A Complete End-to-End View
Laptop

Wifi

AP

BERKELEY

DHCP Server/
Gateway Router

DNS Server (9.9.9.9)

AT&T

GOOGLE

www.google.com
Step 1: Setting up the Network

To get an IP address, broadcast DHCP message that is picked by the DHCP server

DHCP Discovery
Step 1: Setting up the Network

It is a UDP packet sent on source port 68 and destination port 67
Step 1: Setting up the Network

IP contains:

• Source Address: 0.0.0.0
  – We do not yet have an IP address
• Destination Address: 255.255.255.255
  – We broadcast the request
Step 1: Setting up the Network

Add a Link Layer Frame (even Wifi has same format as Ethernet Frame)

- Destination MAC address is FF:FF:FF:FF:FF:FF:FF
  - To broadcast

<table>
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<tr>
<th>LL</th>
<th>IP</th>
<th>UDP</th>
<th>DHCP Discovery</th>
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Step 1: Setting up the Network

- Machine running DHCP server picks up the request
- Link Layer driver in the server shreds the LL header
- IP Layer of the kernel shreds the IP header
- UDP layer shreds the UDP header, after demultiplexing the packet to the server application running on port 67.
Step 1: Setting up the Network

• Prepares an offer containing:
  – IP address of the requesting entity
  – DNS server’s IP address
  – Default Gateway’s IP address
  – Subnet Mask

• Encapsulated by UDP, IP and LL frames
Step 1: Setting up the Network

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Step 1: Setting up the Network

• Next Steps:
  – Client accepts an offer by broadcasting a “Request message"
  – The server sends back an ACK
If Ethernet Instead of Wifi?

- The basic protocol remains same upto network
- Wifi and Ethernet use the same LL header
- Preamble and CRC added by Physical layer varies
- Technology used to transmit the packets varies
  - e.g. CSMA/CD for Ethernet CSMA/CA for Wifi, stronger reliability for Wifi etc
Step 2: Getting Destination IP Address

Send a DNS request to the local DNS server to obtain IP address www.google.com
Step 2: Getting Destination IP Address

It is a UDP packet sent on destination port 53
Step 2: Getting Destination IP Address

IP contains:

- Source Address: Obtained by DHCP
- Destination Address: Local DNS server’s IP address (9.9.9.9), also contained DHCP response
Step 2: Getting Destination IP Address

Add a LL frame
Destination MAC address??
  • It knows that 9.9.9.9 is outside the subnet, since it knows the netmask from DHCP response
  • Needs to route to the Default Gateway Router
  • But its MAC address unknown
ARP

• Broadcast an ARP request message
• ARP response from the Gateway Router contains the MAC address
Step 2: Getting Destination IP Address

- DNS request then processed by local server
  - Does the recursive querying to root, TLD and authoritative DNS server
- DNS response with www.google.com’s IP address
- Can save on complete iterative querying by local server if response if cached
Step 3: Requesting the Page

- Use HTTP to communicate with the destination’s application
- TCP is the transport protocol used
- Encapsulated by IP and LL frames
How is a Packet Transmitted?
Same network layer functionalities irrespective of transport or application layer protocols
Inter-Domain

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Inter-Domain
Intra-Domain

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DV/LS
Link Layer Technology Varies

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- Wifi
- AP
- DHCP Server/Gateway Router
- Ethernet
- ATM
- DNS Server (9.9.9.9)
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- GOOGLE
- www.google.com
Transmitting Packet: All Layers View