COMP 332, Homework 8: *Link layer and MAC addresses*
Due by 11:59pm on November 14, 2018

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1. Written problems (10 points)

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

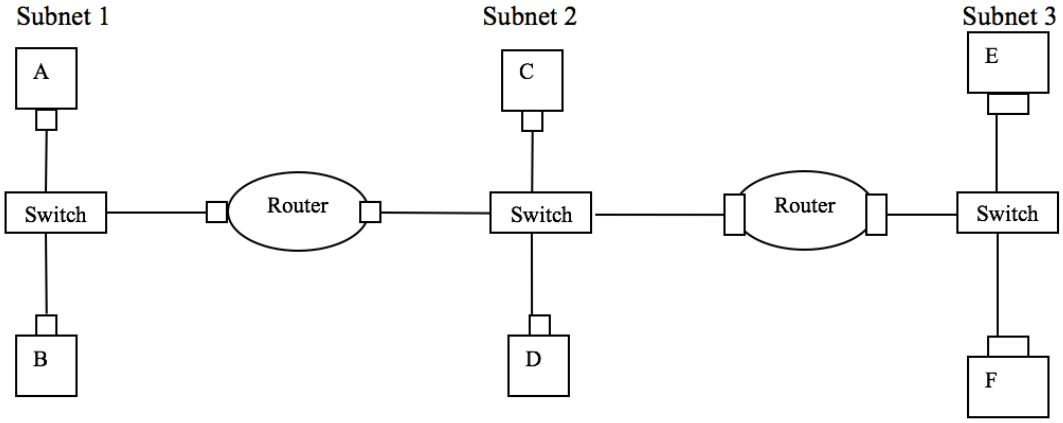

Figure 1. Three LANs interconnected by two routers.

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.

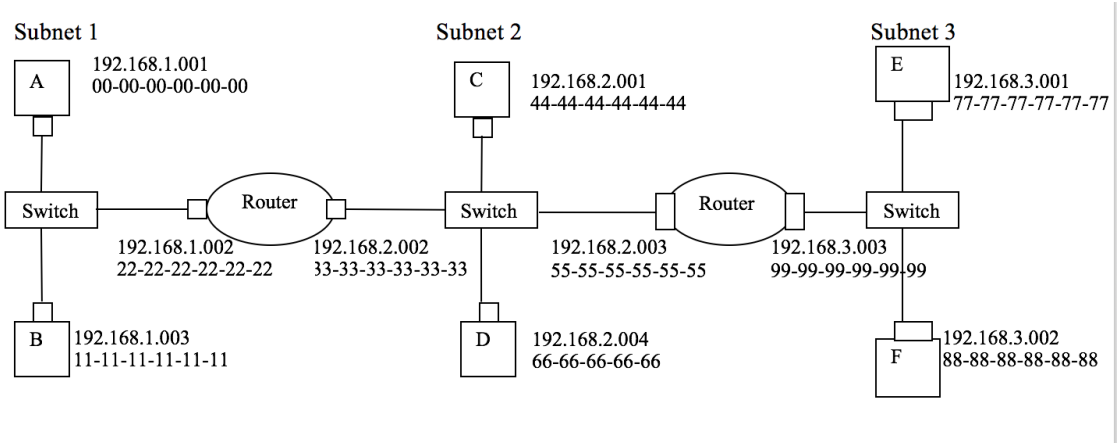

FIGURE 2. Questions 2(a),(b): Assignment of IP and MAC addresses.

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. 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. *Make sure you are on the Wesleyan network for this question. Open wireshark. While recording traffic, open* `www.nytimes.com`. *Once the webpage has loaded, stop recording traffic. Enter the filter* `arp`, *to display only ARP traffic. You should see 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).*

a: *Take a screenshot of one of the gratuitous 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 www.wesleyan.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: *Change the filter to be* `ip.addr == 151.101.117.164`*, the IP address for* `www.nytimes.com`*. 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* `nytimes` *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 a gratuitous ARP frame. For this frame, ARP runs over Ethernet II, the sender MAC address is 3c:8a:b0:1e:18:01, and the sender IP address: 129.133.176.1.

b: Using `ifconfig` (information below), I determine my MAC address is 78:31:c1:c5:b4:9a and my IP address is 129.133.182.236.

```
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
ether 78:31:c1:c5:b4:9a
inet6 fe80::7a31:c1ff:fec5:b49a%en0 prefixlen 64 scopeid 0x4
inet 129.133.182.236 netmask 0xfffff000 broadcast 129.133.191.255
```

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.

```
vmanfredis-MBP:webpage vmanfredi$ traceroute www.wesleyan.edu
traceroute to www.wesleyan.edu (129.133.7.68), 64 hops max, 52 byte packets
1  129.133.176.1 (129.133.176.1)  3.343 ms  3.529 ms  3.942 ms
```

```
2  172.16.100.1 (172.16.100.1)  3.785 ms  3.208 ms  4.396 ms
```

The first hop IP address of 129.133.176.1 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 `nytimes` is shown in Figure 4. For this packet, the MAC address is 3c:8a:b0:1e:18:01 and the IP address is 151.101.117.164. This MAC address does not correspond to the `nytimes`, it belongs to another device, in this case, the gateway router. The upper layer protocol is IPv4.

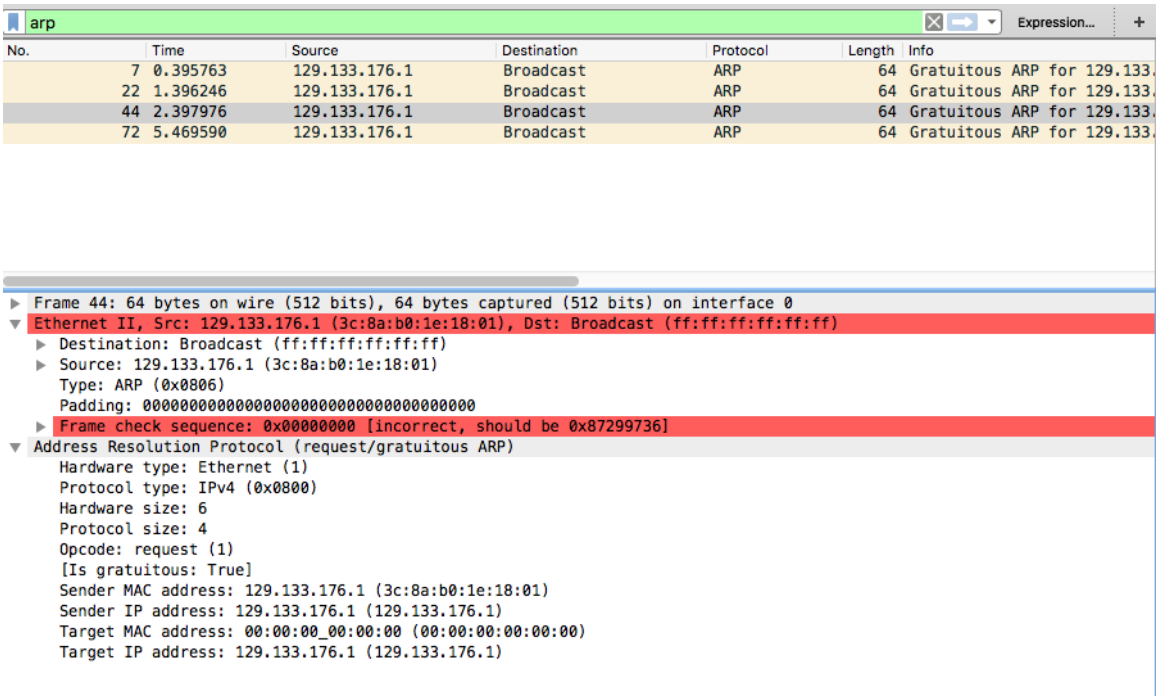

FIGURE 3. Question 4(a): screenshot of gratuitous ARP frame.

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`

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.

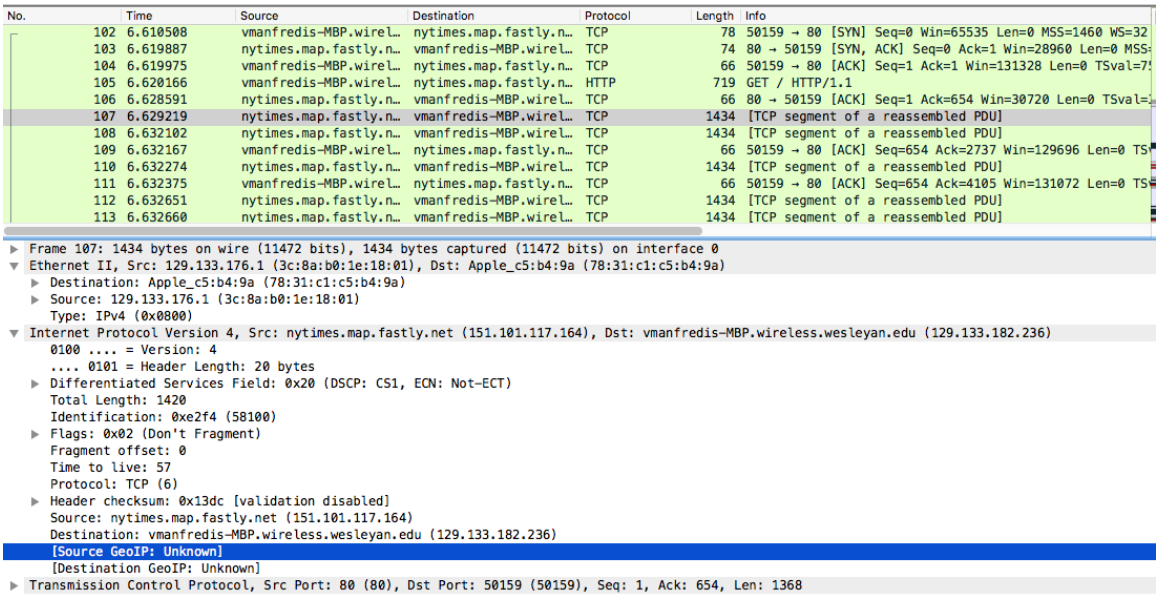

FIGURE 4. Question 4(e): Screenshot of packet received from `nytimes`.