

Chapter 32

Initialization

(BOOTP and DHCP)

Raj Jain

**Raj Jain is now at
Washington University in Saint Louis
Jain@cse.wustl.edu
<http://www.cse.wustl.edu/~jain/>**



- ❑ Bootstrapping (Diskless workstations)
- ❑ BOOTP
- ❑ Dynamic address allocation
- ❑ DHCP

Bootstrapping

- ❑ Computer loads a simple boot program. The boot program loads operating system.
- ❑ On diskless machine, the computer needs to know the network address of the o/s file
- ❑ It needs to know its own IP address.
- ❑ It only knows its h/w address.

Configuration

- ❑ Protocols are software routines.
- ❑ All nodes have the same software.
- ❑ Different nodes have different parameters: Addresses, packet size, etc.
- ❑ Configuration = Setting the parameters
- ❑ IP Address
- ❑ Default router address
- ❑ Subnet mask
- ❑ DNS server addresses

Method 1: Long Past

- ❑ Reverse ARP: "What is the IP address of h/w address xx:xx:...?"
- ❑ But RARP uses IP \Rightarrow Needs IP address.
- ❑ Solution: Use 00.00.00.00 as source address.
- ❑ ICMP: What is my subnet mask?
- ❑ ICMP: What is my default router?
- ❑ Problem: What is the boot file name for IP address nn.nn.nn...?

Method 2: Past

- ❑ Broadcast BOOTP (Bootstrap Protocol) request.
- ❑ Reply: IP Address, Boot Server IP address, Default Router, Boot file name, subnet mask
- ❑ Get boot image using a simple FTP program
⇒ Trivial File Transfer Protocol (TFTP)
- ❑ Problem: Why waste an address when it is not being used.

Method 3: Current

- ❑ Dynamic Host Configuration Protocol (DHCP)
= BOOTP + Dynamic allocation of IP addresses
⇒ Addresses are leased for a period. Reallocated to the same or other nodes after lease expiry.
- ❑ Nonmobile computers get a permanent address.

BOOTP Message Format

0

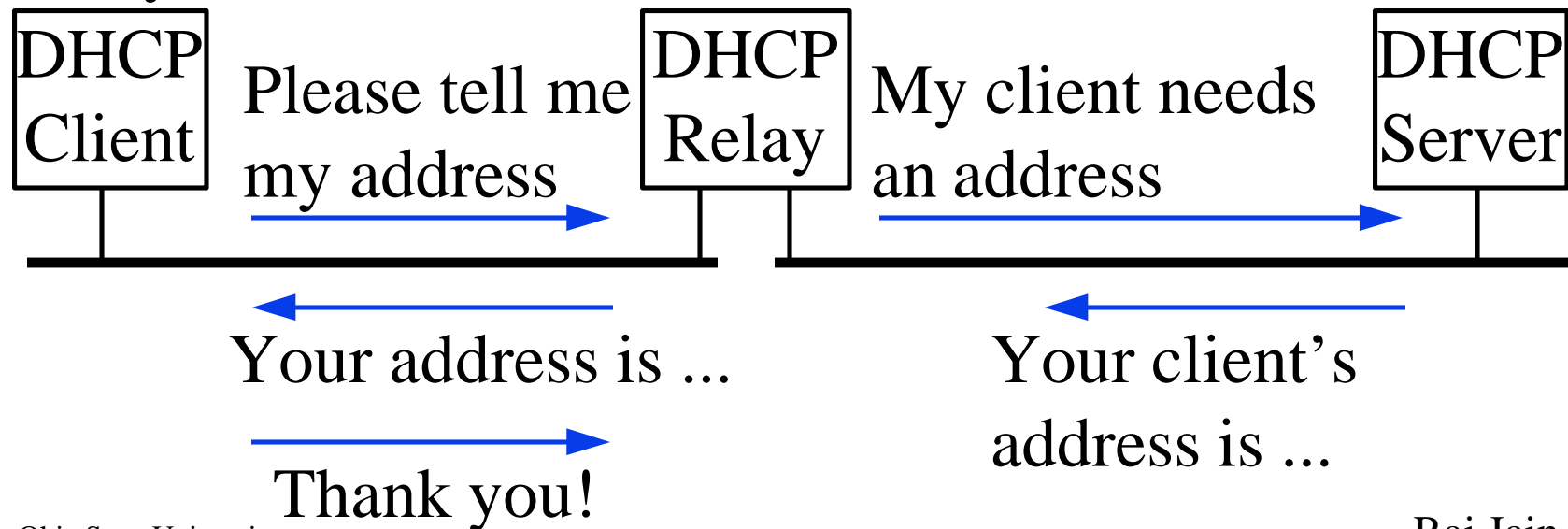
31b

Operation	H/W Type	H/W Length	Hops	
Transaction Identifier				
Seconds elapsed		Unused		
Client IP Address				
Your IP Address				
Server IP Address				
Router IP Address				
Client H/W address				16 B
Server Host Name				64 B
Bootfile Name				128 B
Vendor Specific Area				64 B

Raj Jain

BOOTP Message (Cont)

- ❑ Operation: 1 = Request, 2 = Reply
- ❑ H/w type: 1 = Ethernet
- ❑ H/w Address Length
- ❑ Hops: Initialized to zero. Incremented by DHCP relays (routers)



BOOTP Message (Cont)

- ❑ Transaction ID: used to match responses with requests
- ❑ Seconds = Number of seconds since the client started to boot
- ❑ If a client knows its IP address, it places it in the Client IP address
- ❑ If server address/name fields are non-zero in the request, only the indicated host can answer the request
- ❑ Your IP Address: Clients IP address returned by the server

BOOTP Message (Cont)

- ❑ Boot File name: Generic name like "unix" in the request. Full name in response.
- ❑ Vendor specific area: Misnomer. Also used for general purpose info.
- ❑ Magic cookie: First four octets = 99.130.83.99
- ❑ Type-length-value

Item	Code	Length
Padding	0	-
Subnet mask	1	4
Time of Day	2	4
End	255	-

Contents of Vendor-Specific Area

Item	Code	Length
Routers	3	4n
Time Server	4	4n
IEN116 Server	5	4n
Domain server	6	4n
Log server	7	4n
Quote server	8	4n
LPR servers	9	4n
Impress servers	10	4n
RLP Server	11	4n
Host name	12	4n
Boot size	13	2
Reserved	128-254	-

BOOTP Operation

- ❑ BOOTP request is broadcast
- ❑ BOOTP requires only a single packet exchange
- ❑ BOOTP uses UDP \Rightarrow Bootstrapping can occur across a router
- ❑ BOOTP UDP to use checksum
- ❑ BOOTP replies are also broadcast (since no one knows the requesters IP address, ARP will fail).
- ❑ BOOTP requests and replies are sent with "no fragment bit" set

- ❑ Multiple replies \Rightarrow process the first one
- ❑ Clients uses timeout and retransmission
- ❑ The timeout interval is random to avoid synchronization after a power failure

DHCP Message Format

0

31b

Operation	H/W Type	H/W Length	Hops
Transaction Identifier			
Seconds elapsed		Flags	
Client IP Address			
Your IP Address			
Server IP Address			
Router IP Address			
Client H/W address			
Server Host Name			
Bootfile Name			
Options (Variable)			

16 B

64 B

128 B

Raj Jain

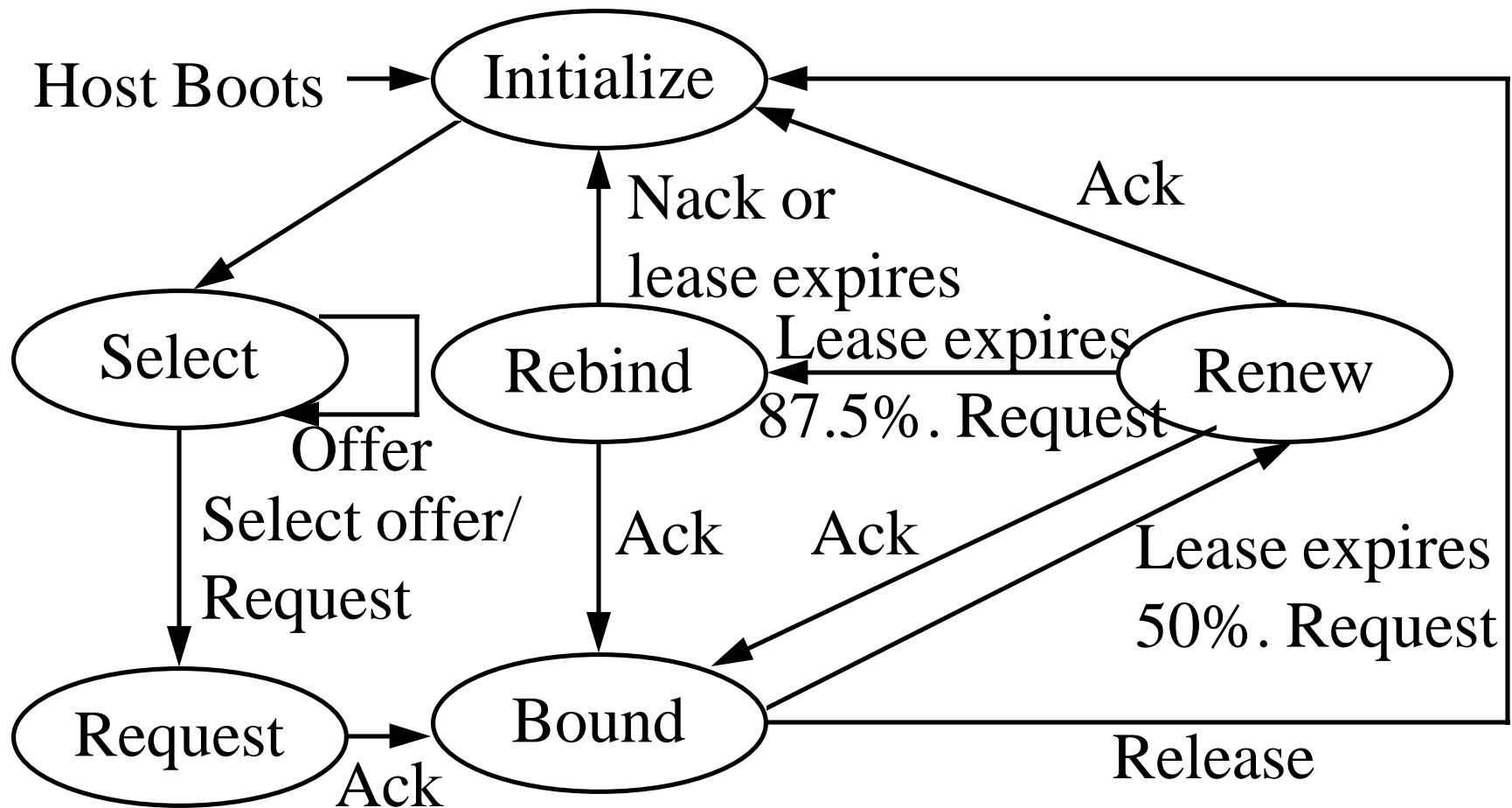
DHCP Message Format

- ❑ Slightly modified version of BOOTP message \Rightarrow A DHCP server can be programmed to answer BOOTP requests
- ❑ BOOTP's Unused field renamed to Flags
- ❑ Only one bit of 16-bit Flags has been defined
- ❑ Left-most flag bit =1 \Rightarrow Servers, please reply using IP broadcast address
- ❑ Servers always send hardware unicast response
- ❑ Vendor specific field renamed to options
- ❑ Option type 53 specifies the "type of the message"

- "Option overload" option \Rightarrow Server Host name and boot file name fields contain options

Type	Meaning
1	DHCP Discover
2	DHCP Offer
3	DHCP Request
4	DHCP Decline
5	DHCP Ack
6	DHCP Nack
7	DHCP Release

DHCP States



DHCP: Current Issues

- ❑ Interaction with DNS
- ❑ Should the names be dynamically leased?
- ❑ Should the names be registered on DNS?
- ❑ Currently there are no protocols for dynamic DNS updates.

Summary



- ❑ RARP allows finding an IP address
- ❑ BOOTP allows default router, subnet mask, DNS
- ❑ DHCP allows dynamic allocation
- ❑ DHCP is backward compatible with BOOTP

Homework

- ❑ Read Chapter 32 and RFC 1541
- ❑ Submit the answer to Exercise 32.7

BOOTP and DHCP: References

- ❑ D. E. Comer, “Internetworking with TCP/IP,” Vol. 1, 3rd Ed, Prentice Hall, 1995, Chapter 21.
- ❑ S. A. Thomas, “IPng and the TCP/IP Protocols,” Wiley, 1996, Chapter 14.

Initialization: RFCs

- ❑ [RFC1533] S. Alexander, R. Droms, "DHCP Options and BOOTP Vendor Extensions", 10/08/1993, 30 pages.
- ❑ [RFC1534] R. Droms, "Interoperation Between DHCP and BOOTP", 10/08/1993, 4 pages.
- ❑ [RFC1541] R. Droms, "**Dynamic Host Configuration Protocol**", 10/27/1993, 39 pages.
- ❑ [RFC1542] W. Wimer, "Clarifications and Extensions for the Bootstrap Protocol", 10/27/1993, 23 pages.
- ❑ [RFC0951] W. Croft, J. Gilmore, "**Bootstrap Protocol**", 09/01/1985, 12 pages. (Updated by RFC1532, RFC1395, RFC1497)
- ❑ [RFC0906] R. Finlayson, "Bootstrap loading using TFTP", 06/01/1984, 4 pages.