Module 9: Address Resolution

Introduction to Networks v7.0
(ITN)

Module Objectives

Module Title: Address Resolution

Module Objective: Explain how ARP and ND enable communication on a network.

Topic Title	Topic Objective
MAC and IP	Compare the roles of the MAC address and the IP address.
ARP	Describe the purpose of ARP.
Neighbor Discovery	Describe the operation of IPv6 neighbor discovery.

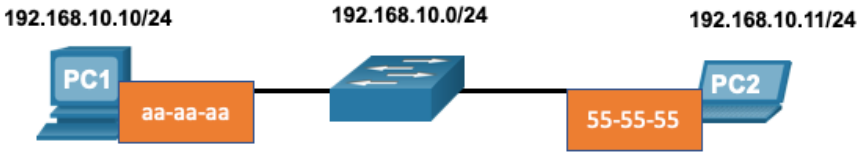
9.1 MAC and IP

Destination on Same Network

There are two primary addresses assigned to a device on an Ethernet LAN:

- **Layer 2 physical address** (the **MAC address**) – Used for NIC to NIC communications on the same Ethernet network.
- Layer 3 logical address (the IP address) – Used to send the packet from the source device to the destination device.

Layer 2 addresses are used to deliver frames from one NIC to another NIC on the same network. If a destination IP address is on the same network, the destination MAC address will be that of the destination device.

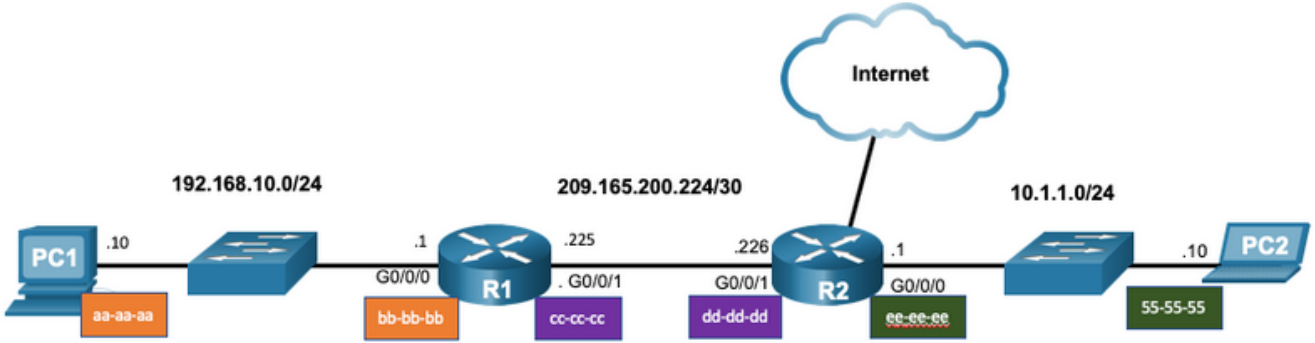


Destination MAC	Source MAC	Source IPv4	Destination IPv4
55-55-55	aa-aa-aa	192.168.10.10	192.168.10.11

Destination on Remote Network

When the destination IP address is on a remote network, the destination MAC address is that of the default gateway.

- ARP is used by IPv4 to associate the IPv4 address of a device with the MAC address of the device NIC.
- ICMPv6 is used by IPv6 to associate the IPv6 address of a device with the MAC address of the device NIC.



Destination MAC	Source MAC	Source IPv4	Destination IPv4
bb-bb-bb	aa-aa-aa	192.168.10.10	10.1.1.10

Packet Tracer – Identify MAC and IP Addresses

In this Packet Tracer, you will complete the following objectives:

- Gather PDU Information for Local Network Communication
- Gather PDU Information for Remote Network Communication

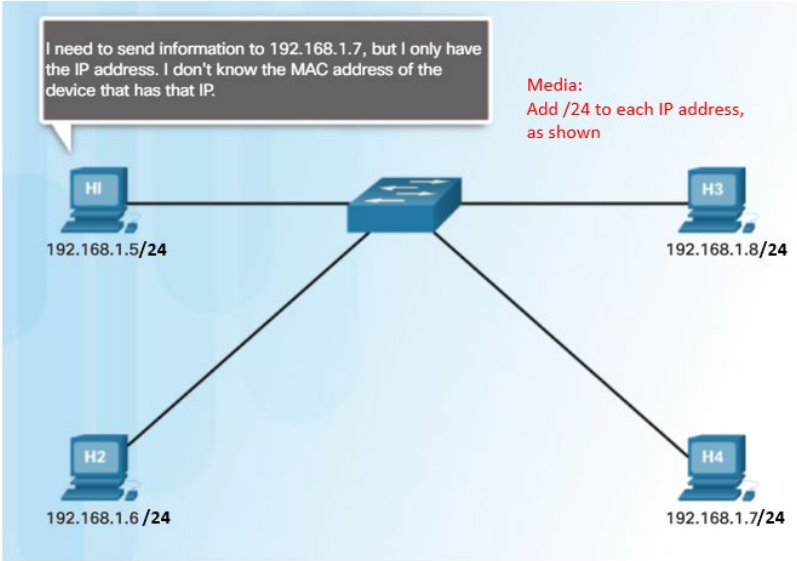
9.2 ARP

ARP Overview

A device uses ARP to determine the destination MAC address of a local device when it knows its IPv4 address.

ARP provides two basic functions:

- Resolving IPv4 addresses to MAC addresses
- Maintaining an ARP table of IPv4 to MAC address mappings



ARP Functions

To send a frame, a device will search its ARP table for a destination IPv4 address and a corresponding MAC address.

- If the packet's destination IPv4 address is on the **same network**, the device will search the ARP table for the destination IPv4 address.
- If the destination IPv4 address is on a **different network**, the device will search the ARP table for the IPv4 address of the default gateway.
- If the device locates the IPv4 address, its corresponding MAC address is used as the destination MAC address in the frame.
- If there is no ARP table entry is found, then the device sends an ARP request.

Video - ARP Request

This video will cover an ARP request for a MAC address.

Video – ARP Operation - ARP Reply

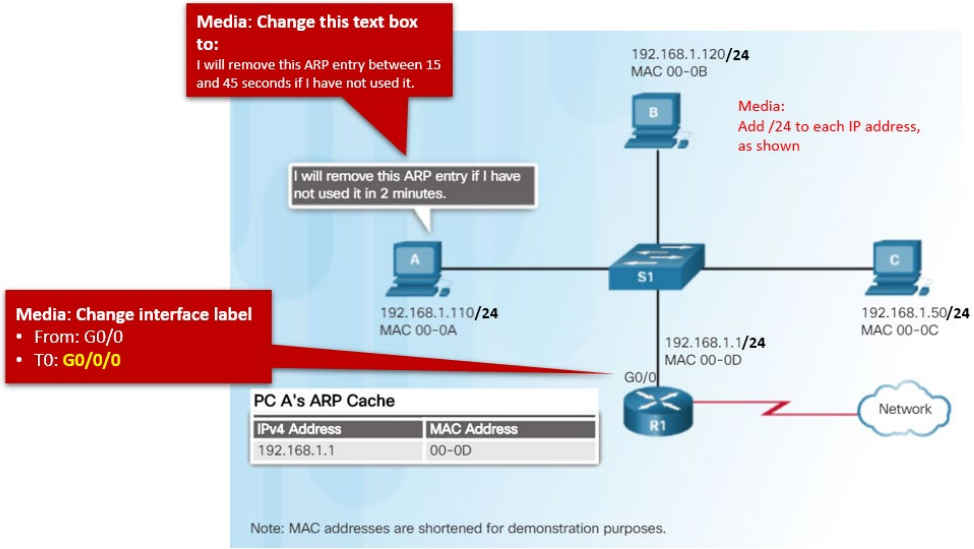
This video will cover an ARP reply in response to an ARP request.

Video - ARP Role in Remote Communications

This video will cover how an ARP request will provide a host the MAC address of the default gateway.

Removing Entries from an ARP Table

- Entries in the ARP table are not permanent and are removed when an ARP cache timer expires after a specified period of time.
- The duration of the ARP cache **timer** differs depending on the operating system.
- ARP table entries can also be removed manually by the administrator.



ARP Tables on Networking Devices

- The **show ip arp** command displays the ARP table on a Cisco router.
- The **arp –a** command displays the ARP table on a Windows 10 PC.

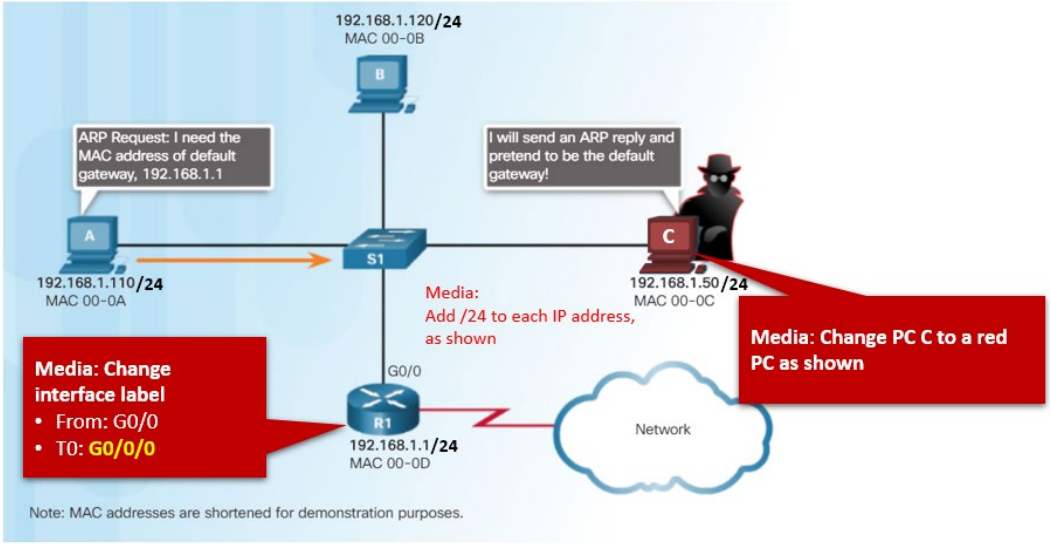
```
R1# show ip arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  192.168.10.1           -   a0e0.af0d.e140  ARPA   GigabitEthernet0/0/0
```

```
C:\Users\PC> arp -a

Interface: 192.168.1.124 --- 0x10
  Internet Address      Physical Address      Type
  192.168.1.1           c8-d7-19-cc-a0-86     dynamic
  192.168.1.101         08-3e-0c-f5-f7-77     dynamic
```

ARP Issues – ARP Broadcasting and ARP Spoofing

- ARP requests are received and processed by every device on the local network.
- Excessive ARP broadcasts can cause some reduction in performance.
- ARP replies can be spoofed by a threat actor to perform an ARP poisoning attack.
- Enterprise level switches include mitigation techniques to protect against ARP attacks.



ARP

Packet Tracer – Examine the ARP Table

In this Packet Tracer, you will complete the following objectives:

- Examine an ARP Request
- Examine a Switch MAC Address Table
- Examine the ARP Process in Remote Communications

9.3 Copper Cabling

Video – IPv6 Neighbor Discovery

This video will explain the process of how IPv6 performs address resolution using ICMPv6 neighbor solicitation and neighbor advertisement messages.

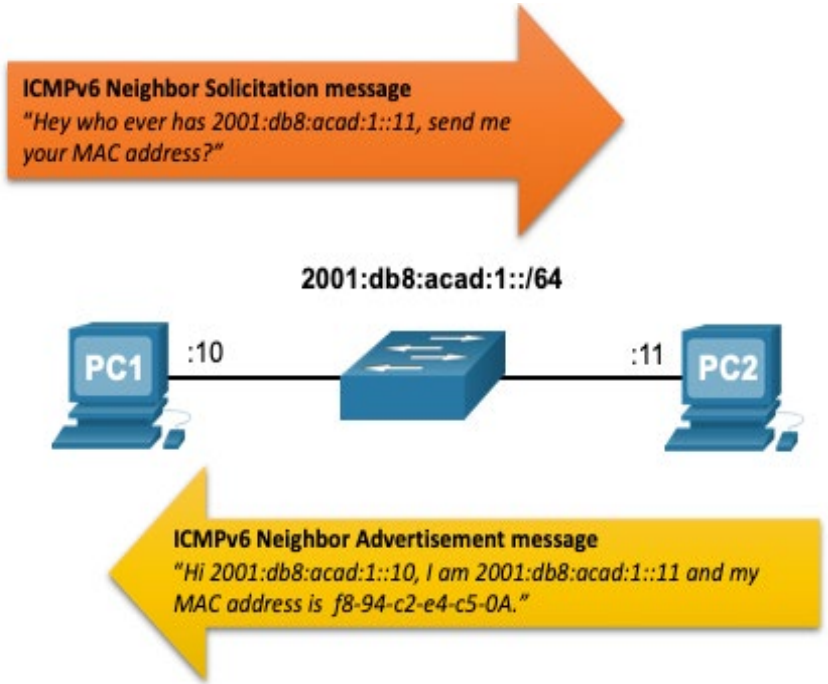
IPv6 Neighbor Discovery Messages

IPv6 Neighbor Discovery (ND) protocol provides:

- **Address resolution**
- **Router discovery**
- **Redirection services**

- ICMPv6 Neighbor Solicitation (NS) and Neighbor Advertisement (NA) messages are used for device-to-device messaging such as address resolution.
- ICMTPv6 Router Solicitation (RS) and Router Advertisement (RA) messages are used for messaging between devices and routers for router discovery.
- ICMPv6 redirect messages are used by routers for better next-hop selection.

IPv6 Neighbor Discovery – Address Resolution



- IPv6 devices use ND to resolve the MAC address of a known IPv6 address.
- ICMPv6 Neighbor Solicitation messages are sent using special Ethernet and IPv6 multicast addresses.

Packet Tracer – IPv6 Neighbor Discovery

In this Packet Tracer, you will complete the following objectives:

- Part 1: IPv6 Neighbor Discovery Local Network
- Part 2: IPv6 Neighbor discovery Remote Network

9.4 Module Practice and Quiz

What did I learn in this module?

- Layer 2 physical addresses (i.e., Ethernet MAC addresses) are used to deliver the data link frame with the encapsulated IP packet from one NIC to another NIC on the same network.
- If the destination IP address is on the same network, the destination MAC address will be that of the destination device.
- When the destination IP address (IPv4 or IPv6) is on a remote network, the destination MAC address will be the address of the host default gateway (i.e., the router interface).
- An **IPv4** device uses ARP to determine the destination MAC address of a local device when it knows its IPv4 address.
- ARP provides two basic functions: resolving IPv4 addresses to MAC addresses and maintaining a table of IPv4 to MAC address mappings.
- After the ARP reply is received, the device will add the IPv4 address and the corresponding MAC address to its ARP table.
- For each device, an ARP cache timer removes ARP entries that have not been used for a specified period of time.
- **IPv6** does not use ARP, it uses the ND protocol to resolve MAC addresses.
- An IPv6 device uses ICMPv6 Neighbor Discovery to determine the destination MAC address of a local device when it knows its IPv6 address.

New Terms and Commands

- Address Resolution Protocol (ARP)
- ARP table
- show ip arp
- arpr -a
- ICMPv6 Neighbor Discovery protocol (ND)
- ICMPv6 Neighbor Solicitation (NS) message
- ICMPv6 Neighbor Advertisement (NA) message
- ICMPv6 Router Solicitation (RS) message
- ICMPv6 Router Advertisement (RA) message
- ICMPv6 Redirect Message


CISCO