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Introduction to Computer Networks   Final exam., Fall 2014
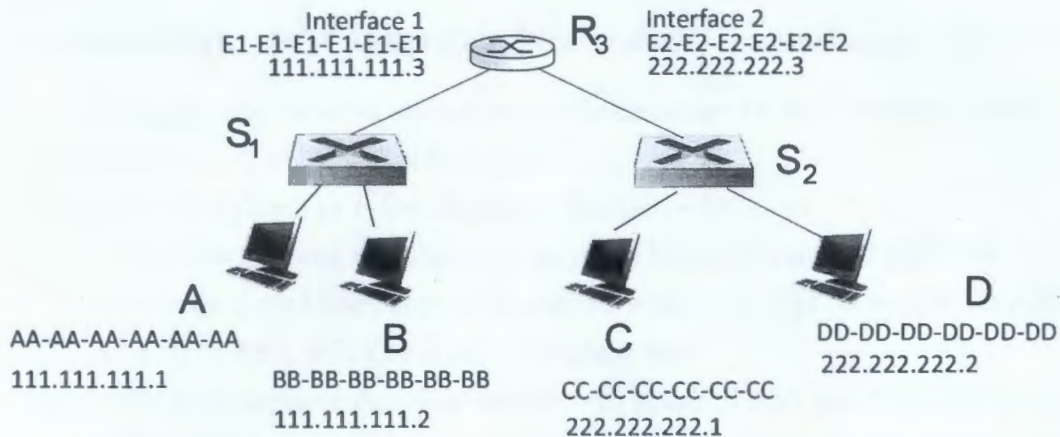
1. (9%) Consider the network shown below. Once router *1b* learns about *x*, it will put an entry (x, l) in its forwarding table.

   (a) (3%) Will l be l_1 or l_2 for this entry? Explain why.

   (b) (3%) Now suppose that there is a physical link between AS2 and AS4, shown by dotted line. Suppose router *1b* learns that X is accessible via AS2 as well as AS3. Will l be l_1 or l_2 ? Explain why.

   (c) (3%) Now suppose that there are two AS's, called AS5 and AS6, which lie on the path between AS1 and AS2 (not shown in diagram). Suppose router *1b* learns that X is accessible via A2AS5AS6 as well as via AS2AS4AS3. Will l be l_1 or l_2 ? Explain why.
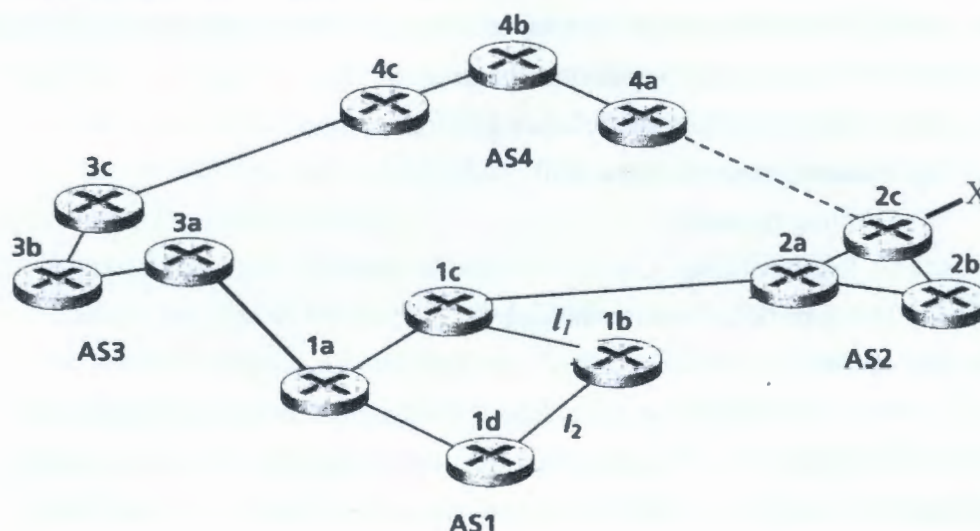
2. (8%) Describe two usages of the AS-PATH attribute.

3. (5%) There are two approaches for determining multicast routing tree, namely, group-shared tree and source-based tree. What are the advantages of using group-shared tree over source-based tree?

4. (5%) What is a minimum spanning tree?

5. (5%) Explain how the sequence-number-controlled flooding works.

6. (5%) Describe the operations of reverse path forwarding.

7. (8%) Consider the topology shown in the following. Suppose that all links have unit cost and node A is the broadcast source. Use arrows to indicate links over which packets will be forwarded using reverse path forwarding (RPF), and links over which packets will not be forwarded.
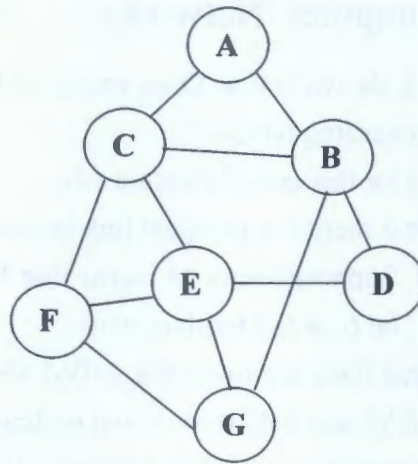
8. (5%) If the links in the Internet were to provide the reliable service, why would the TCP reliable delivery service be needed?

9. (15%) Briefly explain the following terms.
   (a) Binary exponential backoff
   (b) Polling protocol
   (c) VLAN trunking
   (d) Multiprotocol label switching
   (e) Blade

10. (7%) Assume that host A and host B are connected through a bus running CSMA/CD protocol. Assume that the propagation time between A and B is 10 msec. Assume that before time zero there is no packet on the bus and at time zero host A sends a packet to B. Assume that the transmission time of the packet is 5 msec. Assume that at time t=8 msec, host B sends a packet to A. Assume that the transmission time of the second packet is also 5 msec. Assume that the collision detection/abortion time is 1 msec. Draw a picture to show how the packets propagate and how collision is detected and packet transmission is aborted. Indicate events and event times in your picture.

11. (10%) Consider the network shown below. The MAC addresses and the IP addresses are shown. Assume that the ARP tables in all the nodes in this network contain up-to-date information. Also assume that the switch tables in the two link-layer switches have up-to-date information. Suppose that host A wants to send a packet to host C. Explain how host A determines the destination MAC address of this packet and how the packet is forwarded to its destination, host C.

Interface 1
E1-E1-E1-E1-E1-E1
111.111.111.3

R₃

Interface 2
E2-E2-E2-E2-E2-E2
222.222.222.3

S₁   S₂

A
AA-AA-AA-AA-AA-AA
111.111.111.1

B
BB-BB-BB-BB-BB-BB
111.111.111.2

C
CC-CC-CC-CC-CC-CC
222.222.222.1

D
DD-DD-DD-DD-DD-DD
222.222.222.2

12. (18%) Consider the network shown below. Assume that the three switches in the figure are all link-layer switches. The IP addresses and the MAC addresses of the hosts are shown next to the names of the hosts. Assume that at 9 AM the ARP tables in all hosts and the state tables in all switches are empty. Assume that the maximum length of time-to-live (TTL) value in the ARP table is long enough that we ignore this field in the ARP table. We make the same assumption on the aging time in the switch tables.

(a) Suppose that host A sends a packet to host C at 9:00 AM, and host C receives the packet before 9:01 AM. Explain how ARP tables in all nodes and switch tables in all switches are filled and show the content of the all such tables in the network after the packet is received by C.

(b) Following part (a), suppose that at 9:10 AM host D sends a packet to host B, and host B receives the packet before 9:11 AM. Explain how ARP tables in all nodes and the state tables in all switches are filled and show the content all of all such tables after the packet is received by B.

(c) Following part (b), at 9:15 AM, host D sends a packet to host A, and host A receives the packet before 9:16 AM. Explain how ARP is involved and how the switches forward the packet. Show the contents of all ARP tables and all switch tables in the network after the packet is received by A.

S₃

S₁   S₂

A
AA-AA-AA-AA-AA-AA
10.10.10.10.1

B
BB-BB-BB-BB-BB-BB
10.10.10.10.2

C
CC-CC-CC-CC-CC-CC
10.10.10.10.3

D
DD-DD-DD-DD-DD-DD
10.10.10.10.4

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