ARP
Address Resolution Protocol

Networking Basics

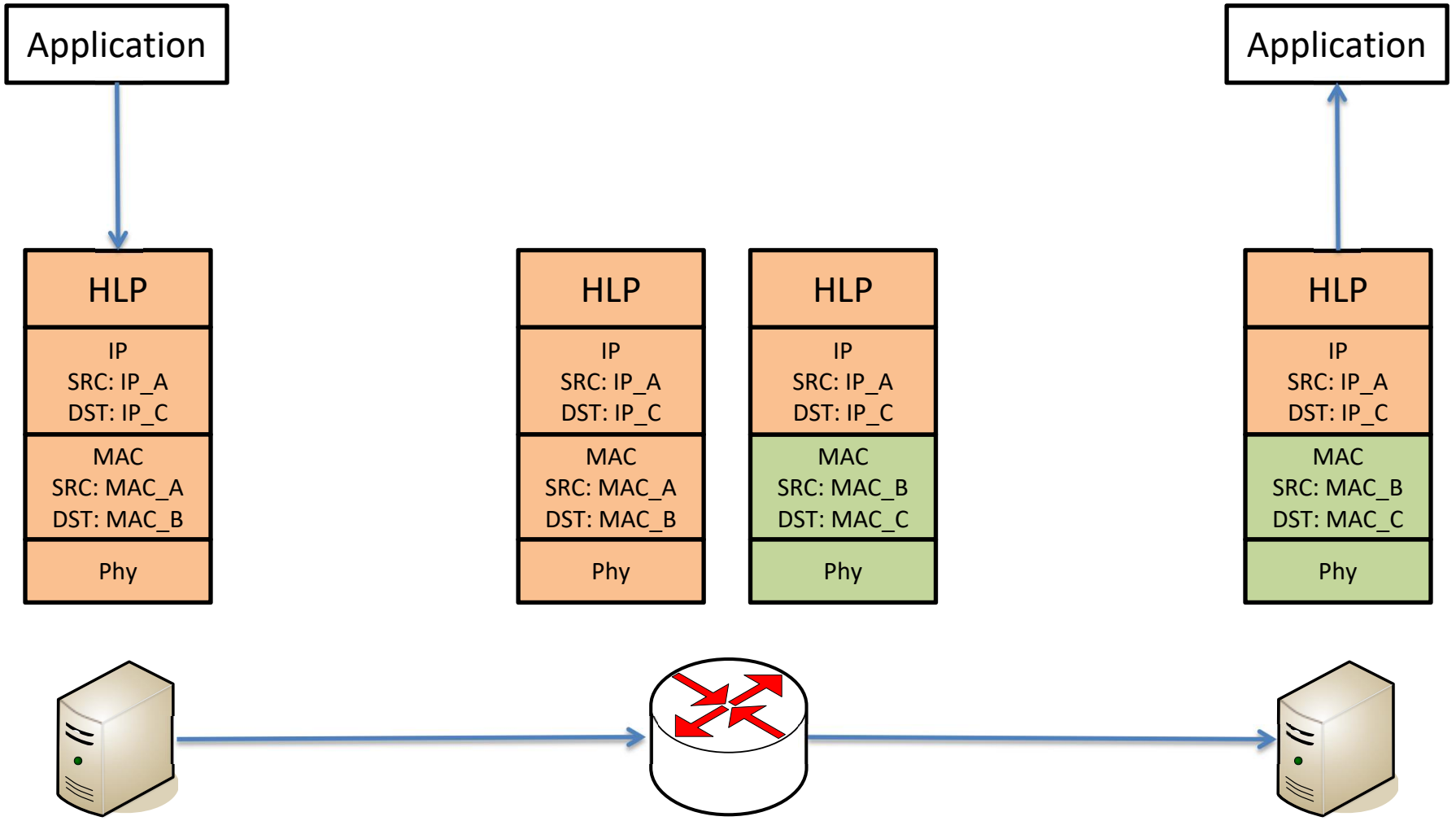
- Communication in packet networks rely on several layers, with different identifiers:
  - Applications use TCP/UDP ports
  - Hosts use IP addresses
  - Interface Cards use MAC addresses

- Communication is typically made between applications using touples <IP_Address:Port> and a protocol (e.g. TCP or UDP).

Networking Basics

- When a packet is to be routed, two situations may occur:
  - The packet is sent to the destination host, which is in the same IP network.
  - The packet must be sent to a next hop (gateway), until it reaches the destination IP network.
- In both cases, packet is transmitted between physical interfaces

Networking Basics



Networking Basics

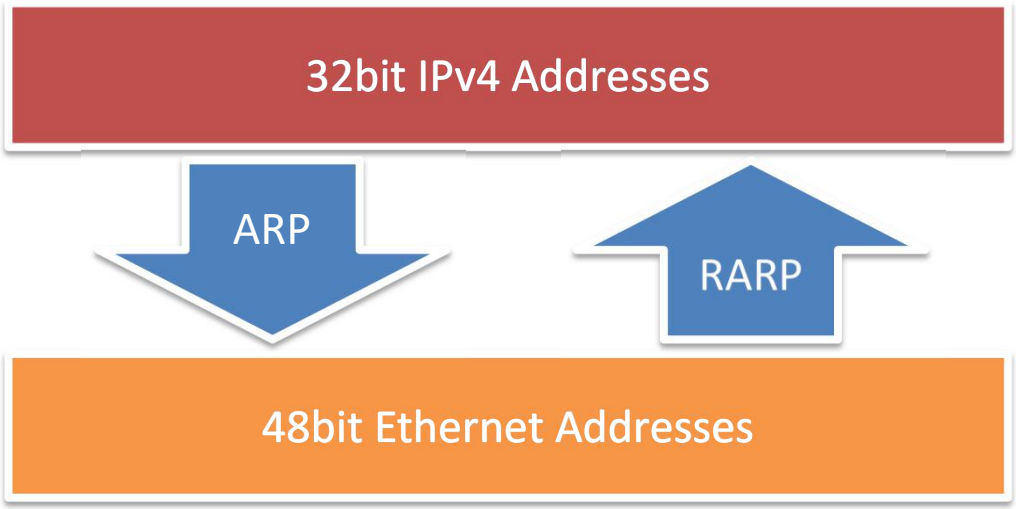
- IP addresses do not change between source and destination
- MAC addresses are valid for a single network segment
  - When packet is routed, MAC address of next hop must be found

IP to MAC mapping

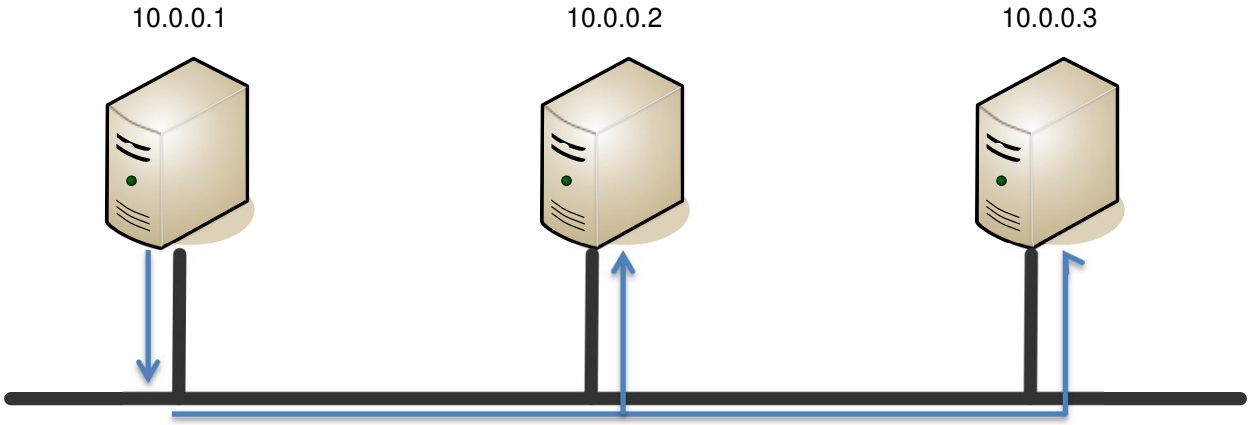
- Static configuration
  - MAC entries of all hosts configured statically
    - All hosts “know” the MAC address of all interfaces of all other hosts
  - Does not scale!
    - Changing a single interface requires updating all other hosts
- Dynamic configuration: ARP

Address Resolution Protocol
RFC 826

- ARP: find MAC address of an Interface which is in a host with IP address
- RARP: find IP address of host having an interface with the given MAC

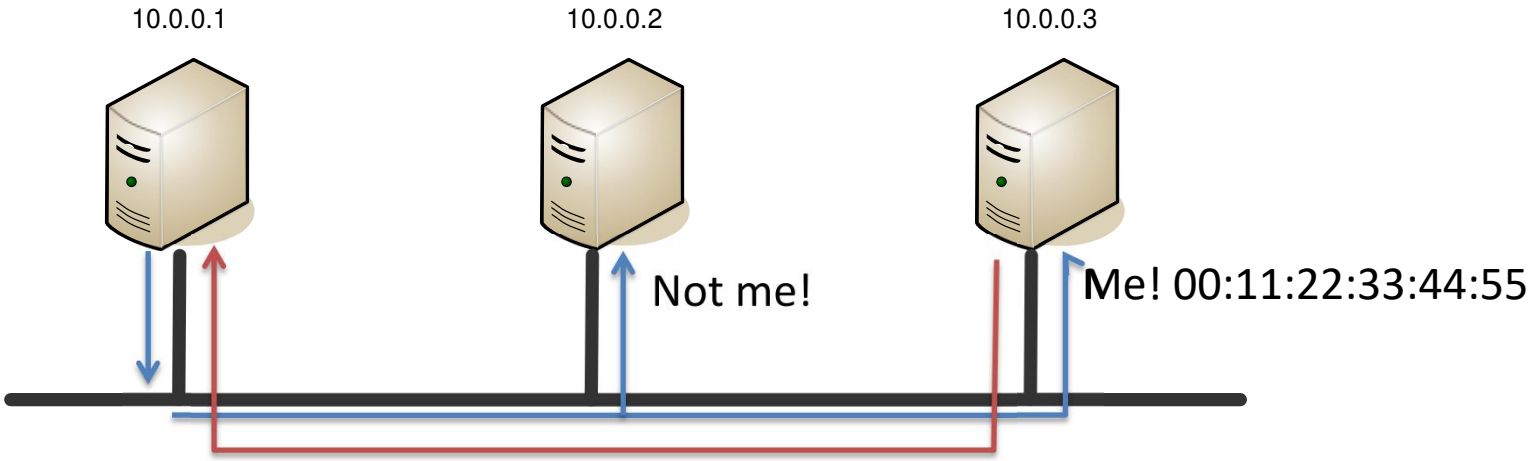


Address Resolution Protocol



- Send ARP Request using broadcast.

Address Resolution Protocol



- Reply using ARP Response using unicast

Address Resolution Protocol

- Every packet sent requires two MAC address
  - Source Address is known
  - Destination Address must be determined
- ARP Cache increases performance
  - Caches both known and unknown entries
  - Avoid repeating the discovery process per packet
  - Entries have a large lifetime (2 minutes)

ARP Cache

```
security@security:~$ arp -a
fog.av.it.pt     (193.136.92.154) at 00:1e:8c:3e:6a:a6 [ether] on eth0
atnog.av.it.pt   (193.136.92.123) at 00:15:17:e6:6f:67 [ether] on eth0
guarani.av.it.pt (193.136.92.134) at 00:0c:6e:da:19:87 [ether] on eth0
aeolus.av.it.pt  (193.136.92.136) at bc:ae:c5:1d:c6:53 [ether] on eth0
```

ARP Spoofing

- MAC addresses can be modified

```
ifconfig eth0 hw ether 00:11:22:33:44:55
```

- Using a colliding MAC address will allow reception of network traffic for other hosts
  - Some switches limit MAC addresses to single ports

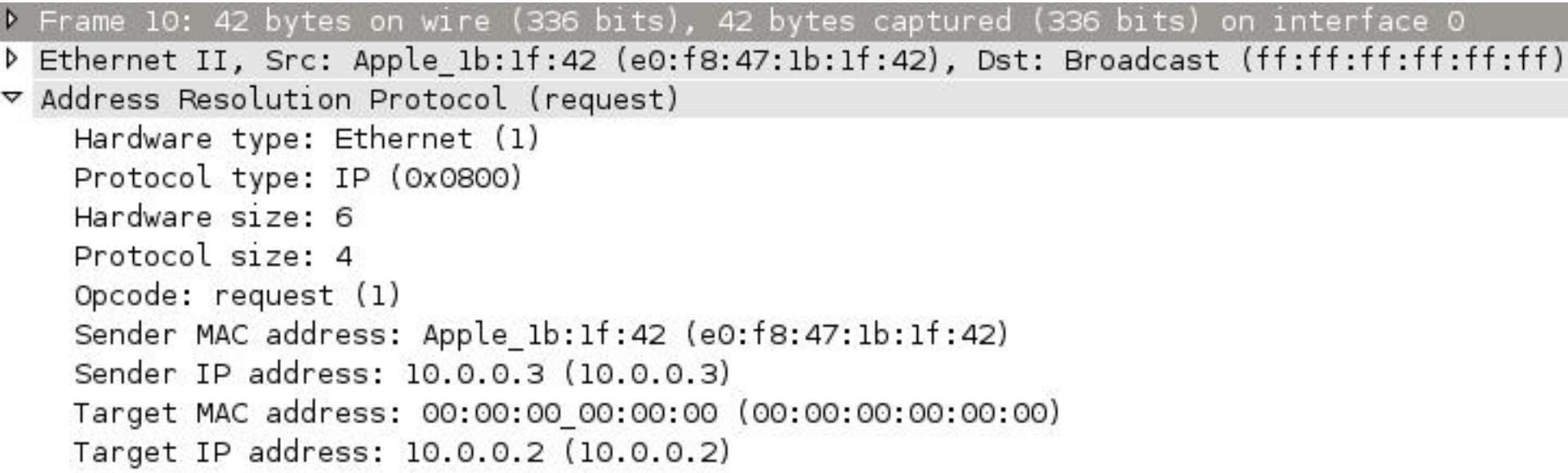
- Sending ARP packets with spoofed addressed may poison the cache of other stations
  - ARP Poisoning

ARP Poisoning

- Hosts cache information directly from ARP packets
  - No other verification is done
- New information will replace existing entries
  - Great for allowing network dynamism
  - Very bad for security
- Possible to send specially crafted packets to create specific entries in remote hosts

ARP Poisoning

- When receiving an ARP Request:



10.0.0.2 will send an ARP Reply

But… 10.0.0.2 will also “learn” that 10.0.0.3 is at e0:f8:47:1b:1f:42

ARP Poisoning

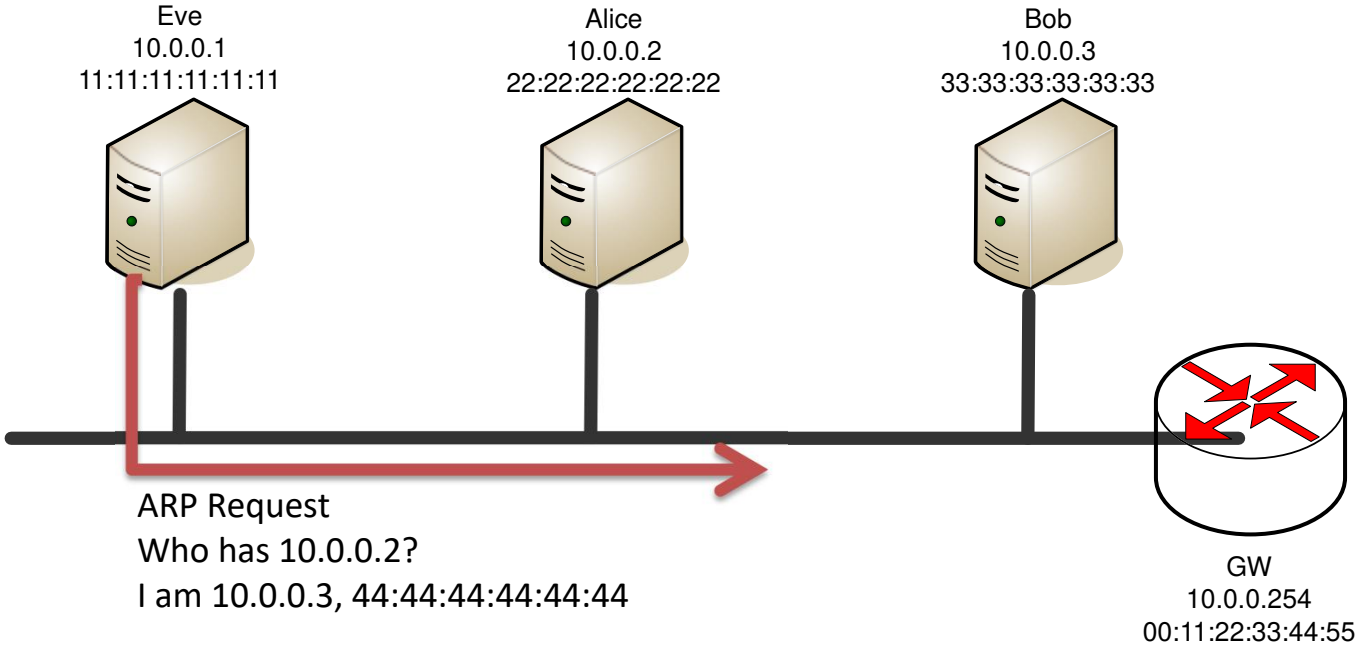
- When receiving an ARP Reply

```
▷ Frame 123: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface 0
▷ Ethernet II, Src: Tp-LinkT_f2:77:62 (90:f6:52:f2:77:62), Dst: Apple_1b:1f:42 (e0:f8:47:1b:1f:42)
▽ Address Resolution Protocol (reply)
    Hardware type: Ethernet (1)
    Protocol type: IP (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: reply (2)
    Sender MAC address: Tp-LinkT_f2:77:62 (90:f6:52:f2:77:62)
    Sender IP address: 10.0.0.246 (10.0.0.246)
    Target MAC address: Apple_1b:1f:42 (e0:f8:47:1b:1f:42)
    Target IP address: 10.0.0.3 (10.0.0.3)
```

- 10.0.0.3 will learn that 10.0.0.246 is at 90:f6:52:f2:77:62
- …. even if no matching request as made…

ARP Poisoning: Consequences

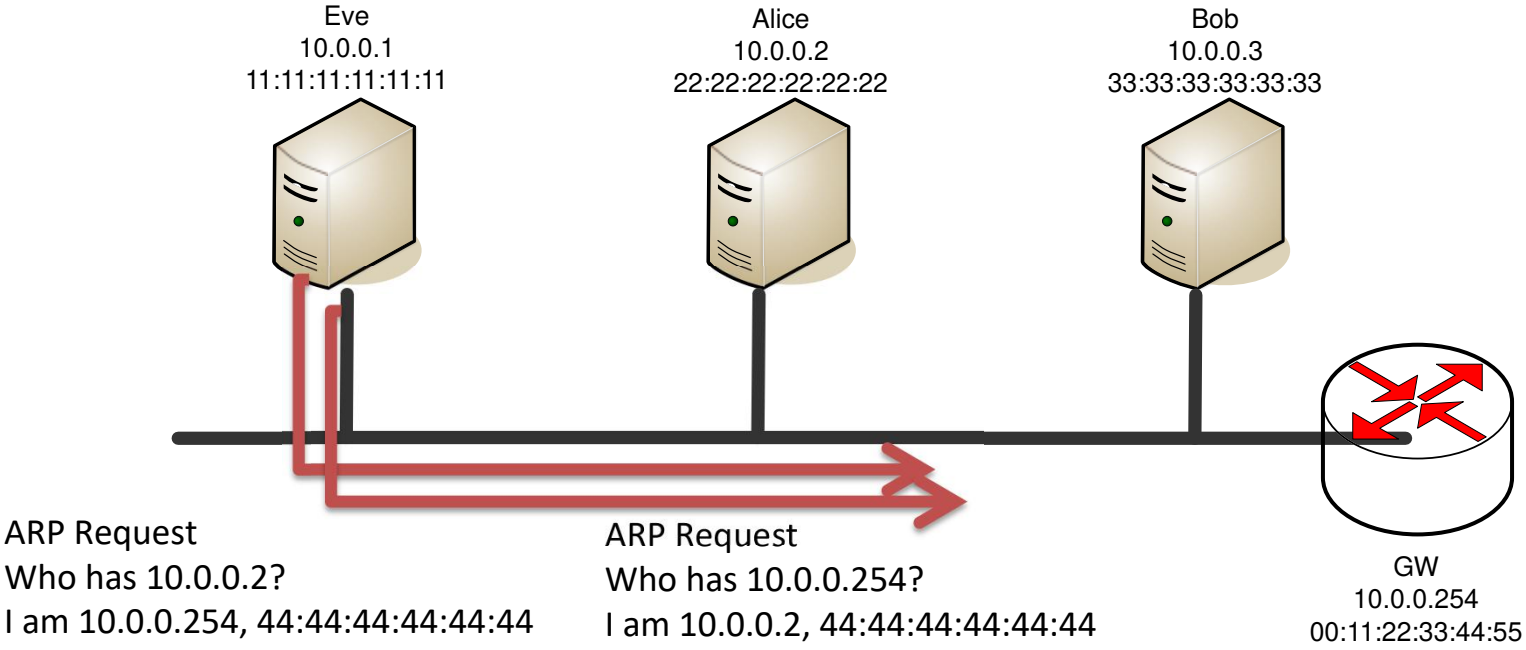
- Hosts can be isolated from the network
  - Create fake entries for all other hosts



- Alice will use 44:44:44:44:44:44 when talking to Bob

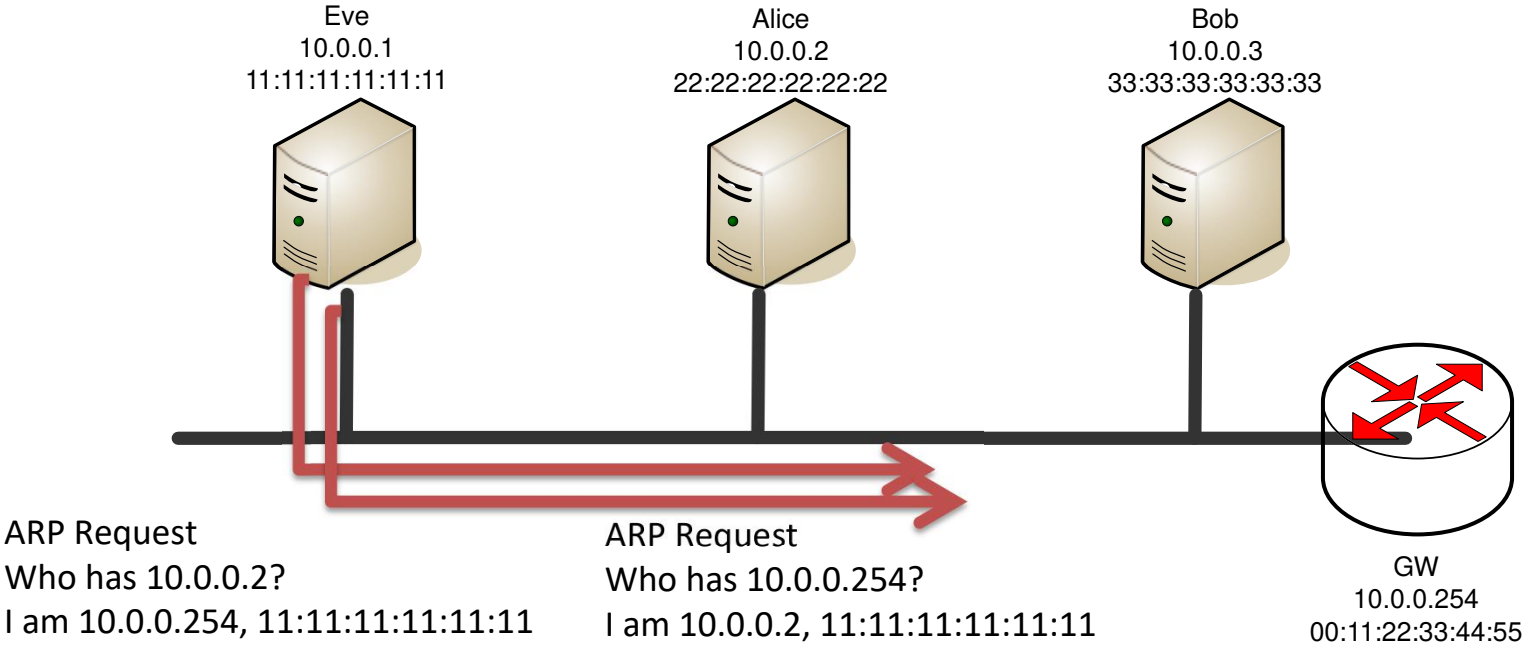
ARP Poisoning: Consequences

- Hosts can be denied communication with the outside world



ARP Poisoning: Consequences

- Traffic between two hosts can be intercepted (MitM)



  - Then Eve will forward traffic

ARP Poisoning: Avoidance

- Use static entries
  - No resolution process is triggered
  - Colliding Information from ARP packets is discarded
- Behaviour detection
  - Detect ARP Replies without Request
  - Detect repeated Requests from same host.

ARP Poisoning: Avoidance

- Use monitoring software
  - Software watches for MAC changes
    - Network administrator is notified
  - ARP Poison is not actually avoided!
- Port based packet filtering at switch ingress
  - Spoofed ARP packets are dropped
  - Only possible in static scenarios