

Subject: Computer Networks	
Name of the Student:	
Class:	Roll no:
PRN:	
Date of Performance:	Date of Submission:
Examined by:	

EXPERIMENT NO. 3

AIM: Observe and note the details of the live type of traffic (ARP, Frame analysis, ethernet) from interface using packet capture and analysis tool.

THEORY :

Requirements :

Wireshark: Wireshark software tool to capture and examine a packet trace. A packet trace is a record of traffic at a location on the network, as if a snapshot was taken of all the bits that passed across a particular wire. The packet trace records a timestamp for each packet, along with the bits that make up the packet, from the lower-layer headers to the higher-layer contents. Wireshark runs on most operating systems, including Windows, Mac and Linux. It provides a graphical UI that shows the sequence of packets and the meaning of the bits when interpreted as protocol headers and data. It color-codes packets by their type, and has various ways to filter and analyze packets to let you investigate the behavior of network protocols. Wireshark is widely used to troubleshoot networks.

arp: “arp” command-line utility to inspect and clear the cache used by the ARP protocol on your computer. arp is installed as part of the operating system on Windows, Linux, and Mac computers, but uses different arguments. It requires administrator privileges to clear the cache.

ifconfig / ipconfig: “ipconfig” (Windows) command-line utility to inspect the state of your computer’s network interface. ipconfig is installed as part of the operating system on Windows computers.

route / netstat: “route” or “netstat” command-line utility to inspect the routes used by your computer. A key route is the default route (or route to prefix 0.0.0.0) that uses the default gateway to reach remote parts of the Internet. Both “route” and “netstat” are installed as part of the operating system across Windows and Mac/Linux, but there are many variations on the command-line parameters that must be used.

Browser: This lab uses a web browser to find or fetch pages as a workload. Any web browser will do.

Network Setup

We want to observe the ARP protocol in action. ARP is used to find the Ethernet address that corresponds to a local IP address to which your computer wants to send a packet. A typical example of a local IP address is that of the local router or default gateway that connects your computer to the rest of the Internet. Your computer caches these translations in an ARP cache so that the ARP protocol need only be used occasionally to do the translation. The setup from the viewpoint of your computer is as shown in the example below.

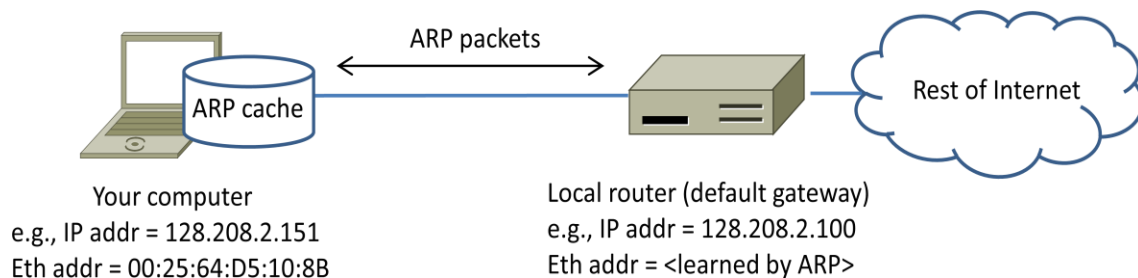


Figure 1: Network setup under which we will study ARP in second part

How ARP Works

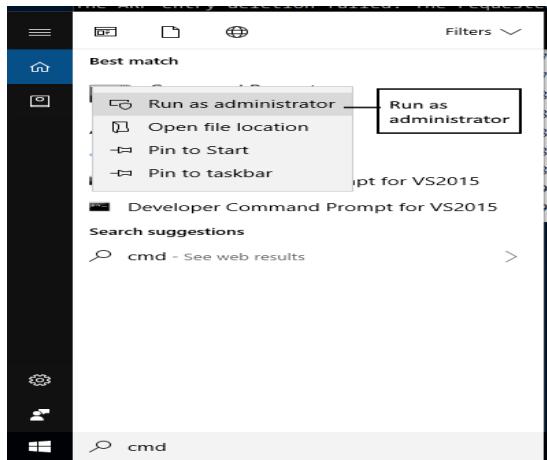
When an incoming packet destined for a host machine on a particular local area network arrives at a gateway, the gateway asks the ARP program to find a physical host or MAC address that matches the IP address. The ARP program looks in the ARP cache and, if it finds the address, provides it so that the packet can be converted to the right packet length and format and sent to the machine. If no entry is found for the IP address, ARP broadcasts a request packet in a special format to all the machines on the LAN to see if one machine knows that it has that IP address associated with it.

A machine that recognizes the IP address as its own returns a reply so indicating. ARP updates the ARP cache for future reference and then sends the packet to the MAC address that replied.

There is a Reverse ARP (RARP) for host machines that don't know their IP address. RARP enables them to request their IP address from the gateway's ARP cache.

Step 1: Finding your IP address and Gateway address

1. Open a command prompt as an administrator as follows:



2. Find the **Ethernet** address of the main network interface OR the **wireless** address (see figure 3) of your computer with the ipconfig command. You will want to know this address for later analysis. On Windows, bring up a command-line shell and type “ipconfig /all”. Among the output will be a section for the main interface of the computer (likely an Ethernet interface) and its Ethernet address. Common names for the interface are “eth0” or “Ethernet adapter”. An example is shown below in figure 2, with added highlighting.

```

C:\Users\se10042310>ipconfig /all

Windows IP Configuration

Host Name . . . . . : ISRCD1109
Primary Dns Suffix . . . . . : scis.ulster.ac.uk
Node Type . . . . . : Hybrid
IP Routing Enabled. . . . . : No
WINS Proxy Enabled. . . . . : No
DNS Suffix Search List. . . . . : scis.ulster.ac.uk

Ethernet adapter Ethernet 2:

Connection-specific DNS Suffix . : scis.ulster.ac.uk
Description . . . . . : Realtek PCIe GBE Family Controller
Physical Address. . . . . : F4-8E-38-AF-8C-13
DHCP Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
Link-local IPv6 Address . . . . . : fe80::6c23:3d1b:b3e4:abb8%4(Preferred)
IPv4 Address. . . . . : 193.61.190.80(Preferred)
Subnet Mask . . . . . : 255.255.255.0
Lease Obtained. . . . . : 13 February 2018 22:02:56
Lease Expires . . . . . : 15 February 2018 18:03:44
Default Gateway . . . . . : 193.61.190.201
```

Figure 2: Finding the computer's Ethernet address with ipconfig (Windows)

```
Administrator: Command Prompt
Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . . : 
Description . . . . . : Microsoft Wi-Fi Direct Virtual Adapter #2
Physical Address. . . . . : AE-B6-D0-E1-69-3F
DHCP Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes

Wireless LAN adapter Wi-Fi:

Connection-specific DNS Suffix . . : lan
Description . . . . . : Killer Wireless-n/a/ac 1535 Wireless Network Adapter
Physical Address. . . . . : 9C-B6-D0-E1-69-3F
DHCP Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
IPv6 Address. . . . . : fd00::bbcc:ddee:0:e891:7ea1:1314:a9c(Preferred)
Temporary IPv6 Address. . . . . : fd00::bbcc:ddee:0:253d:3075:631e:70b2(Preferred)
Link-local IPv6 Address . . . . . : fe80::e891:7ea1:1314:a9c%11(Preferred)
IPv4 Address. . . . . : 192.168.1.61(Preferred)
Subnet Mask . . . . . : 255.255.255.0
Lease Obtained. . . . . : 16 February 2021 19:11:46
Lease Expires . . . . . : 19 February 2021 19:12:27
Default Gateway . . . . . : 192.168.1.1
DHCP Server . . . . . : 192.168.1.1
DHCPv6 IAID . . . . . : 110933712
DHCPv6 Client DUID. . . . . : 00-01-00-01-25-4B-92-4B-9C-B6-D0-E1-69-3F
DNS Servers . . . . . : 192.168.1.1
NetBIOS over Tcpip. . . . . : Enabled
Connection-specific DNS Suffix Search List :
lan
```

Figure 3: Finding the computer's WiFi IP address with ipconfig (Windows)

- Find the IP address of the local router or default gateway that your computer uses to reach the rest of the Internet using the netstat / route command. You should be able to use the netstat-r command on Windows.

Alternatively, you can use the route command (“route print” on Windows). In either case you are looking for the gateway IP address that corresponds to the destination of default or 0.0.0.0. An example is shown in figure 3 for netstat, with added highlighting.

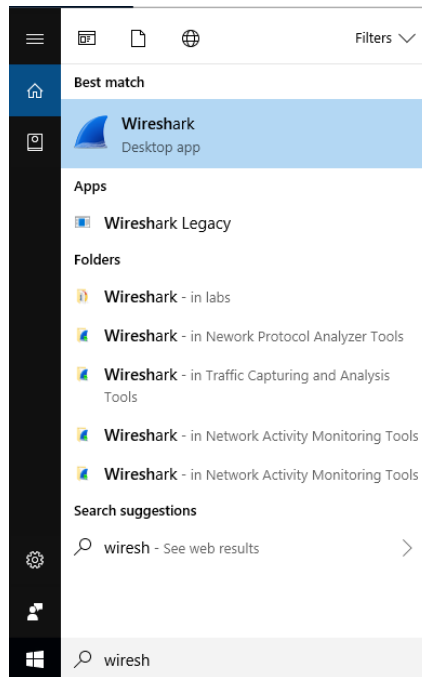
```
C:\Users\se10042310>netstat -r

=====
Interface List
4...f4 8e 38 af 8c f3 .....Realtek PCIe GBE Family Controller
3...00 50 56 c0 00 01 .....VMware Virtual Ethernet Adapter for VMnet1
6...00 50 56 c0 00 08 .....VMware Virtual Ethernet Adapter for VMnet8
1.....Software Loopback Interface 1
=====

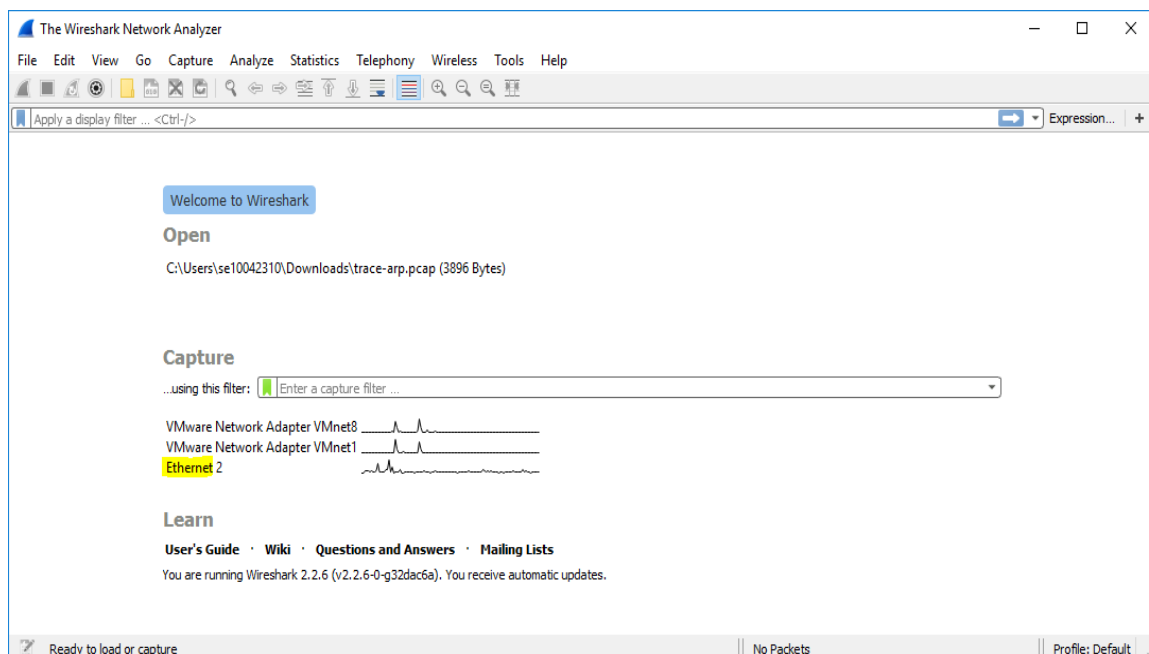
IPv4 Route Table
=====
Active Routes:
Network Destination        Netmask          Gateway             Interface           Metric
0.0.0.0                    0.0.0.0          193.61.190.201      193.61.190.80       25
127.0.0.0                  255.0.0.0        On-link             127.0.0.1           331
127.0.0.1                  255.255.255.255 On-link             127.0.0.1           331
127.255.255.255            255.255.255.255 On-link             127.0.0.1           331
192.168.139.0              255.255.255.0   On-link             192.168.139.1       291
192.168.139.1              255.255.255.255 On-link             192.168.139.1       291
192.168.139.255            255.255.255.255 On-link             192.168.139.1       291
192.168.159.0              255.255.255.0   On-link             192.168.159.1       291
192.168.159.1              255.255.255.255 On-link             192.168.159.1       291
192.168.159.255            255.255.255.255 On-link             192.168.159.1       291
```

Figure 4: Finding the default gateway IP address with netstat (Windows)

4. Now **run Wireshark** by typing “*wireshark*” in the bottom left search box in Windows



5. You should see the main Wireshark interface. **Click on the Ethernet OR Wireless interface** to start traffic analysis on that interface.



6. Add a filter of “arp”. Your capture window should be like the one pictured below.

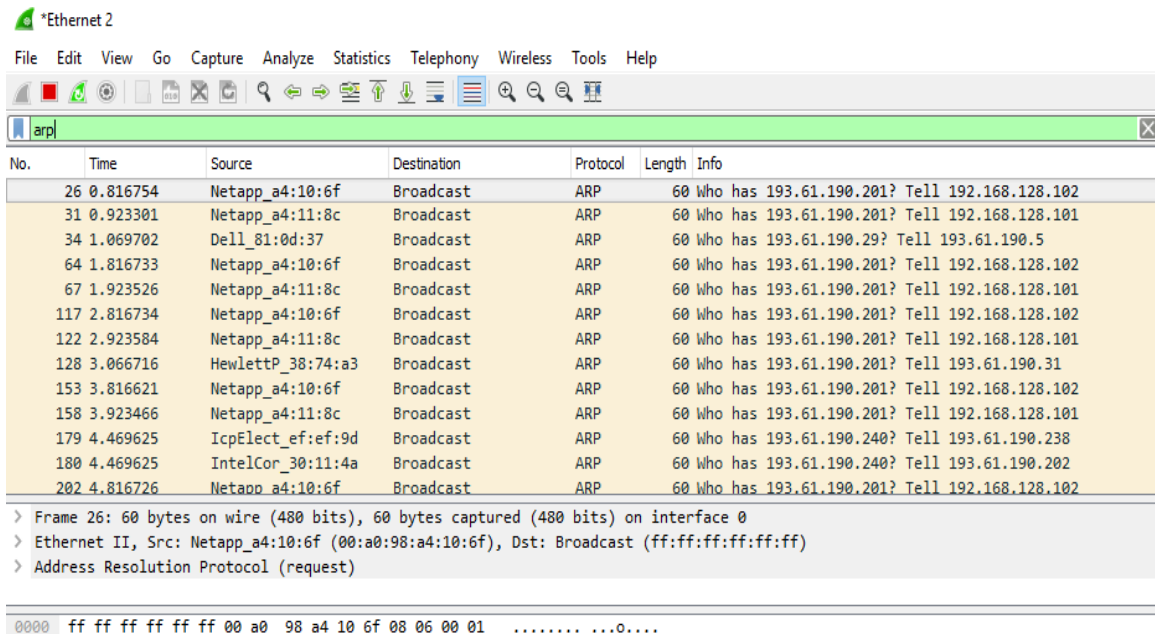


Figure 6: Setting up the capture options

7. When the capture is started, use the “arp” command to clear the default gateway from the ARP cache. Using the command “arp -a” will show you the contents of the ARP cache as a check that you can run “arp”.

Go to command prompt and type **arp -a** as shown below.

```

C:\Command Prompt
4 281 fe80::6c23:3d1b:b3e4:abb8/128 On-link
1 331 ff00::/8 On-link
3 291 ff00::/8 On-link
6 291 ff00::/8 On-link
4 281 ff00::/8 On-link
=====
Persistent Routes:
None
C:\Users\se10042310>arp -a

Interface: 192.168.159.1 --- 0x3
Internet Address Physical Address Type
192.168.159.254 00-50-56-e5-5b-d7 dynamic
192.168.159.255 ff-ff-ff-ff-ff-ff static
224.0.0.22 01-00-5e-00-00-16 static
224.0.0.251 01-00-5e-00-00-fb static
224.0.0.252 01-00-5e-00-00-fc static
224.1.7.57 01-00-5e-01-07-39 static
239.255.255.250 01-00-5e-7f-ff-fa static
239.255.255.253 01-00-5e-7f-ff-fd static
255.255.255.255 ff-ff-ff-ff-ff-ff static

Interface: 193.61.190.80 --- 0x4
Internet Address Physical Address Type
193.61.190.3 ec-f4-bb-2c-5f-1d dynamic
193.61.190.29 d0-bf-9c-bd-ce-b7 dynamic
193.61.190.30 b8-ca-3a-bd-04-43 dynamic
193.61.190.36 b8-ca-3a-bd-0a-f2 dynamic
193.61.190.42 d4-be-d9-a7-31-6e dynamic
193.61.190.49 00-1c-c0-9b-60-9d dynamic
193.61.190.51 70-8b-cd-aa-9b-a6 dynamic
193.61.190.54 b8-ca-3a-aa-4a-7c dynamic
193.61.190.55 34-17-eb-c3-18-01 dynamic
193.61.190.56 5c-50-dd-66-a3-76 dynamic

```

You should see an entry for the IP address of the default gateway as shown in image below. In this case it is 193.61.190.201 which is the default gateway on my office PC.

```

193.61.190.152 00-24-81-c5-52-f4 dynamic
193.61.190.155 d4-be-d9-a7-38-f6 dynamic
193.61.190.165 5c-f9-dd-6f-9f-df dynamic
193.61.190.168 70-8b-cd-80-4b-b4 dynamic
193.61.190.180 b8-ca-3a-77-63-e1 dynamic
193.61.190.194 00-e0-81-b7-c0-e6 dynamic
193.61.190.198 00-30-05-30-57-6a dynamic
193.61.190.201 00-23-0d-f4-92-0d dynamic
193.61.190.202 a0-36-9f-30-11-4a dynamic
193.61.190.226 78-2b-cb-07-6e-f7 dynamic
193.61.190.243 00-21-28-6a-d9-76 dynamic
193.61.190.245 00-21-28-6a-d9-76 dynamic

```

8. To clear this entry, use the arp command with different arguments (“arp -d” on Windows) as follows. Type **arp -d** in the command prompt.

```
C:\WINDOWS\system32>arp -d
C:\WINDOWS\system32>
```

Note: This usage of arp will need administrator privileges to run, so you have to run as a privileged user on Windows which is what you should have done in step 1. The command should run without error, but the ARP entry may not appear to be cleared if you check with “arp -a”. This is because your computer will send ARP packets to repopulate this entry as soon as you need to send a packet to a remote IP address, and that can happen very quickly due to background activity on the computer.

9. Now that you have cleared your ARP cache, **fetch a remote page with your Web browser**. This will cause ARP to find the Ethernet address of the default gateway so that the packets can be sent.
10. You will see these packets flowing through your computer by scrolling down in the Wireshark window to the bottom as shown below.

53571	1015.866134	Netapp_a4:10:6f	Broadcast	ARP	60 Who has 193.61.190.201? Tell 192.168.128.102
53618	1016.610934	Dell_07:6e:f7	Broadcast	ARP	60 Who has 193.61.190.68? Tell 193.61.190.226
53628	1016.822691	Netapp_a4:11:8c	Broadcast	ARP	60 Who has 193.61.190.201? Tell 192.168.128.101
53631	1016.866059	Netapp_a4:10:6f	Broadcast	ARP	60 Who has 193.61.190.201? Tell 192.168.128.102
53642	1017.219032	Dell_07:6e:f7	Broadcast	ARP	60 Who has 193.61.190.74? Tell 193.61.190.226

0000	ff ff ff ff ff ff 00 a0 98 a4 10 6f 08 06 00 01 0....
0010	08 00 06 04 00 01 00 a0 98 a4 10 6f c0 a8 80 66 0...f
0020	00 00 00 00 00 00 c1 3d be c9 00 00 00 00 00=

11. These ARP packets will be captured by Wireshark. You might clear the ARP cache and fetch a document a couple of times. Hopefully there will also be other ARP packets sent by other computers on the local network that will be captured. These packets are likely to be present if there are other computers on your local network. In fact, if you have a busy computer and extensive local network then you may capture many ARP packets. The ARP traffic of other computers will be captured when the ARP packets are sent to the broadcast address, since in this case they are destined for all computers including the one on which you are running Wireshark. Because ARP activity happens slowly, you may need to wait up to 30 seconds to observe some of this background ARP traffic.
12. *Once you have captured some ARP traffic, stop the capture.* You will need the trace, plus the Ethernet address of your computer and the IP address of the default gateway for the next steps.

Step 2: Inspect the supplied ARP Trace

1. **Close** Wireshark.
2. Once Wireshark is closed, **open** the ARP trace here:
3. You should see a screen as shown below.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	Microsoft_02:3a:01	Broadcast	ARP	60	Who has 128.208.2.151? Tell 128.208.2.201
2	0.000013	Dell_d5:10:8b	Microsoft_02:3a:01	ARP	42	128.208.2.151 is at 00:25:64:d5:10:8b
3	0.457872	Cisco_15:44:80	Broadcast	ARP	60	Who has 128.208.2.31? Tell 128.208.2.102
4	0.903552	Netgear_3f:a0:08	Broadcast	ARP	60	Who has 192.168.22.46? Tell 192.168.22.5
5	0.939192	Apple_f0:8a:e8	Broadcast	ARP	60	Who has 128.208.2.100? Tell 128.208.2.129
6	1.075499	G-ProCom_0a:d2:dd	Broadcast	ARP	60	Who has 128.208.2.42? Tell 128.208.2.76
7	3.857866	Dell_d5:10:8b	IETF-VRRP-VRID_01	ARP	42	Who has 128.208.2.100? Tell 128.208.2.151
8	3.859336	IETF-VRRP-VRID_01	Dell_d5:10:8b	ARP	60	128.208.2.100 is at 00:00:5e:00:01:01
9	4.403601	G-ProCom_0a:94:16	Broadcast	ARP	60	Who has 128.208.2.42? Tell 128.208.2.150
10	4.857915	Dell_d5:10:8b	Microsoft_02:3a:01	ARP	42	Who has 128.208.2.201? Tell 128.208.2.151
11	4.858025	Microsoft_02:3a:01	Dell_d5:10:8b	ARP	60	128.208.2.201 is at 00:15:5d:02:3a:01
12	5.103602	Micro-St_6f:5e:ed	Broadcast	ARP	60	Who has 128.208.2.100? Tell 128.208.2.83
13	6.285130	Dell_d5:10:8b	Broadcast	ARP	42	Who has 128.208.2.100? Tell 128.208.2.151
14	6.286695	IETF-VRRP-VRID_01	Dell_d5:10:8b	ARP	60	128.208.2.100 is at 00:00:5e:00:01:01
15	6.381012	Dell_d5:10:8b	Broadcast	ARP	42	Who has 128.208.2.42? Tell 128.208.2.151
16	6.381103	Dell_db:66:a9	Dell_d5:10:8b	ARP	60	128.208.2.42 is at 00:19:b9:db:66:a9
17	7.148681	HewlettP_01:6c:24	Broadcast	ARP	60	Who has 128.208.2.42? Tell 128.208.2.55
18	7.467606	Cisco_15:44:80	Broadcast	ARP	60	Who has 128.208.2.31? Tell 128.208.2.102

The setup from the viewpoint of your computer from this trace is shown in the example below.

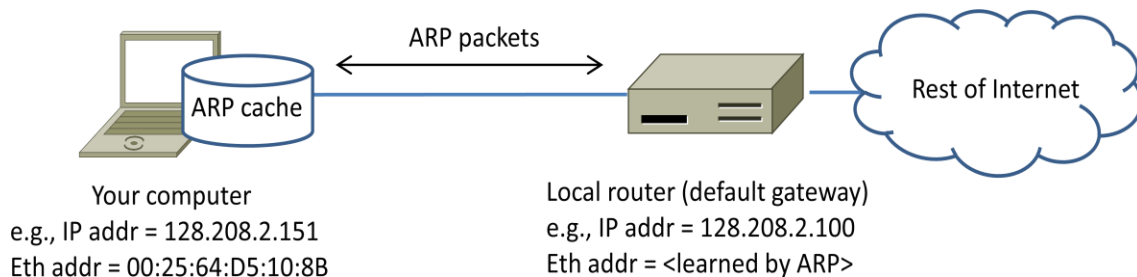


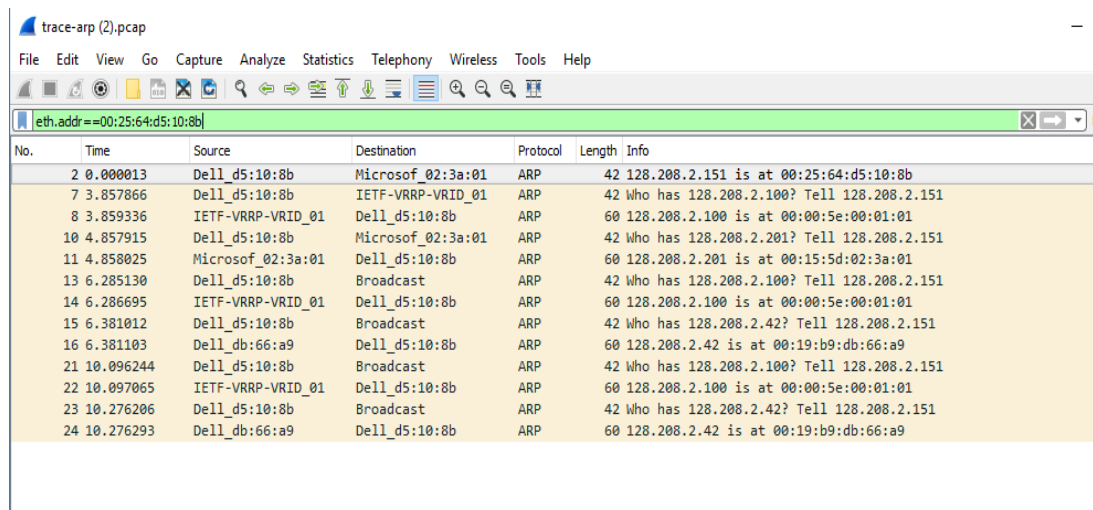
Figure 7: Network setup under which we will study ARP in this part

Note: **Ethernet address** of computer: 00:25:64:d5:10:8b and IP address of **gateway**: 128.208.2.100

4. Now we can look at an ARP exchange. Since there may be many ARP packets in your trace, we'll first narrow our view to only the ARP packets that are sent directly from or to your computer.

Set a display filter for packets with the Ethernet address of your computer which is this case is **00:25:64:d5:10:8b**.

You can do this by entering an expression in the blank “Filter:” box near the top of the Wireshark window and clicking “Apply” or Enter. After applying this filter your capture should look something like the figure below, in which we have expanded the ARP protocol details.



No.	Time	Source	Destination	Protocol	Length	Info
2	0.000013	Dell_d5:10:8b	Microsoft_02:3a:01	ARP	42	128.208.2.151 is at 00:25:64:d5:10:8b
7	3.857866	Dell_d5:10:8b	IETF-VRRP-VRID_01	ARP	42	Who has 128.208.2.100? Tell 128.208.2.151
8	3.859336	IETF-VRRP-VRID_01	Dell_d5:10:8b	ARP	60	128.208.2.100 is at 00:00:5e:00:01:01
10	4.857915	Dell_d5:10:8b	Microsoft_02:3a:01	ARP	42	Who has 128.208.2.201? Tell 128.208.2.151
11	4.858025	Microsoft_02:3a:01	Dell_d5:10:8b	ARP	60	128.208.2.201 is at 00:15:5d:02:3a:01
13	6.285130	Dell_d5:10:8b	Broadcast	ARP	42	Who has 128.208.2.100? Tell 128.208.2.151
14	6.286695	IETF-VRRP-VRID_01	Dell_d5:10:8b	ARP	60	128.208.2.100 is at 00:00:5e:00:01:01
15	6.381012	Dell_d5:10:8b	Broadcast	ARP	42	Who has 128.208.2.42? Tell 128.208.2.151
16	6.381103	Dell_db:66:a9	Dell_d5:10:8b	ARP	60	128.208.2.42 is at 00:19:b9:db:66:a9
21	10.096244	Dell_d5:10:8b	Broadcast	ARP	42	Who has 128.208.2.100? Tell 128.208.2.151
22	10.097065	IETF-VRRP-VRID_01	Dell_d5:10:8b	ARP	60	128.208.2.100 is at 00:00:5e:00:01:01
23	10.276206	Dell_d5:10:8b	Broadcast	ARP	42	Who has 128.208.2.42? Tell 128.208.2.151
24	10.276293	Dell_db:66:a9	Dell_d5:10:8b	ARP	60	128.208.2.42 is at 00:19:b9:db:66:a9

Figure 8: Capture of ARP packets, showing details of a request

Find and select an ARP request for the default gateway and examine its fields. There are two kinds of ARP packets, a request and a reply, and we will look at each one in turn. The Info line for the request will start with “Who has ...”. You want to look for one of these packets that asks for the MAC address of the default gateway, e.g., “Who has xx.xx.xx.xx ...” where xx.xx.xx.xx is your default gateway. You can click on the + expander or icon for the Address Resolution Protocol block to view the fields:

- Hardware and Protocol type are set to constants that tell us the hardware is Ethernet and the protocol is IP. This matches the ARP translation from IP to Ethernet address.
- Hardware and Protocol size are set to 6 and 4, respectively. These are the sizes of Ethernet and IP addresses in bytes.

- The opcode field tells us that this is a request.
- Next come the four key fields, the sender MAC (Ethernet) and IP and the target MAC (Ethernet) and IP. These fields are filled in as much as possible. For a request, the sender knows their MAC and IP address and fills them in. The sender also knows the target IP

address – it is the IP address for which an Ethernet address is wanted. But the sender does not know the target MAC address, so it does not fill it in.

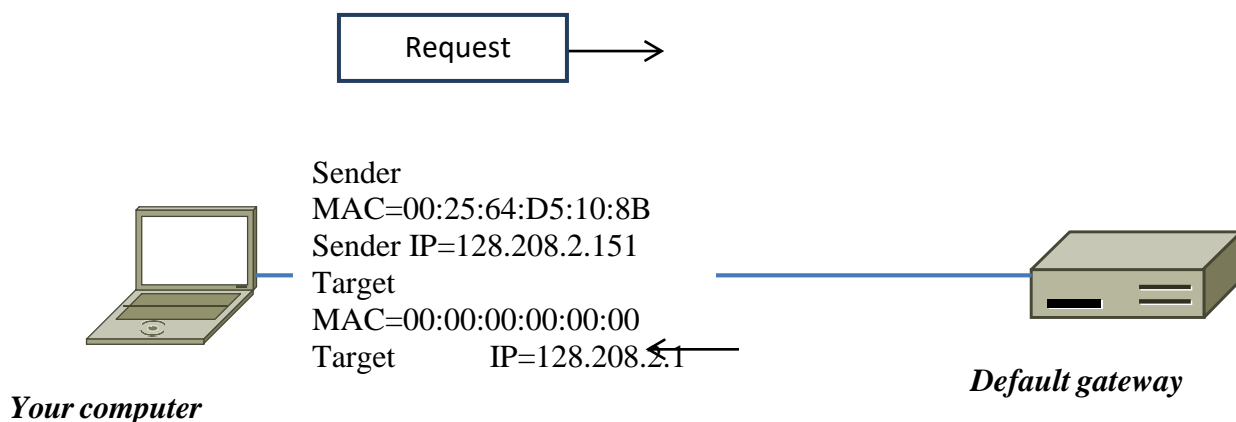
Next, select an ARP reply and examine its fields. The reply will answer a request and have an Info line of the form “xx.xx.xx.xx is at yy:yy:yy:yy:yy:yy”:

- The Hardware and Protocol type and sizes are as set as before.
- The opcode field has a different value that tells us that this is a reply.
- Next come the four key fields, the sender MAC (Ethernet) and IP and the target MAC (Ethernet) and IP just as before. These fields are reversed from the corresponding request, since the old target is the new sender (and vice versa). The fields should now be all filled in since both computers have supplied their addresses.

Step 3: Details of ARP over Ethernet

ARP packets are carried in Ethernet frames, and the values of the Ethernet header fields are chosen to support ARP. For instance, you may wonder how an ARP request packet is delivered to the target computer so that it can reply and tell the requestor its MAC address. The answer is that the ARP request is (normally) broadcast at the Ethernet layer so that it is received by all computers on the local network including the target. Look specifically at the destination Ethernet address of a request: it is set to ff:ff:ff:ff:ff:ff, the broadcast address. So, the target receives the request and recognizes that it is the intended recipient of the message; other computers that receive the request know that it is not meant for them. Only the target responds with a reply. However, anyone who receives an ARP packet can learn a mapping from it: the sender MAC and sender IP pair. The ARP header for a request and a reply is 28 bytes for both the request and reply for IPv4.

Answers to Step 3: ARP request and reply



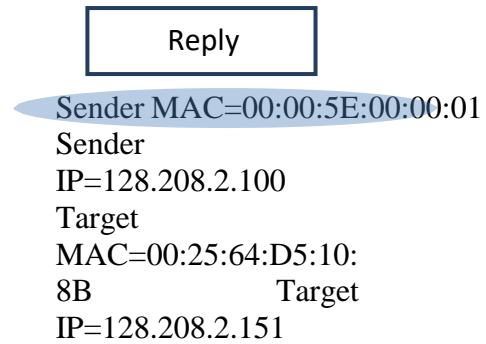


Figure 9: Details of the ARP request and reply to resolve the default gateway

There are several features to note:

- On the request, the target MAC is not known so it is usually filled in as 00:00:00:00:00:00.
- On the reply, the request target becomes the reply sender and vice versa.
- On the reply, the sender MAC returns the answer that is sought; it is highlighted.
- All of the fields that are shown are ARP header fields

Conclusion: