Dynamic Host Configuration Protocol (DHCP)
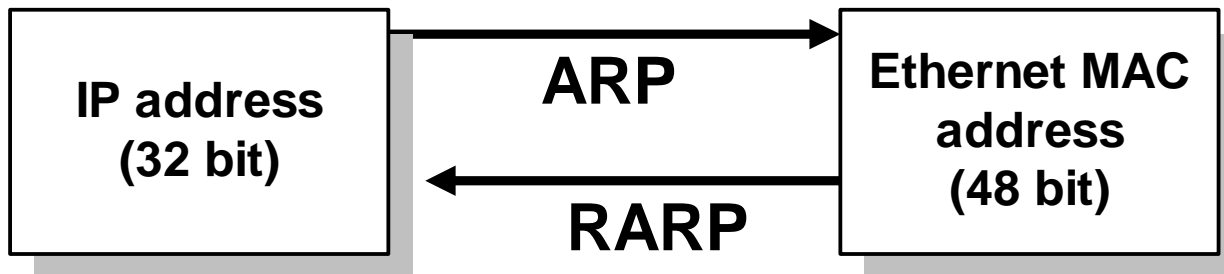
Relates to Lab 7.

Module about dynamic assignment of IP addresses with DHCP.

Dynamic Assignment of IP addresses

- Dynamic assignment of IP addresses is desirable for several reasons:
    - IP addresses are assigned on-demand
    - Avoid manual IP configuration
    - Support mobility of laptops

- Three Protocols:
    - RARP (until 1985, no longer used)
    - BOOTP (1985-1993)
    - DHCP (since 1993)
- Only DHCP is widely used today.

Solutions for dynamic assignment of IP addresses

- **Reverse Address Resolution Protocol (RARP)**
  - RARP is no longer used
  - Works similar to ARP
  - Broadcast a request for the IP address associated with a given MAC address
  - RARP server responds with an IP address
  - Only assigns IP address (not the default router and subnetmask)

```
┌─────────────┐      ARP      ┌─────────────┐
│ IP address  │ ───────────►  │ Ethernet MAC│
│  (32 bit)   │               │   address   │
│             │ ◄───────────  │  (48 bit)   │
└─────────────┘     RARP      └─────────────┘
```
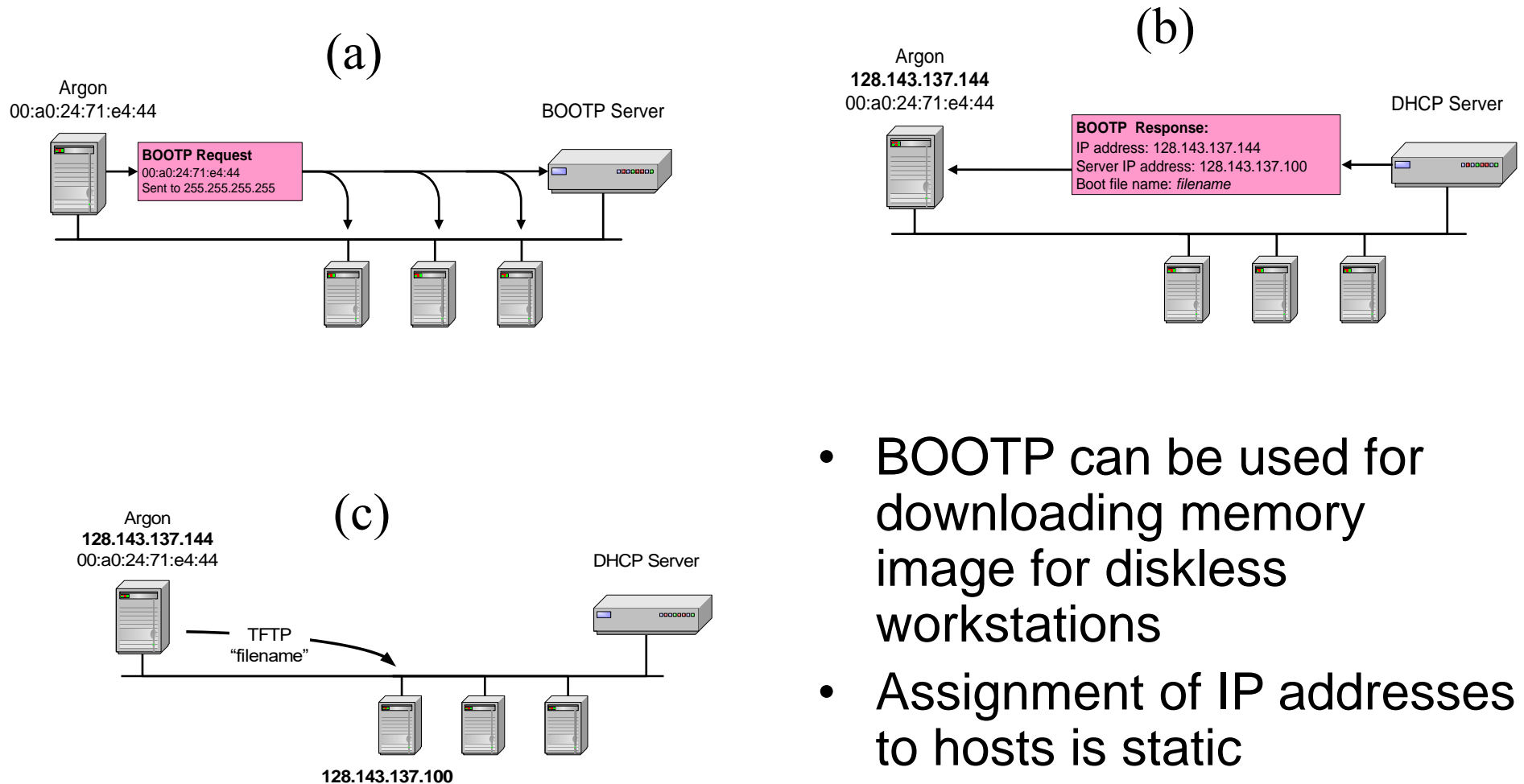
BOOTP

- **BOOTstrap Protocol (BOOTP)**
  - 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)

  - Not only assigns 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

BOOTP Interaction

(a)

Argon
00:a0:24:71:e4:44

BOOTP Server

BOOTP Request
00:a0:24:71:e4:44
Sent to 255.255.255.255

(b)

Argon
128.143.137.144
00:a0:24:71:e4:44

DHCP Server

BOOTP Response:
IP address: 128.143.137.144
Server IP address: 128.143.137.100
Boot file name: *filename*

(c)

Argon
128.143.137.144
00:a0:24:71:e4:44

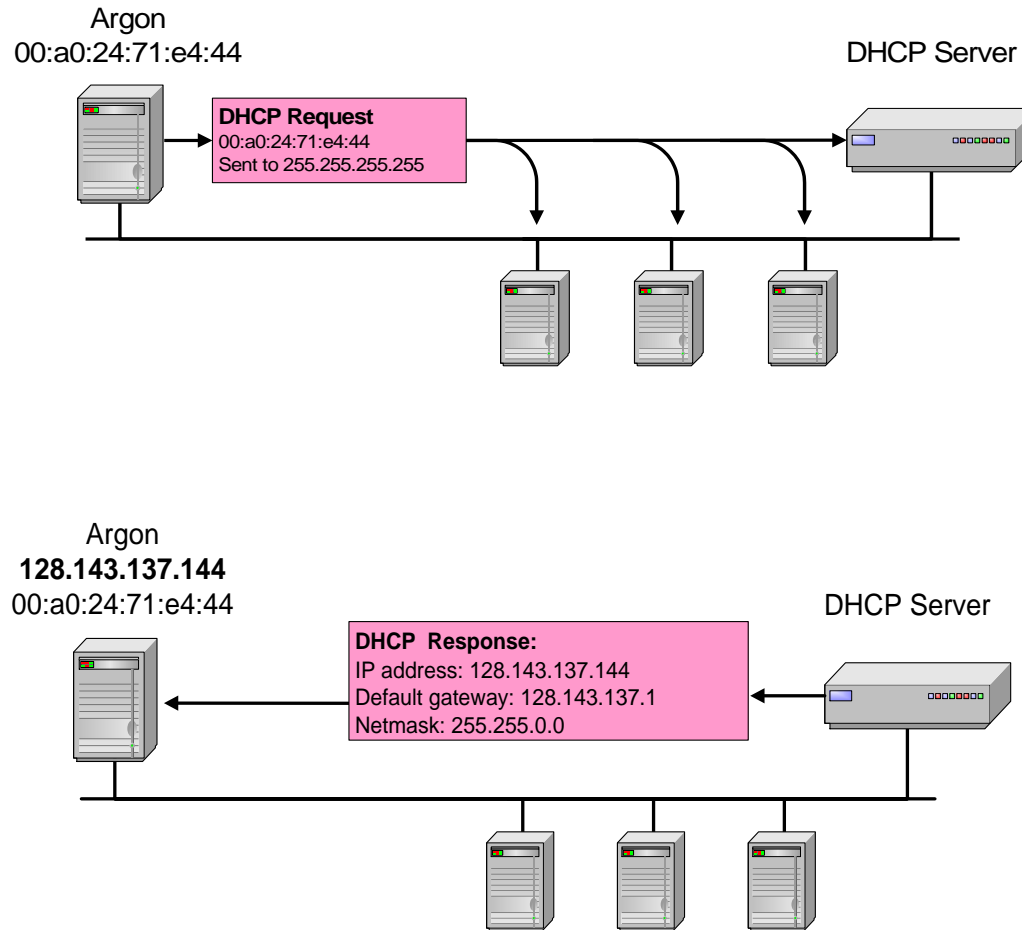DHCP Server

TFTP
"filename"

128.143.137.100

- BOOTP can be used for downloading memory image for diskless workstations
- Assignment of IP addresses to hosts is static

DHCP

- **Dynamic Host Configuration Protocol (DHCP)**
  - Designed in 1993
  - An extension of BOOTP (Many similarities to BOOTP)
  - Same port numbers as BOOTP
  - Extensions:
    - Supports temporary allocation ("leases") of IP addresses
    - DHCP client can acquire all IP configuration parameters

  - DHCP is the preferred mechanism for dynamic assignment of IP addresses
  - DHCP can interoperate with BOOTP clients.

DHCP Interaction (simplified)

Argon
00:a0:24:71:e4:44

DHCP Server

DHCP Request
00:a0:24:71:e4:44
Sent to 255.255.255.255

Argon
128.143.137.144
00:a0:24:71:e4:44

DHCP Server

DHCP Response:
IP address: 128.143.137.144
Default gateway: 128.143.137.1
Netmask: 255.255.0.0

BOOTP/DHCP Message Format

OpCode	Hardware Type	Hardware Address Length	Hop Count
Number of Seconds		Unused (in BOOTP) Flags (in DHCP)	
Transaction ID			
Client IP address			
Your IP address			
Server IP address			
Gateway IP address			
Client hardware address (16 bytes)			
Server host name (64 bytes)			
Boot file name (128 bytes)			
Options			

(There are >100 different options)

BOOTP/DHCP

- **OpCode**: *1 (Request), 2(Reply)*
  Note: DHCP message type is sent in an option
- **Hardware Type**: *1 (for Ethernet)*
- **Hardware address length**: *6 (for Ethernet)*
- **Hop count**: *set to 0 by client*
- **Transaction ID**: *Integer (used to match reply to response)*
- **Seconds:** *number of seconds since the client started to boot*
- **Client IP address, Your IP address, server IP address, Gateway IP address, client hardware address, server host name, boot file name:**
  client fills in the information that it has, leaves rest blank

DHCP Message Type

- Message type is sent as an option.

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

Other options (selection)

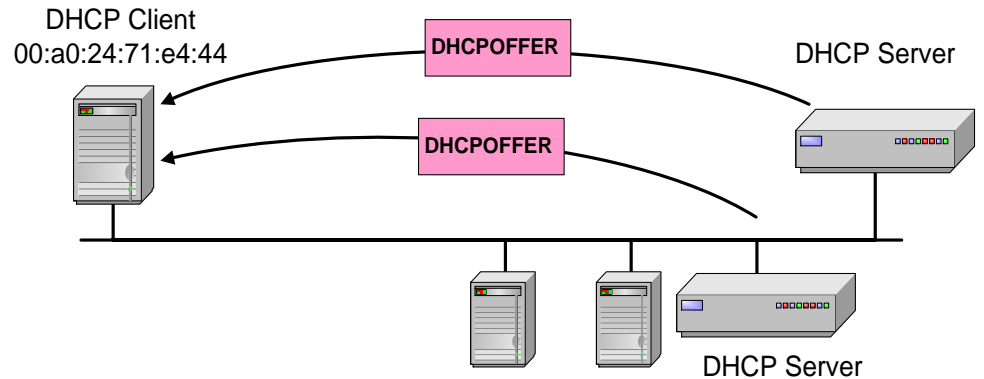- Other DHCP information that is sent as an option:

  Subnet Mask, Name Server, Hostname, Domain Name, Forward On/Off, Default IP TTL, Broadcast Address, Static Route, Ethernet Encapsulation, X Window Manager, X Window Font, DHCP Msg Type, DHCP Renewal Time, DHCP Rebinding, Time SMTP-Server, SMTP-Server, Client FQDN, Printer Name, …
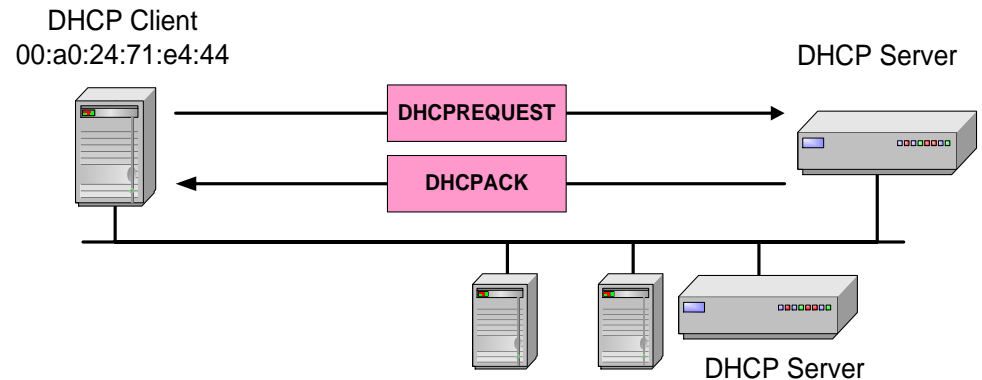
DHCP Operation
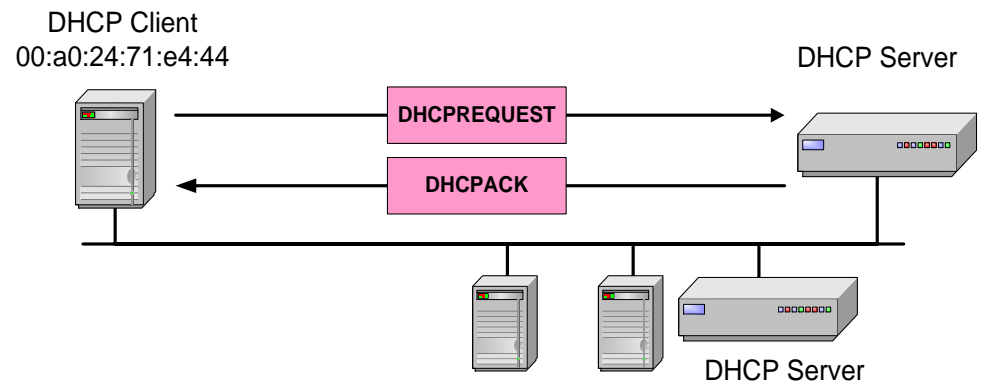
- DCHP DISCOVER
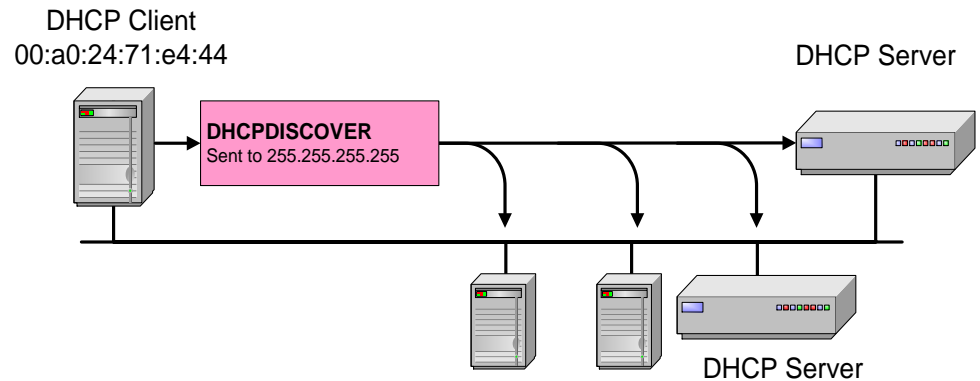
- DCHP OFFER

DHCP Operation

- DCHP DISCOVER

At this time, the DHCP client can start to use the IP address

- Renewing a Lease
(sent when 50% of lease has expired)
    If DHCP server sends DHCPNACK, then address is released.

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

DHCP Server

DHCPREQUEST

DHCPACK

DHCP Server

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

DHCP Server

DHCPREQUEST

DHCPACK

DHCP Server

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DHCP Operation

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

DHCP Server

DHCPRELEASE

DHCP Server

• DCHP RELEASE

At this time, the DHCP client has released the IP address