Wesleyan University, Spring 2023, COMP 332

Homework 8: Link layer and MAC addresse

Due by 11:59pm on May 3, 2023

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1. Written problems (10 points)

Problem 1. *Consider three LANs interconnected by two routers, as in Figure 1.*

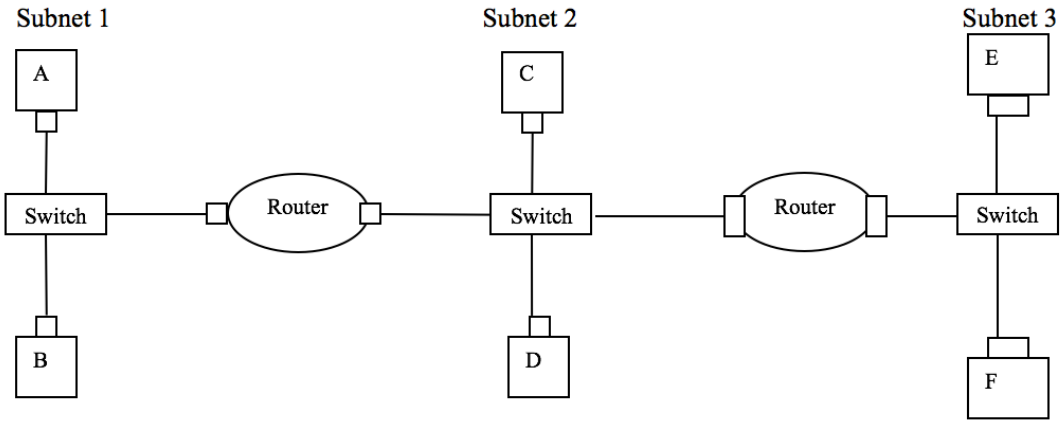

Figure 1. Three LANs interconnected by two routers.

a: *Assign IP addresses to all of the interfaces. For Subnet 1 use addresses of the form 192.168.1.*, for Subnet 2 use addresses of the form 192.168.2.*, and for Subnet 3 use addresses of the form 192.168.3.*.*

b: *Assign MAC addresses to all of the adapters.*

c: *A host can tell whether another host is on the same LAN by comparing its IP address with that of the other host. Consider sending an IP packet from Host E to Host B. Suppose all of the ARP tables are up to date. Enumerate all of the steps, as done for the single-router example in Section 6.4.1.*

d: *Suppose the router between Subnets 1 and 2 is replaced with a switch S1, and label the router between Subnets 2 and 3 as R1. Also suppose that now the ARP tables are not up to date. Will E perform an ARP query to find B's MAC address? Why? In the Ethernet frame (containing the IP packet destined to B), that is delivered to router R1, what are the source and destination MAC addresses?*

Solution:

a: See Figure 2.

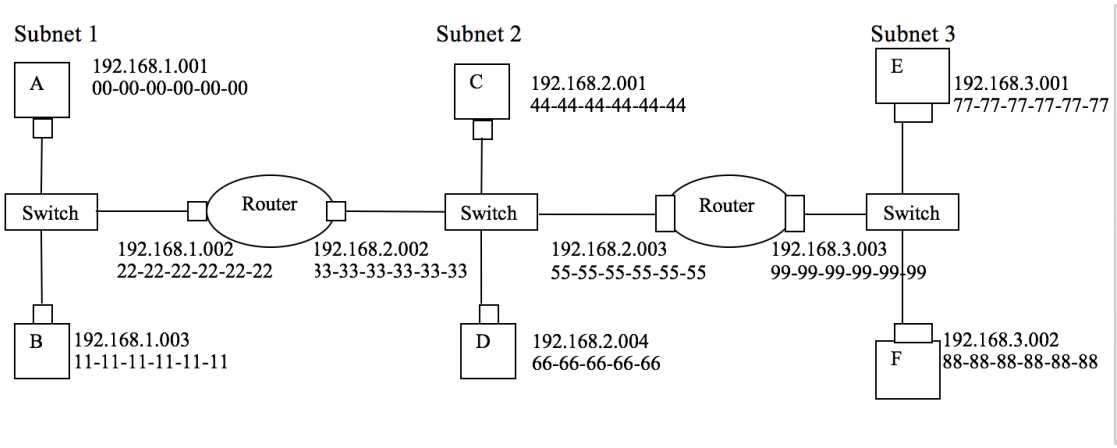

FIGURE 2. Questions 2(a),(b): Assignment of IP and MAC addresses.

b: See Figure 2.

c: (1) Forwarding table in E determines that the packet should be routed to interface 192.168.3.003, since the IP address of B is on a different LAN than that of A.
(2) The adapter in E creates an Ethernet packet with Ethernet source address 77-77-77-77-77-77 and destination address 99-99-99-99-99-99
(3) The router on Subnet 3 receives the packet. The forwarding table in this router indicates that the packet is to be routed to 198.162.2.002.
(4) The router then sends the Ethernet packet with source address of 55-55-55-55-55-55 and destination address of 33-33-33-33-33-33 via its interface with IP address of 198.162.2.003.
(5) The router in Subnet 2 receives the packet. The forwarding table in this router indicates that the packet is to be routed to 192.168.1.003.
(6) The router then sends the Ethernet packet with source address of 22-22-22-22-22-22 and destination address of 11-11-11-11-11-11 via its interface with IP address of 198.162.1.002.

d: No, E will not perform an ARP query to find B's MAC address since they are not on the same LAN. E can find this out by checking B's IP address and comparing to B's subnet prefix: Becasue B is on a different subnet, these prefixes won't match. In the Ethernet frame that is delivered to router R1 there are the following addresses:

```
Source IP = E's IP address
Destination IP = B's IP address
Source MAC = E's MAC address
Destination MAC = The MAC address of R1's interface connecting to Subnet 3.
```

PROBLEM 2. *Open wireshark and start recording. While recording traffic, open* `stanford.edu`. *Once the webpage has loaded, stop recording traffic. Enter the filter* `arp`*, to display only ARP traffic. You may see some (gratuitous) ARP traffic, with destination address 00:00:00:00:00:00*

(which is used as the broadcast address by ARP: you will see this corresponds to ff:ff:ff:ff:ff:ff for the destination address for Ethernet).

Find an ARP frame being sent to your device rather than being sent to the Broadcast address.

a: *Take a screenshot of one of the ARP frames displayed, making sure the ARP header is expanded. What protocol does ARP run over? What upper layer protocol is in the type field of the Ethernet frame? What is the 48-bit sender MAC address? What is the sender IP address?*

b: *Using* `ifconfig`*, determine the IP address of your computer. Associated with the entry for the IP address is the 48-bit MAC address for your computer. What are the IP and MAC addresses for your computer?*

c: *Are the addresses in (a) and (b) the same or different? Do the addresses have a shared prefix? Did your computer send the ARP or did another device send the ARP?*

d: *Open a terminal and run* `traceroute stanford.edu`*. What is the IP address of the first hop? Does this IP address correspond to the IP address observed in (a)? What do you think this address might correspond to?*

e: *Set the wireshark filter to be* `ip.addr == 171.67.215.200`*, the IP address for* `stanford.edu`*. Take a screenshot of a packet sent to your computer, making sure the link layer and network layer headers are expanded. What is the MAC address of the packet source? What is the IP address of the packet source? Does this MAC address correspond to the address in (a)? Does this MAC address belong to the* `stanford.edu` *or to another device? What upper layer protocol is in the type field of the Ethernet frame?*

Solution:

a: Figure 3 shows a screenshot of an ARP frame. For this frame, ARP runs over Ethernet II, the sender MAC address is 38:80:df:f6:83:2b and the sender IP address: 192.168.0.1.

b: Using `ifconfig` (information below), I determine my MAC address is 88:66:5a:28:6e:b1 and my IP address is 192.168.0.14.

```
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
options=400<CHANNEL_IO>
ether 88:66:5a:28:6e:b1
inet6 fe80::1838:147b:9068:17c6%en0 prefixlen 64 secured scopeid 0x6
inet 192.168.0.14 netmask 0xffffff00 broadcast 192.168.0.255
```

c: The addresses in (a) and (b) are different, although their IP addresses have a shared prefix indicating that they are on the same subnet. Therefore my computer did not send the ARP frame, another device did.

d: Running `traceroute` gives me the following information.

```
traceroute to stanford.edu (171.67.215.200), 64 hops max, 52 byte packets
1  192.168.0.1 (192.168.0.1)  10.612 ms  1.397 ms  1.326 ms
2  96.120.66.245 (96.120.66.245)  18.007 ms  14.925 ms  22.475 ms
3  po-304-1222-rur102.berlin.ct.hartford.comcast.net (96.110.29.249)  41.939 ms  12.582
4  96.108.71.181 (96.108.71.181)  17.300 ms  12.947 ms  20.505 ms
5  be-2-ar01.needham.ma.boston.comcast.net (68.87.147.149)  19.720 ms  17.353 ms  14.491
6  be-1005-pe11.onesummer.ma.ibone.comcast.net (68.86.90.66)  20.181 ms  15.324 ms  14.9
```

The first hop IP address of 192.168.0.1 does correspond to the IP address in part (a). This address corresponds to the address of the gateway router, which is the router used to get off the subnet.

e: A screenshot of the packet from the `stanford.com` is shown in Figure 4. For this packet, the MAC address is 38:80:df:f6:83:2b and the IP address is 171.67.215.200. This MAC address does not correspond to the `stanford.com`, it belongs to another device, in this case, the gateway router. The upper layer protocol is IPv4.

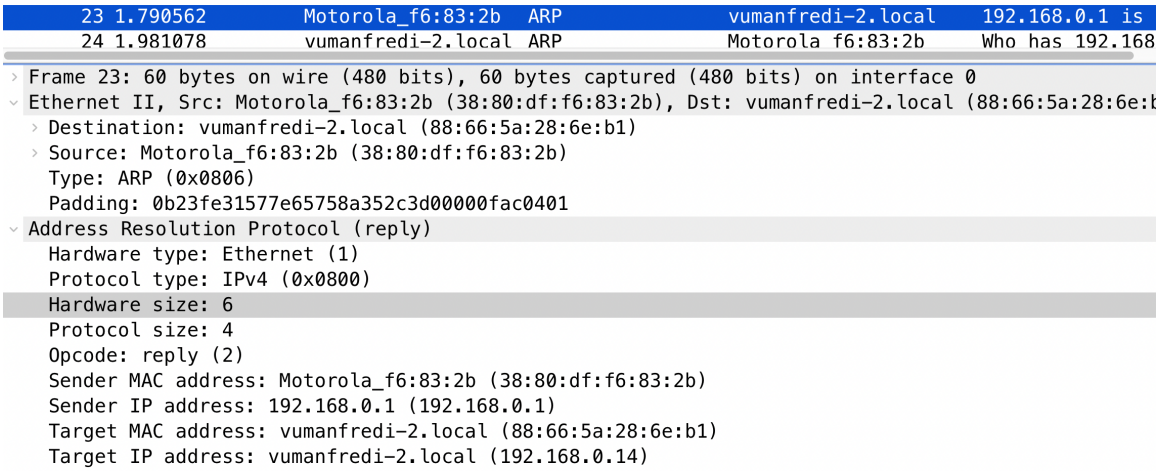

FIGURE 3. Question 4(a): screenshot of gratuitous ARP frame.

2. SUBMISSION

Upload your written work as `hw8.pdf` and your *.py files to the WesFiles directory I have created for you at the following URL. All files should include your name!

`https://wesfiles.wesleyan.edu/home/vumanfredi/web/comp332-f18/submissions/hw8/USERNAME`

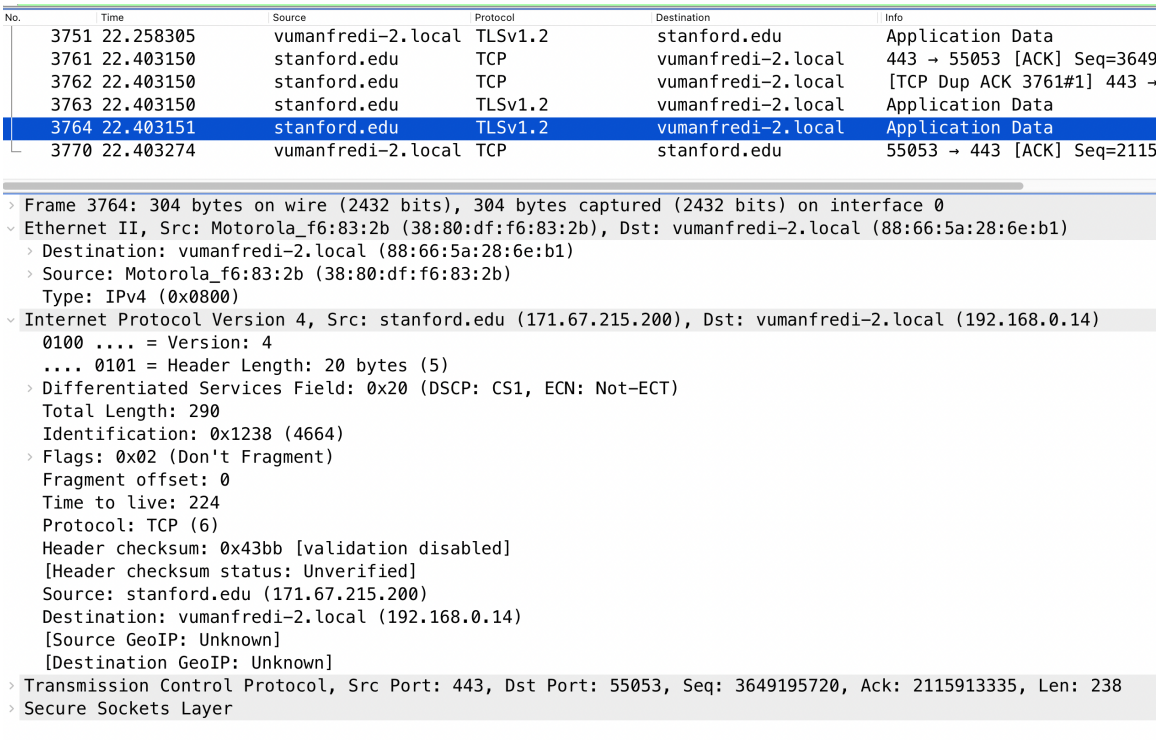

FIGURE 4. Question 4(e): Screenshot of packet received from `stanford`.

You should replace `USERNAME` with your Wesleyan username. You will be asked to enter your Wesleyan username and password to access the page. Once the page opens, you should click on the "Open Web View" link that shows up on the page, and that should take you to a page that gives you options to upload files.

3. SUBMISSION

Submit your written work as `hw8.pdf` files to the Google Drive directory I have created for you named `comp332-s23-USERNAME/hw8/`. You should replace `USERNAME` with your Wesleyan username.

Do not forget that your written work must be submitted as a PDF! And make sure that at the top of each file you have put your name! Do not, however, change the names of the files.