Chapter 5: Ethernet

Introduction to Networks - R&S 6.0

Chapter 5 - Sections

5.1 Ethernet Protocol

- **Describe the Ethernet MAC address and frame fields**

5.2 LAN Switches

- **Explain how a switch operates and builds its MAC address table**
- **Describe switch forwarding methods and types of port settings**

5.3 Address Resolution Protocol

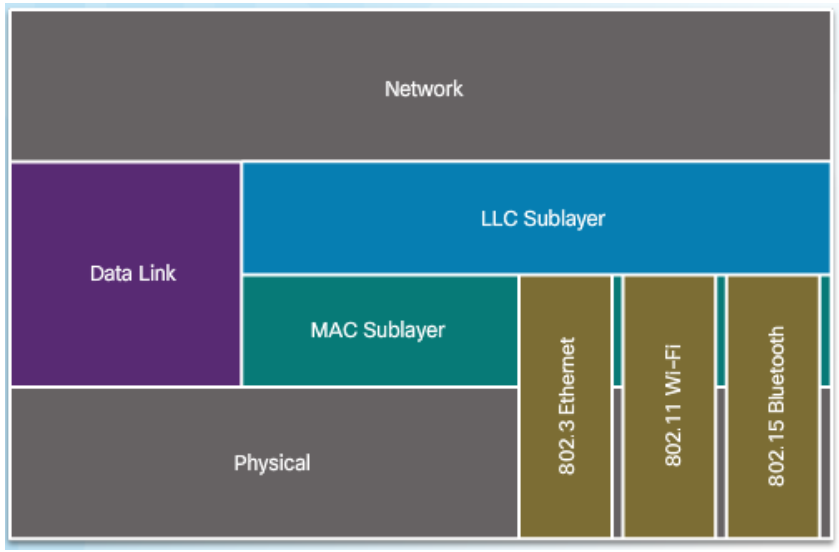
- **Compare the roles of the MAC address and the IP address**
- **Describe the purpose of ARP.**

5.1 Ethernet Protocol

Ethernet Frame

- **Ethernet Encapsulation**
  - **Ethernet operates in the data link layer and the physical layer**
  - **Ethernet supports data bandwidths from 10Mbps through 100Gbps**
  - **Ethernet standards define both the Layer 2 protocols and the Layer 1 technologies.**

Ethernet Frame



- **MAC Sublayer**
  - **MAC constitutes the lower sublayer of the data link layer**
  - **Responsible for Data encapsulation and Media access control.**

Ethernet Frame

- **Ethernet Frame Fields**
  - **The minimum Ethernet frame size is 64 bytes and the maximum is 1518 bytes**
  - **Frame smaller than the minimum or greater than the maximum are dropped**
  - **Dropped frames are likely to be the result of collisions or other unwanted signals and are therefore considered invalid.**

Ethernet MAC Addresses

00-FF-1B-D1-92-90

OUI Serial

00-FF-1B-D1-92-90

- **MAC Addresses and Hexadecimal**
  - **MAC address is 48-bit long and expressed as 12 hexadecimal digits**
- **MAC Addresses: Ethernet Identity**
  - **IEEE requires a vendor to follow two simple rules:**
  - **Must use that vendor's assigned OUI (Organizationally Unique Identifier) as the first three bytes**
  - **All MAC addresses with the same OUI must be assigned a unique value in the last three bytes.**

Ethernet MAC Addresses

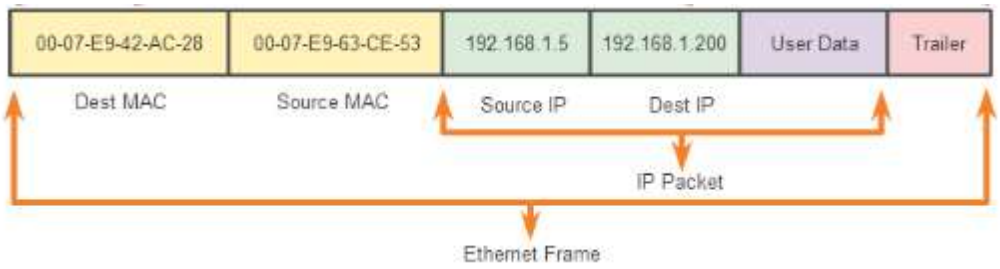
- **MAC Address Representations**
  - **MAC addresses can be represented with colons, dashes or dots and are case-insensitive**
  - **00-60-2F-3A-07-BC**
  - **00:60:2F:3A:07:BC**
  - **0060.2F3A.07BC**
  - **00-60-2f-3a-07-bc**

are all valid representations of the same MAC address.

Ethernet MAC Addresses

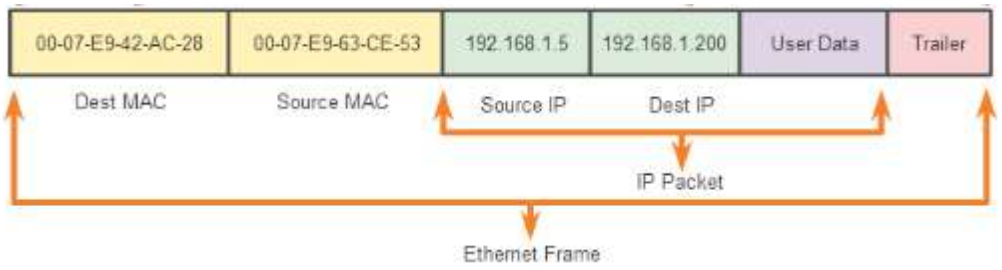
- **Frame Processing**
  - **The NIC compares the destination MAC address in the frame with the device's physical MAC address stored in RAM**
  - **If there is a match, the framed is passed up the OSI layers**
  - **If there is no match, the device discards the frame.**

Ethernet MAC Addresses



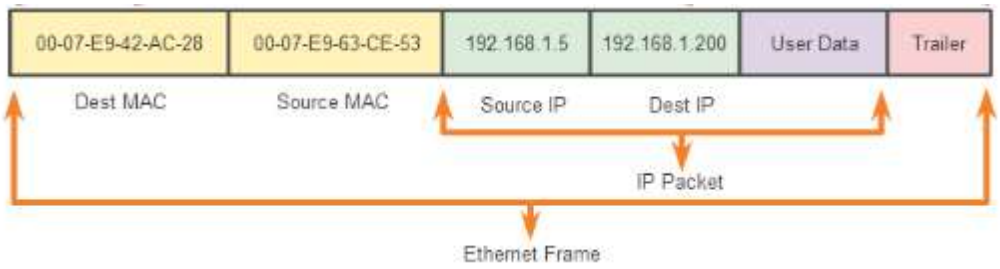
- **Unicast MAC Address**
  - **Unique address used when a frame is sent from a single transmitting device to a single destination device**
  - **The source MAC address must always be a unicast.**

Ethernet MAC Addresses



- **Unicast MAC Address**
  - **Single Host**
- **Broadcast MAC Address**
  - **Used to address all nodes in the segment**
  - **The destination MAC address is the address of FF-FF-FF-FF-FF-FF in hexadecimal (48 ones in binary).**

Ethernet MAC Addresses



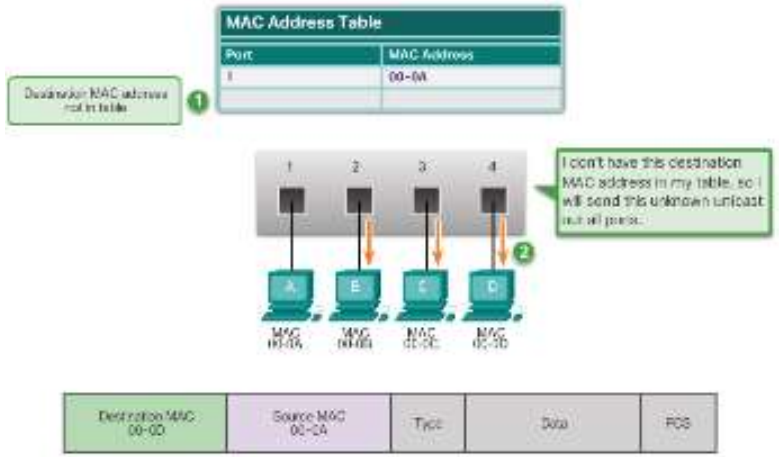
- Unicast MAC Address
- Broadcast MAC Address
- **Multicast MAC Address**
  - **Used to address a group of nodes in the segment**
  - **The multicast MAC address is a special value that begins with 01-00-5E in hexadecimal**
  - **The remaining portion of the multicast MAC address is created by converting the lower 23 bits of the IP multicast group address into 6 hexadecimal characters.**

5.2 LAN Switches

The MAC Address Table

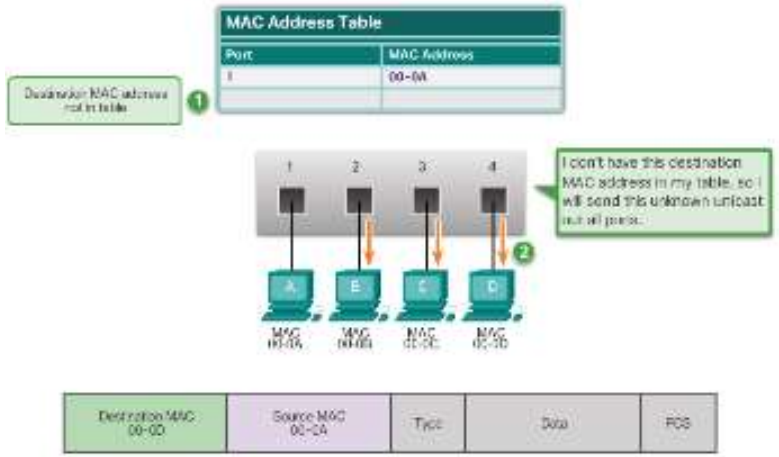
- **Switch Fundamentals**
  - **An Ethernet Switch is a Layer 2 device**
  - **It uses MAC addresses to make forwarding decisions**
  - **The MAC address table is sometimes referred to as a content addressable memory (CAM) table.**

The MAC Address Table



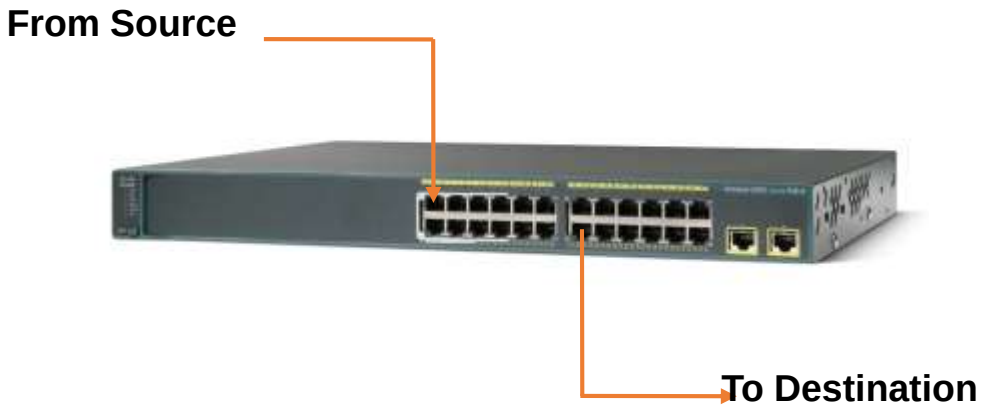
- **Learning MAC Addresses**
  - **Switches dynamically build the CAM by monitoring source MACs**
  - **Every frame that enters a switch is checked for new addresses**
  - **The frame is forwarded based on the CAM.**

The MAC Address Table



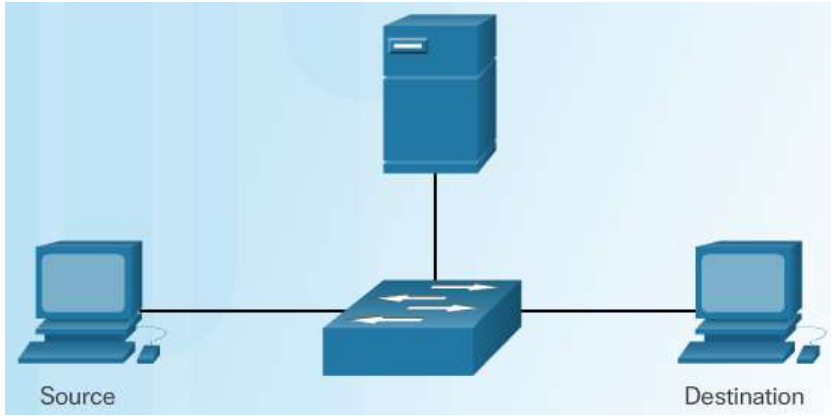
- **Filtering Frames**
  - **Since the switch knows where to find a specific MAC address, it can filter the frames to that port only**
  - **Filtering is not done is the destination MAC is not present in the CAM.**

Switch Forwarding Methods



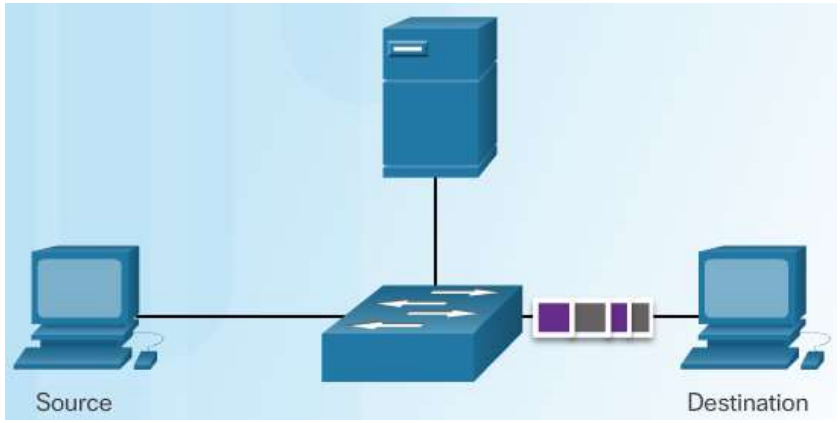
- **Frame Forwarding Methods on Cisco Switches**
  - **Store-And-Forward**
  - **Cut-Through.**

Switch Forwarding Methods



- **Store-and-forward**
  - **A store-and-forward switch receives the entire frame**
  - **It computes the CRC**
  - **If the CRC is valid, the switch looks up the destination address**
  - **The frame is then forwarded out the correct port.**

Switch Forwarding Methods

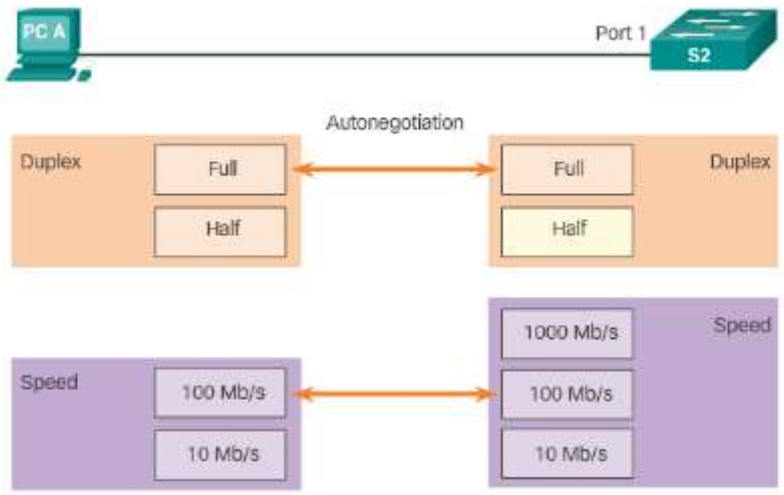


- **Cut-Through Switching (Two Methods)**
  - **Fast-forward switching**
  - **Lowest level of latency immediately forwards a packet after reading the destination address**
  - **Typical cut-through method of switching.**
  - **Fragment-free switching**
  - **Switch stores the first 64 bytes of the frame before forwarding**
  - **Most network errors and collisions occur during the first 64 bytes.**

Switch Forwarding Methods

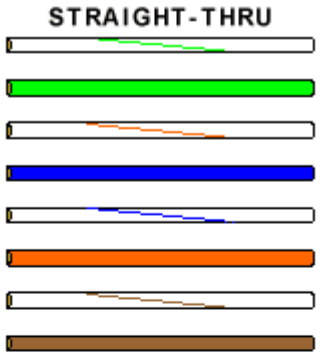
- **Memory Buffering on Switches**
  - **Port-based memory**
  - **Frames are stored in ques that are linked to specific incoming and outgoing ports**
  - **Share memory**
  - **All frames are deposited into a common buffer, which all the ports on the switch share.**

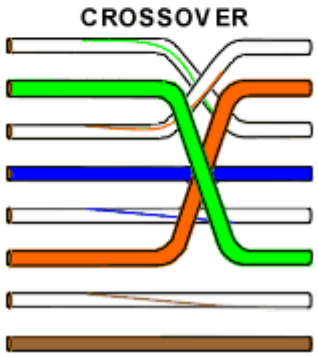
Switch Port Settings



- **Duplex and Speed Settings**
  - **Full-duplex – Both ends of the connection can send and receive simultaneously**
  - **Half-duplex – Only one end of the connection can send at a time**
  - **A common cause of performance issues on Ethernet links is when one port on the link operates at half-duplex and the other on full-duplex.**

Switch Port Settings





- **Auto-MDX**
  - **Detects the type of connection required and configures the interface accordingly**
  - **Helps reducing configuration errors.**

5.3 Address Resolution Pr

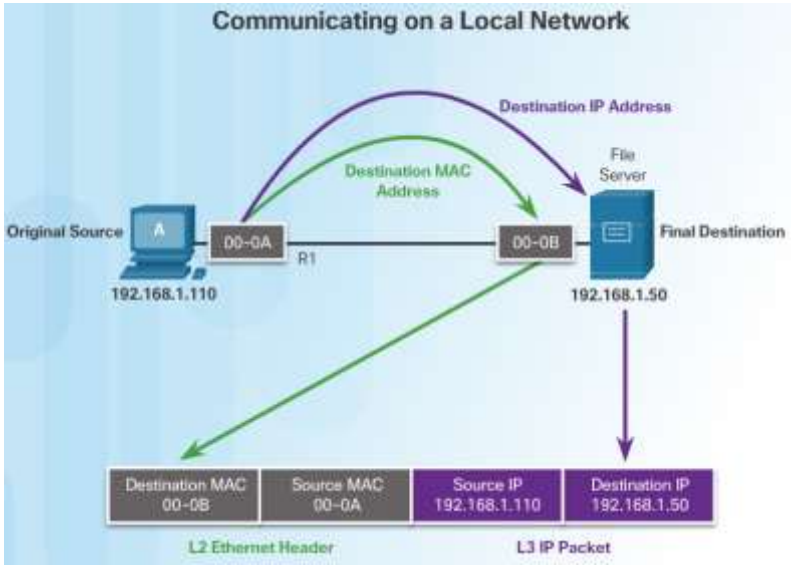
ARP

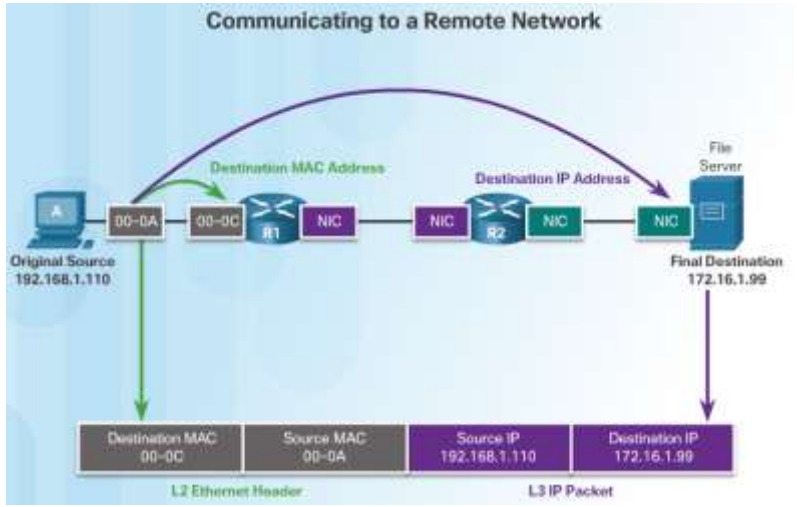
```
Router# show ip arp

                     Age
Protocol  Address          (min)  Hardware Addr   Type   Interface
Internet  172.16.233.229    -    0000.0c59.f892  ARPA   Ethernet0/0
Internet  172.16.233.218    -    0000.0c07.ac00  ARPA   Ethernet0/0
Internet  172.16.168.11     -    0000.0c63.1300  ARPA   Ethernet0/0
Internet  172.16.168.254    9    0000.0c36.6965  ARPA   Ethernet0/0
```

- **Introduction to ARP**
  - **ARP allows the source to request the MAC address of the destination**
  - **The request is based upon the layer 3 address of the destination (known by the source).**

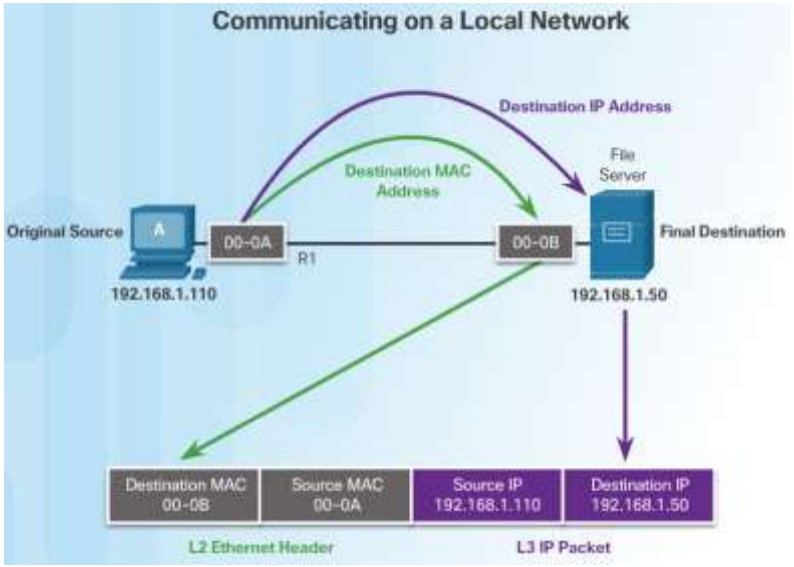
MAC and IP

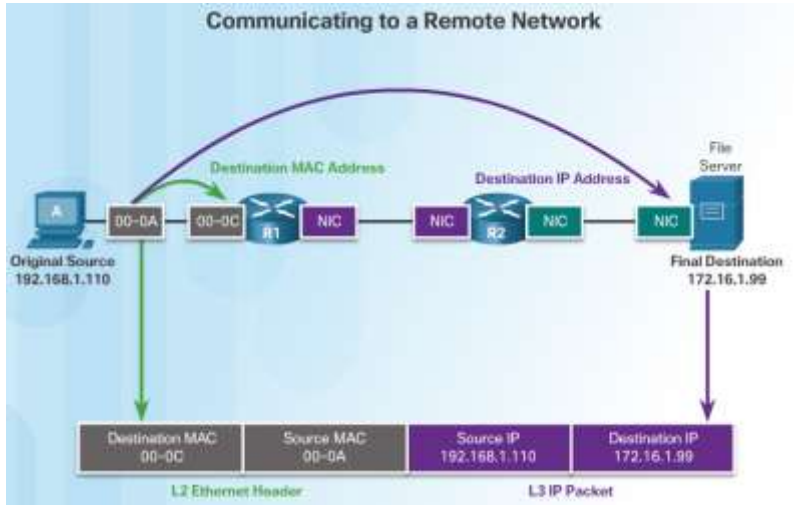




- **The combination of MAC and IP addresses facilitate the End-to-End communication**
  - **Layer 2 MAC addresses are used to move the frame within the local network**
  - **Layer 3 IP addresses are used to move the packets through remote networks.**

MAC and IP





- **ARP Functions**
  - **Resolving IPv4 addresses to MAC addresses**
  - **Maintaining a table of mappings**
  - **ARP uses ARP Request and ARP Reply to perform its functions.**

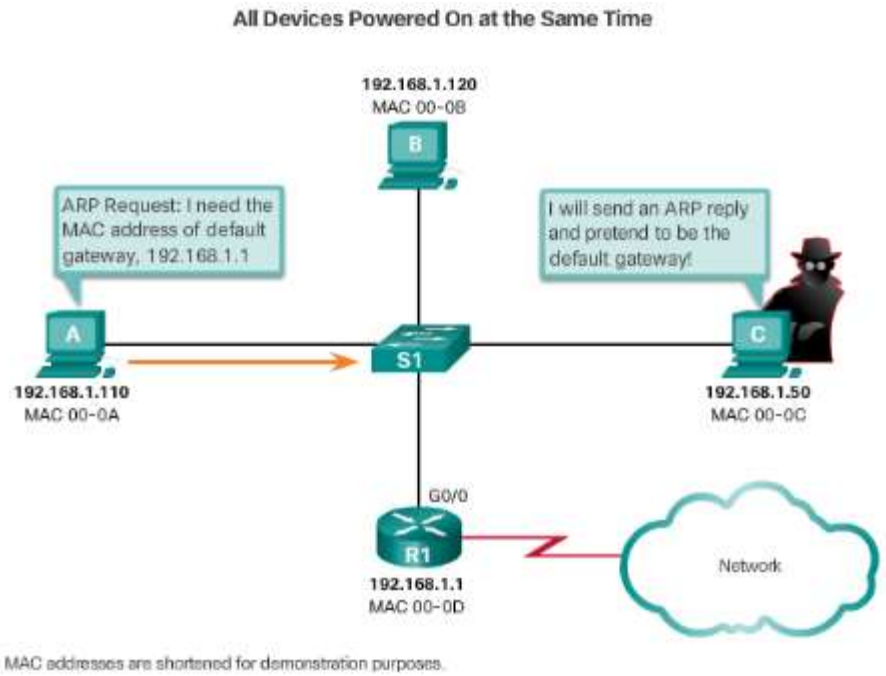
ARP

```
Router# show ip arp

                     Age
Protocol  Address          (min)  Hardware Addr   Type   Interface
Internet  172.16.233.229    -    0000.0c59.f892  ARPA   Ethernet0/0
Internet  172.16.233.218    -    0000.0c07.ac00  ARPA   Ethernet0/0
Internet  172.16.168.11     -    0000.0c63.1300  ARPA   Ethernet0/0
Internet  172.16.168.254    9    0000.0c36.6965  ARPA   Ethernet0/0
```

- **ARP Tables**
  - **On IOS: show ip arp**
  - **On Windows PCs: arp –a**
- **Removing Entries from an ARP Table**
  - **Entries are removed from the device's ARP table when its cache timer expires**
  - **Cache timers are OS dependent**
  - **ARP entries can be manually removed via commands.**

ARP Issues



- **ARP Broadcasts**
  - **ARP requests can flood the local segment**
- **ARP Spoofing**
  - **Attackers can respond to requests and pretend to be providers of services.**
  - **Example: default gateway.**

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