Redes de Computadores II

Universidade do Algarve

Semana 5

https://github.com/ncatanoc/redes_algarve

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ARP and DHCP

Goal:

To understand the basic functionality of ARP and DHCP.

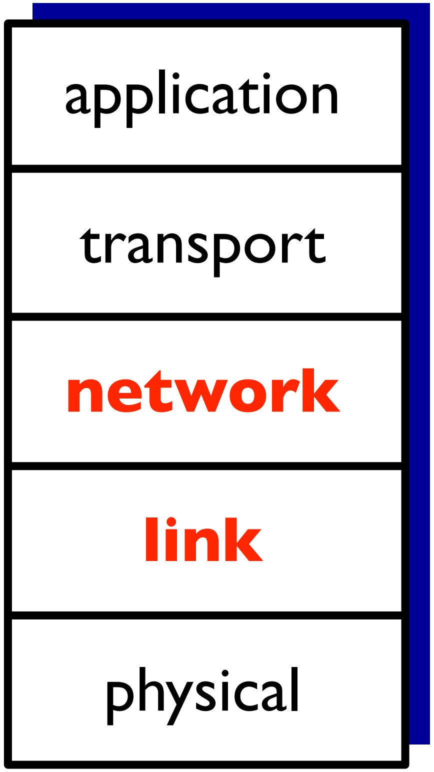
Roadmap

1. ARP
2. DHCP (Dynamic Hosting Control Protocol)
3. DHCP security

introduction

- How do we connect the link layer to the network layer?
- How do we get MAC address 0C:0C:0B:14:CD:98 connected to IP address 192.0.2.1?

How to connect these two?



application

transport

network

link

physical

properties of MAC and IP addresses

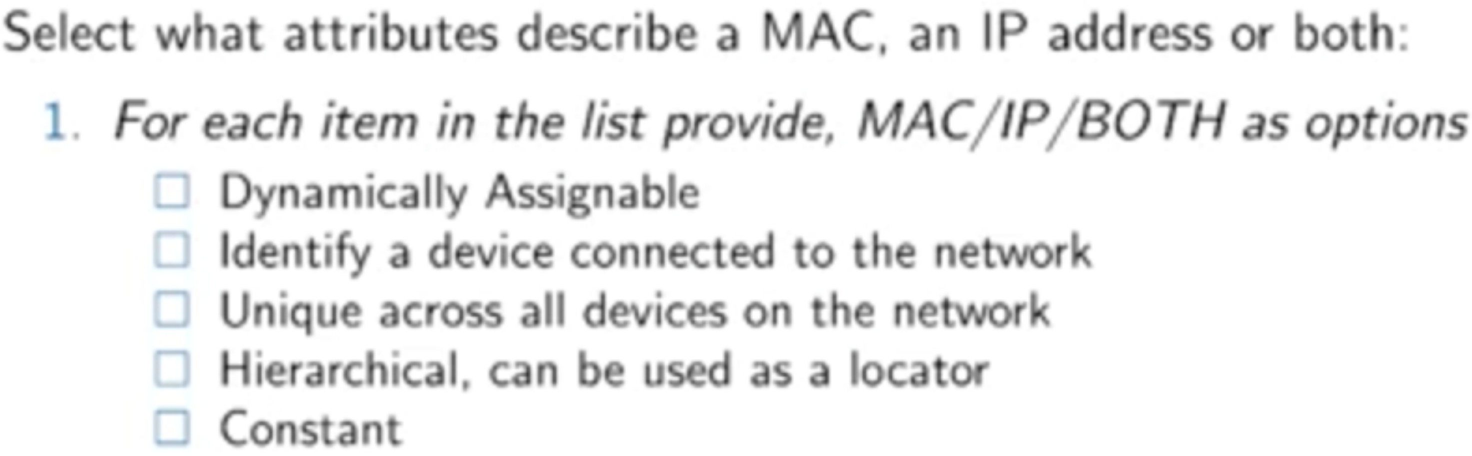
- **MAC addresses**
  - Consist of an OUI and NIC identifier
  - Are associated with a network adapter, e.g., hardware
- **IP addresses**
  - Not dependent on hardware
  - Assigned by some authority
  - Have a hierarchical structure
  - Geographical location

why do we need a MAC address at all?

- why not have an IP address per device?
- why not just have only an IP and no link-layer address(es)?
- having different addresses keep the layers separate
- each layer needs its own addressing scheme
- Whereas MAC addresses signify the next hop, IP addresses indicate the final destination

ARP connects IP to MAC

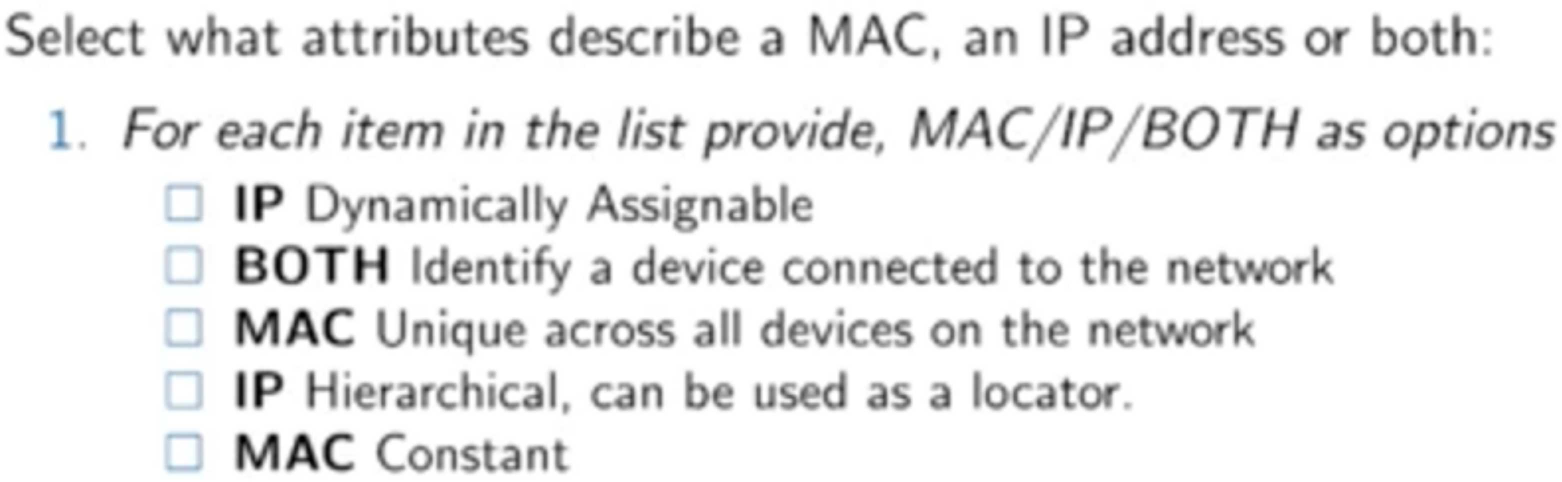
Quiz



Select what attributes describe a MAC, an IP address or both:

1. *For each item in the list provide, MAC/IP/BOTH as options*
   - □ Dynamically Assignable
   - □ Identify a device connected to the network
   - □ Unique across all devices on the network
   - □ Hierarchical, can be used as a locator
   - □ Constant

Answer



Select what attributes describe a MAC, an IP address or both:

1. *For each item in the list provide, MAC/IP/BOTH as options*
   - □ **IP** Dynamically Assignable
   - □ **BOTH** Identify a device connected to the network
   - □ **MAC** Unique across all devices on the network
   - □ **IP** Hierarchical, can be used as a locator.
   - □ **MAC** Constant

ARP (address resolution protocol)

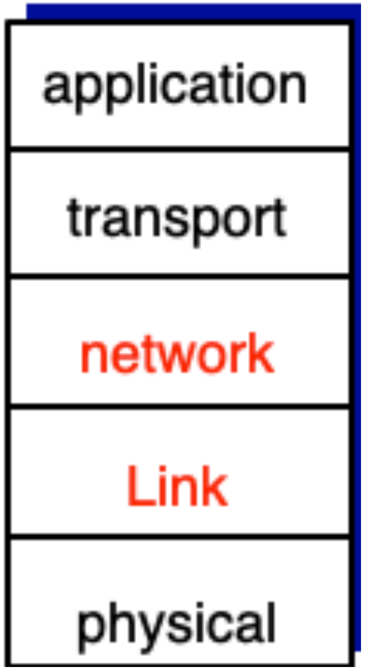
- when sending an IP packet to some IP address, the ethernet frame should contain the right MAC address for the next hop.
  - However, we usually have the IP address but not the MAC address.

ARP goes from the network layer to the link layer

how does ARP work? Postcard example

- a postcard is sent to Sergio who lives at some residence building
- the postman knows the postcard is for Sergio and knows his address.

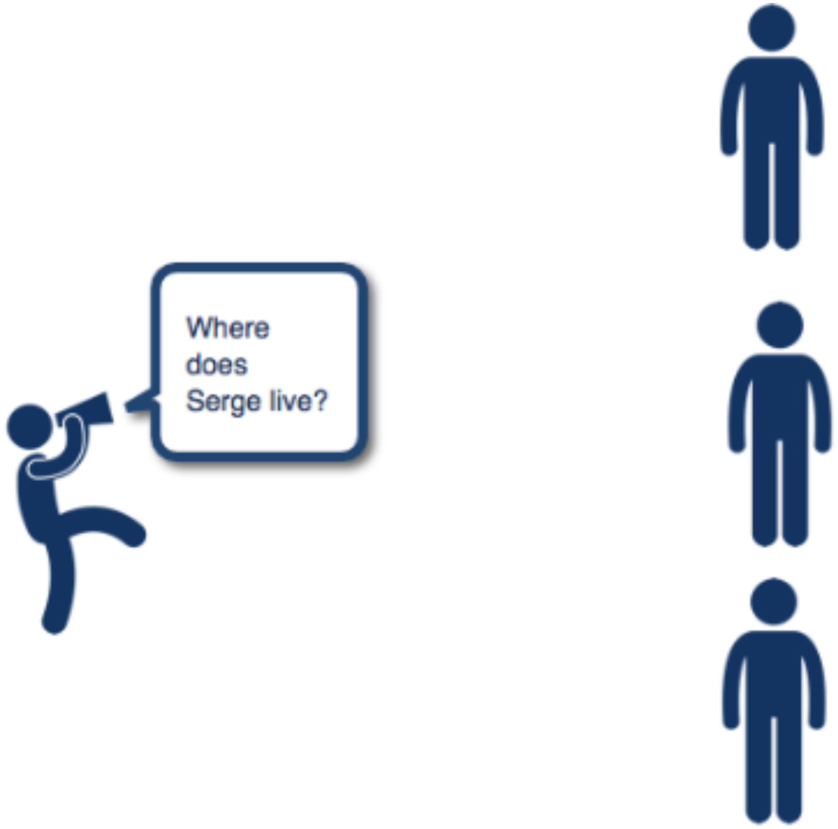
- transport layer: recipient's name (Sergio)
- network layer: Sergio's address
- link layer: andar 6, fracção Z



how does ARP work?

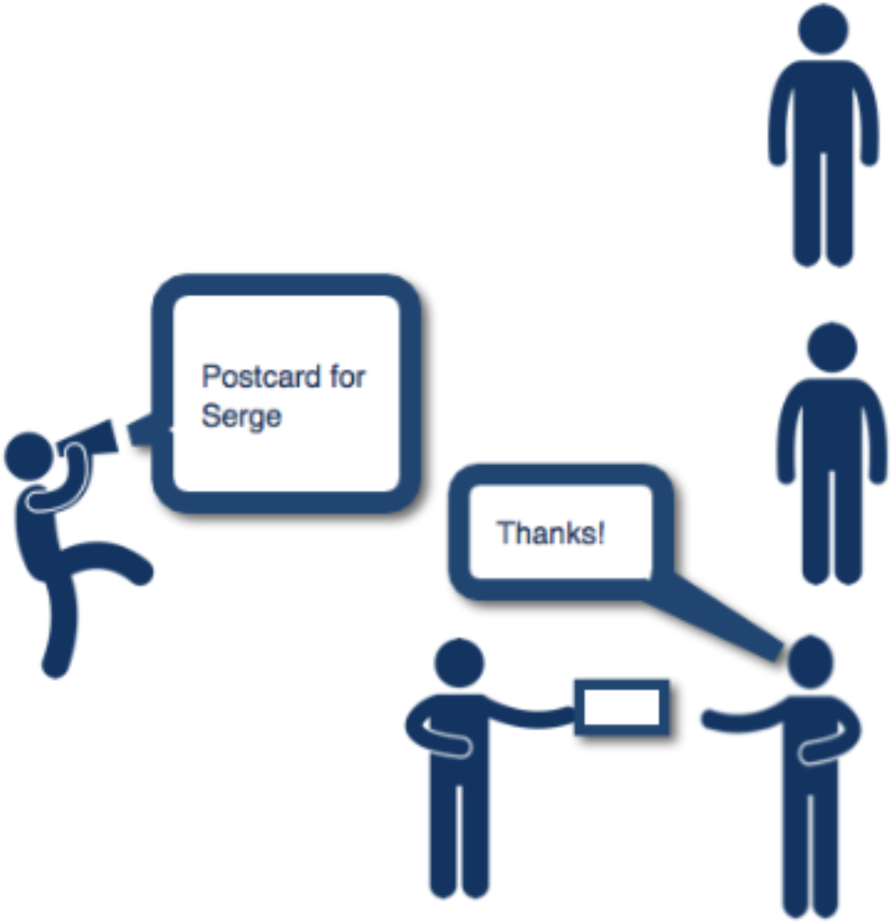
Postcard example

- Using network routing the packet has arrived at the final destination.
- The postman broadcasts "Where does Sergio live?"
- Everybody hears the postman's announcement, including Sergio



how does ARP work? Postcard example

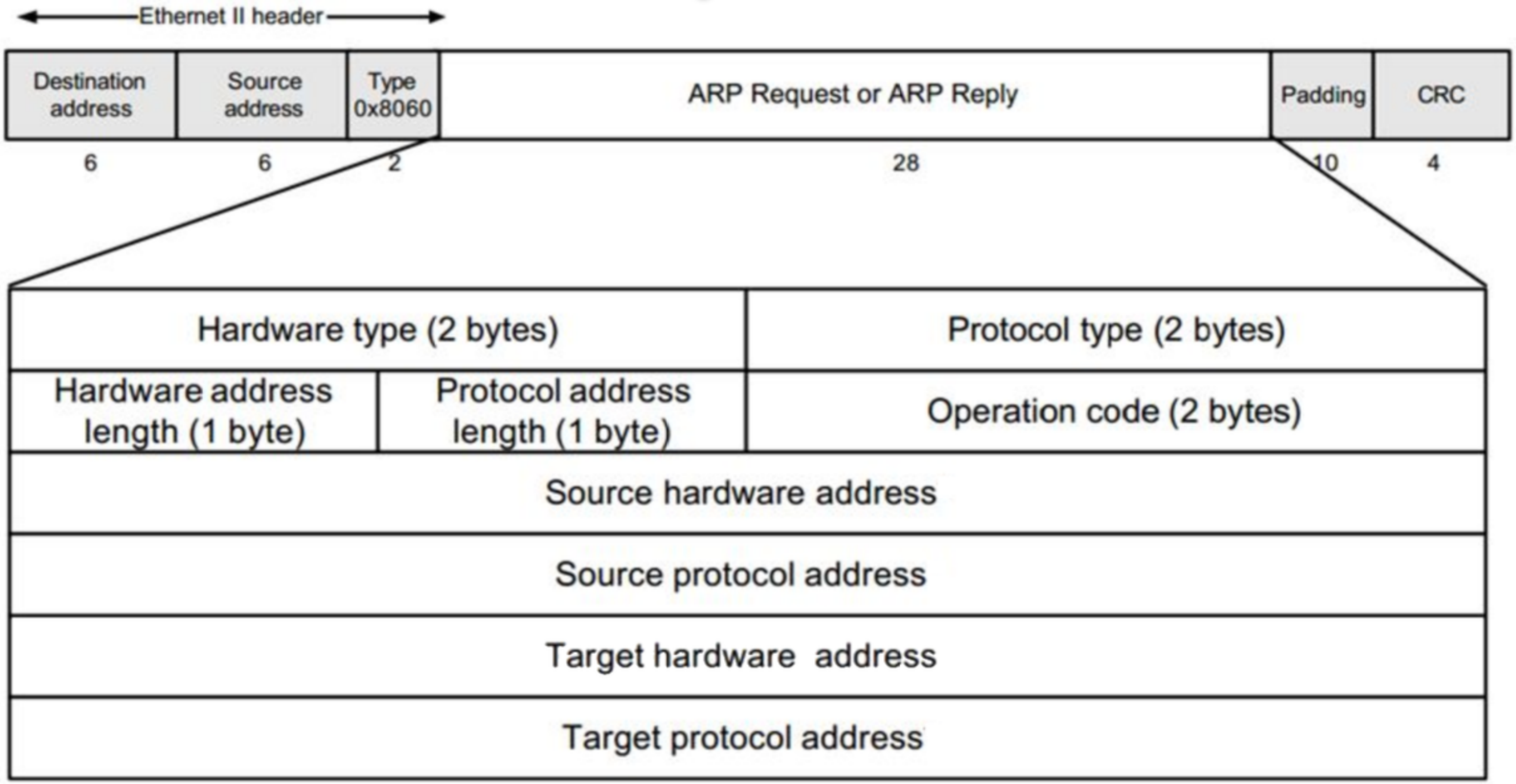
- Sergio would notice it and acknowledge it by shouting his location back … "I live here".
- The next time the postman wants to deliver a postcard to Sergio, he won't need to ask again.
  - He will know where and how to find Sergio



how does ARP work?

1. ARP sends an ethernet broadcast query that states the intended destination IP address.
2. If the target device (Sergio) is on the network, it sends a message stating its MAC address.
3. ARP stores previous results in a lookup table to ensure this process is not repeated for every packet.

ARP structure packet



Ethernet II header

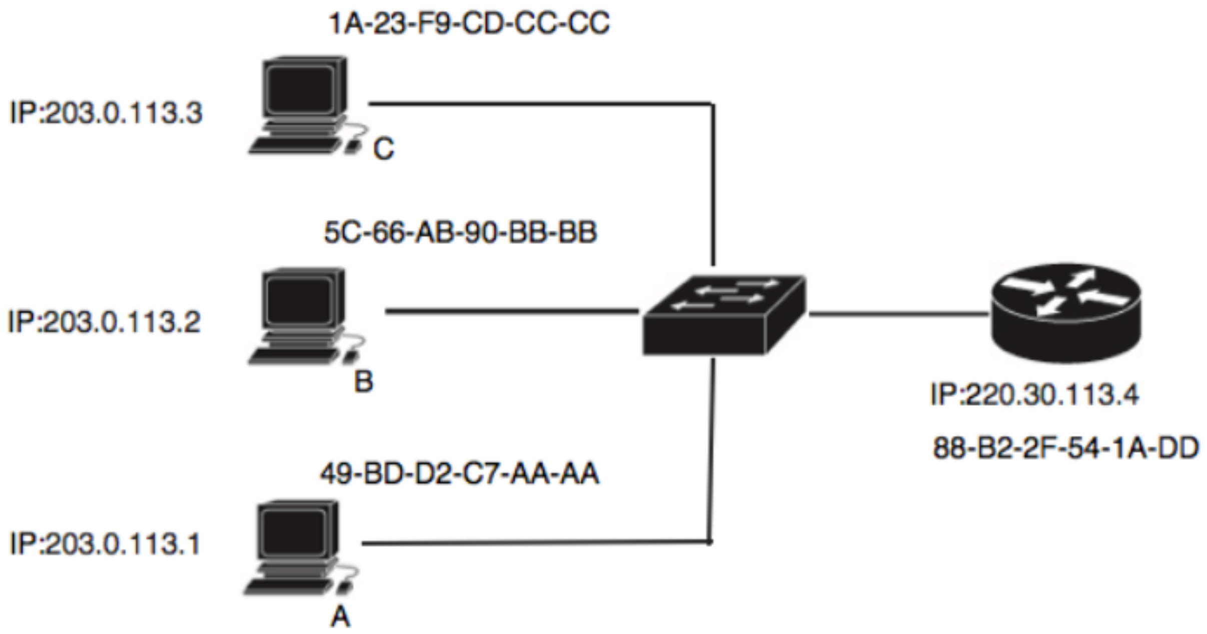
Destination address	Source address	Type 0x8060	ARP Request or ARP Reply	Padding	CRC
6	6	2	28	10	4

Hardware type (2 bytes)		Protocol type (2 bytes)
Hardware address length (1 byte)	Protocol address length (1 byte)	Operation code (2 bytes)
Source hardware address		
Source protocol address		
Target hardware address		
Target protocol address		

Type 0x8060 indicates ARP packet

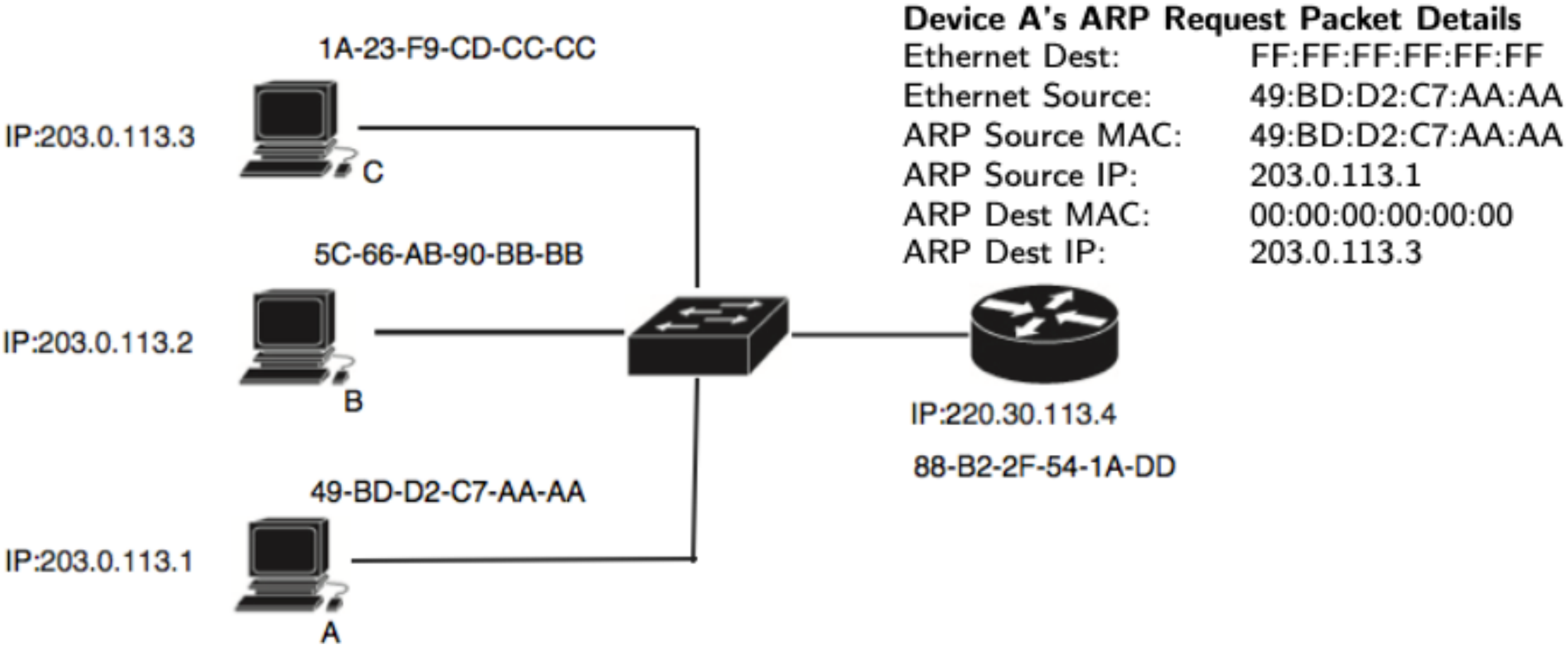
how does ARP work?

simple network -
no routing



- A wants to send a message to C
  - A knows C's IP address
  - A does not know C's MAC address
  - C is not in A's ARP table: 00:00:00:00:00:00

how does ARP work? from A to B, C

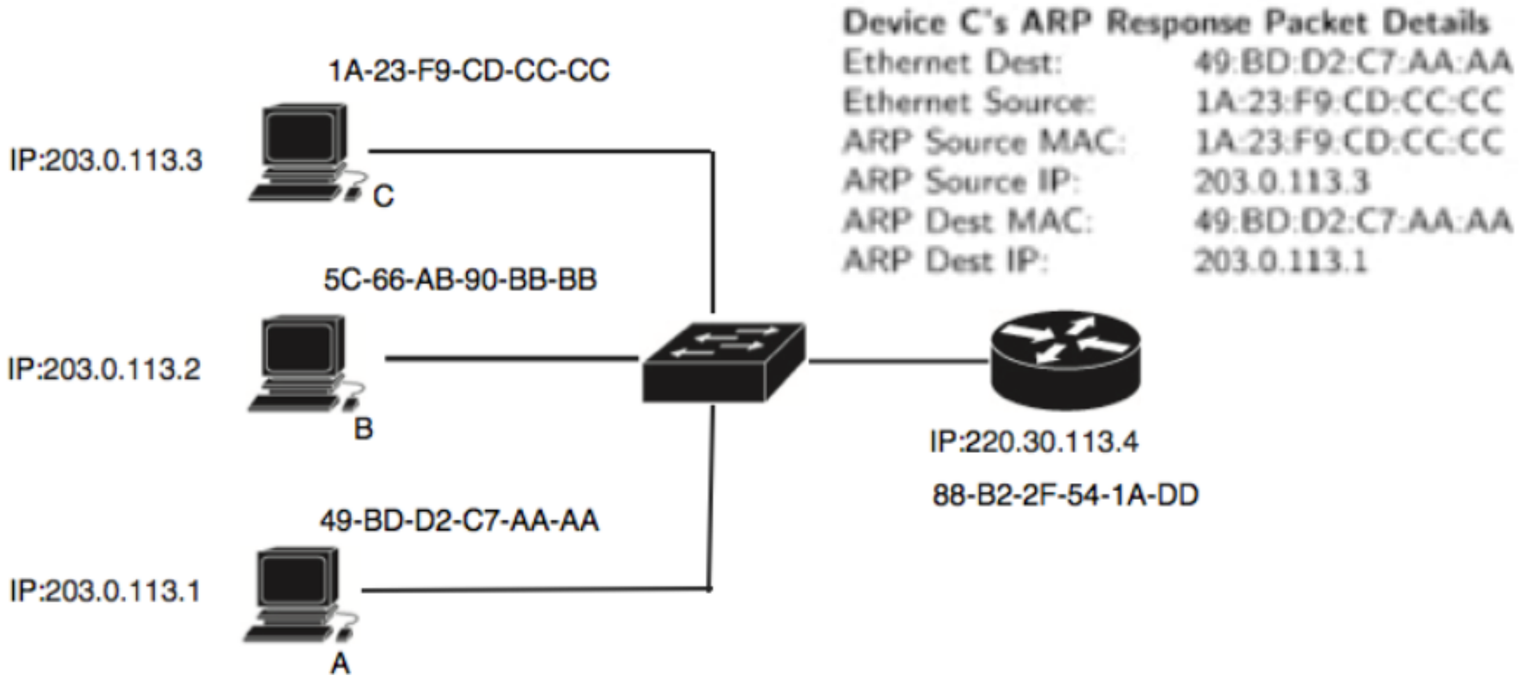


Device A's ARP Request Packet Details

Ethernet Dest:	FF:FF:FF:FF:FF:FF
Ethernet Source:	49:BD:D2:C7:AA:AA
ARP Source MAC:	49:BD:D2:C7:AA:AA
ARP Source IP:	203.0.113.1
ARP Dest MAC:	00:00:00:00:00:00
ARP Dest IP:	203.0.113.3

- A creates an **ARP packet** and broadcasts a **Discovery Request**
  - this request is inside an ethernet frame (Type = ARP)
  - ARP Source IP: A's IP
  - ARP Dest IP: C's IP
  - ARP Source MAC: A's MAC
  - ARP Dest MAC: broadcast address

how does ARP work? from C to A



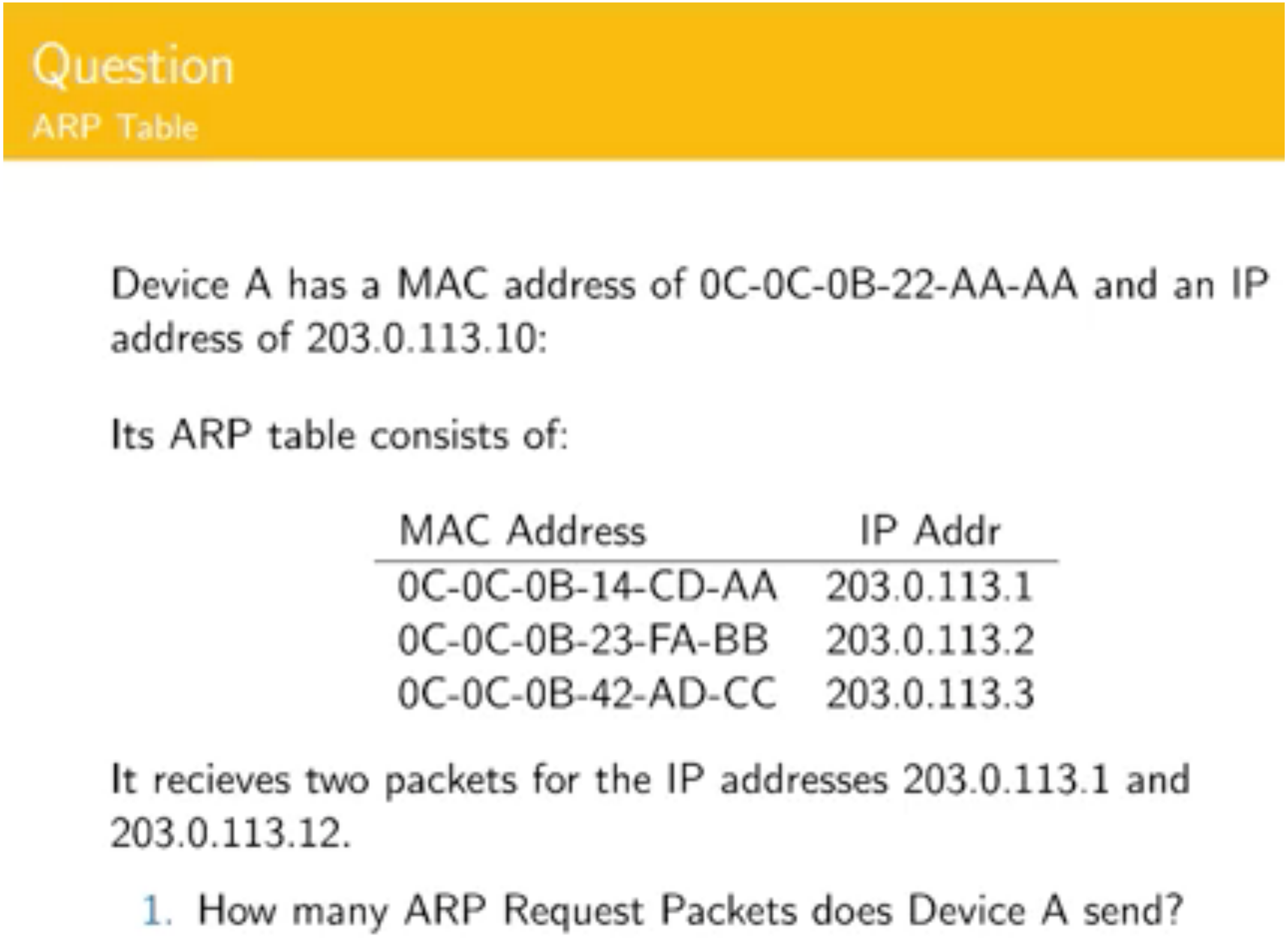
Device C's ARP Response Packet Details

Ethernet Dest:	49:BD:D2:C7:AA:AA
Ethernet Source:	1A:23:F9:CD:CC:CC
ARP Source MAC:	1A:23:F9:CD:CC:CC
ARP Source IP:	203.0.113.3
ARP Dest MAC:	49:BD:D2:C7:AA:AA
ARP Dest IP:	203.0.113.1

- C creates an **ARP packet** and sends a **Response** to A
  - ARP Source IP: C's IP
  - ARP Dest IP: A's IP
  - ARP Source MAC: C's MAC
  - ARP Dest MAC: A's MAC

A then update its ARP table

Question



Question

ARP Table

Device A has a MAC address of 0C-0C-0B-22-AA-AA and an IP address of 203.0.113.10:

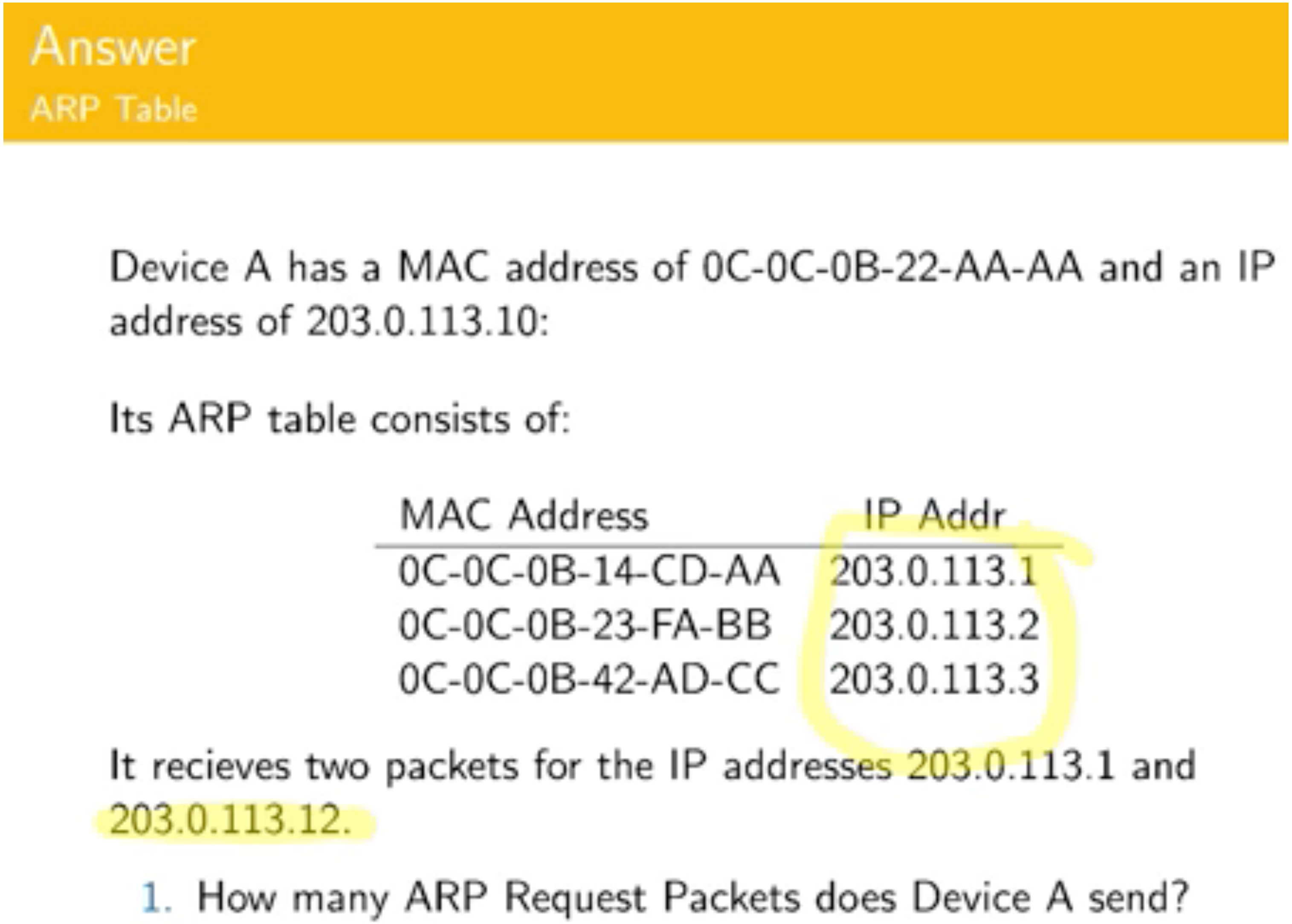
Its ARP table consists of:

MAC Address	IP Addr
0C-0C-0B-14-CD-AA	203.0.113.1
0C-0C-0B-23-FA-BB	203.0.113.2
0C-0C-0B-42-AD-CC	203.0.113.3

It recieves two packets for the IP addresses 203.0.113.1 and 203.0.113.12.

1. How many ARP Request Packets does Device A send?

Answer



Answer

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It recieves two packets for the IP addresses 203.0.113.1 and 203.0.113.12.

1. How many ARP Request Packets does Device A send?

Roadmap

1. ARP
2. DHCP (Dynamic Hosting Control Protocol)
3. DHCP security

DHCP - Dynamic Hosting Control Protocol

- **Why DHCP?**
  1. IP addresses can be static or dynamic
  2. IP addresses are assigned on the fly
  3. Reduce overhead for assigning IP addresses
  4. Reduce overhead for managing IP addresses assigned

DHCP - protocol for a newly added device

1. DHCP Server Discovery - finding the DHCP server.
2. DHCP CP Server Offer Message - providing the client with an IP address
3. DHCP Request Message - accepting and requesting the offered IP address.
4. DHCP ACK Message - confirming to the client that they are granted the IP address

DHCP - protocol for a newly added device e.g., connecting your laptop to the Wi-Fi

A. The Requester uses an IP broadcast to send out a DHCP Discovery Request

B. When the DHCP server sees the Request, it picks up the Request and prepares for the next step …

C. The server recommends an IP address to the Requester

    A. Several servers on the network can offer IP addresses

D. The Laptop accesses one of the offers, which contains information about the server and the IP address to talk to

Roadmap

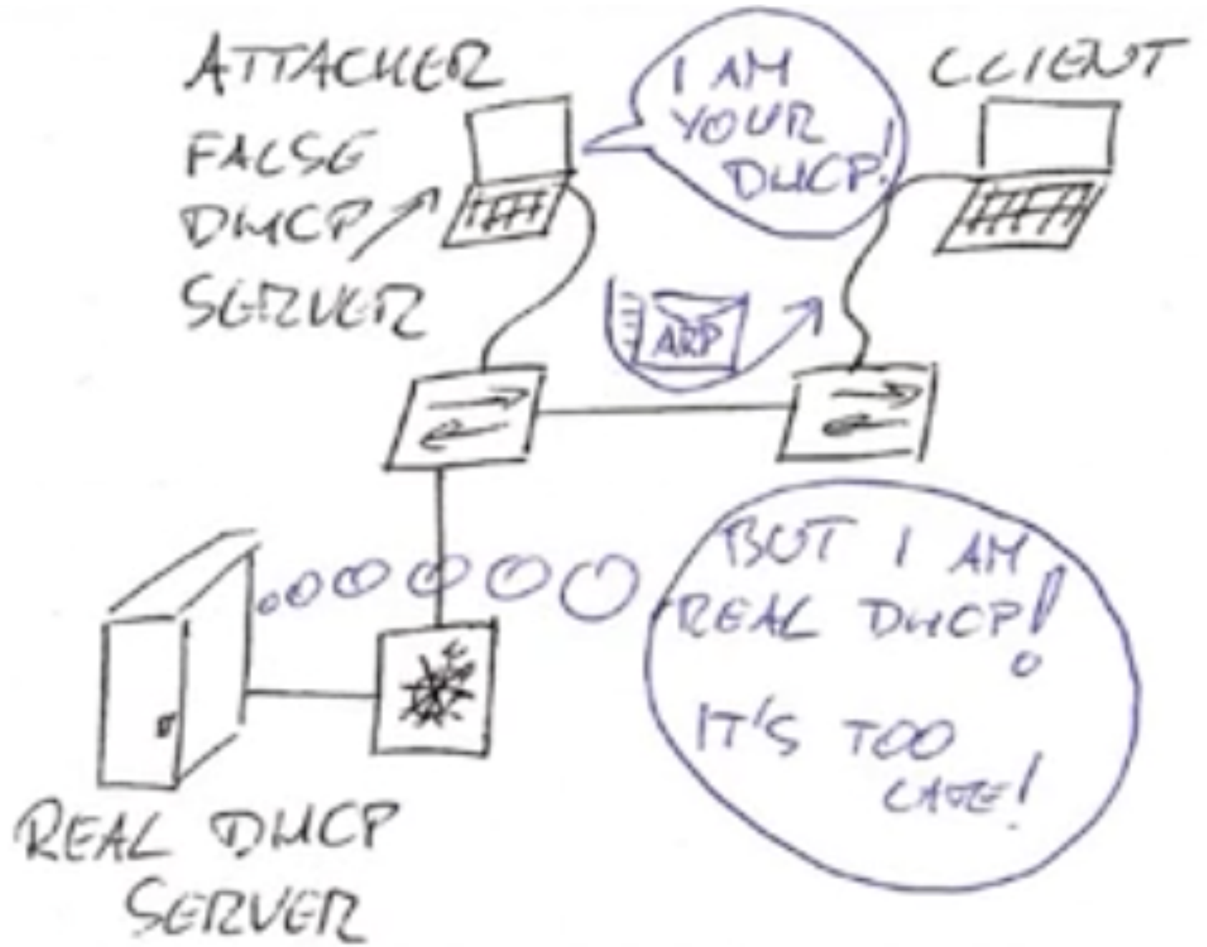
1. ARP
2. DHCP
3. DHCP security

DHCP Spoofing in 3 steps

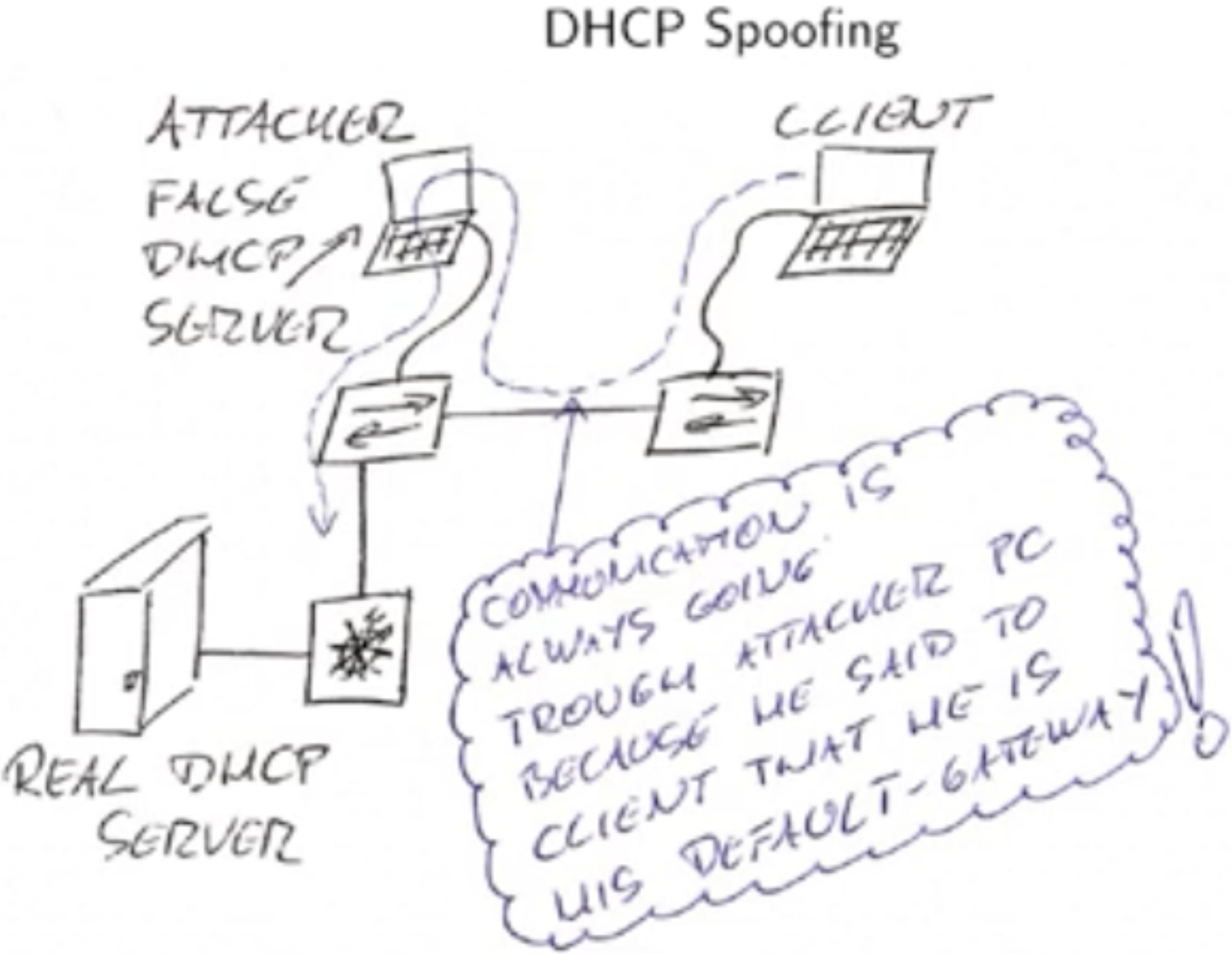
1. Client sends a DHCP Request.
2. DHCP Request responded to by a false DHCP server faster than the actual/real server.
3. Traffic from Client now goes to some IP which the false DHCP server pointed to.

Spoofing: a malicious server provides the client with malicious IP information

DHCP Spoofing



DHCP Spoofing

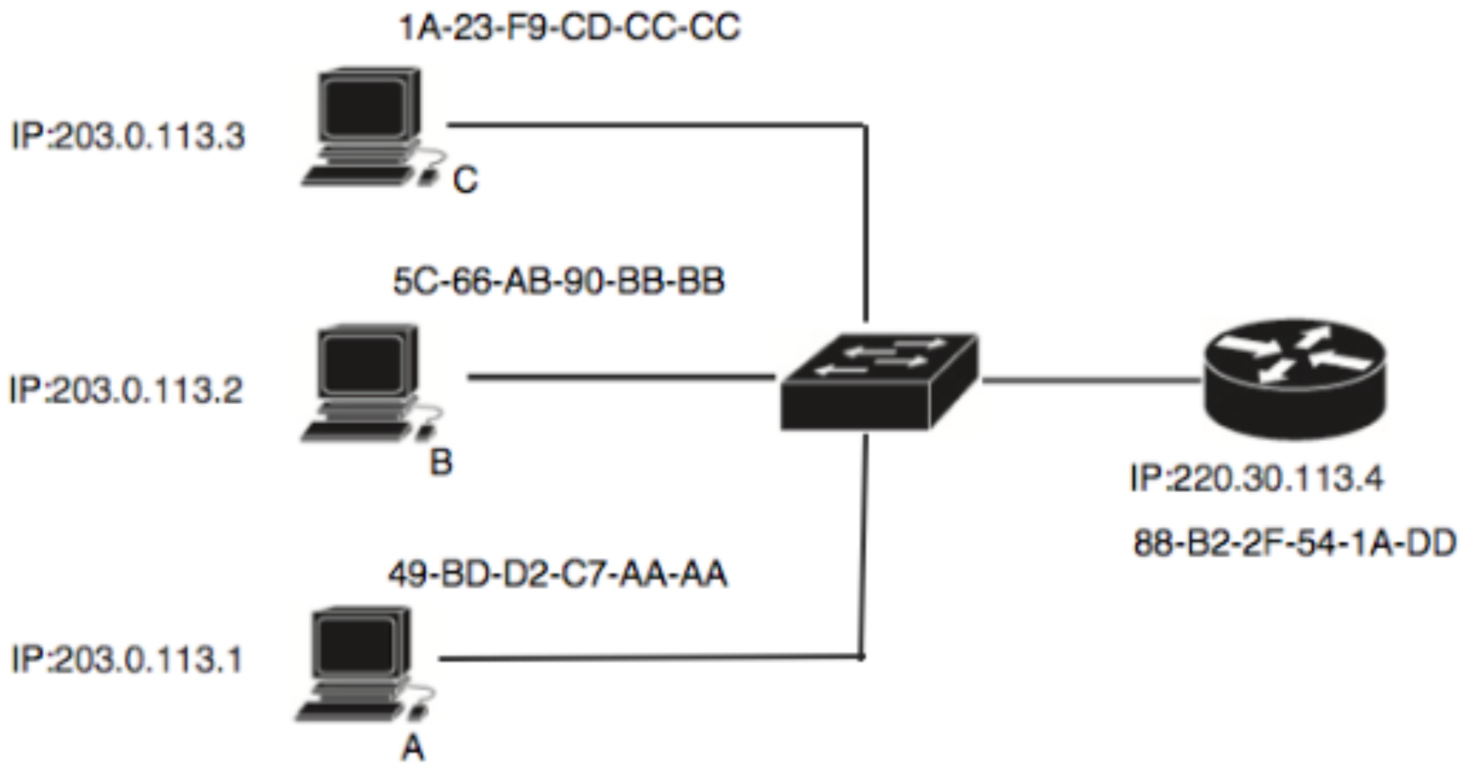

DHCP Spoofing
ATTACKER
FALSE DHCP SERVER
CLIENT
REAL DHCP SERVER
COMMUNICATION IS ALWAYS GOING TROUGH ATTACKER PC BECAUSE HE SAID TO CLIENT THAT HE IS HIS DEFAULT-GATEWAY!

DHCP starvation

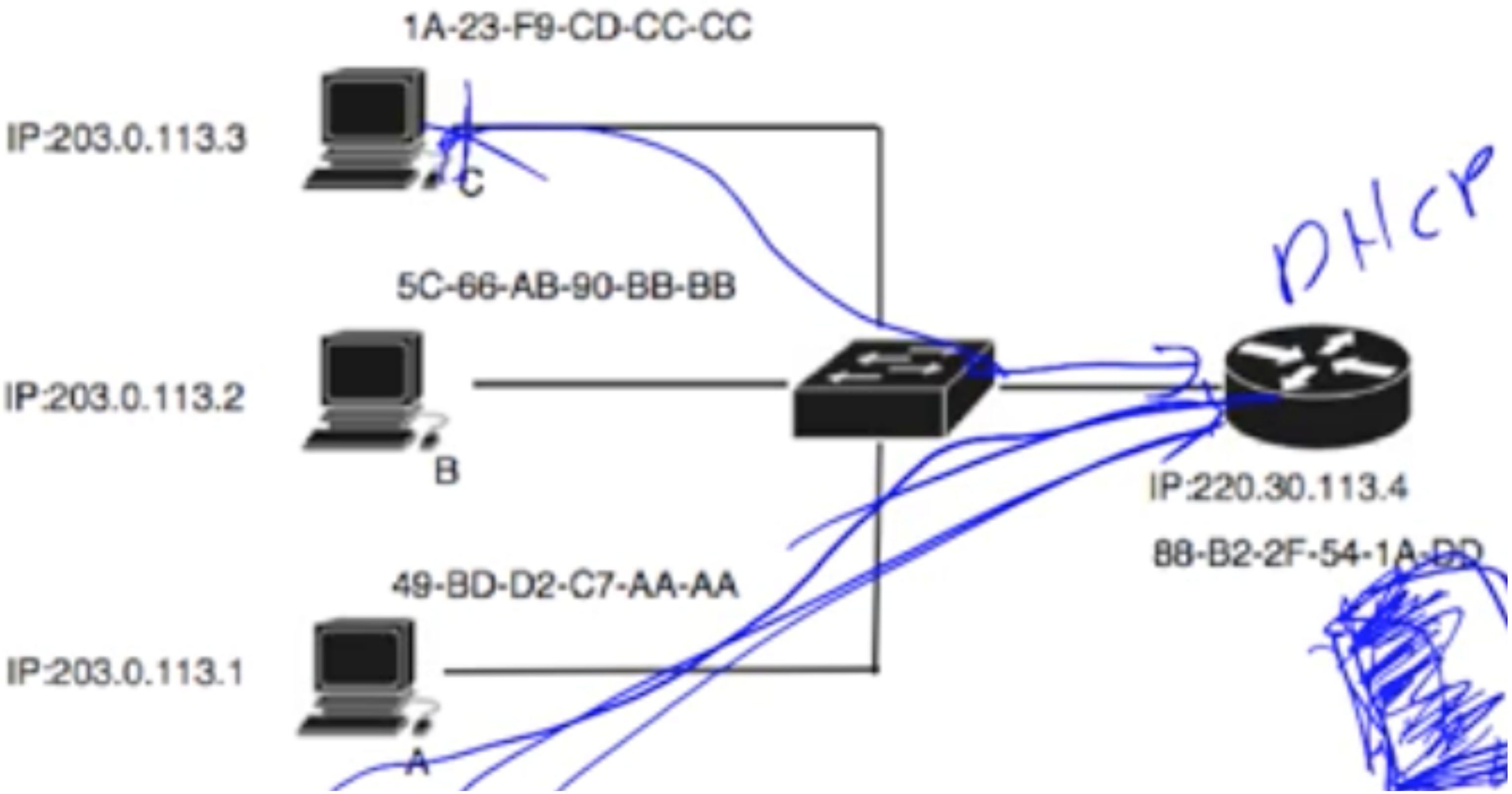
1. An attacker creates many clients that make requests to the DHCP server.
2. The attacker thus floods the DHCP server with requests from MACs that do not exist.
3. DHCP starvation prevents legitimate clients (laptops …) from accessing the network.

recall: a DHCP server responds to a client request with an IP address

DHCP starvation



DHCP starvation



summary

- ARP and DHCP
- DHCP spoofing and starvation attacks