CSCI369 Ethical Hacking

Lecture 3-1 ARP and ARP Poisoning

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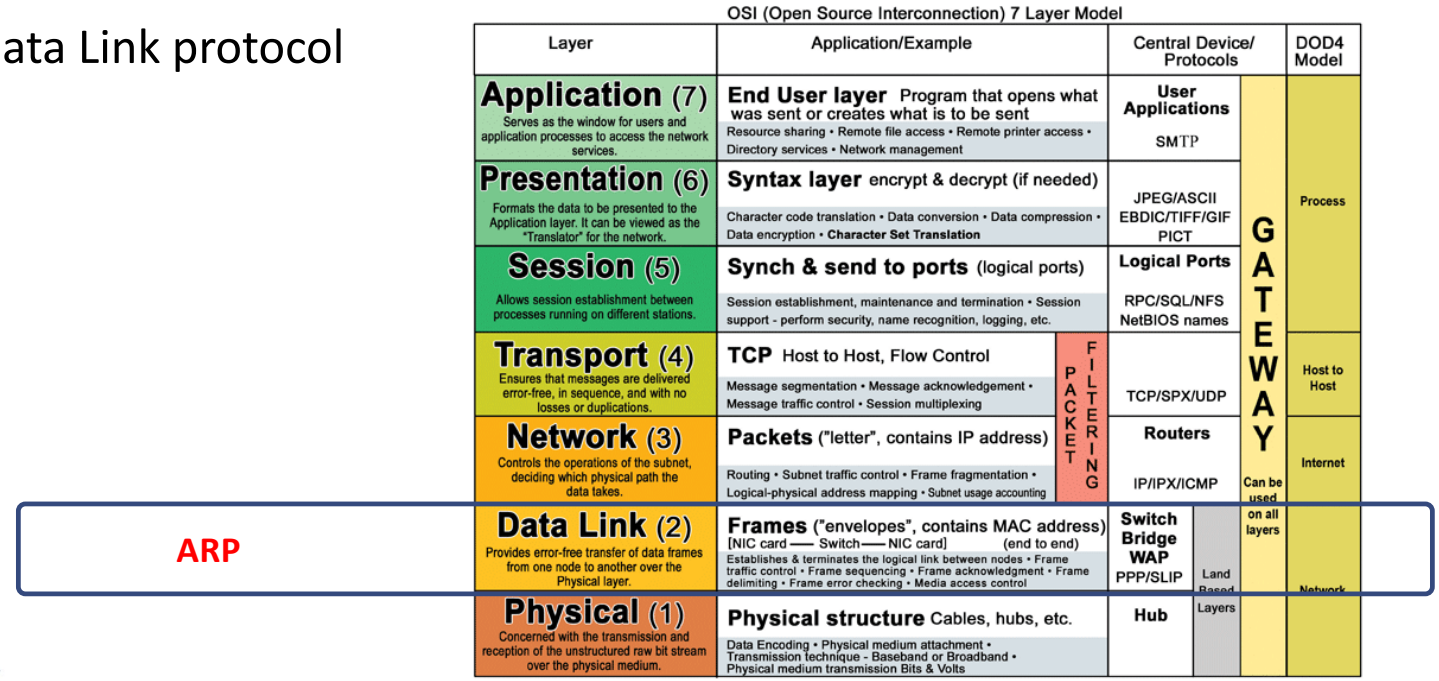
ARP (Address Resolution Protocol)

- ARP
  - ➢ARP is a Data Link protocol (Layer 2).



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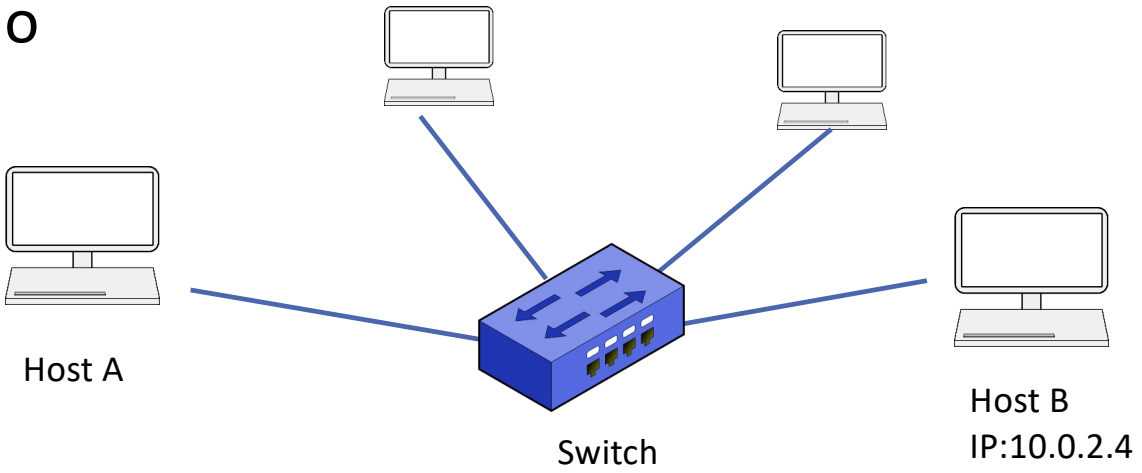
ARP Basics

- ARP (Address Resolution Protocol)
  - A network protocol used to discover the hardware (**MAC**) address of a host from an IP address.
  - ARP is used on Ethernet LANs when hosts want to communicate with each other and they should know each other's MAC address.
  - It is a simple request-reply protocol; **ARP request** messages are used to request the MAC address, while **ARP reply** messages are used to send the requested MAC address.

ARP Basics

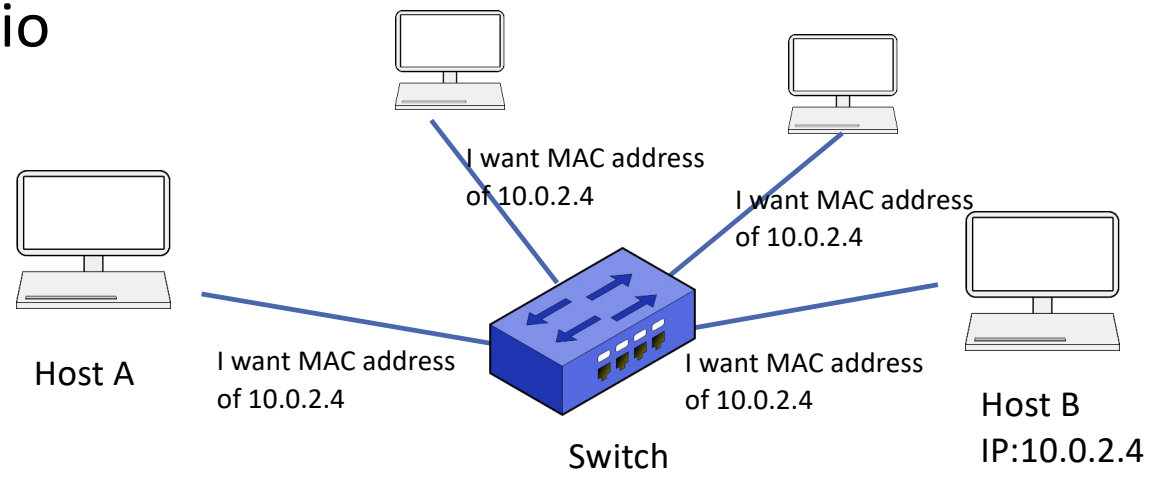
- Scenario



Host A wants to communicate with Host B with IP 10.0.2.4.
Host A does not know Host B's MAC address.

ARP Basics

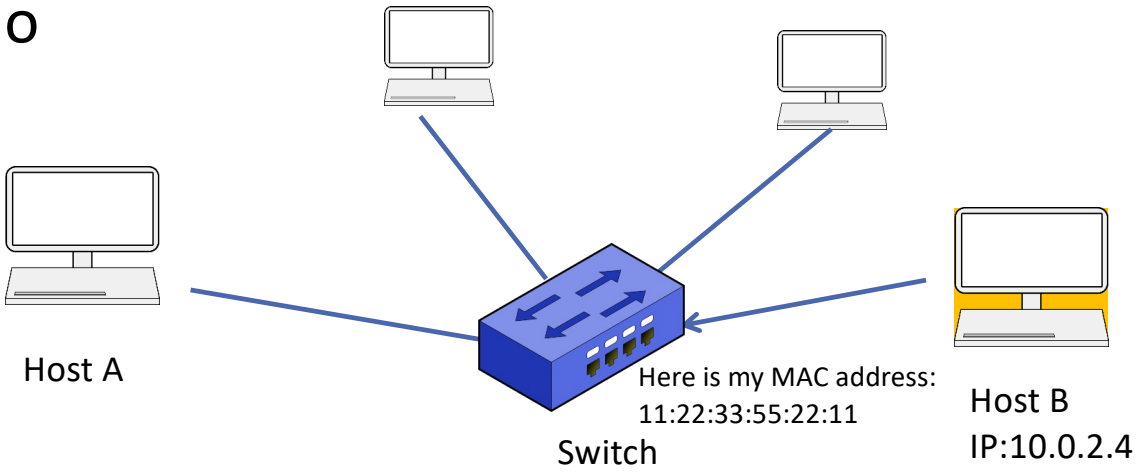
- Scenario



Host A sends ARP request to broadcast address. Switch will flood this request to all interfaces.

ARP Basics

- Scenario



Once Host B receives this request, it processes the request and prepares ARP reply containing MAC address of Host B.

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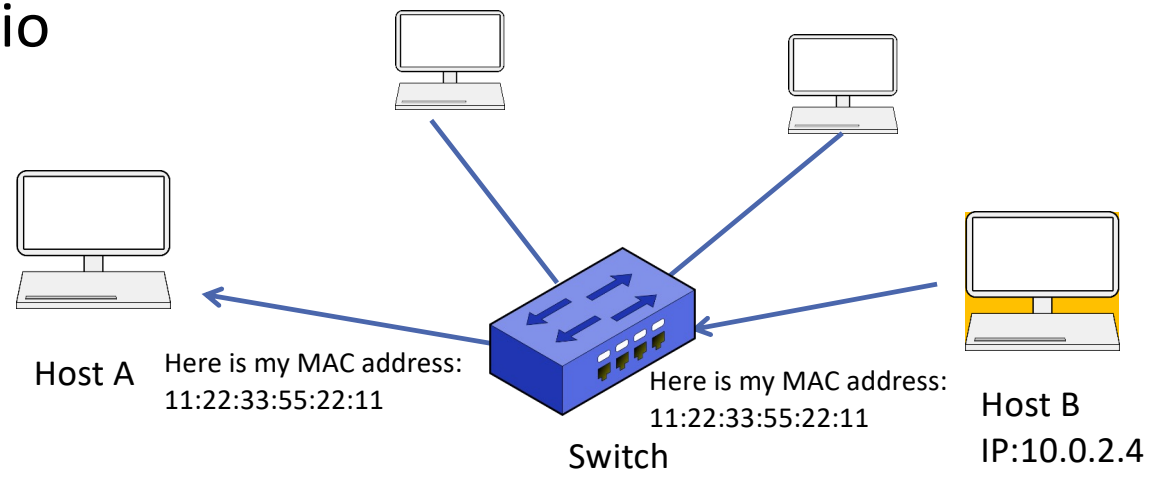
ARP Basics

- Scenario



ARP reply will be relayed to Host A.

ARP Poisoning – Preparation

- Features of ARP packet
  - ➢ICMP can be filtered by a host's local firewall, while ARP requests cannot be blocked because ARP requests are not routed on a TCP/IP network. → ARP can be used to discover hosts that are directly connected to the same network hub or switch.
- Assumption
  - ➢We assume that an attacker has obtained access to a target's internal network
    - ✓For example, a hacker has gained access to our university network having obtained username/password of some student/staff

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ARP Basics

- `arp` command
  - This command is to display and modify a current ARP cache.
  - Each host will use the ARP cache first to resolve the address of the neighbor.
  - `-a` option will display the device name, IP address, HW address (MAC address), HW type and network interface.
  - If the cache does not contain the information required to resolve the address then a request is sent to every device (machine) on the network.

ARP Basics

- `netdiscover`
  - A tool used to discover the connected clients to the current network interface.
  - Shows basic information about the clients: IP and MAC address and the hardware manufacturers of the clients' network card.
  - Passive mode: This mode does not generate any packet on the network, it just sniffs arp request on the network.
    - ✓ `netdiscover -i [INTERFACE] -p`
  - Active mode: This mode allows to find nodes by sending arp requests
    - ✓ Command structure: `netdiscover -i [INTERFACE] -r [RANGE]`
  - Note that `RANGE` should be given as CIDR notations like 10.0.2.1/24.

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ARP Scanning

- ARP host recovery
  - The Address Resolution Protocol (ARP) maps system's MAC address (hardware address) to its IP address.
  - An ARP can send ARP request to every host on a subnet: If an ARP reply is received, that host is considered "live".
  - As it operates below the layers of ICMP/TCP/UDP, it can bypass firewall, the attacker needs to be located on the same local network.
  - Ex) `arp-scan 192.169.8.2 - 192.169.8.10`

ARP Scanning Example

- ARP Scanning can be visualized through Wireshark.
  - ➢ARP scan with Scapy
    - ✓`ans, unans = srp(Ether(dst="ff:ff:ff:ff:ff:ff")/ARP(pdst = ips), timeout = 2, iface = interface, inter = 0.1)` where `ips` is ip addresses such as “10.0.2.0/30” and `iface` is the network interface name such as “eth0”.

Source	Destination	Protocol	Length	Info
PcsCompu_22:…	Broadcast	ARP	42	Who has 10.0.2.0? Tell 10.0.2.6
PcsCompu_22:…	Broadcast	ARP	42	Who has 10.0.2.1? Tell 10.0.2.6
RealtekU_12:…	PcsCompu_22:a4:…	ARP	60	10.0.2.1 is at 52:54:00:12:35:00
PcsCompu_22:…	Broadcast	ARP	42	Who has 10.0.2.2? Tell 10.0.2.6
RealtekU_12:…	PcsCompu_22:a4:…	ARP	60	10.0.2.2 is at 52:54:00:12:35:00
PcsCompu_22:…	Broadcast	ARP	42	Who has 10.0.2.3? Tell 10.0.2.6
PcsCompu_7f:…	PcsCompu_22:a4:…	ARP	60	10.0.2.3 is at 08:00:27:7f:9f:d0

ARP Scanning Example

- ARP addresses is cached in the OS. The `arp -a` command to view and modify the ARP table entries on the local computer.
- The command can be used to display all the known connected hosts on the target's local network segment (if they have been active and in the cache).

```
$ arp -a
Net to Media Table: IPv4
Device   IP Address               Mask      Flags      Phys Addr
------ -------------------- --------------- -------- ---------------
aggr557001 pan-SharedCompute-557-router.its.uow.edu.au 255.255.255.255
00:1b:17:00:01:26
igb0   scylla.cs.uow.edu.au 255.255.255.255 SPLA     00:21:28:f1:a2:dc
igb0   pan-VirtualInfra-553-router.its.uow.edu.au 255.255.255.255          00:1b
:17:00:01:26
```

Man-In-the-Middle (MITM)

- MITM
  - An attack where the attacker secretly relays and possibly modifies the communication between two parties, who believe they are directly communicating with each other.
  - The attacker must be able to intercept all relevant messages passing between the two victims and inject new ones.

    Alice ←→ Bob: Normal communication

    Alice ←→Charlie (attacker) ←→ Bob: MITM

ARP Poisoning

- ARP Poisoning (Sometimes called ARP Spoofing)
  - ➢An attacker can exploit the fact that
  1) ARP request/reply is trusted
  2) Clients can accept any responses even if they did not send a request

ARP Poisoning

- Preliminary: Default gateway
  - ➢In general, a gateway is a network node that serves as an access point to another network.
  - ➢The default gateway is a device, such as a DSL router or cable router, that connects the local network to the public network (the Internet).
  - ➢In a home or small office environment:
    - ✓The default gateway router directly connects the local network to the public network.
  - ➢In enterprise network environment:
    - ✓The default gateway router connects the local network to adjacent network, one hop closer to the public network.

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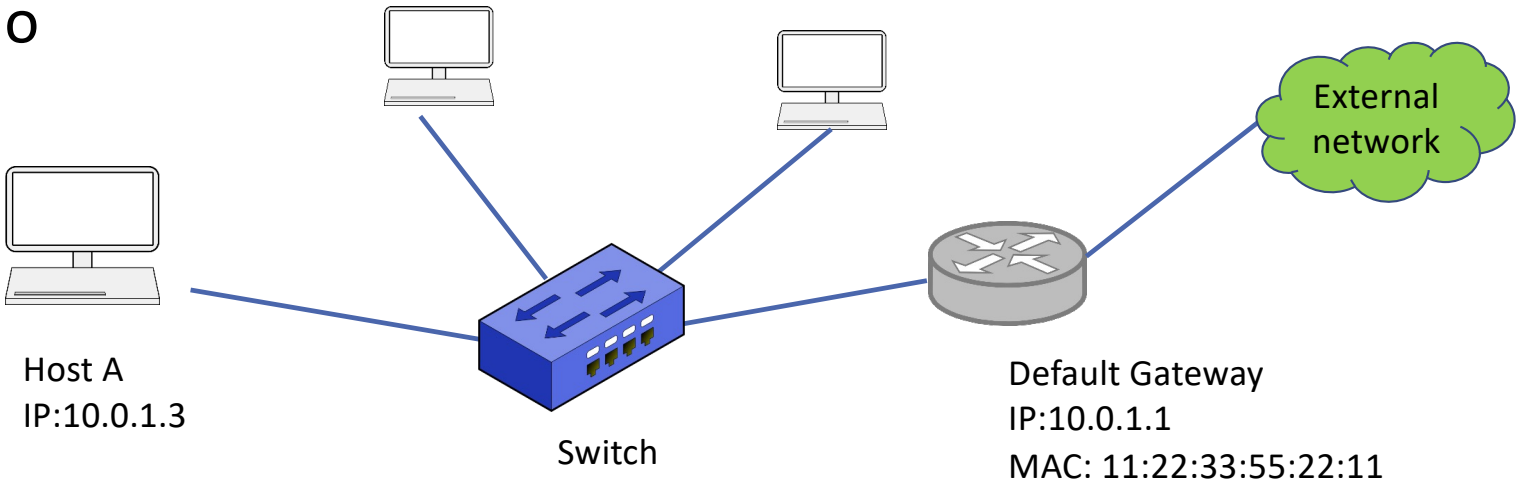
ARP Poisoning

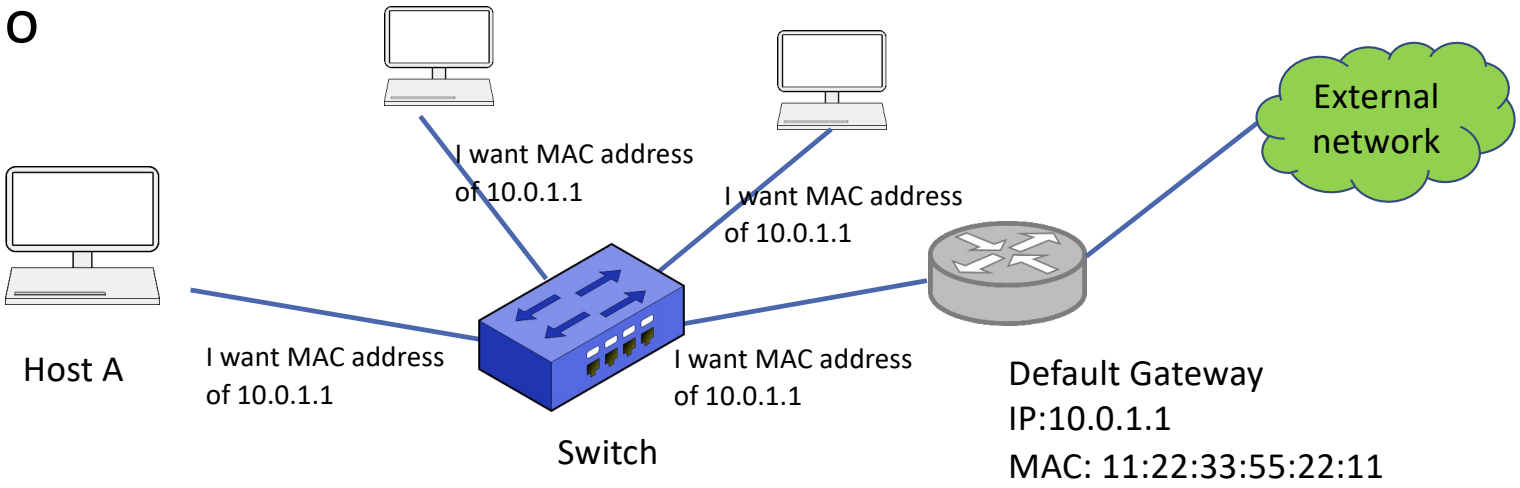
- Scenario



Host A wants to communicate with the external network through Default Gateway with IP 10.0.1.1. Host A does not know Default Gateway's MAC address.

ARP Basics

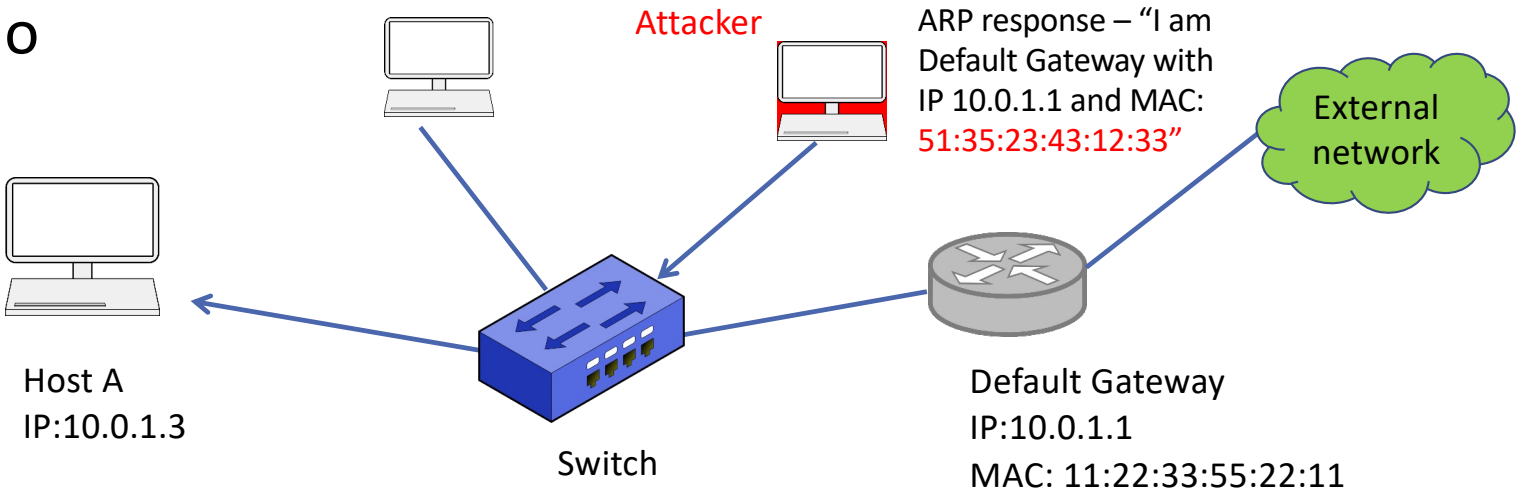
- Scenario



Host A sends ARP request to broadcast address. Switch will flood this request to all interfaces.

ARP Poisoning

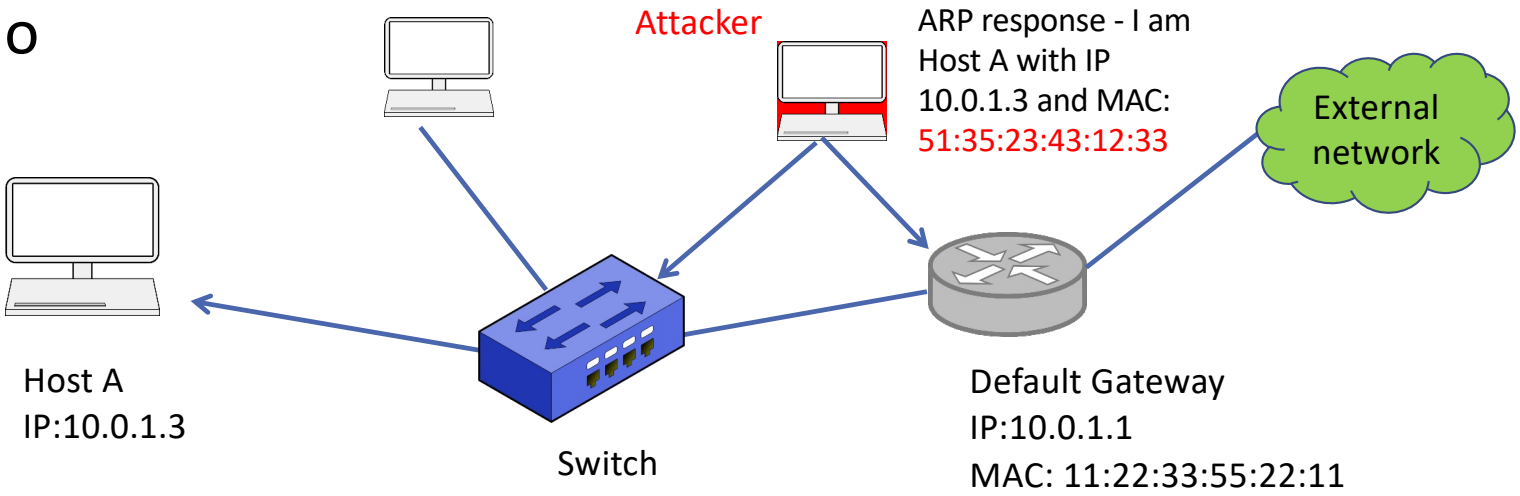
- Scenario



The attacker sends ARP response to Host A (through switch) claiming that it is a Default Gateway with the IP address 10.0.1.1 and its own MAC.

ARP Poisoning

- Scenario



The attacker now sends ARP response to Default Gateway claiming that it is Host A with the (real) Host A IP address and its own MAC.

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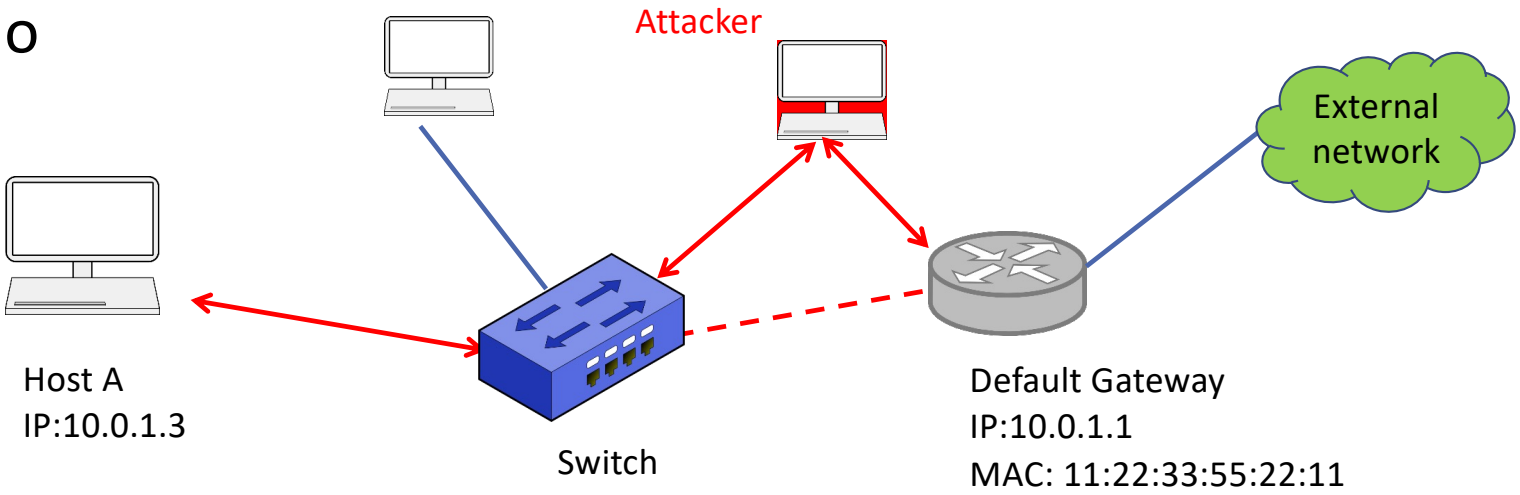
ARP Poisoning

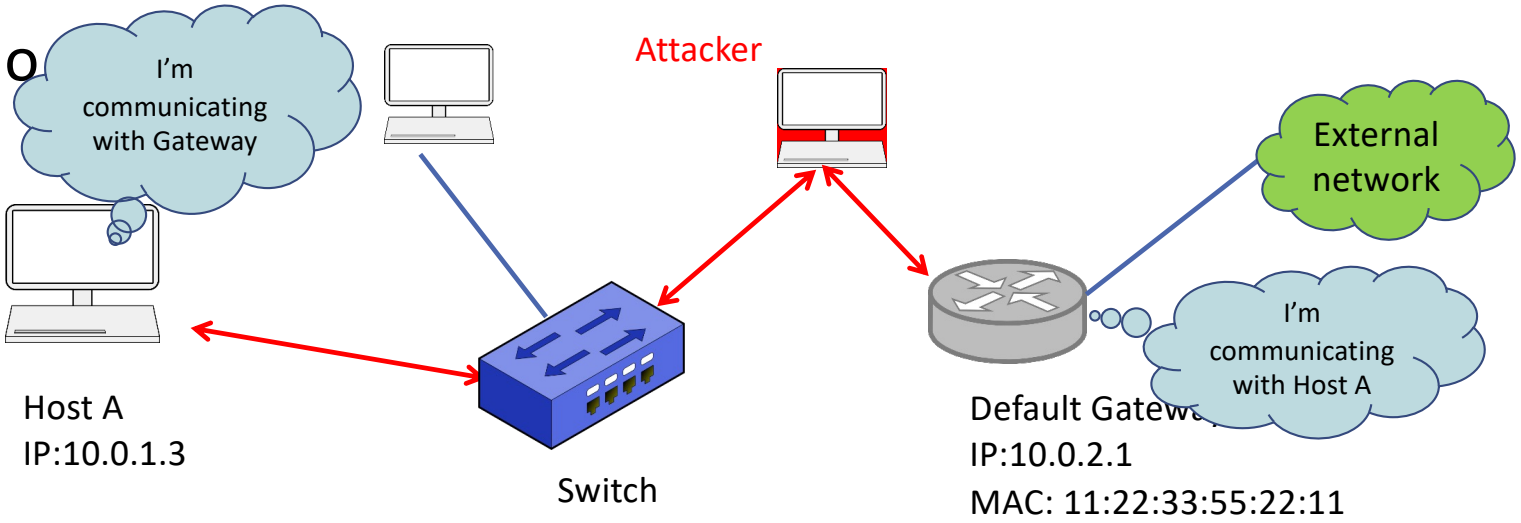
- Scenario



Host A sends its packets to the external network via the attacker.

ARP Poisoning

- Scenario



Host A and Default Gateway believe that they are communicating each other, which is not true.

ARP Poisoning

- After the ARP poisoning happens:
  - ➢ *The real gateway thinks that the attacker is Host A while Host A thinks that the attacker is the gateway*.
  - ➢ So the attacker's device is in the middle of the connection between Host A and the gateway →Every packet that is going to/from the client will have to go through the attacker's device first.

Danger of ARP Poisoning

- ARP poisoning will redirect traffic to and from any client to the attacker's device
  - ➢The attacker can read/modify/drop these packets in the traffic.
  - ➢This allows the attacker to conduct more powerful attacks.
- It is very effective and dangerous, but it is difficult to protect against it.

ARP Poisoning with Arpspoof

- How to perform ARP poisoning attack on Kali
  - Arpspoof is a tool for performing ARP Poisoning attack

```
arpspoof –i [interface] –t [Target A][Target B]
```

  - Step 1: Tell the target that the attacker is the default gateway

```
arpspoof –i eth0 –t 10.0.1.3 10.0.1.1
```

  - Step 2: Tell the default gateway that the attacker is the target

```
arpspoof –i eth0 –t 10.0.1.1 10.0.1.3
```

  - Step 3: Enable IP forward to make packets go through the attacker's device.

```
echo 1 > /proc/sys/net/ipv4/ip_forward
```

ARP Poisoning with Arpspoof

- How to check the attack has been successful
  - Run `arp -a` (on the target's machine) to check whether the MAC address of the default gateway has been changed
  - In the scenario above, Host A will see **51:35:23:43:12:33** as the MAC address of Default Gateway, whose real MAC address is 11:22:33:55:22:11

ARP Poisoning with Bettercap

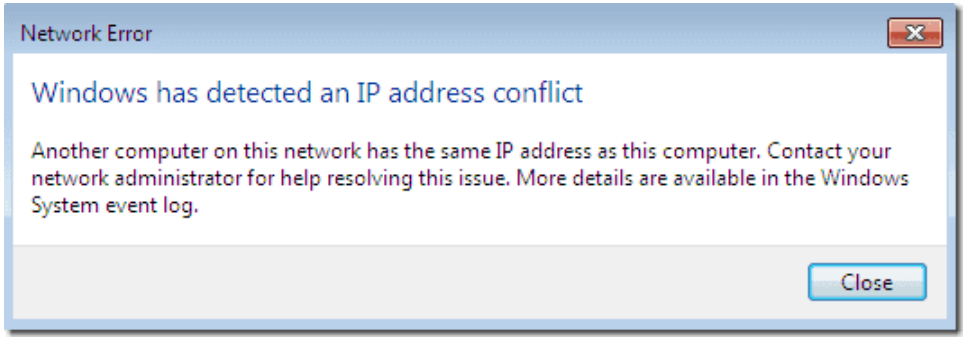
- Another method to perform ARP poisoning attack on Kali
  - Bettercap provides a nicer user interface to perform ARP poisoning (spoofing).
  - Bettercap Scripting called “caplet” can be used to automate command executions.
  - Can be combined with other attacks.

Protection against ARP Poisoning

- It is very difficult to prevent ARP poisoning itself as it exploits the insecure way that ARP works.
- Using static ARP tables can protect against MITM attacks but it does not scale well → It is not practical in large networks (Note that even in small networks, ARP tables have to be configured every time a new device is connected to the network)
- In fact ARP poisoning can easily be discovered by looking at the current ARP table (`arp -a`)
  - ➢ If the MAC address of the gateway (router) changes then poisoning has panned; but we do not check the ARP table all the time

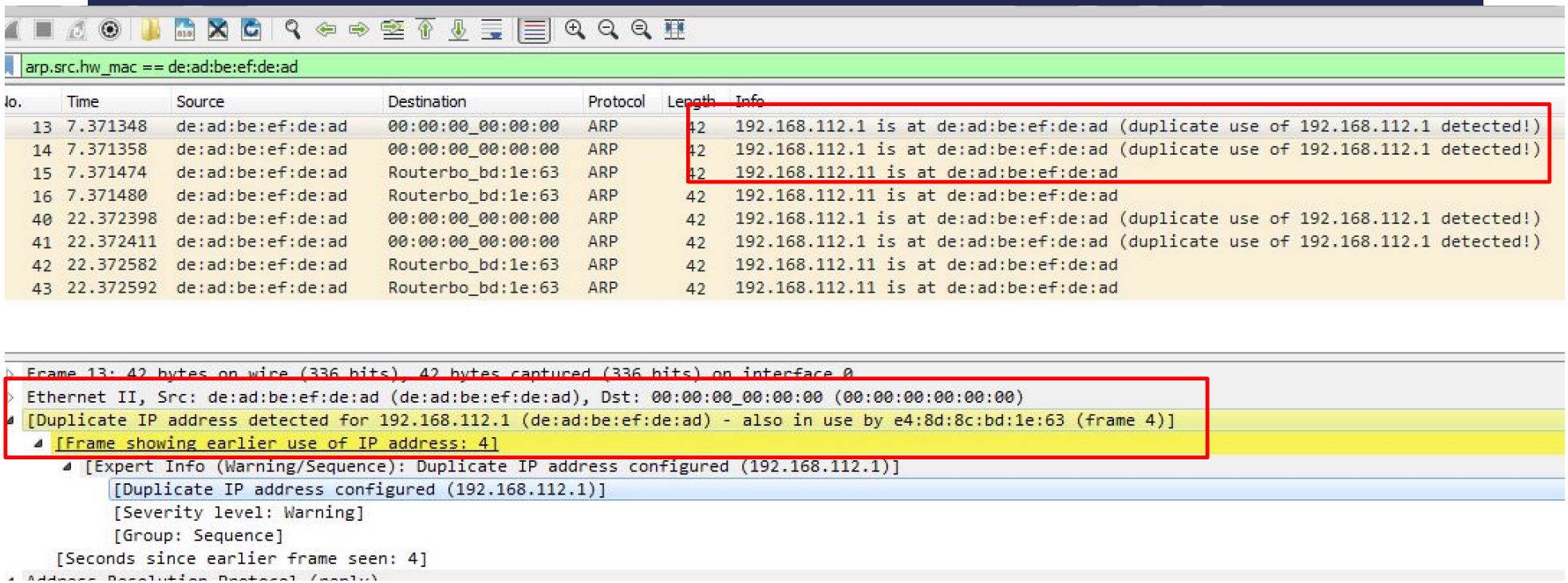
Protection against ARP Poisoning

- There are tools that monitors the ARP table automatically and sends a user a notification if anything suspicious happens.



- By using Wireshark, one can detect ARP poisoning (and other suspicious activities) in the network. → Next slide

Protection against ARP Poisoning



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