

HOST AUTO CONFIGURATION (BOOTP, DHCP)

Internet Protocols

CSC / ECE 573

Fall, 2005

N. C. State University

Announcements

- I. HW5 online today, due in 1 week!

Today's Lecture

- I. Auto configuration
- II. BOOTP
- III. DHCP

AUTO CONFIGURATION

Host Autoconfiguration

- What are the networking parameters needed to configure a host?
- Essential
 - Own IP address
 - subnet mask
 - gateway (default router) IP address
 - DNS server IP address
- Many others would be useful, as well

Host Autoconfiguration (cont'd)

- Choices of configuration
 - static (in configuration file on the local disk)
 - dynamic (from a server)
- How do you ask a server to send configuration information if you don't have an IP address?

Protocol Choices

- Minimal: **Reverse ARP (RARP)**
 - requests IP address corresponding to MAC address
 - can only provide the client's IP address
- Better: **BOOTP**
 - provides many other configuration parameter values
- Best: **DHCP**
 - provides limited lifetimes on configuration information

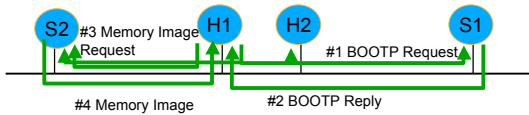
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BOOTP

BOOTstraP Protocol (RFCs 951,1542)

- Single message exchange from server to client
 - provides many items needed at startup, in addition to the IP address



- BOOTP can tell clients where to get a “memory image” (startup program)

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BOOTP Messages

- Client (host) uses the limited broadcast IP address (255.255.255.255) to broadcast the **BOOTP Request** on the local net
 - source IP address = 0.0.0.0 (used **only** during bootstrapping)
 - multi-homed hosts issue **one BOOTP Request** for each interface
- BOOTP server responds, may use the **limited broadcast address** as destination of the **BOOTP Reply**

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BOOTP Reliability

- BOOTP runs over UDP
 - client is responsible for ensuring reliable communication
- if no **Reply** after sufficient time, timeout and retransmit **Request**
 - wait “random” delay before retransmission (between 0 and 4 s)
 - double timeout value each time (exponential backoff)

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BOOTP Message Format

- Length = 236 bytes + Options

Field	# Bytes	Interpretation
Operation Type	1	Request or Reply
Hardware Type	1	e.g., Ethernet
Length of physical address	1	6 for Ethernet
# of Hops	1	Initialized to 0, relays increment
Transaction ID	4	For matching Reply with Request
Seconds (since booting started)	2	For prioritizing / forwarding Requests
Flags	2	To indicate response should be broadcast

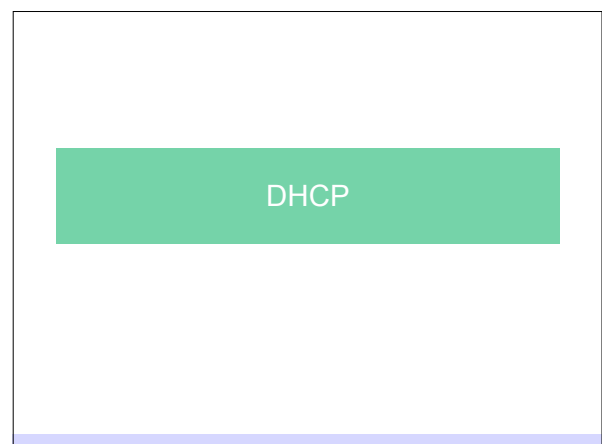
BOOTP Message Format (cont'd)		
Field	# Bytes	Interpretation
Client IP Address	4	0 if client doesn't know
Your IP Address	4	IP address to use (returned by server)
Server IP Address	4	If client wants specific server to respond
Relay's IP Address	4	(Discussed later)
Client Hardware Address	16	So server can unicast response to client
Server Hostname	64	If client wants specific server to respond
Boot File Name	128	Name of file containing memory image (in Request, type of OS desired)
Options	variable	(Discussed later)

- ### Address Fields
- **Client Request**
 - client fills in as many fields as known, zeroes otherwise
 - **Server IP Address?**
 - **Server Host Name?**
 - **Client IP Address?**
 - **Server Reply**
 - if server specified by client, only that server responds
 - fills in whatever fields were set to zeroes by client

- ### BOOTP Options Field
- Encoding of each option: **TLV** format
 - **T** = type or tag (1 byte)
 - **L** = length (1 byte)
 - **V** = value of option (*N* bytes)
 - Examples of options
 - subnet mask
 - client host name
 - memory image size
 - time of day
 - gateway IP addresses
 - DNS server IP addresses

- ### BOOTP Relays
- BOOTP *Relay Agents* permit a machine to contact a BOOTP server on a non-local network
 - If a server decides to relay a **Request...**
 - it puts its own IP interface address in the **Relay IP Address** field
 - and forwards to the BOOTP server
 - clients ignore the **Relay IP Address** field in a **Reply**

- ### BOOTP Relays (cont'd)
- Destination server sends **Reply** message to the relay agent (server)
 - all **Replies** received by a relay agent are intended for clients on **its directly-connected network**
 - A Relay Agent examines the **Relay IP address**, **Your IP Address**, and **Client Hardware Address** to deliver the **Reply** message to the client



Dynamic Configuration

- RARP and BOOTP are designed for a relatively static environment
- Problems
 - need to assign one machine different IP addresses at different times
 - need to **reuse** pool of IP addresses (clients only use addresses temporarily)
- Solution: **dynamic** address assignment mechanism

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Dynamic Host Configuration Protocol (RFCs 2131, 2132)

- Extends BOOTP to handle dynamic address assignment
 - “leases” an address for a limited time (from 1 sec to forever)
 - backwards-compatible with BOOTP clients, message format is the same

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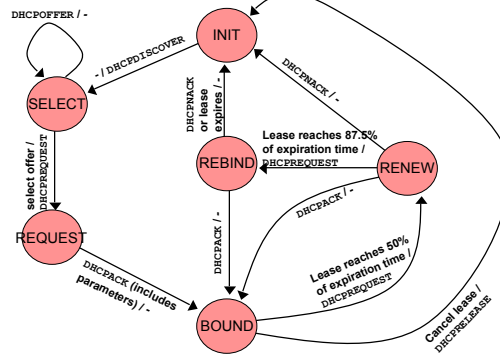
DHCP (cont'd)

- DHCP server
 - is given a set of addresses to manage
 - **leases** addresses to clients
 - informs client of lease period (during which it will not lease same address to another client)
- At end of the lease period, the client must either renew the lease, or stop using the address

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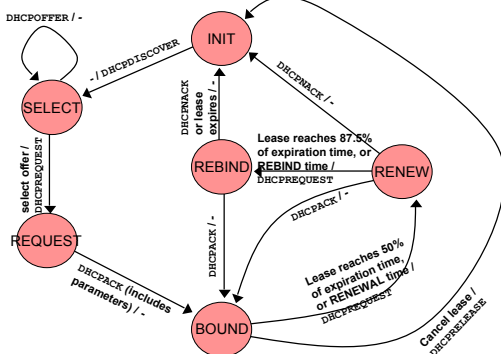
DHCP Client State Diagram



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DHCP Client State Diagram



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DHCP Messages

- Same format as BOOTP messages
- Client should set **Broadcast Flag** to 1 if it does not have a valid IP address already
- **DHCPOFFER** message includes configuration parameters, such as **Your IP Address**
- Same **Options** as BOOTP, plus some additional ones

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DHCPINFORM Message

- If client already has IP address but requests other configuration parameters from the server
- Server unicasts to client a **DHCPACK** with parameters, but
 - Does not allocate new IP address
 - Does not provide lease times

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Some Example Options Fields

- IP information
 - subnet mask
 - host name and domain name (for client)
 - IP forwarding option
 - default IP TTL
 - interface MTU, maximum datagram reassembly size
 - broadcast address to use
 - static routes option

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Example Options Fields (cont'd)

- Bootstrapping information
 - local time
 - boot file size
 - image server, root path
 - relay agents to use
- Other
 - ARP cache timeout intervals
 - application parameters
- Lots of “vendor-specific” parameters

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Example DHCP Request (Selected Fields)

Ethernet II, Src: 152.14.62.39 (00:11:43:41:28:ed), Dst: Broadcast (ff:ff:ff:ff:ff:ff)

Internet Protocol, Src: 0.0.0.0 (0.0.0.0), Dst: 255.255.255.255 (255.255.255.255)

User Datagram Protocol, Src Port: bootpc (68), Dst Port: bootps (67)

Bootstrap Protocol

Message type: Boot Request (1)

Hardware type: Ethernet

Hardware address length: 6

Transaction ID: 0xc9ea1fd2

Bootp flags: 0x0000 (Unicast)

0... .. = Broadcast flag: 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: 152.14.62.39 (00:11:43:41:28:ed)

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Example DHCP Request (Selected Fields)

Option 50: Requested IP Address = 152.14.62.39

Option 12: Host Name = "mulberry"

Option 55: Parameter Request List

1 = Subnet Mask

15 = Domain Name

3 = Router

6 = Domain Name Server

44 = NetBIOS over TCP/IP Name Server

31 = Perform Router Discover

33 = Static Route

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Example DHCP ACK (Selected Fields)

Ethernet II, Src: 152.14.62.3 (00:08:7c:25:bf:fd), Dst: 152.14.62.39 (00:11:43:41:28:ed)

Internet Protocol, Src: 152.14.19.3 (152.14.19.3), Dst: 152.14.62.39 (152.14.62.39)

User Datagram Protocol, Src Port: bootps (67), Dst Port: bootpc (68)

Bootstrap Protocol

Message type: Boot Reply (2)

Transaction ID: 0xc9ea1fd2

Bootp flags: 0x0000 (Unicast)

Client IP address: 0.0.0.0 (0.0.0.0)

Your (client) IP address: 152.14.62.39 (152.14.62.39)

Next server IP address: 0.0.0.0 (0.0.0.0)

Relay agent IP address: 152.14.19.3 (152.14.19.3)

Client MAC address: 152.14.62.39 (00:11:43:41:28:ed)

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Example DHCP ACK (Selected Fields)

Option 54: Server Identifier = 152.1.1.107
Option 1: Subnet Mask = 255.255.255.192
Option 3: Router = 152.14.62.1
Option 6: Domain Name Server
 IP Address: 152.1.1.161
 IP Address: 152.1.1.248
Option 12: Host Name = "mulberry"
Option 15: Domain Name = "csc.ncsu.edu"
Option 44: NetBIOS over TCP/IP Name Server = 152.1.2.42
Option 58: Renewal Time Value = 3 days
Option 59: Rebinding Time Value = 7 days
Option 51: IP Address Lease Time = infinity

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Summary

-  BOOTP works well, but doesn't allow limited lifetimes
-  DHCP pretty much universally used to configure hosts
-  Can be combined with user authentication to restrict who can get network access

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Next Lecture

- Domain Name System (DNS), Part I

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