host A an ARP response message. But will it send an ARP query message to ask for A's MAC address? Why? Will switch S1 receive the ARP response message from Host B?

Answer: Switch S1 would first receive the Ethernet frame from its left interface, and it will forward it to its right interface as the received ARP frame's destination MAC address is a broadcast address. Switch S1 would also learn that A exists on the left interface of S1, and it will update its own forwarding table to include an entry for Host A.

While router R1 does receive this ARP request message, it will actually not forward the message to S3.

B would not send another ARP query message asking for A's MAC address since this address can be obtained from A's query message.

As an ARP reply from B is a unicast message with the destination MAC being A's MAC address, and switch S0 would already have A's entry in its forwarding table, it will only forward to A. Thus, switch S1 would not receive B's response message.

3. Consider the Cyclic Redundancy Check (CRC) algorithm. Suppose that the 4-bit generator (G) is 1001, that the data payload (D) is 10011001 and that r = 3. What are the CRC bits (R) associated with the data payload D? Please include in your answer the process you calculate the CRC.

Answer: (D << r) / G = (10011001 << 3) / 1001 = 10011001000 / 1001 = 10001000, with a remainder of exactly 0. Hence, the CRC bits (R) are **000**.