

- What is the 48-bit Ethernet address of your computer? The Ethernet address of my computer is 50:ed:3c:4a:36:31
- What is the 48-bit destination address in the Ethernet frame? Is this the Ethernet address of gaia.cs.umass.edu? (Hint: the answer is no). What device has this as its Ethernet

address? [Note: this is an important question, and one that students sometimes get wrong. Re-read pages 468–469 in the text and make sure you understand the answer here.] The destination address 2e:67:be:05:95:c5 is not the Ethernet address of gaia.cs.umass.edu. It is the address of my router, which is the link used to get off the subnet.

3. Give the hexadecimal value for the two-byte Frame type field. What upper layer protocol does this correspond to? The hex value for the Frame type field is 0x0800. This corresponds to the IP protocol, the frame type field indicates that the next layer above IP, the layer to which the payload of this Ethernet frame will be passed, is IP.
4. How many bytes from the very start of the Ethernet frame does the ASCII “G” in “GET” appear in the Ethernet frame? The ASCII “G” appears 55 bytes from the start of the Ethernet frame.(47 value)

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> Frame 69: 1486 bytes on wire (11888 bits), 1486 bytes captured (11888 bits) on interface en0, id 0
  Ethernet II, Src: 2e:67:be:05:95:c5 [2e:67:be:05:95:c5], Dst: Apple_4a:36:31 (50:ed:3c:4a:36:31)
    Destination: Apple_4a:36:31 (50:ed:3c:4a:36:31)
    Source: 2e:67:be:05:95:c5 (2e:67:be:05:95:c5)
    Type: IPv4 (0x0800)

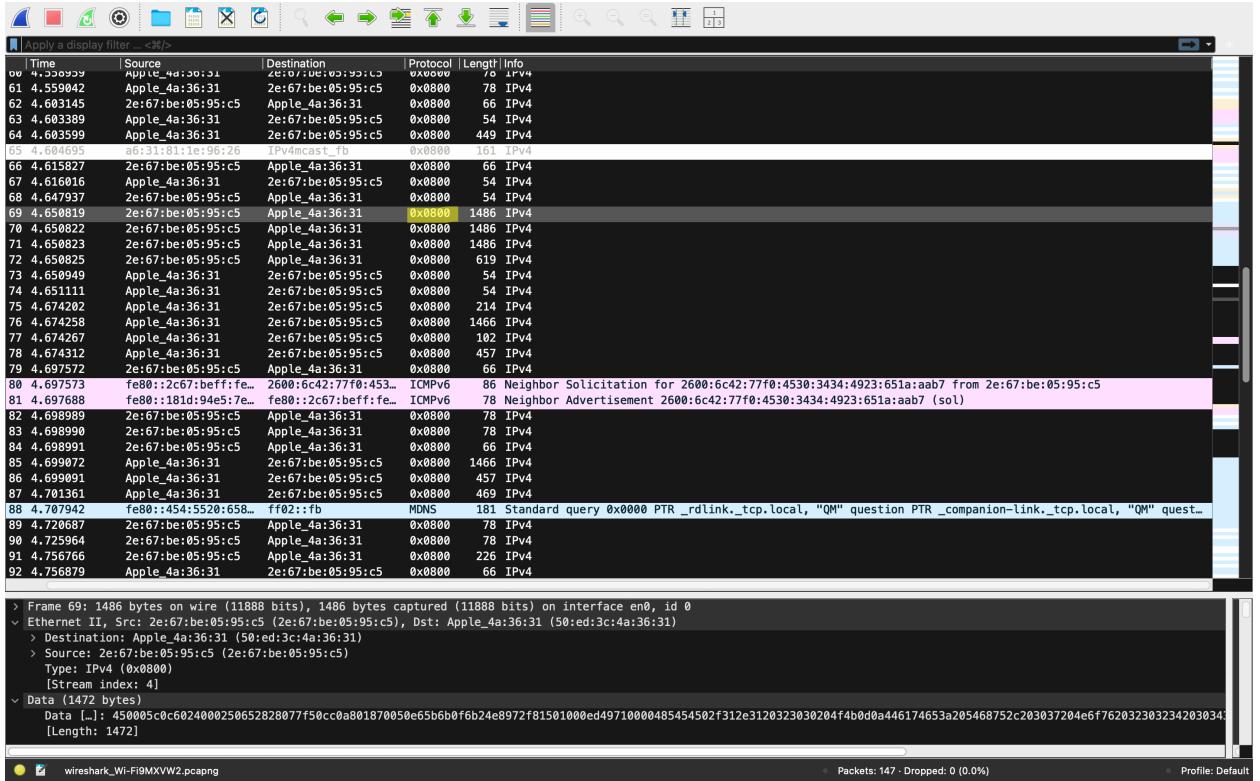
0000  50 ed 3c 4a 36 31 2e 67 be 05 95 c5 08 00 45 00 P-<J61.g .....E-
0010  05 c0 c6 02 40 00 25 06 52 82 80 77 15 0c c0 a8 ...@% R-w...
0020  01 87 00 50 e5 b6 0f 6b 24 e8 97 2f 81 50 10 ..P [k: k5--/P-
0030  00 ed 49 71 00 00 48 54 54 50 2f 31 2e 31 20 32 ..Iq-HT TP/L1.2
0040  30 30 28 4f 4b 0d 0a 44 61 74 65 3a 20 54 68 75 00 OK-D ate: Thu
0050  2c 20 30 37 20 4e 6f 76 20 32 30 32 34 20 30 34 , 07 Nov 2024 04
0060  3a 31 30 3a 31 35 20 47 4d 54 0d 0a 53 65 72 76 :10:15 G MT-Serv
0070  65 72 3a 20 41 70 61 63 68 65 2f 32 2e 34 2e 36 er: Apa he/2.4.6
0080  20 28 43 65 6e 74 4f 53 29 20 4f 70 65 6a 53 53 (CentOS ) OpenSS
0090  4c 2f 31 25 30 2e 32 6b 2d 66 69 70 73 20 58 48 L/1.0.2k -fips PH
00a0  50 2f 37 24 34 33 33 28 6d 6f 64 5f 70 65 72 P/7.4.33 mod_per
00b0  6c 2d 30 28 2e 2d 59 65 2d 2f 64 69 .18.3..L ast-MoU
00c0  00 31 36 25 30 20 0d 0a 4c 61 73 2d 4d 6f 64 69 fiedi_W d, 06 No
00d0  66 69 65 54 3a 30 57 65 64 2c 28 30 36 30 4e 6f v 2024 0 6:59:02
00e0  76 20 32 30 32 34 20 30 36 3a 35 39 3a 30 32 20
00f0  47 4d 54 0d 0a 45 54 61 67 3a 20 22 31 31 39 34 GMT-Eta g: "1194
0100  2d 36 32 33 33 39 38 64 38 37 36 37 62 33 22 0d -6263980 8767b3"
0110  0a 41 63 63 65 70 74 2d 52 61 6e 67 65 73 3a 20 Accept- Ranges:
0120  62 79 74 65 73 0d 0a 43 6f 6e 74 65 6e 74 2d 4c bytes content-L
0130  65 6e 67 74 68 3a 20 34 35 30 0d 0a 4b 65 65 engh 4 500 - Kee
0140  70 2d 41 6e 69 76 65 3a 20 74 69 6d 65 6f 75 74 p-Alive: timeout
0150  3d 35 2c 2d 6d 61 78 3d 31 30 0d 0a 43 6f 6e =5, max= 100 - Con
0160  6e 65 63 74 69 6f 6e 3a 28 4b 65 65 70 2d 41 6c nnection Keep-Al
0170  69 76 65 0d 0a 43 6f 6e 74 65 6e 74 2d 5d 79 70 iverContent-Typ
0180  65 3a 28 74 65 78 2f 68 74 6d 6b 20 63 6b er;text/html; ch
0190  61 6d 65 64 6d 55 34 2d 50 0d 0a 0d 0d 0d 0d arge-UTI <> <
01a0  68 74 6d 3c 3c 68 65 61 64 3c 20 0d 0c 74 69 html>the add <ti
01b0  74 6c 65 3e 48 69 73 74 61 72 69 63 61 6c 20 44 tle>Hist orical D
01c0  6f 63 75 6d 65 74 73 3a 54 4f 48 20 42 49 4c documents :THE_BIL
01d0  4c 20 4f 46 20 52 49 47 48 54 53 3c 2f 74 69 74 L_OF_RIG_HTS</tit
01e0  6c 65 3e 2f 68 65 61 64 3e 0a 0a 0a 3c 62 6f le></head><bo dy_bgcol or="#ffff
01f0  64 79 20 62 67 63 6f 6c 6f 72 3d 22 23 66 66 66 0ff" lin k="#3300
0200  66 66 66 22 20 69 66 6b 3d 22 23 33 33 30 30 00" vlin k="#6666
0210  30 30 22 20 76 6c 69 66 6b 3d 22 23 36 36 36 36 33"><br></p>
0220  33 33 22 30 0a 79 70 3e 3c 62 72 3a 0a 3c 2f 70 ><p></p> ><center>
0230  3e 0a 3c 70 3e 3c 2f 70 3e 3c 63 65 6e 74 65 72 ><dt>THE BILL OF
0240  3e 3c 62 3c 54 48 20 42 49 4c 4c 20 4f 46 20 RIGHIS</dt><b><br>
0250  52 49 47 48 54 53 3c 2f 62 3e 3c 62 72 3e 0a 20 <em>Ame ndments
0260  26 3c 65 6d 3e 41 6d 65 6e 64 6d 65 6e 74 73 20 1-10 of the Cons
0270  31 2d 31 30 20 6f 66 20 74 68 65 20 43 6f 6e 73 titution </em></p>
0280  74 69 74 75 74 69 6f 6e 3c 2f 65 6d 3e 0a 3c 2f

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No.: 69 · Time: 4.650819 · Source: 2e:67:be:05:95:c5 · Destination: Apple\_4a:36:31 · Protocol: 0x0800 · Length: 1486 · Info: IPv4

Show packet bytes   Layout: Vertical (Stacked) 

 Help 



5. What is the value of the Ethernet source address? Is this the address of your computer, or of gaia.cs.umass.edu (Hint: the answer is no). What device has this as its Ethernet address? The source address 2e:67:be:05:95:c5 is neither the Ethernet address of gaia.cs.umass.edu nor the address of my computer. It is the address of my router, which is the link used to get onto my subnet.
6. What is the destination address in the Ethernet frame? Is this the Ethernet address of your computer? The destination address 50:ed:3c:4a:36:31 is the address of my computer.
7. Give the hexadecimal value for the two-byte Frame type field. What do the bit(s) whose value is 1 mean within the flag field? The hex value for the Frame type field is 0x0800. This value corresponds to the IP protocol (see also answer to 3. above).
8. How many bytes from the very start of the Ethernet frame does the ASCII “O” in “OK” (i.e., the HTTP response code) appear in the Ethernet frame? The ASCII “O” appears 68 bytes from the start of the Ethernet frame. (4f)

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stuarttech@Stuarts-Air ~ % arp -a
Last login: Tue Nov  5 16:13:23 on ttys002
stuarttech@Stuarts-Air ~ % arp -a
sax2v1r.lan (192.168.1.1) at 2e:67:be:5:95:c5 on en0 ifscope [ethernet]
amazon-21a7a55ab.lan (192.168.1.52) at 40:a2:db:25:28:b7 on en0 ifscope [etherne
t]
? (192.168.1.117) at 36:27:c4:de:53:57 on en0 ifscope [ethernet]
stuarts-air.lan (192.168.1.135) at 50:ed:3c:4a:36:31 on en0 ifscope permanent [e
thernet]
? (192.168.1.139) at 6e:c3:80:a:76:71 on en0 ifscope [ethernet]
? (192.168.1.163) at a6:31:81:1e:96:26 on en0 ifscope [ethernet]
? (192.168.1.255) at ff:ff:ff:ff:ff:ff on en0 ifscope [ethernet]
mdns.mcast.net (224.0.0.251) at 1:0:5e:0:0:fb on en0 ifscope permanent [ethernet
]
? (239.255.255.250) at 1:0:5e:7f:ff:fa on en0 ifscope permanent [ethernet]
stuarttech@Stuarts-Air ~ %

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```

Last login: Wed Nov  6 23:45:09 on ttys002
stuarttech@Stuarts-Air ~ % arp -a
sax2v1r.lan (192.168.1.1) at 2e:67:be:5:95:c5 on en0 ifscope [ethernet]
amazon-21a7a55ab.lan (192.168.1.52) at 40:a2:db:25:28:b7 on en0 ifscope [ethernet]
? (192.168.1.117) at 36:27:c4:de:53:57 on en0 ifscope [ethernet]
stuarts-air.lan (192.168.1.135) at 50:ed:3c:4a:36:31 on en0 ifscope permanent [ethernet]
? (192.168.1.139) at 6e:c3:80:a:76:71 on en0 ifscope [ethernet]
? (192.168.1.163) at a6:31:81:1e:96:26 on en0 ifscope [ethernet]
? (192.168.1.255) at ff:ff:ff:ff:ff:ff on en0 ifscope [ethernet]
mdns.mcast.net (224.0.0.251) at 1:0:5e:0:0:fb on en0 ifscope permanent [ethernet
]
? (239.255.255.250) at 1:0:5e:7f:ff:fa on en0 ifscope permanent [ethernet]
stuarttech@Stuarts-Air ~ % sudo ip -s -s neigh flush all
Password:
sudo: ip: command not found
stuarttech@Stuarts-Air ~ % sudo ip -s -s neigh flush all
sudo: ip: command not found
stuarttech@Stuarts-Air ~ % sudo arp -a -d
192.168.1.1 (192.168.1.1) deleted
192.168.1.52 (192.168.1.52) deleted
192.168.1.117 (192.168.1.117) deleted
deleted cannot be deleted
192.168.1.135 (192.168.1.135) deleted
192.168.1.139 (192.168.1.139) deleted
192.168.1.163 (192.168.1.163) deleted
192.168.1.255 (192.168.1.255) deleted
224.0.0.251 (224.0.0.251) deleted
239.255.255.250 (239.255.255.250) deleted
stuarttech@Stuarts-Air ~ %

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- Write down the contents of your computer's ARP cache. What is the meaning of each column value?

The macOS ARP cache output includes several key details for each device on the network. The **Hostname** column displays the network name of the device, such as sax2v1r.lan. The **Internet Address** column contains the IP address of the device, like 192.168.1.1, while the **Physical Address** column shows the MAC address associated

with that IP, such as 2e:67:be:5:95:c5. The **Interface** column identifies the network interface in use, for example, en0, and the **Scope and Type** columns provide additional information about the connection. The [ethernet] label indicates the protocol type, and [permanent] signifies that an entry is static if applicable. Each entry in the ARP cache represents a unique device on the network, showing its IP address, MAC address, interface, and connection type.

The screenshot shows the Wireshark interface with the following details:

**ARP Table (Top):**

No.	Time	Source	Destination	Protocol	Length	Info
49	1.844359	Netgear_01:89:9c	Broadcast	ARP	52	Who has 192.168.1.76? Tell 192.168.1.84
57	1.944466	Netgear_01:89:9c	Broadcast	ARP	52	Who has 192.168.1.76? Tell 192.168.1.84
59	2.047908	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
60	2.047911	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
61	2.047911	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
62	2.150138	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
108	3.077023	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
109	3.077036	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
110	3.077038	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
111	3.177134	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
115	3.583730	Netgear_5d:80:d5	Broadcast	ARP	42	Who has 192.168.1.84? Tell 192.168.1.76
122	4.098047	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
123	4.098050	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
124	4.098050	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
125	4.203203	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
128	5.124829	AmazonTechno_25:28:b7	Broadcast	ARP	52	Who has 192.168.1.135? Tell 192.168.1.52
129	5.124973	Apple_4a:36:31	AmazonTechno_25:28:b7	ARP	42	192.168.1.135 is at 50:ed:3c:4a:36:31

**Detailed View of Frame 128 (Bottom):**

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> Frame 128: 52 bytes on wire (416 bits), 52 bytes captured (416 bits) on interface en0, id 0
< Ethernet II, Src: AmazonTechno_25:28:b7 (40:a2:db:25:28:b7), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
  Destination: Broadcast (ff:ff:ff:ff:ff:ff)
    ....1..... .... = LG bit: Locally administered address (this is NOT the factory default)
    ....1..... .... = IG bit: Group address (multicast/broadcast)
  Source: AmazonTechno_25:28:b7 (40:a2:db:25:28:b7)
    ....0..... .... = LG bit: Globally unique address (factory default)
    ....0..... .... = IG bit: Individual address (unicast)
  Type: ARP (0x0806)
[Stream index: 9]

```

Packet details and bytes panes are visible at the bottom.

10. What are the hexadecimal values for the source and destination addresses in the Ethernet frame containing the ARP request message? The hex value for the source address is 40:a2:db:25:28:b7. The hex value for the destination address is ff:ff:ff:ff:ff, the broadcast address.
11. Give the hexadecimal value for the two-byte Ethernet Frame type field. What do the bit(s) whose value is 1 mean within the flag field? The hex value for the Ethernet Frame type field is 0x0806, for ARP.
12. Download the ARP specification from <ftp://ftp.rfc-editor.org/innotes/std/std37.txt>. A readable, detailed discussion of ARP is also at <http://www.erg.abdn.ac.uk/users/gorry/course/inet-pages/arp.html>.

- a) How many bytes from the very beginning of the Ethernet frame does the ARP opcode field begin? The ARP opcode field begins 20 bytes from the very beginning of the Ethernet frame.
- b) What is the value of the opcode field within the ARP-payload part of the Ethernet frame in which an ARP request is made? The hex value for opcode field within the ARP-payload of the request is 0x0001, for request.
- c) Does the ARP message contain the IP address of the sender? Yes, the ARP message containing the IP address 192.168.1.105 for the sender.
- d) Where in the ARP request does the “question” appear – the Ethernet address of the machine whose corresponding IP address is being queried? The field “Target MAC address” is set to 00:00:00:00:00:00 to question the machine whose corresponding IP address (192.168.1.1) is being queried.

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> Frame 129: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface en0, id 0
> Ethernet II, Src: Apple_4a:36:31 (50:ed:3c:4a:36:31), Dst: AmazonTechno_25:28:b7 (40:a2:db:25:28:b7)
> Address Resolution Protocol (reply)

0000  40 a2 db 25 28 b7 50 ed 3c 4a 36 31 08 06 00 01 @:-%(-P-<J61.....
0010  08 00 06 04 00 02 50 ed 3c 4a 36 31 c0 a8 01 87 .....P-<J61.....
0020  40 a2 db 25 28 b7 c0 a8 01 34 @:-%(...4

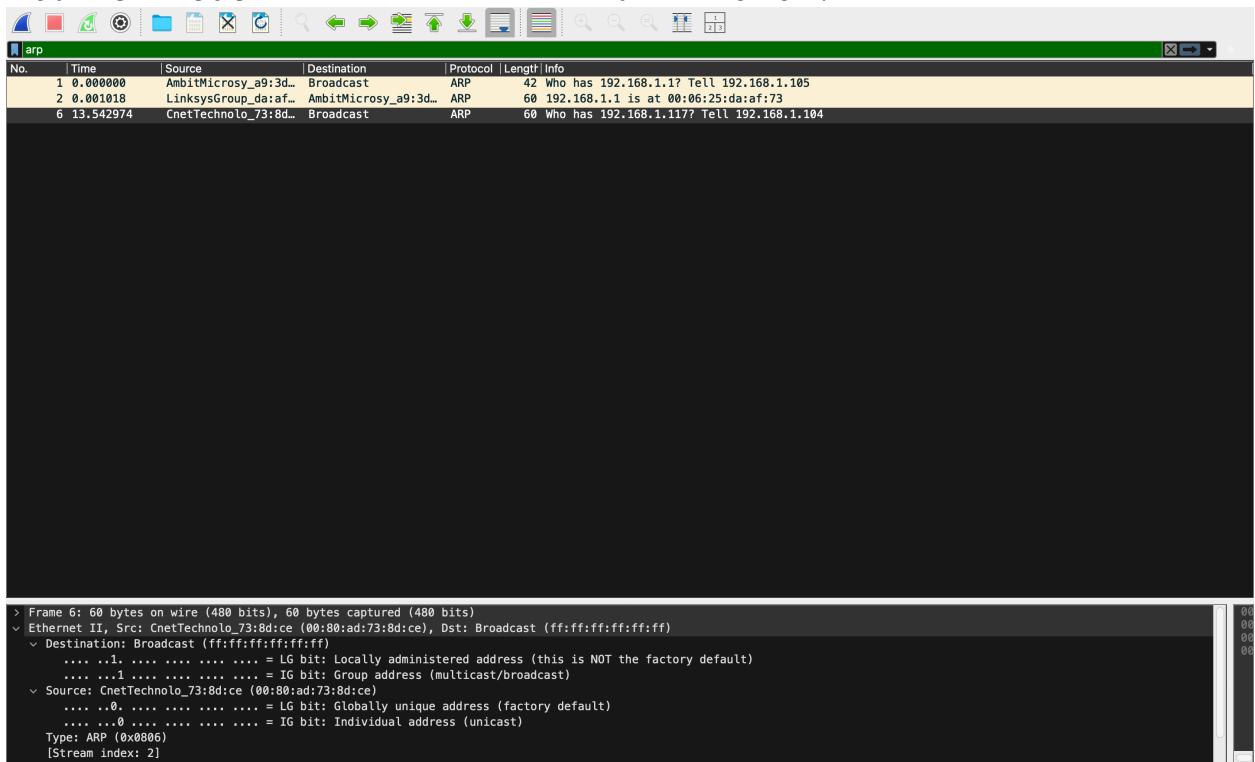
No.: 129 · Time: 5.124973 · Source: Apple_4a:36:31 · Destination: AmazonTechno_25:28:b7 · Protocol: ARP · Length: 42 · Info: 192.168.1.105 is at 50:ed:3c:4a:36:31
 Show packet bytes   Layout: Vertical (Stacked) 
 

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No.	Time	Source	Destination	Protocol	Length	Info
Apply a display filter... <⌘/>						
100	2.464395	2600:6c42:77f0:453..	2620:1ec:8f8:10	TCP	74	55919 - 443 [FIN, ACK] Seq=1993 Ack=8480 Win=262144 Len=0
101	2.484752	2620:1ec:8f8:10	2600:6c42:77f0:453..	TCP	74	[TCP Dup ACK 89#1] 443 -> 55919 [ACK] Seq=8480 Ack=1930 Win=4194304 Len=0
102	2.490988	2620:1ec:8f8:10	2600:6c42:77f0:453..	TCP	74	443 - 55919 [ACK] Seq=8480 Ack=1994 Win=4194304 Len=0
103	2.490981	2620:1ec:8f8:10	2600:6c42:77f0:453..	TCP	74	443 - 55919 [FIN, ACK] Seq=8480 Ack=1994 Win=4194304 Len=0
104	2.491128	2600:6c42:77f0:453..	2620:1ec:8f8:10	TCP	74	55919 - 443 [ACK] Seq=1994 Ack=8481 Win=262144 Len=0
105	2.559869	2600:6c42:77f0:453..	ff02::1	ICMPv6	118	Echo (ping) request id=0x0ae0, seq=0, hop limit=1 (multicast)
106	2.559868	2600:6c42:77f0:453..	ff02::1	ICMPv6	118	Echo (ping) reply id=0x0ae0, seq=0, hop limit=64
107	2.846303	Apple_4a:36:31	IPv4mcast_7ffff:fa	0x0800	217	IPv4
108	3.077023	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.19? Tell 192.168.1.1
109	3.077036	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
110	3.077038	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.19? Tell 192.168.1.1
111	3.177134	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
112	3.177190	AmazonTechno_25:28..	Apple_4a:36:31	0x0800	379	IPv4
113	3.486626	2600:6c42:77f0:453..	ff02::1	ICMPv6	118	Echo (ping) request id=0x0ae0, seq=1, hop limit=1 (multicast)
114	3.486872	2600:6c42:77f0:453..	2600:6c42:77f0:453..	ICMPv6	118	Echo (ping) reply id=0xae0, seq=1, hop limit=64
115	3.583730	Netgear_5d:80:d5	Broadcast	ARP	42	Who has 192.168.1.84? Tell 192.168.1.76
116	3.583732	2600:6c42:77f0:453..	ff02::1	ICMPv6	118	Echo (ping) request id=0x0ae0, seq=1, hop limit=1 (multicast)
117	3.583968	2600:6c42:77f0:453..	2600:6c42:77f0:453..	ICMPv6	118	Echo (ping) reply id=0x0ae0, seq=1, hop limit=64
118	3.686284	Netgear_01:89:9c	Broadcast	0x0800	92	IPv4
119	3.788573	Netgear_01:89:9c	Broadcast	0x0800	92	IPv4
120	3.896784	Netgear_01:89:9c	Broadcast	0x0800	92	IPv4
121	3.999602	Netgear_01:89:9c	Broadcast	0x0800	92	IPv4
122	4.098047	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
123	4.098050	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.19? Tell 192.168.1.1
124	4.098056	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.137? Tell 192.168.1.1
125	4.203203	2e:67:be:05:95:c5	Broadcast	ARP	52	Who has 192.168.1.19? Tell 192.168.1.1
126	4.304466	fe80::2c67:beff:fe:..	fe80::181d:94e5:7e..	ICMPv6	86	Neighbor Solicitation for fe80::181d:94e5:7e1d:a1f1 from 2e:67:be:05:95:c5
127	4.304702	fe80::181d:94e5:7e..	fe80::2c67:beff:fe:..	ICMPv6	78	Neighbor Advertisement fe80::181d:94e5:7e1d:a1f1 (sol)
128	5.124829	AmazonTechno_25:28..	Broadcast	ARP	52	Who has 192.168.1.135? Tell 192.168.1.52
129	5.124973	Apple_4a:36:31	AmazonTechno_25:28..	ARP	42	192.168.1.135 is at 50:ed:3c:4a:36:31
130	5.238269	2600:6c42:77f0:453..	2600:6c42:77f0:453..	ICMPv6	86	Neighbor Solicitation for 2600:6c42:77f0:453::1 from 50:ed:3c:4a:36:31
131	5.244325	2600:6c42:77f0:453..	2600:6c42:77f0:453..	ICMPv6	78	Neighbor Advertisement 2600:6c42:77f0:453::1 (rtr, sol)
Frame 129: 42 bytes captured (336 bits) on interface en0, id 0						
> Ethernet II, Src: Apple_4a:36:31 (50:ed:3c:4a:36:31), Dst: AmazonTechno_25:28:b7 (40:a2:db:25:28:b7)						
> Address Resolution Protocol (reply)						
No. 100 Time 2.464395 Source 2600:6c42:77f0:453.. Destination 2620:1ec:8f8:10 Protocol TCP Length 74 Info [FIN, ACK] Seq=1993 Ack=8480 Win=262144 Len=0						
No. 101 2.484752 Time 2.484752 Source 2620:1ec:8f8:10 Destination 2600:6c42:77f0:453.. Protocol TCP Length 74 Info [TCP Dup ACK 89#1] 443 -> 55919 [ACK] Seq=8480 Ack=1930 Win=4194304 Len=0						
No. 102 2.490988 Time 2.490988 Source 2620:1ec:8f8:10 Destination 2600:6c42:77f0:453.. Protocol TCP Length 74 Info 443 - 55919 [ACK] Seq=8480 Ack=1994 Win=4194304 Len=0						
No. 103 2.490981 Time 2.490981 Source 2620:1ec:8f8:10 Destination 2600:6c42:77f0:453.. Protocol TCP Length 74 Info 443 - 55919 [FIN, ACK] Seq=8480 Ack=1994 Win=4194304 Len=0						
No. 104 2.491128 Time 2.491128 Source 2600:6c42:77f0:453.. Destination 2620:1ec:8f8:10 Protocol TCP Length 74 Info 55919 - 443 [ACK] Seq=1994 Ack=8481 Win=262144 Len=0						
No. 105 2.559869 Time 2.559869 Source 2600:6c42:77f0:453.. Destination ff02::1 Protocol ICMPv6 Length 118 Info Echo (ping) request id=0x0ae0, seq=0, hop limit=1 (multicast)						
No. 106 2.559868 Time 2.559868 Source 2600:6c42:77f0:453.. Destination ff02::1 Protocol ICMPv6 Length 118 Info Echo (ping) reply id=0x0ae0, seq=0, hop limit=64						
No. 107 2.846303 Time 2.846303 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 217 IPv4						
No. 108 3.077023 Time 3.077023 Source 2e:67:be:05:95:c5 Destination Broadcast Protocol ARP Length 52 Info Who has 192.168.1.19? Tell 192.168.1.1						
No. 109 3.077036 Time 3.077036 Source 2e:67:be:05:95:c5 Destination Broadcast Protocol ARP Length 52 Info Who has 192.168.1.137? Tell 192.168.1.1						
No. 110 3.077038 Time 3.077038 Source 2e:67:be:05:95:c5 Destination Broadcast Protocol ARP Length 52 Info Who has 192.168.1.19? Tell 192.168.1.1						
No. 111 3.177134 Time 3.177134 Source 2e:67:be:05:95:c5 Destination Broadcast Protocol ARP Length 52 Info Who has 192.168.1.137? Tell 192.168.1.1						
No. 112 3.177190 Time 3.177190 Source AmazonTechno_25:28.. Destination Apple_4a:36:31 Protocol 0x0800 Length 379 Info 217 IPv4						
No. 113 3.486626 Time 3.486626 Source 2600:6c42:77f0:453.. Destination ff02::1 Protocol ICMPv6 Length 118 Info Echo (ping) request id=0x0ae0, seq=1, hop limit=1 (multicast)						
No. 114 3.486872 Time 3.486872 Source 2600:6c42:77f0:453.. Destination 2600:6c42:77f0:453.. Protocol ICMPv6 Length 118 Info Echo (ping) reply id=0xae0, seq=1, hop limit=64						
No. 115 3.583730 Time 3.583730 Source Netgear_5d:80:d5 Destination Broadcast Protocol ARP Length 42 Info Who has 192.168.1.84? Tell 192.168.1.76						
No. 116 3.583732 Time 3.583732 Source 2600:6c42:77f0:453.. Destination ff02::1 Protocol ICMPv6 Length 118 Info Echo (ping) request id=0x0ae0, seq=1, hop limit=1 (multicast)						
No. 117 3.583968 Time 3.583968 Source 2600:6c42:77f0:453.. Destination 2600:6c42:77f0:453.. Protocol ICMPv6 Length 118 Info Echo (ping) reply id=0x0ae0, seq=1, hop limit=64						
No. 118 3.686284 Time 3.686284 Source Netgear_01:89:9c Destination Broadcast Protocol 0x0800 Length 92 Info IPv4						
No. 119 3.788573 Time 3.788573 Source Netgear_01:89:9c Destination Broadcast Protocol 0x0800 Length 92 Info IPv4						
No. 120 3.896784 Time 3.896784 Source Netgear_01:89:9c Destination Broadcast Protocol 0x0800 Length 92 Info IPv4						
No. 121 3.999602 Time 3.999602 Source Netgear_01:89:9c Destination Broadcast Protocol 0x0800 Length 92 Info IPv4						
No. 122 4.098047 Time 4.098047 Source 2e:67:be:05:95:c5 Destination Broadcast Protocol ARP Length 52 Info Who has 192.168.1.137? Tell 192.168.1.1						
No. 123 4.098050 Time 4.098050 Source 2e:67:be:05:95:c5 Destination Broadcast Protocol ARP Length 52 Info Who has 192.168.1.19? Tell 192.168.1.1						
No. 124 4.098056 Time 4.098056 Source 2e:67:be:05:95:c5 Destination Broadcast Protocol ARP Length 52 Info Who has 192.168.1.137? Tell 192.168.1.1						
No. 125 4.203203 Time 4.203203 Source 2e:67:be:05:95:c5 Destination Broadcast Protocol ARP Length 52 Info Who has 192.168.1.19? Tell 192.168.1.1						
No. 126 4.304466 Time 4.304466 Source fe80::2c67:beff:fe:.. Destination fe80::181d:94e5:7e.. Protocol ICMPv6 Length 86 Info Neighbor Solicitation for fe80::181d:94e5:7e1d:a1f1 from 2e:67:be:05:95:c5						
No. 127 4.304702 Time 4.304702 Source fe80::181d:94e5:7e.. Destination fe80::2c67:beff:fe:.. Protocol ICMPv6 Length 78 Info Neighbor Advertisement fe80::181d:94e5:7e1d:a1f1 (sol)						
No. 128 5.124829 Time 5.124829 Source AmazonTechno_25:28.. Destination Broadcast Protocol ARP Length 52 Info Who has 192.168.1.135? Tell 192.168.1.52						
No. 129 5.124973 Time 5.124973 Source Apple_4a:36:31 Destination AmazonTechno_25:28.. Protocol ARP Length 42 Info 192.168.1.135 is at 50:ed:3c:4a:36:31						
No. 130 5.238269 Time 5.238269 Source 2600:6c42:77f0:453.. Destination 2600:6c42:77f0:453.. Protocol ICMPv6 Length 86 Info Neighbor Solicitation for 2600:6c42:77f0:453::1 from 50:ed:3c:4a:36:31						
No. 131 5.244325 Time 5.244325 Source 2600:6c42:77f0:453.. Destination 2600:6c42:77f0:453.. Protocol ICMPv6 Length 78 Info Neighbor Advertisement 2600:6c42:77f0:453::1 (rtr, sol)						
No. 132 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 133 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 134 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 135 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 136 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 137 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 138 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 139 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 140 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 141 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 142 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 143 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 144 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 145 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 146 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 147 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length 0x0800 Info 0 Packets: 131 - Dropped: 0 (0.0%) Profile: Default						
No. 148 5.244325 Time 5.244325 Source Apple_4a:36:31 Destination IPv4mcast_7ffff:fa Protocol 0x0800 Length						

- b) What is the value of the opcode field within the ARP-payload part of the Ethernet frame in which an ARP response is made? The field with the ARP-payload of the request is 2, for reply.
- c) Where in the ARP message does the “answer” to the earlier ARP request appear – the IP address of the machine having the Ethernet address whose corresponding IP address is being queried? The answer to the earlier ARP request appears in the “Sender MAC address” field, which contains the Ethernet address 50:ed:3c:4a:36:31 for the sender with IP address 192.168.1.135.

14. What are the hexadecimal values for the source and destination addresses in the Ethernet frame containing the ARP reply message? The hex value for the source address is 50:ed:3c:4a:36:31 and for the destination is 40:a2:db:25:28:b7.



15. Open the ethernet-ethereal-trace-1 trace file in <http://gaia.cs.umass.edu/wireshark-labs/wireshark-traces.zip>. The first and second ARP packets in this trace correspond to an ARP request sent by the computer running Wireshark, and the ARP reply sent to the computer running Wireshark by the computer with the ARP-requested Ethernet address. But there is yet another computer on this network, as indicated by packet 6 – another ARP request. Why is there no ARP reply (sent in response to the ARP request in packet 6) in the packet trace? There is no reply in this trace, because I am not at the machine that sent the request. The ARP request is broadcast, but the ARP reply is sent back directly to the sender’s Ethernet address.

### Extra Credit

```

stuartlech@Stuarts-Air ~ % sudo arp -a -d
192.168.1.1 (192.168.1.1) deleted
192.168.1.52 (192.168.1.52) deleted
192.168.1.117 (192.168.1.117) deleted
delete: cannot locate 192.168.1.135
192.168.1.135 (192.168.1.135) deleted
192.168.1.163 (192.168.1.163) deleted
192.168.1.255 (192.168.1.255) deleted
224.0.0.251 (224.0.0.251) deleted
239.255.255.250 (239.255.255.250) deleted
[stuartlech@Stuarts-Air ~ % sudo arp -a -d

192.168.1.1 (192.168.1.1) deleted
192.168.1.52 (192.168.1.52) deleted
192.168.1.117 (192.168.1.117) deleted
delete: cannot locate 192.168.1.135
192.168.1.135 (192.168.1.135) deleted
192.168.1.163 (192.168.1.163) deleted
192.168.1.255 (192.168.1.255) deleted
239.255.255.250 (239.255.255.250) deleted
[stuartlech@Stuarts-Air ~ % sudo arp -s InetAddr EtherAddr
arp: IntAddr: Unknown host
[stuartlech@Stuarts-Air ~ % arp -a
sax2v1r.lan (192.168.1.1) at 2e:67:be:5:95:c5 on en0 ifscope [ethernet]
amazon-21a7a55ab.lan (192.168.1.52) at 40:a2:db:25:28:b7 on en0 ifscope [ethernet]
? (192.168.1.117) at 36:27:c4:de:53:57 on en0 ifscope [ethernet]
stUARTS.lan (192.168.1.135) at 50:ed:3c:4a:36:31 on en0 ifscope permanent [ethernet]
? (192.168.1.139) at 0:e:c3:8a:76:71 on en0 ifscope [ethernet]
? (192.168.1.255) at ff:ffff:ffff:ffff:ff:ff on en0 ifscope [ethernet]
? (192.168.1.255) at ff:ffff:ffff:ffff:ff:fa on en0 ifscope permanent [ethernet]
? (239.255.255.250) at 1:0:5e:7:f:fffffa on en0 ifscope permanent [ethernet]
[stuartlech@Stuarts-Air ~ % sudo arp -s 192.168.1.1 2e:67:be:5:95:c5

>Password:
[stuartlech@Stuarts-Air ~ % sudo arp -s 192.168.1.1 2e:67:be:5:95:c5
arp: writing to routing socket: File exists
[stuartlech@Stuarts-Air ~ % arp -a
sax2v1r.lan (192.168.1.1) at 2e:67:be:5:95:c5 on en0 permanent [ethernet]
amazon-21a7a55ab.lan (192.168.1.52) at 40:a2:db:25:28:b7 on en0 ifscope [ethernet]
? (192.168.1.117) at 36:27:c4:de:53:57 on en0 ifscope [ethernet]
stUARTS.lan (192.168.1.135) at 50:ed:3c:4a:36:31 on en0 ifscope permanent [ethernet]
? (192.168.1.139) at 0:e:c3:8a:76:71 on en0 ifscope [ethernet]
? (192.168.1.255) at ff:31:81:1e:96:26 on en0 ifscope [ethernet]
? (192.168.1.255) at ff:ffff:ffff:ffff:ff:ff on en0 ifscope [ethernet]
mdns.mcast.net (224.0.0.251) at 1:0:5e:8:0:fb on en0 ifscope permanent [ethernet]
? (239.255.255.250) at 1:0:5e:7:f:fffffa on en0 ifscope permanent [ethernet]
[stuartlech@Stuarts-Air ~ % arp -a

sax2v1r.lan (192.168.1.1) at 2e:67:be:5:95:c5 on en0 permanent [ethernet]
amazon-21a7a55ab.lan (192.168.1.52) at 40:a2:db:25:28:b7 on en0 ifscope [ethernet]
? (192.168.1.117) at 36:27:c4:de:53:57 on en0 ifscope [ethernet]
stUARTS.lan (192.168.1.135) at 50:ed:3c:4a:36:31 on en0 ifscope permanent [ethernet]
? (192.168.1.139) at 0:e:c3:8a:76:71 on en0 ifscope [ethernet]
? (192.168.1.255) at ff:ffff:ffff:ffff:ff:ff on en0 ifscope [ethernet]
? (192.168.1.255) at ff:ffff:ffff:ffff:ff:fa on en0 ifscope permanent [ethernet]
? (239.255.255.250) at 1:0:5e:8:0:fb on en0 ifscope permanent [ethernet]
[stuartlech@Stuarts-Air ~ %

```

## 1. The arp command:

`arp -s InetAddr EtherAddr`

allows you to manually add an entry to the ARP cache that resolves the IP address InetAddr to the physical address EtherAddr. What would happen if, when you manually added an entry, you entered the correct IP address, but the wrong Ethernet address for that remote interface?

If you manually add an ARP entry with the correct IP but an incorrect Ethernet (MAC) address, packets intended for that IP will be misrouted to the wrong device. This results in failed communication with the intended device and could lead to security risks or network disruptions if the wrong device receives the packets.

- What is the default amount of time that an entry remains in your ARP cache before being removed. You can determine this empirically (by monitoring the cache contents) or by looking this up in your operation system documentation. Indicate how/where you determined this value.

On macOS, the default timeout for dynamically learned ARP entries is typically around 4 minutes or 240 seconds. I determined this by reviewing macOS networking documentation and observing entries with the `arp -a` command, where dynamic entries refresh or expire after this duration. In terminal output, its observed that the ARP entry for 192.168.1.1 was marked as "permanent" after I manually added it with the `arp -s`

command. This means it won't expire or follow the usual ARP cache timeout, as it's manually set and thus persistent until removed.