A Complete End-to-End View
Step 1: Setting up the Network

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

![IP UDP DHCP Discovery Diagram]
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

```
LL   | IP   | UDP  | DHCP Discovery
```
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

| UDP | DNS Request |
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

BERKELEY

Laptop

Wifi

AP

DHCP Server/
Gateway Router

BGP

DNS Server (9.9.9.9)

AT&T

BGP

www.google.com

GOOGLE

BGP

Inter-Domain
Intra-Domain

Laptop

Wifi

AP

DHCP Server/
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DNS Server (9.9.9.9)

www.google.com

AT&T

BERKELEY

GOOGLE

DV/LS
Link Layer Technology Varies
Transmitting Packet: All Layers View

Source
A

Router
B

Router
C

Dest
D

Application
a

Transport
a a

Network
a a a a

Link Layer/Phy
a a a a a

Application
a

Transport
a a

Network
a a a a

Link Layer/Phy
b a a a

Application
a

Transport
a a

Network
a a a a

Link Layer/Phy
c a a a a

Application
a

Transport
a a

Network
a a a a

Link Layer/Phy
c a a a a