Dynamic Host Configuration Protocol

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CS 3103: Compute Networks and Protocols

IP addresses: how to get one?

Q: How does a *host* get its IP address?

- hard-coded by system admin in a file
  - Windows: control-panel->network->configuration->tcp/ip->properties
  - UNIX: /etc/rc.config
- DHCP: Dynamic Host Configuration Protocol: dynamically get address from as server
  - "plug-and-play"
  - RFC 2131

Bootstrap a host

- When a host is booted, it needs
  - An IP address
  - Its subnet mask
  - The IP address of default gateway
  - The IP address of domain name server

- DHCP provides all the above automatically
  - It is a client/server program
  - It runs as an application level protocol

Before DHCP

- Reverse Address Resolution Protocol (RARP)
  - Used broadcast service in the data link layer
  - Each subnet needs a server
  - Provide only the IP address
- Bootstrap Protocol (BOOTP)
  - Application level client/server program
  - Could provide multiple pieces of information
  - However, it uses a table to do ***static*** mapping
  - Binding is predetermined

DHCP: Dynamic Use Cases

- Mobile users
  - A student who carries a laptop from a dormitory room to a library to a classroom.
  - In each location, the student will be connecting into a new subnet and need a new IP address.
- Residential ISP
  - has 2,000 customers, but no more than 400 customers are ever online at the same time.
  - rather than 2,048 addresses, a DHCP server that assigns addresses dynamically needs only a block of 512 addresses (e.g., a.b.c.d/23).

DHCP: Dynamic Host Configuration Protocol

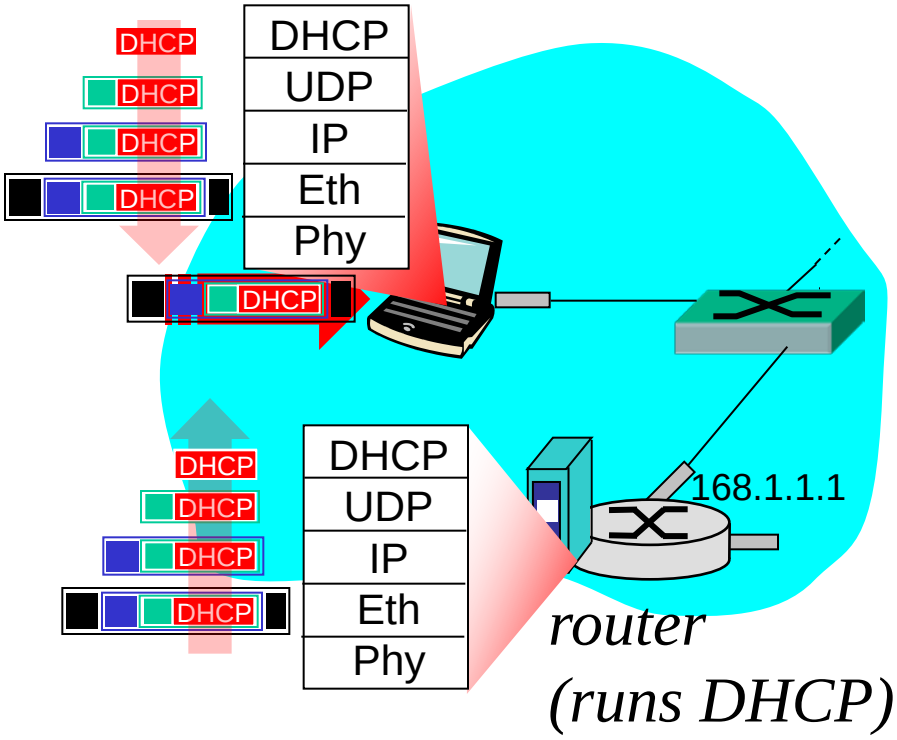
Goal: allow host to *dynamically* obtain its IP address from network server when it joins network

- Allows reuse of addresses (static binding, BOOTP compatible)
- Can renew its lease on address in use
- Support for mobile users who want to join network (more shortly)

DHCP overview:

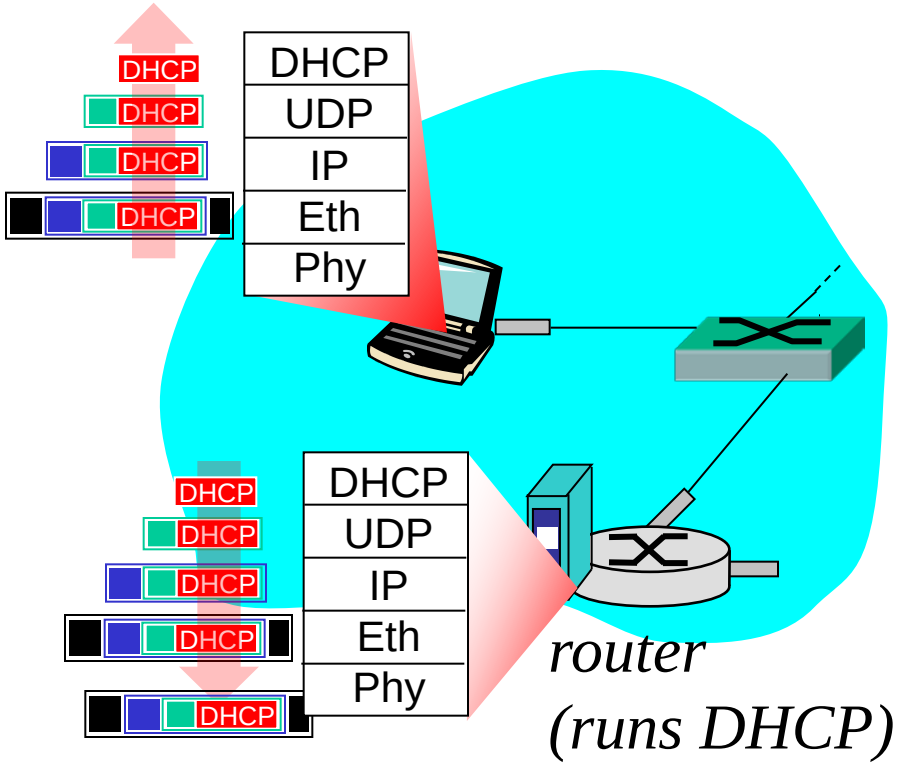
- host broadcasts "DHCP discover" msg [optional]
- DHCP server responds with "DHCP offer" msg [optional]
- host requests IP address: "DHCP request" msg
- DHCP server sends address: "DHCP ack" msg

DHCP Request-Response (BOOTP compatible)



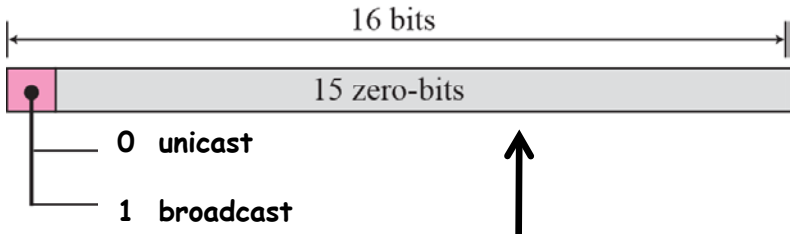
- connecting laptop needs its IP address, addr of first-hop router, addr of DNS server
- DHCP request encapsulated in UDP, encapsulated in IP, encapsulated in 802.1 Ethernet
- Ethernet frame broadcast (dest: FFFFFFFFFFFF) on LAN, received at router running DHCP server
- Ethernet demuxed to IP demuxed, UDP demuxed to DHCP

DHCP Request-Response (BOOTP compatible)



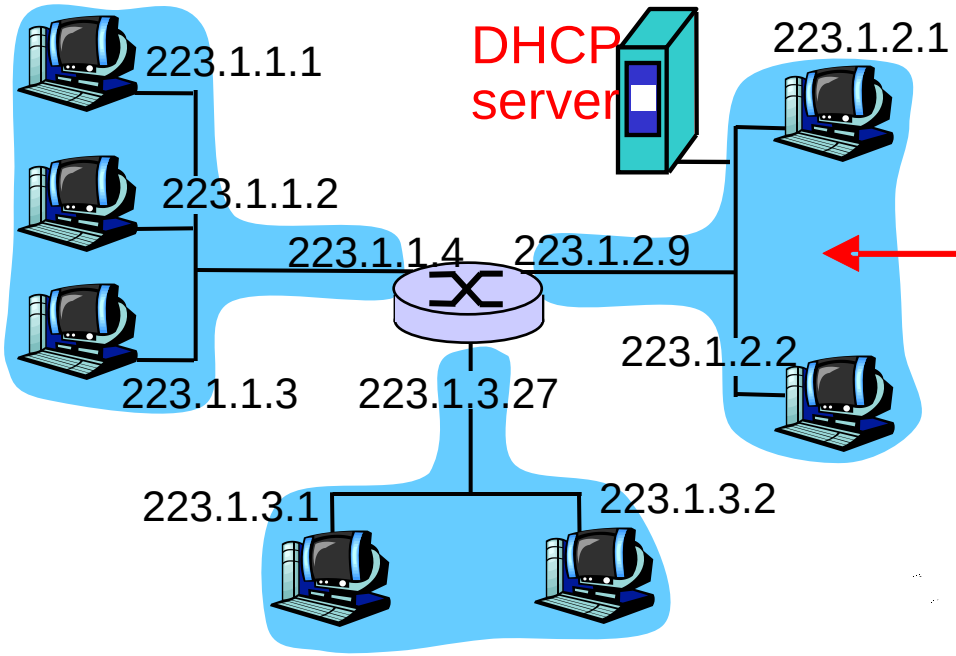
- DHCP server formulates DHCP ACK containing client's IP address, IP address of first-hop router for client, name & IP address of DNS server
- encapsulation of DHCP server, frame forwarded to client, demuxing up to DHCP at client
- client now knows its IP address, name and IP address of DSN server, IP address of its first-hop router

Packet Header



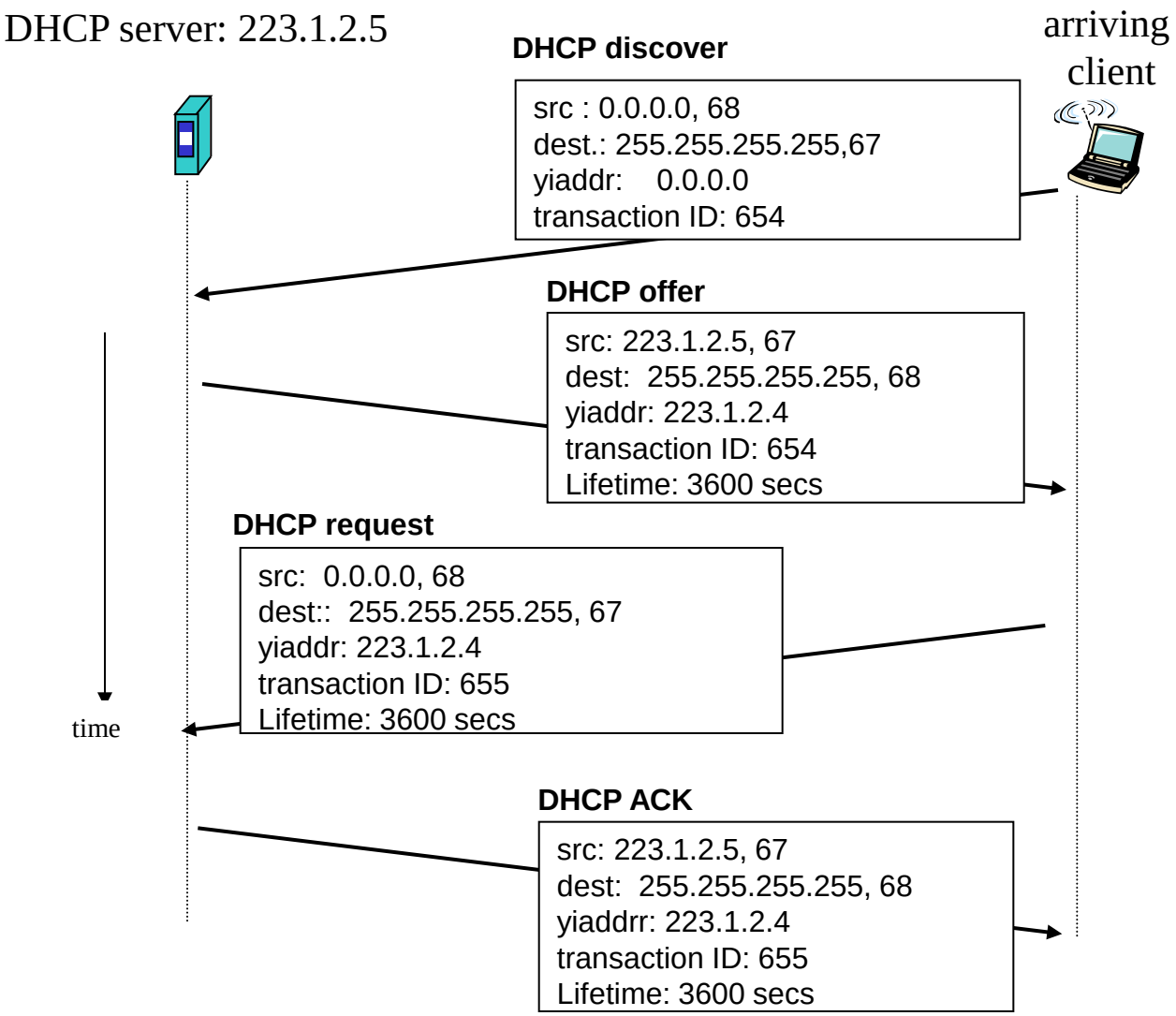
0	8	16	24	31
Operation code	Hardware type	Hardware length	Hop count	
Transaction ID				
Number of seconds		Flags		
Client IP address				
Your IP address				
Server IP address				
Gateway IP address				
Client hardware address (16 bytes)				
Server name (64 bytes)				
Boot file name (128 bytes)				
Options (Variable length)				

DHCP client-server scenario



arriving DHCP client needs address in this network

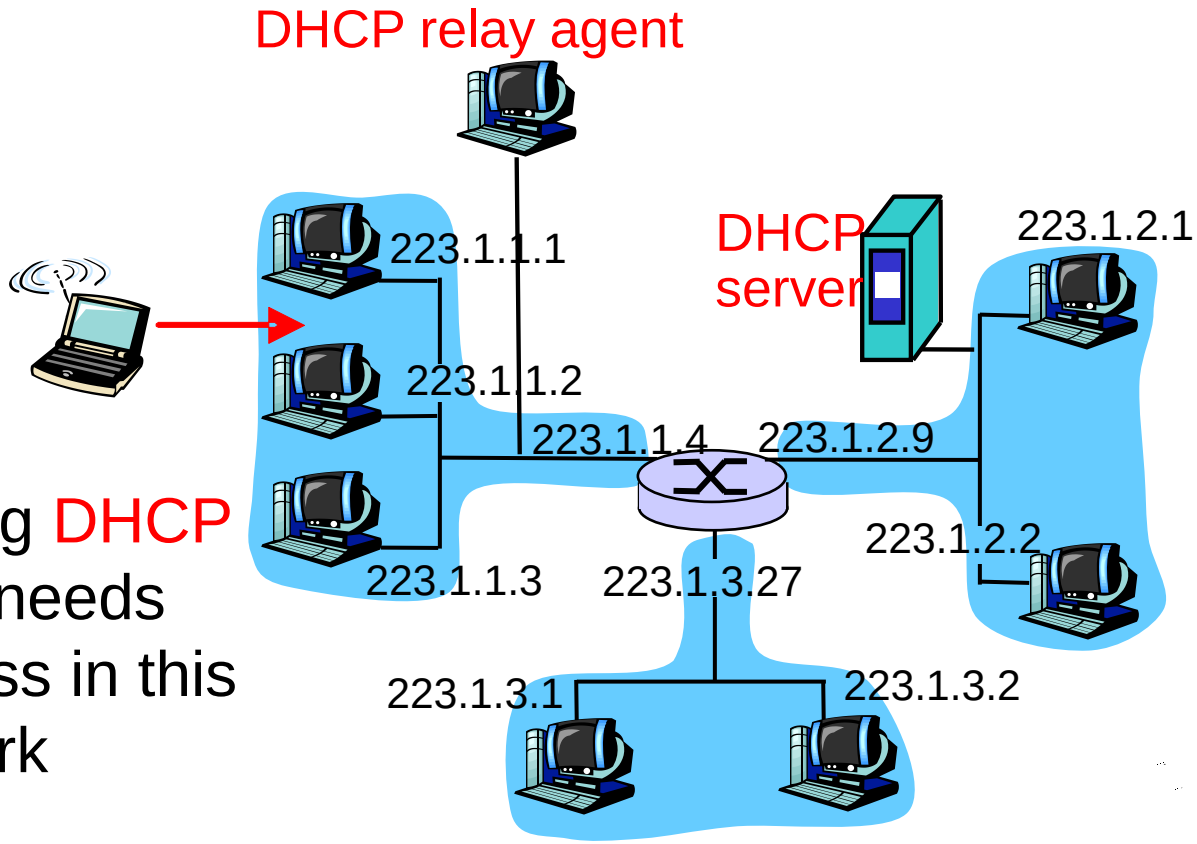
DHCP client-server scenario



Discussions

- Why is DHCP implemented at the application layer?
- Why does DHCP use UDP instead of TCP?
- Why does DHCP use a well-known port number 68 at the client side?
- Why is Transaction ID useful in DHCP?
- How about the cases when the server is in a different subnet?

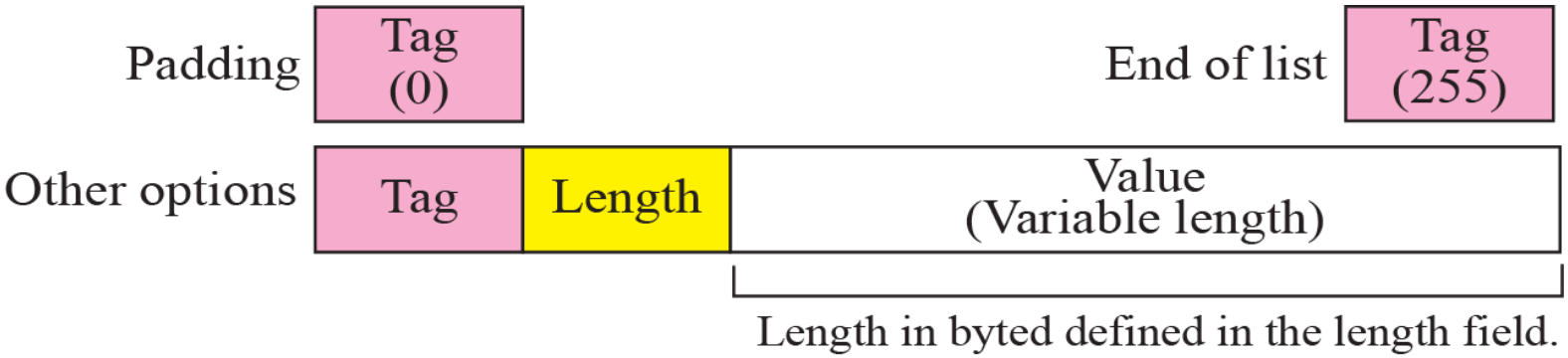
DHCP: Client and server on two different networks



arriving DHCP client needs address in this network

DHCP options

- Options are only used in reply DHCP reply
- Starts with a *magic cookie*
  - 99.130.83.99
- Followed by 1 byte Tag + 1 byte Length



The Dynamic Aspect of DHCP

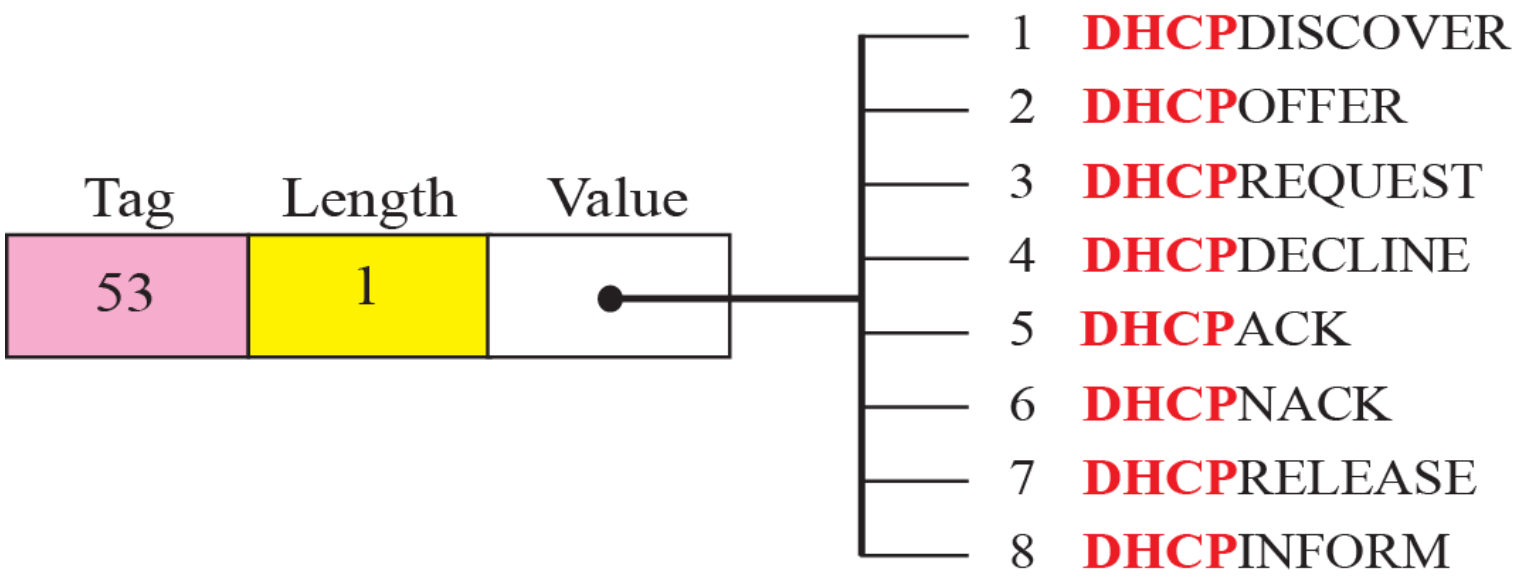
- A DHCP server has a static database that binds physical addresses to IP addresses.
  - Compatible with BOOTP
- It has a second database with a pool of available IP addresses
  - Lease to hosts for temporary uses
  - Possible renewal upon expirations
  - Uses the *Options* field

Options for DHCP

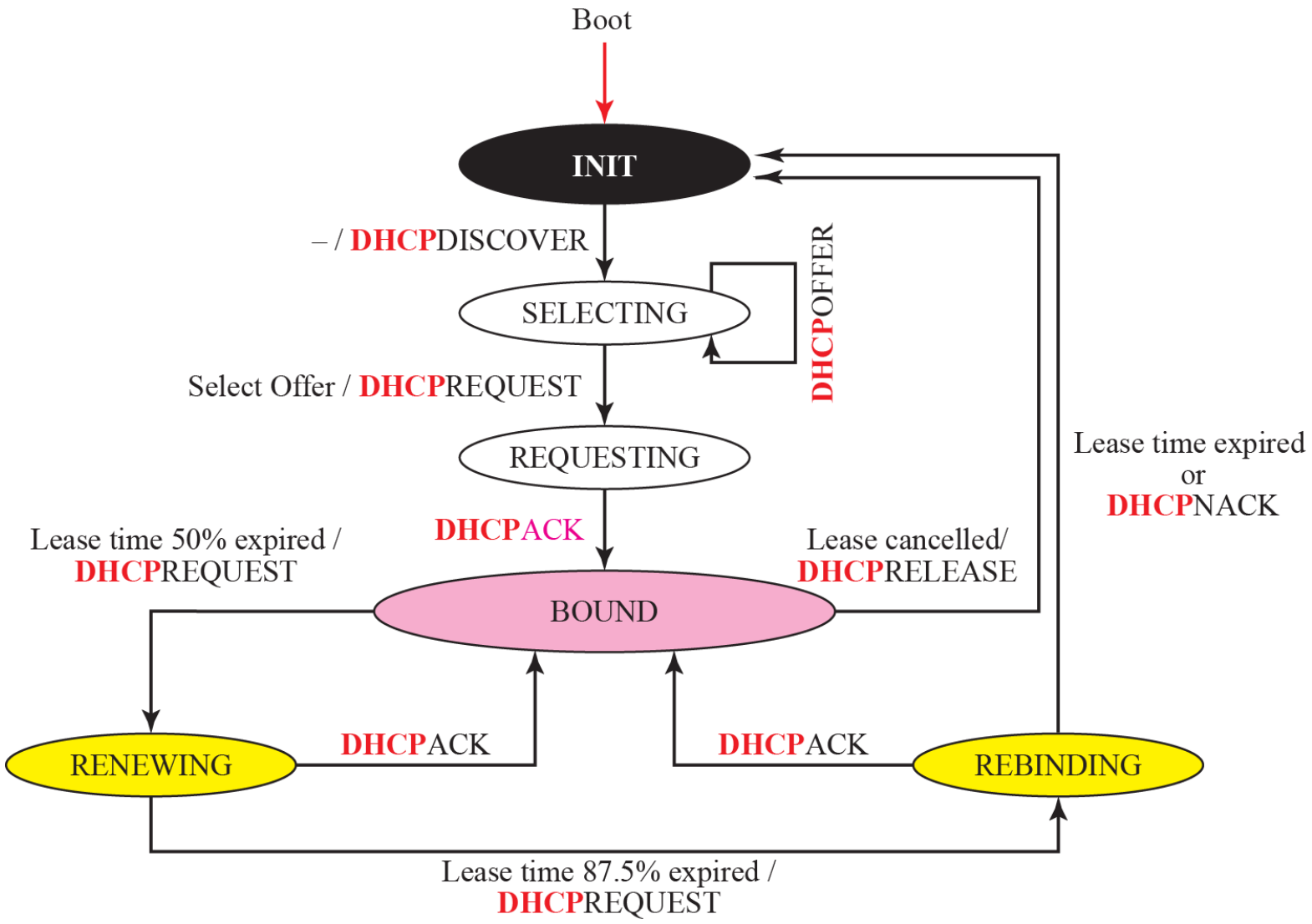
Tag	*Length*	*Value*	*Description*
0			Padding
1	4	Subnet mask	Subnet mask
2	4	Time of the day	Time offset
3	Variable	IP addresses	Default router
4	Variable	IP addresses	Time server
5	Variable	IP addresses	IEN 16 server
6	Variable	IP addresses	DNS server
7	Variable	IP addresses	Log server
8	Variable	IP addresses	Quote server
9	Variable	IP addresses	Print server
10	Variable	IP addresses	Impress
11	Variable	IP addresses	RLP server
12	Variable	DNS name	Host name
13	2	Integer	Boot file size
53	1	Discussed later	Used for dynamic configuration
128–254	Variable	Specific information	Vendor specific
255			End of list

DHCP: dynamic configuration

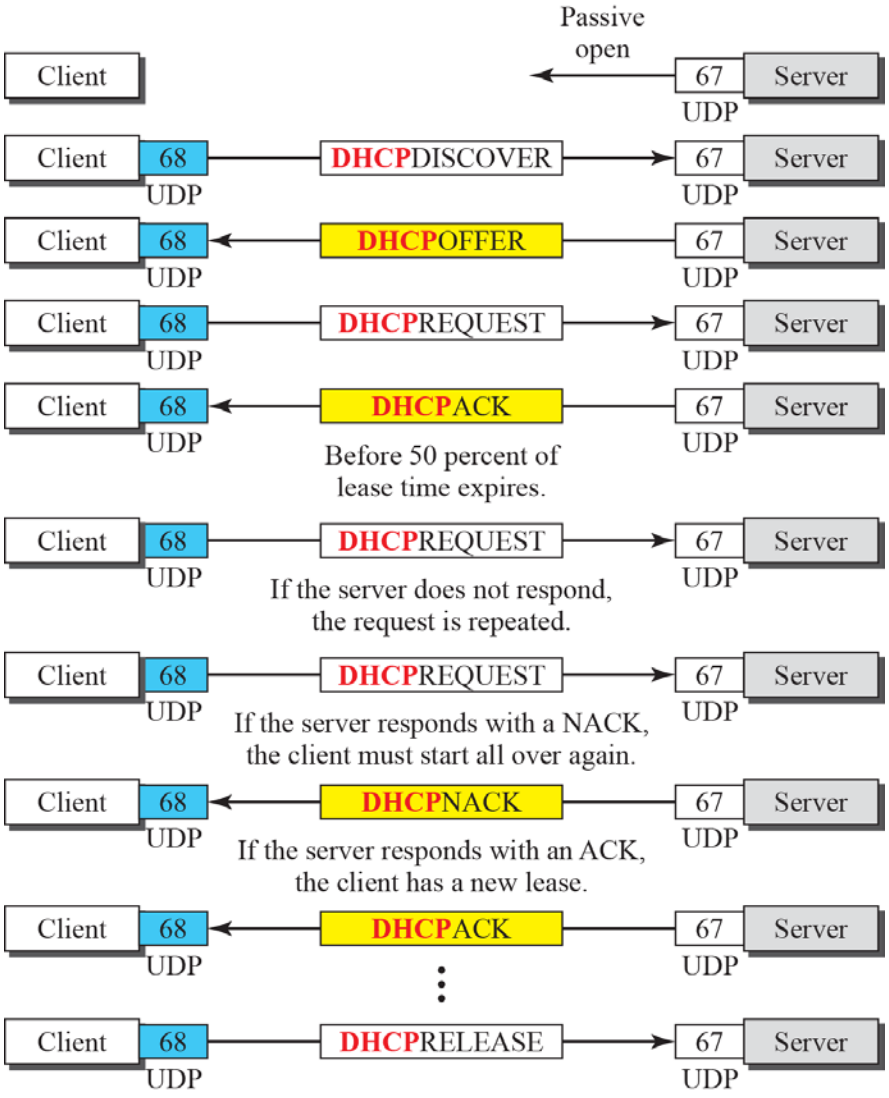
- Option with tag 53



DHCP client transition diagram



DHCP Message Exchange



DHCP: Wireshark output (home LAN)

request

Message type: **Boot Request (1)**
Hardware type: Ethernet
Hardware address length: 6
Hops: 0
Transaction ID: 0x6b3a11b7
Seconds elapsed: 0
Bootp flags: 0x0000 (Unicast)
Client IP address: 0.0.0.0 (0.0.0.0)
Your (client) IP address: 0.0.0.0 (0.0.0.0)
Next server IP address: 0.0.0.0 (0.0.0.0)
Relay agent IP address: 0.0.0.0 (0.0.0.0)
Client MAC address: Wistron_23:68:8a (00:16:d3:23:68:8a)
Server host name not given
Boot file name not given
Magic cookie: (OK)
Option: (t=53,l=1) **DHCP Message Type = DHCP Request**
Option: (61) Client identifier
    Length: 7; Value: 010016D323688A;
    Hardware type: Ethernet
    Client MAC address: Wistron_23:68:8a (00:16:d3:23:68:8a)
Option: (t=50,l=4) Requested IP Address = 192.168.1.101
Option: (t=12,l=5) Host Name = "nomad"
Option: (55) Parameter Request List
    Length: 11; Value: 010F03062C2E2F1F21F92B
    1 = Subnet Mask; 15 = Domain Name
    3 = Router; 6 = Domain Name Server
    44 = NetBIOS over TCP/IP Name Server
    ……

reply

Message type: **Boot Reply (2)**
Hardware type: Ethernet
Hardware address length: 6
Hops: 0
Transaction ID: 0x6b3a11b7
Seconds elapsed: 0
Bootp flags: 0x0000 (Unicast)
Client IP address: 192.168.1.101 (192.168.1.101)
Your (client) IP address: 0.0.0.0 (0.0.0.0)
Next server IP address: 192.168.1.1 (192.168.1.1)
Relay agent IP address: 0.0.0.0 (0.0.0.0)
Client MAC address: Wistron_23:68:8a (00:16:d3:23:68:8a)
Server host name not given
Boot file name not given
Magic cookie: (OK)
Option: (t=53,l=1) DHCP Message Type = DHCP ACK
Option: (t=54,l=4) Server Identifier = 192.168.1.1
Option: (t=1,l=4) Subnet Mask = 255.255.255.0
Option: (t=3,l=4) Router = 192.168.1.1
Option: (6) Domain Name Server
    Length: 12; Value: 445747E2445749F244574092;
    IP Address: 68.87.71.226;
    IP Address: 68.87.73.242;
    IP Address: 68.87.64.146
Option: (t=15,l=20) Domain Name = "hsd1.ma.comcast.net."