PART XXII

BOOTSTRAP AND AUTOCONFIGURATION (DHCP)
System Startup

- To keep protocol software general
  - IP stack designed with many parameters
  - Values filled in when system starts
- Two possible sources of information
  - Local storage device (e.g., disk)
  - Server on the network
Bootstrapping

- BOOTstrap Protocol (BOOTP)
  - Early alternative to RARP
  - Provided more than just an IP address
  - Obtained configuration parameters from a server
  - Used UDP

- Dynamic Host Configuration Protocol (DHCP)
  - Replaces and extends BOOTP
  - Provides dynamic address assignment
Apparent Contradiction

- DHCP used to obtain parameters for an IP stack
- DHCP uses IP and UDP to obtain the parameters
- Stack must be initialized before being initialized
Solving The Apparent Contradiction

- DHCP runs as application
- Only needs basic facilities
- In particular:

An application program can use the limited broadcast IP address to force IP to broadcast a datagram on the local network before IP has discovered the IP address of the local network or the machine’s IP address.

- Note: server cannot use ARP when replying to client because client does not know its own IP address
DHCP Retransmission

- Client handles retransmission
- Initial timeout selected at random
- Timeout for successive retransmissions doubled
Two-Step Bootstrap

- DHCP provides information, not data
- Client receives
  - Name of file that contains boot image
  - Address of server
- Client must use another means to obtain the image to run (typically TFTP)
Dynamic Address Assignment

- Needed by ISPs
  - Client obtains an IP address and uses temporarily
  - When client finishes, address is available for another client
- Also used on many corporate networks
DHCP Address Assignment

- Backward compatible with BOOTP
- Can assign addresses in three ways
  - Manual (manager specifies binding as in BOOTP)
  - Automatic (address assigned by server, and machine retains same address)
  - Dynamic (address assigned by server, but machine may obtain new address for successive request)
- Manager chooses type of assignment for each address
Because it allows a host to obtain all the parameters needed for communication without manual intervention, DHCP permits autoconfiguration. Autoconfiguration is, of course, subject to administrative constraints.
Dynamic Address Assignment

- Client is granted a *lease* on an address
- Server specifies length of lease
- At end of lease, client must renew lease or stop using address
- Actions controlled by finite state machine
To use DHCP, a host becomes a client by broadcasting a message to all servers on the local network. The host then collects offers from servers, selects one of the offers, and verifies acceptance with the server.
## DHCP Message Format

<table>
<thead>
<tr>
<th>0</th>
<th>8</th>
<th>16</th>
<th>24</th>
<th>31</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OP</strong></td>
<td><strong>HTYPE</strong></td>
<td><strong>HLLEN</strong></td>
<td><strong>HOPS</strong></td>
<td></td>
</tr>
<tr>
<td><strong>TRANSACTION ID</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SECONDS</strong></td>
<td><strong>FLAGS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CLIENT IP ADDRESS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>YOUR IP ADDRESS</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>SERVER IP ADDRESS</strong></td>
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<td></td>
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<tr>
<td><strong>ROUTER IP ADDRESS</strong></td>
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<tr>
<td><strong>CLIENT HARDWARE ADDRESS (16 OCTETS)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>SERVER HOST NAME (64 OCTETS)</strong></td>
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<tr>
<td><strong>BOOT FILE NAME (128 OCTETS)</strong></td>
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</tr>
<tr>
<td><strong>OPTIONS (VARIABLE)</strong></td>
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</tr>
</tbody>
</table>
# Message Type Field

<table>
<thead>
<tr>
<th>TYPE FIELD</th>
<th>Corresponding DHCP Message Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>DHCPDISCOVER</td>
</tr>
<tr>
<td>2</td>
<td>DHCPOFFER</td>
</tr>
<tr>
<td>3</td>
<td>DHCPREQUEST</td>
</tr>
<tr>
<td>4</td>
<td>DHCPDECLINE</td>
</tr>
<tr>
<td>5</td>
<td>DHCPACK</td>
</tr>
<tr>
<td>6</td>
<td>DHCPNACK</td>
</tr>
<tr>
<td>7</td>
<td>DHCPRELEASE</td>
</tr>
<tr>
<td>8</td>
<td>DHCPINFORM</td>
</tr>
</tbody>
</table>
Summary

- Two protocols available for bootstrapping
  - BOOTP (static binding of IP address to computer)
  - DHCP (extension of BOOTP that adds dynamic binding of IP addresses)
- DHCP
  - Server grants lease for an address
  - Lease specifies length of time
  - Host must renew lease or stop using address when lease expires
  - Actions controlled by finite state machine