Advanced Networking

DHCP (Dynamic Host Configuration Protocol)

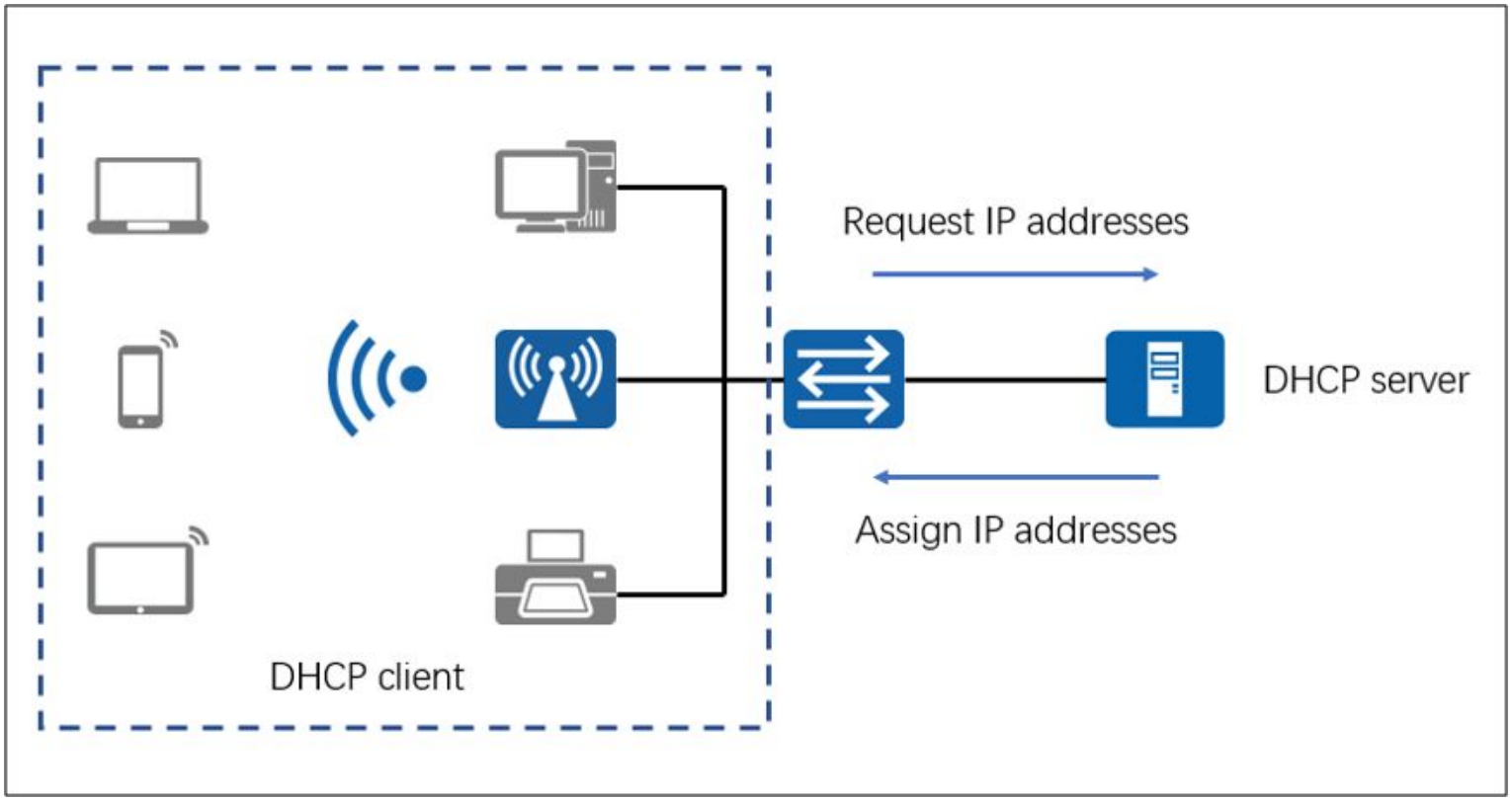
DHCP

- Dynamic Host Configuration Protocol, is a network management protocol used on IP networks.
- Automates the process of configuring devices on IP networks, enabling them to use network services such as IP routing without manual configuration.
- Automatically assigns IP addresses, subnet masks, default gateways, DNS servers, and other network parameters to client devices.
- Simplifies network administration, reduces configuration errors, and efficiently manages IP addresses in large networks.

BOOTP

- BOOTstrap Protocol (BOOTP)
  - From 1985
  - Host can configure its IP parameters at boot time.
  - 3 services.
    - IP address assignment.
    - Detection of the IP address for a serving machine.
    - The name of a file to be loaded and executed by the client machine (boot file name)
- How it works?
  - Not only assign IP address, but also default router, network mask, etc.
  - Sent as UDP messages (UDP Port 67 (server) and 68 (host))
  - Use limited broadcast address (255.255.255.255):
    - These addresses are never forwarded

DHCP An Overview



DHCP Components

- DHCP Server: Hosts DHCP service, manages IP address allocation.
- DHCP Client: Device requesting configuration from DHCP server.
- DHCP Relay Agent: Forwards requests between clients and servers on different networks.
- DHCP Scope: Defined range of IP addresses available for assignment.

DHCP Components - Server

- Function: Hosts the DHCP service and is responsible for managing the allocation of IP addresses and other network configuration parameters to clients.
- Key Roles:
  - Maintains a pool of IP addresses and assigns them to clients.
  - Stores configuration information like default gateway, DNS server addresses, and subnet masks.
  - Manages lease times for the IP addresses it assigns.
- Importance: Enables automated, centralized management of network settings, reducing manual configuration errors and administrative overhead.

DHCP Components - Client

- Function: A device that requests configuration information from a DHCP server. This can be any device that needs to connect to the network, such as a computer, smartphone, or printer.
- Key Roles:
  - Initiates the **DORA** process to obtain IP configuration from a DHCP server.
  - Uses the provided IP address and other network settings to communicate on the network.
  - Must request new lease or renew existing lease to maintain network connectivity.
- Importance: Allows devices to seamlessly join and communicate on the network without requiring manual configuration by users or administrators.

DHCP Components - Relay Agent

- Function: Acts as an intermediary that forwards DHCP messages between clients and servers when they are not on the same physical subnet.
- Key Roles:
  - Listens for **DHCPDISCOVER** messages from clients on its local network.
  - Forwards these messages to one or more specified DHCP servers on different networks.
  - Relays messages back and forth between the server and client, including **DHCPOFFER**, **DHCPREQUEST**, and **DHCPACK** messages.
- Importance: Enables DHCP services to extend across multiple networks, which is essential for large networks or networks divided into subnets.

DHCP Components - Scope

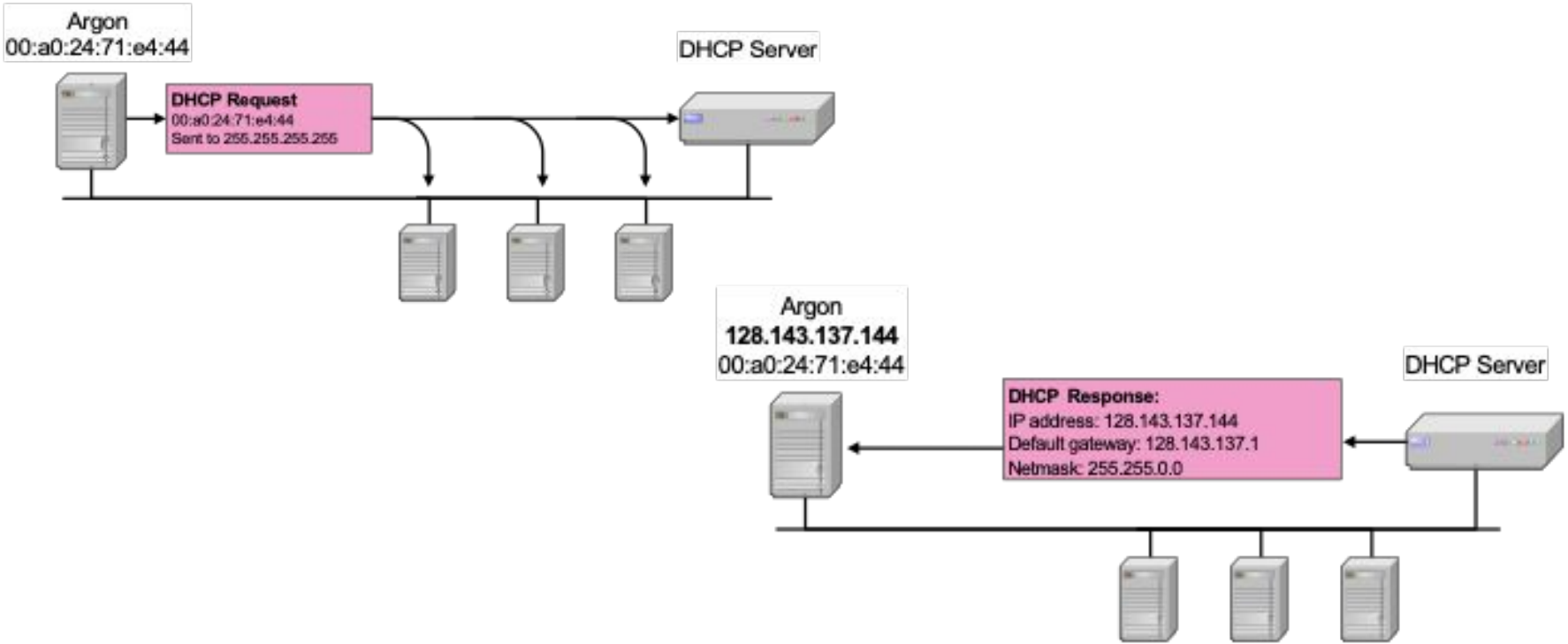
- Function: A range of IP addresses that the DHCP server is authorized to allocate to clients.
- Key Roles:
  - Defines a contiguous block of IP addresses that the server can assign.
  - Includes configuration options specific to the range, such as the subnet mask, default gateway, lease duration, and DNS servers.
- Importance: Organizes IP address distribution and ensures that addresses are allocated efficiently and without conflict within the network.

How DHCP Works?

- Works through a client-server model where a DHCP server dynamically distributes network configuration parameters to client devices (DHCP clients).
- Utilizes a four-step process known as **DORA** (Discovery, Offer, Request, Acknowledgment) for IP address assignment.
- Four-step process known as DORA:
  - **Discovery**: Client broadcasts a request for configuration (**DHCPDISCOVER**).
  - **Offer**: DHCP server sends an offer with network configuration (**DHCPOFFER**).
  - **Request**: Client requests the offered configuration (**DHCPREQUEST**).
  - **Acknowledgment**: Server acknowledges and assigns the IP address (**DHCPACK**).

How DHCP Works?

How DHCP Works?



How DHCP Works?

Discovery

- Action: The client broadcasts a **DHCPDISCOVER** message on the network, searching for a DHCP server.
- Purpose: To initiate the configuration process and find available DHCP servers.
- Key Points:
  - This is a broadcast message because the client does not yet have an IP address.
  - All DHCP servers on the network can receive this message.

How DHCP Works?

Offer

- Action: DHCP servers respond to the **DHCPDISCOVER** message with a DHCPOFFER message.
- Purpose: To offer network configuration parameters (including an IP address) to the client.
- Key Points:
  - Each server offers parameters based on its configuration and available IP addresses.
  - The client may receive offers from multiple servers but can only accept one.

How DHCP Works?

Request

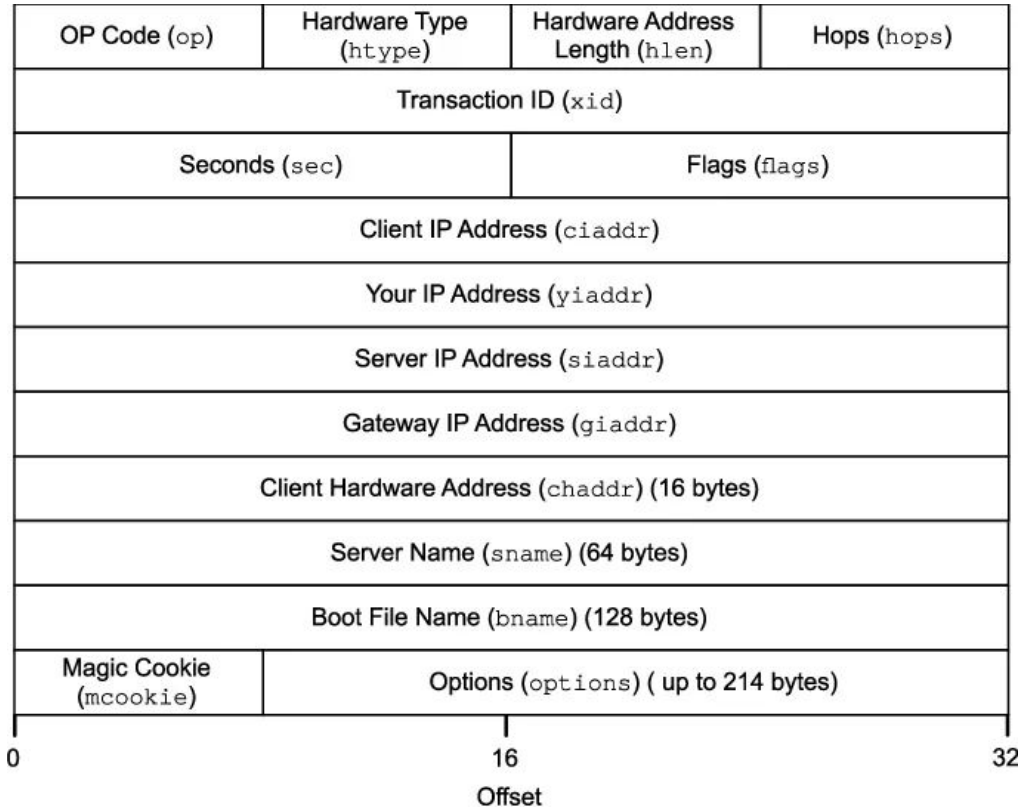
- Action: The client responds to one of the offers by broadcasting a **DHCPREQUEST** message.
- Purpose: To request the network configuration parameters from one selected DHCP server and inform the rest of the servers that the offer is being accepted.
- Key Points:
  - This message includes the server identifier to specify which server's offer is being accepted.
  - This phase also implicitly declines offers from other servers.

How DHCP Works?

Acknowledgment

- Action: The chosen DHCP server responds to the **DHCPREQUEST** with a **DHCPACK** (acknowledgment) message.
- Purpose: To confirm the leased IP address and other network configuration settings to the client.
- Key Points:
  - The DHCPACK message contains the IP address lease duration and any other configuration information required by the client.
  - If the requested configuration is no longer valid or available, the server may send a DHCPNAK (negative acknowledgment) instead, prompting the client to start the process over.

DHCP Header Message



DHCP Header Message- Explained

OP Code (8 bits)— this field indicates whether this DHCP packet is a request or a response packet.

Hardware Type (8 bits) — this field indicates the type of Layer 2 protocol that is using the DHCP. Some examples of layer 2 (the data link layer) protocols includes Ethernet and 802.11x.

Hardware Address Length (8 bits) — this field indicates the length of the hardware address.

Hops (8 bits) — this field indicates the number of hops the DHCP DORA packet can travel before being discarded.

DHCP Header Message- Explained

Transaction ID (32 bits) — this number is used to identify the DORA's ID. This is an arbitary number generated by DHCP protocol

Seconds (16 bits) — this field indicates the elapsed time since the client ask for an IP.

Flags (8 bits) — this field indicates the flags option in the DHCP header. We are only concerned with the first bit among these 8 bits. The first bit indicate if it is a broadcast or a unicast.

Client IP (32 bits) — all IPv4 is 32 bits long. This field indicate the IP address of the DHCP client. In TCP/IP, any new host who join a network without an IP address will use 0.0.0.0 temporarily.

Your IP Address (32 bits) — this field hold the IP address that is being offered by the server to the client. Client checks on this field to find out what's the IP being offered.

DHCP Header Message- Explained

Server IP (32 bits) — this field indicates the IPv4 address of the DHCP server.

Gateway IP (32 bits) — this field indicate the gateway IP address in LAN to reach a remote DHCP server.

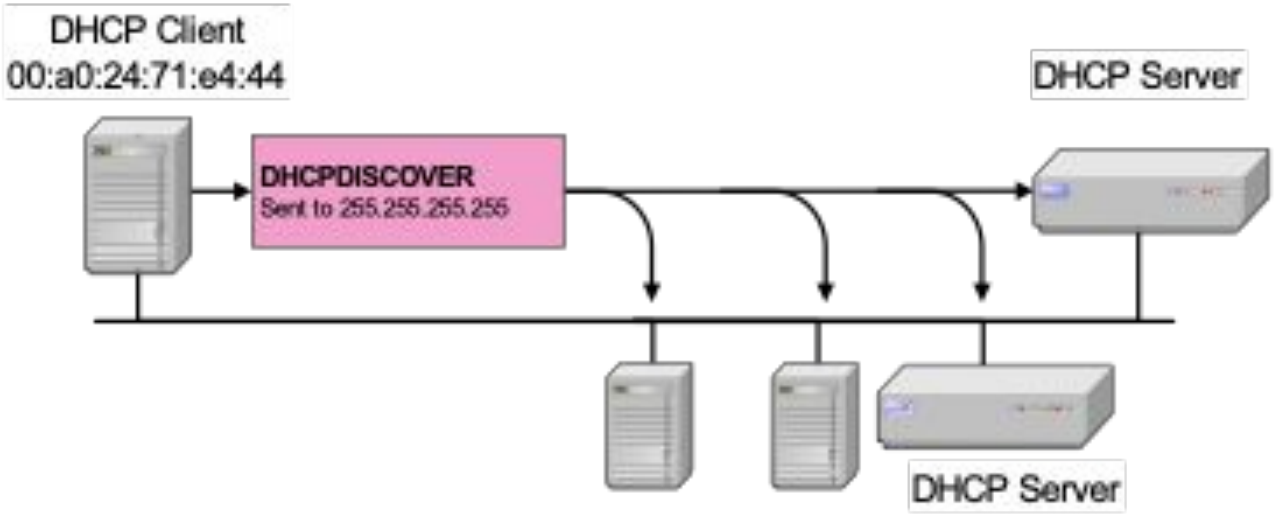
Client Hardware (16 bytes) — this field indicates the MAC address of the DHCP client.

Options (8–214 bytes) — the options field allows DHCP to specify what types of DHCP messages that is being encapsulated in the DHCP packet.

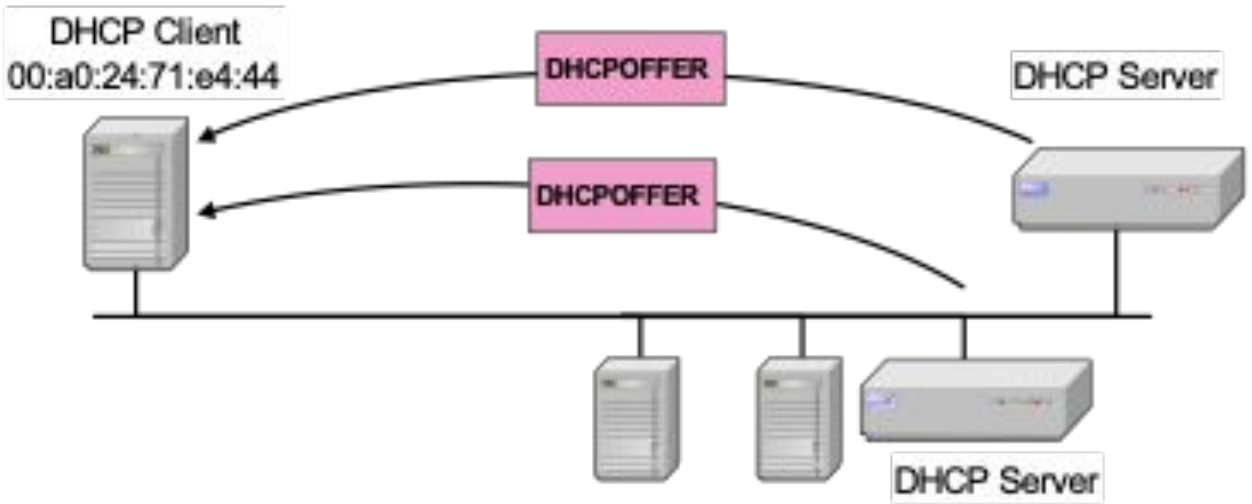
DHCP Message Type

Value	Message Type
1	DHCPDISCOVER
2	DHCPOFFER
3	DHCPREQUEST
4	DHCPDECLINE
5	DHCPACK
6	DHCPNAK
7	DHCPRELEASE
8	DHCPINFORM

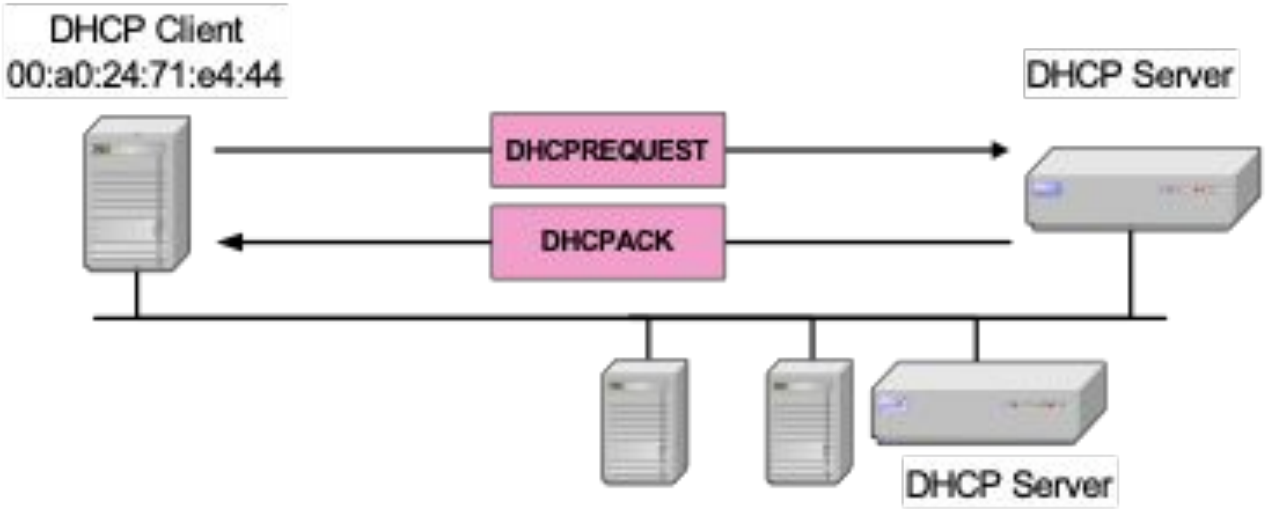
DHCP Discover



DHCP Offer


DHCP Client
00:a0:24:71:e4:44
DHCPOFFER
DHCP Server
DHCPOFFER
DHCP Server

DHCP Request/Ack



DHCP Release

- Renewing a Lease (sent when 50% of lease has expired) If DHCP server sends DHCPNACK, then address is released.
- The "release" in DHCP refers to the DHCPRELEASE message that a DHCP client sends to the DHCP server.
- A client typically sends a DHCPRELEASE message when it is shutting down or when the user explicitly releases the IP address configuration (for example, via a command on the client device). This can be part of normal device operation or when changing networks.
- When the DHCP server receives a DHCPRELEASE message, it marks the client's IP address as available in its address pool.

Summary

- DHCP is essential in modern networks, particularly in environments where devices frequently join and leave the network, such as wireless networks, business environments, and schools.
- DHCP is an application layer protocol operates over UDP and uses client/server architecture.
- Utilizes a four-step process known as DORA (Discovery, Offer, Request, Acknowledgment) for IP address assignment.