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CS 4480 - Homework Assignment 8

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For this problem, let the routers on the left and right be named R1 and R2, respectively. Furthermore, let each router's left and right interfaces be named -L and -R, respectively. Also, let the switches from left to right be named S1, S2, and S3, respectively.

- a. The interfaces are assigned the following IP addresses:

A => 192.168.1.10
B => 192.168.1.11
R1-L => 192.168.1.12

C => 192.168.2.20
D => 192.168.2.21
R1-R => 192.168.2.22
R2-L => 192.168.2.23

E => 192.168.3.30
F => 192.168.3.31
R2-R => 192.168.3.32

- b. The adapters are assigned the following MAC addresses:

A => 11-11-11-11-11-10
B => 11-11-11-11-11-11
R1-L => 11-11-11-11-11-12

C => 22-22-22-22-22-20
D => 22-22-22-22-22-21
R1-R => 22-22-22-22-22-22
R2-L => 22-22-22-22-22-23

E => 33-33-33-33-33-30
F => 33-33-33-33-33-31
R2-R => 33-33-33-33-33-32

- c. With all ARP tables up to date, the steps are as follows:

1. Host E encapsulates the datagram in a frame destined for MAC address 33-33-33-33-33-32 (adapter R2-R), and sends it.
 2. S3 receives the frame and only forwards it to the link with R2-R (host F does not receive the frame).
 3. R2-R processes the frame, sees that the destination IP address is not on its subnet, looks up the appropriate interface in its forwarding table, then forwards the datagram to R2-L.
 4. R2-L sees that the destination IP address is not on its subnet, encapsulates the datagram in a frame destined for MAC address 22-22-22-22-22-22 (adapter R1-R), and sends it.
 5. S2 receives the frame and only forwards it to the link with R1-R (hosts C and D do not receive the frame).
 6. R1-R processes the frame, sees that the destination IP address is not on its subnet, looks up the appropriate interface in its forwarding table, then forwards the datagram to R1-L.
 7. R1-L sees that the destination IP address is on its subnet, encapsulates the datagram in a frame destined for MAC address 11-11-11-11-11-11 (host B), and sends it.
 8. S1 receives the frame and forwards it to the link with B (host A does not receive the frame).
 9. Host B receives the frame and processes it.
- d. With the ARP table in host E empty and all other ARP tables up to date, the steps are as follows:
1. Because the destination IP address is not on the same subnet, host E constructs an ARP query packet destined for the broadcast MAC address FF-FF-FF-FF-FF-FF, requesting the MAC address corresponding to IP address 192.168.3.32 (its default gateway, R2-R).
 2. S3 receives the ARP query packet and forwards it to the link with R2-R and the link with F.
 3. Host F receives the ARP query packet but does not respond. R2-R processes the packet and sends a response ARP packet directly

back to MAC address 192.168.3.30 (host E).

4. S3 receives the ARP response and forwards it to the link with host E (host F does not receive the packet).
5. Host E encapsulates the datagram in a frame destined for MAC address 33-33-33-33-33-32 (adapter R2-R), and sends it.
6. S3 receives the frame and only forwards it to the link with R2-R (host F does not receive the frame).
7. R2-R processes the frame, sees that the destination IP address is not on its subnet, looks up the appropriate interface in its forwarding table, then forwards the datagram to R2-L.
8. R2-L sees that the destination IP address is not on its subnet, encapsulates the datagram in a frame destined for MAC address 22-22-22-22-22-22 (adapter R1-R), and sends it.
9. S2 receives the frame and only forwards it to the link with R1-R (hosts C and D do not receive the frame).
10. R1-R processes the frame, sees that the destination IP address is not on its subnet, looks up the appropriate interface in its forwarding table, then forwards the datagram to R1-L.
11. R1-L sees that the destination IP address is on its subnet, encapsulates the datagram in a frame destined for MAC address 11-11-11-11-11-11 (host B), and sends it.
12. S1 receives the frame and forwards it to the link with B (host A does not receive the frame).
13. Host B receives the frame and processes it.

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- a. Host E will not ask router R1 for help forwarding the datagram. This is because host E knows that the IP address of host F is on the same subnet (thanks to the network mask).

The source and destination IP addresses are 192.168.3.30 (host E) and 192.168.3.31 (host F), respectively.

The source and destination MAC addresses are 33-33-33-33-33-30 (host E)

and 33-33-33-33-33-31 (host F), respectively.

- b. Host E will not perform an ARP query to find host B's MAC address. This is because host E knows that host B is not on the same subnet (thanks to the network mask).

The source and destination IP addresses are 192.168.3.31 (host E) and 192.168.1.11 (host B), respectively.

The source and destination MAC addresses are 33-33-33-33-33-30 (host E) and 33-33-33-33-33-32 (interface R1-R).

- c. S1 will broadcast the ARP request on the interface that is not connected to the link from which the request came.

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The answer to this problem is effectively a regurgitation of the entirety of section 5.7. I'll give a much more succinct answer, hoping that I don't lose points. The steps are as follows:

1. At some point after our PC is powered on, it transmits a DHCP request to the broadcast IP address 255.255.255.255 (via UDP).
2. An Ethernet switch connected to our PC broadcasts the frame containing the DHCP request on all outgoing ports. For the sake of brevity, we'll assume that the DHCP server is connected to one of said outgoing ports.
3. The DHCP server broadcasts a DHCP ACK containing an IP address, network mask, DNS servers, and default gateway. The frame for this response is addressed to the MAC address of our PC.
4. The switch transmits the DHCP ACK to our PC (and we're connected)!
5. We launch Google Chrome, type <https://www.google.com> into the address bar, and press Enter. We'll assume that the DNS server is not on the same subnet as our PC.
6. Our PC broadcasts an ARP query to FF-FF-FF-FF-FF-FF, requesting the MAC address of its default gateway (one of the router's interfaces).
7. The router sends an ARP response with its MAC address directly to the MAC address of our PC.

8. Our PC creates a DNS query and sends it via UDP. The frame containing this query is addressed to the MAC address of the router.
9. The router forwards the DNS query to the interface connected to the subnet containing the DNS server, which sends it to the MAC address of the DNS server.
10. The DNS server sends a response to the MAC address of the router. The router forwards to the MAC address of our PC.
11. Our PC creates a TCP connection to the web server (via SYN, SYNACK, ACK).
12. Our PC's browsers sends an HTTPS request to the web server.
13. The web server responds with an HTML page.