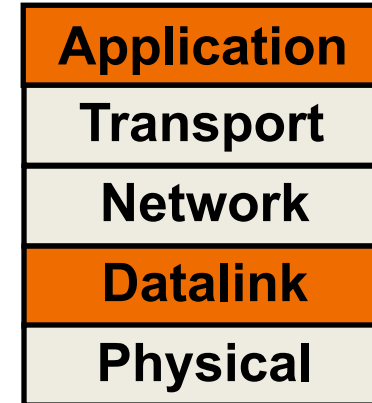

L2, End-to-End

CS 168 – Spring 2024– Section 11

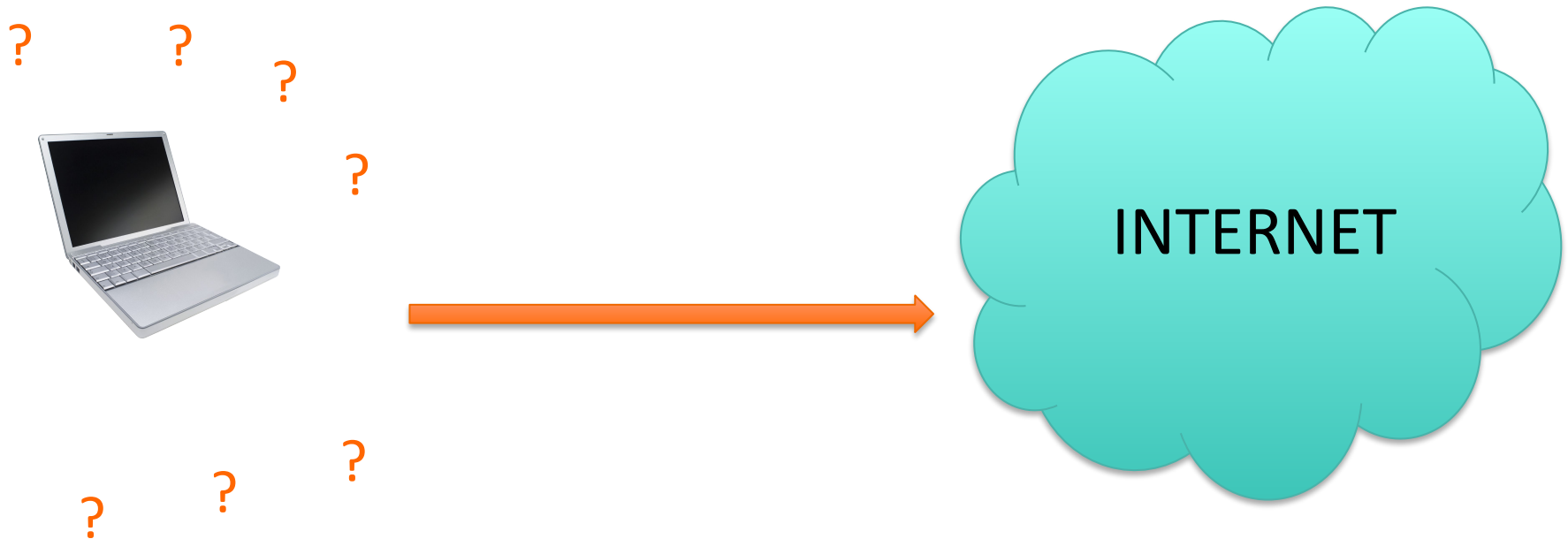
Agenda

- Addressing
 - DHCP (Application)
 - ARP (Datalink)



DHCP

- Enables a host to learn about its....
 - Own IP Address
 - Network Mask
 - First-hop router's IP Address
 - DNS Server(s) IP Address(es)



DHCP Discovery

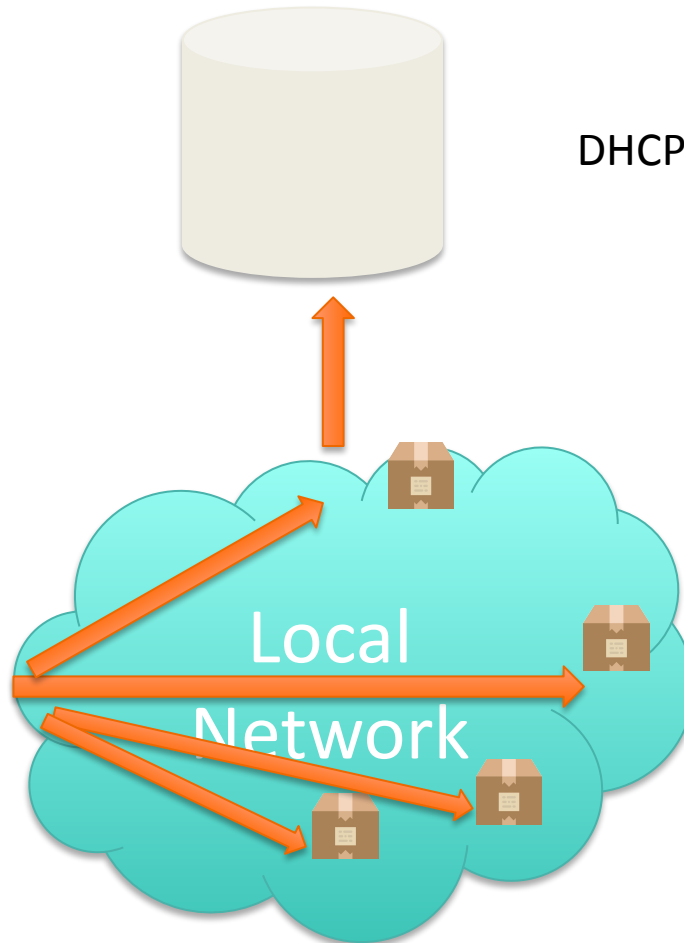
- DHCP server(s) located on same local network as host
- Host initially broadcasts **discover** message

IP Address: ???

Subnet Mask: ???

First-hop Router IP Address: ???

DNS IP Address: ???



DHCP Server

DHCP Offer

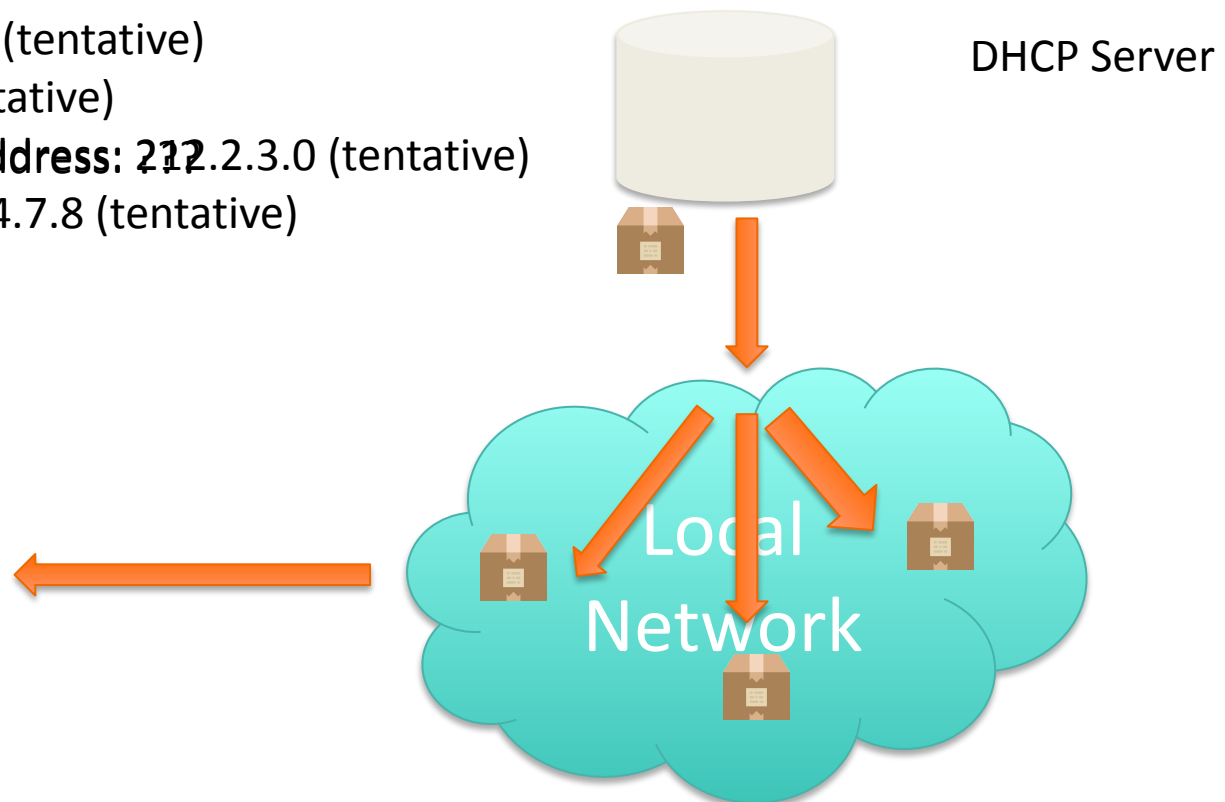
- DHCP server(s) responds by broadcasting **offer** message
- Message includes assigned IP address, network mask, first-hop router address, DNS server addresses

IP Address: ~~192~~2.0.0.0 (tentative)

Subnet Mask: ~~255~~255 (tentative)

First-hop Router IP Address: ~~192~~2.2.3.0 (tentative)

DNS IP Address: ~~212~~2.4.7.8 (tentative)



DHCP Request

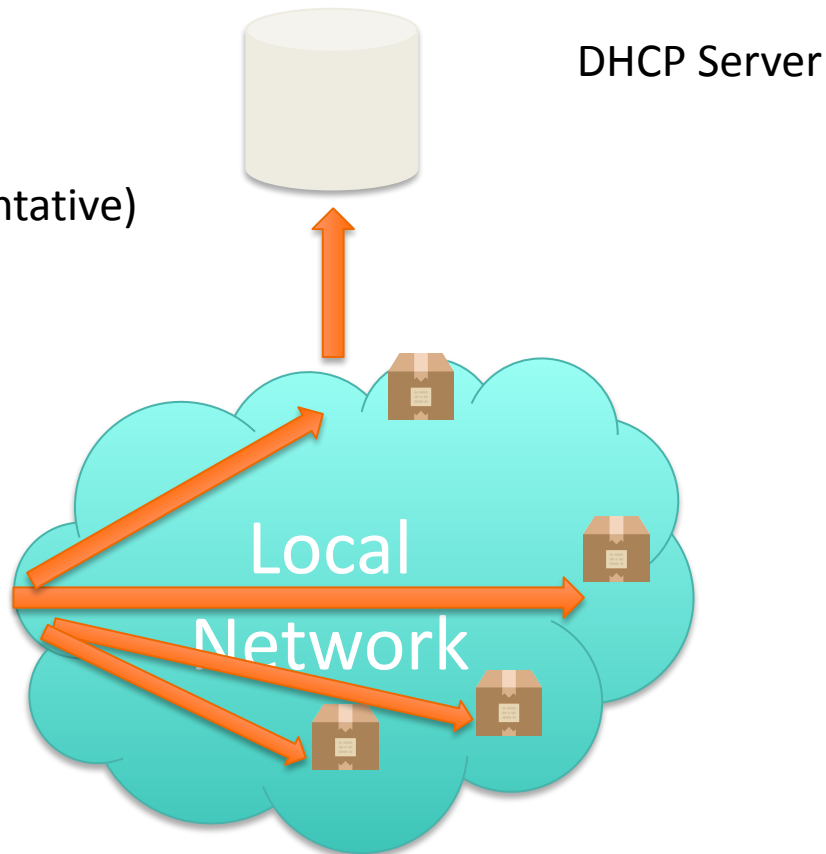
- Host responds by broadcasting **request** message
- This message identifies which offer was accepted (helps when there are multiple local DHCP servers)

IP Address: 212.0.0.0 (tentative)

Subnet Mask: /8 (tentative)

First-hop Router IP Address: 212.2.3.0 (tentative)

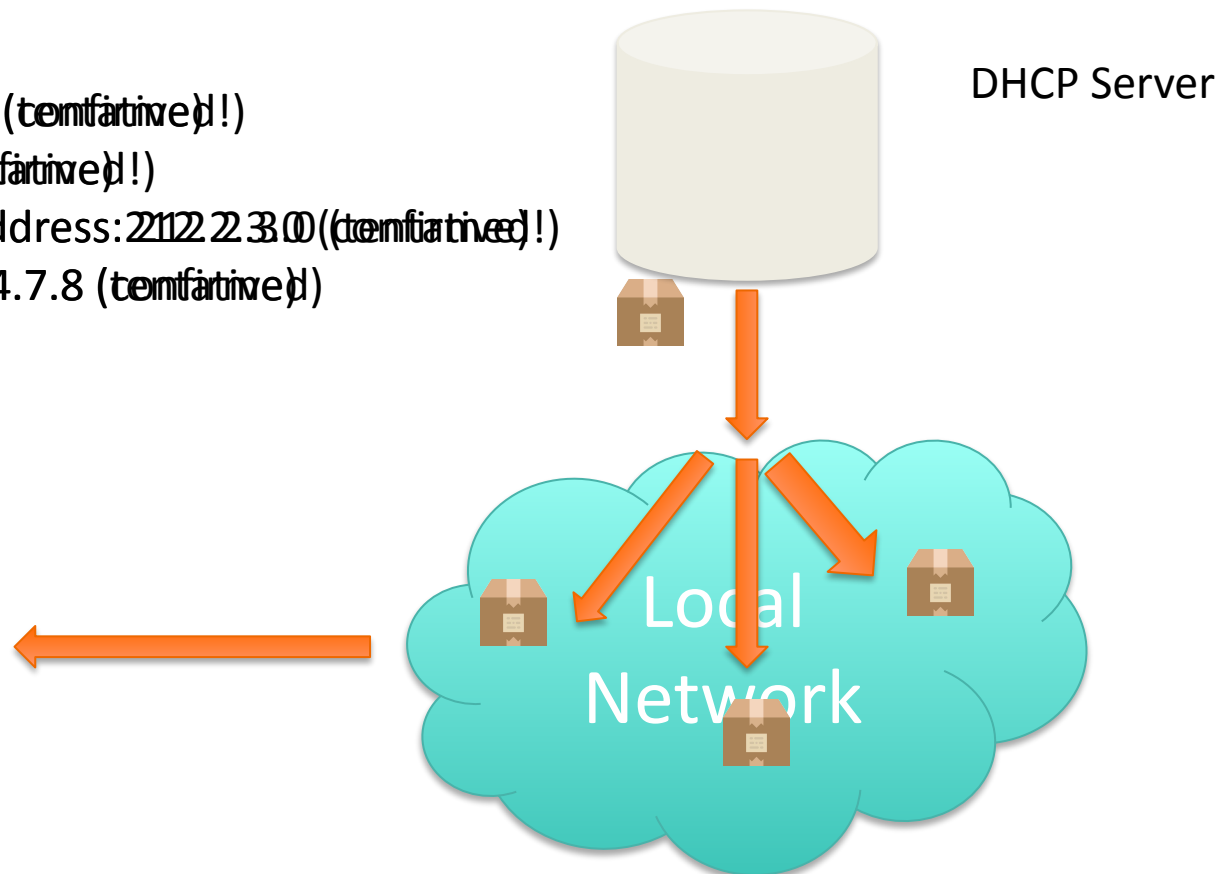
DNS IP Address: 212.4.7.8 (tentative)



DHCP Acknowledgement

- Chosen DHCP server responds by broadcasting **ACK**

IP Address: 212.0.0.0 (tentative!)
Subnet Mask: /8 (tentative!)
First-hop Router IP Address: 212.23.0 (tentative!)
DNS IP Address: 212.4.7.8 (tentative!)



A Couple Questions....

1. Dealing with failures?

- Hosts have a lease periods for their IP addresses
- Hosts must refresh before lease period ends

2. Why do we need the first-hop router's IP address and the subnet mask?

- Answered when we talk about ARP.

ARP (Overview)

- When host sends packet, specify dest Ethernet address so packet can traverse local networks
- Each host has ARP table, which maps IP to Ethernet
- If mapping unknown, ask (solicit) local network by broadcasting “Who has IP address **x**?”
 - Host with IP **x** responds “My Ethernet address is **y**”

ARP Table

IP Addr.	Ethernet Addr.
a.b.c.d	40:11:11:11:11:11
a.b.c.a	50:37:11:11:11:11



Dest Host
IP: a.b.c.d
Ethernet address:
40:11:11:11:11:11



ARP (Within local network)

Destination is in same local network

- Use ARP table to lookup Ethernet address of dest
- Specify Ethernet address when sending packet

ARP Table

IP Addr.	Ethernet Addr.
a.b.c.d	40:11:11:11:11:11
a.b.c.a	50:37:11:11:11:11



Dest Host

IP: a.b.c.d

Ethernet address:
40:11:11:11:11:11



Src Host



ARP (Across local networks)

Destination is NOT in same local network

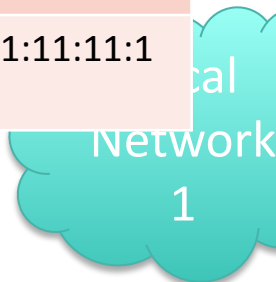
- How can we tell?
 - Use subnet mask to check dest network address

ARP Table

IP Addr.	Ethernet Addr.
d.c.b.a	50:11:11:11:11:11
d.c.b.c	60:37:11:11:11:11



Src Host



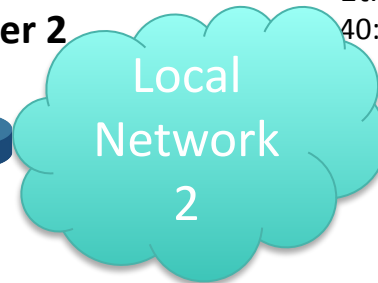
Src's First Hop

Router

IP: d.c.b.a
Ethernet address:
50:11:11:11:11:11



Router 2



Dest Host

IP: a.b.c.d
Ethernet address:
40:11:11:11:11:11



ARP (Across local networks)

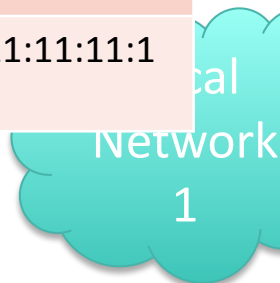
- Use ARP table to lookup Ethernet address of first-hop-router (which is in same local network)
 - We know router's IP address through DHCP!
- Specify **first-hop router's** Ethernet address in packet and send packet

ARP Table

IP Addr.	Ethernet Addr.
d.c.b.a	50:11:11:11:11:11
d.c.b.c	60:37:11:11:11:11



Src Host

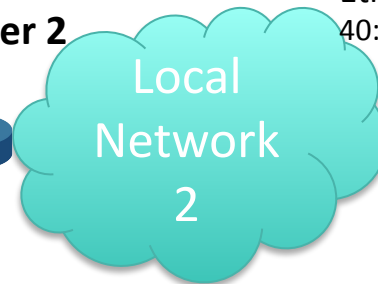


Src's First Hop
Router

IP: d.c.b.a
Ethernet address:
50:11:11:11:11:11



Router 2



Dest Host
IP: a.b.c.d
Ethernet address:
40:11:11:11:11:11



ARP (Across local networks)

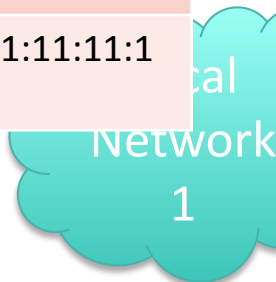
- First-hop router will route packet to router 2 using dest IP address
 - Dest IP address is a.b.c.d. in this example

ARP Table

IP Addr.	Ethernet Addr.
d.c.b.a	50:11:11:11:11:11
d.c.b.c	60:37:11:11:11:11



Src Host

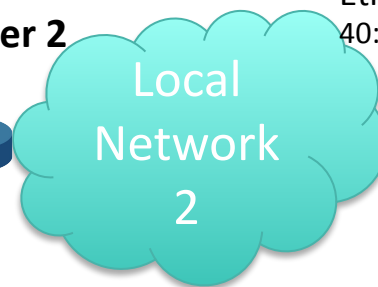


Src's First Hop
Router

IP: d.c.b.a
Ethernet address:
50:11:11:11:11:11



Router 2



Dest Host
IP: a.b.c.d
Ethernet address:
40:11:11:11:11:11



ARP (Across local networks)

- Router 2 will use its ARP table to **set** packet's dest Ethernet address to actual dest host's Ethernet address:

- Router 2 then sends packet to dest host

ARP Table

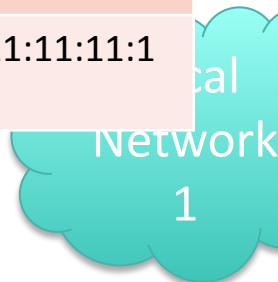
IP Addr.	Ethernet Addr.
a.b.c.d	40:11:11:11:11:11
a.b.c.c	70:33:33:33:11:11

ARP Table

IP Addr.	Ethernet Addr.
d.c.b.a	50:11:11:11:11:11
d.c.b.c	60:37:11:11:11:11



Src Host

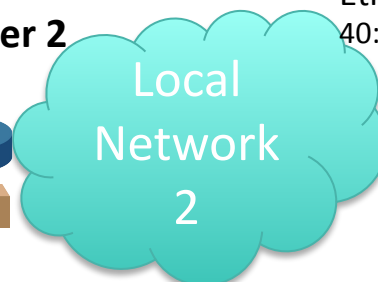


Src's First Hop Router

IP: d.c.b.a
Ethernet address:
50:11:11:11:11:11



Router 2

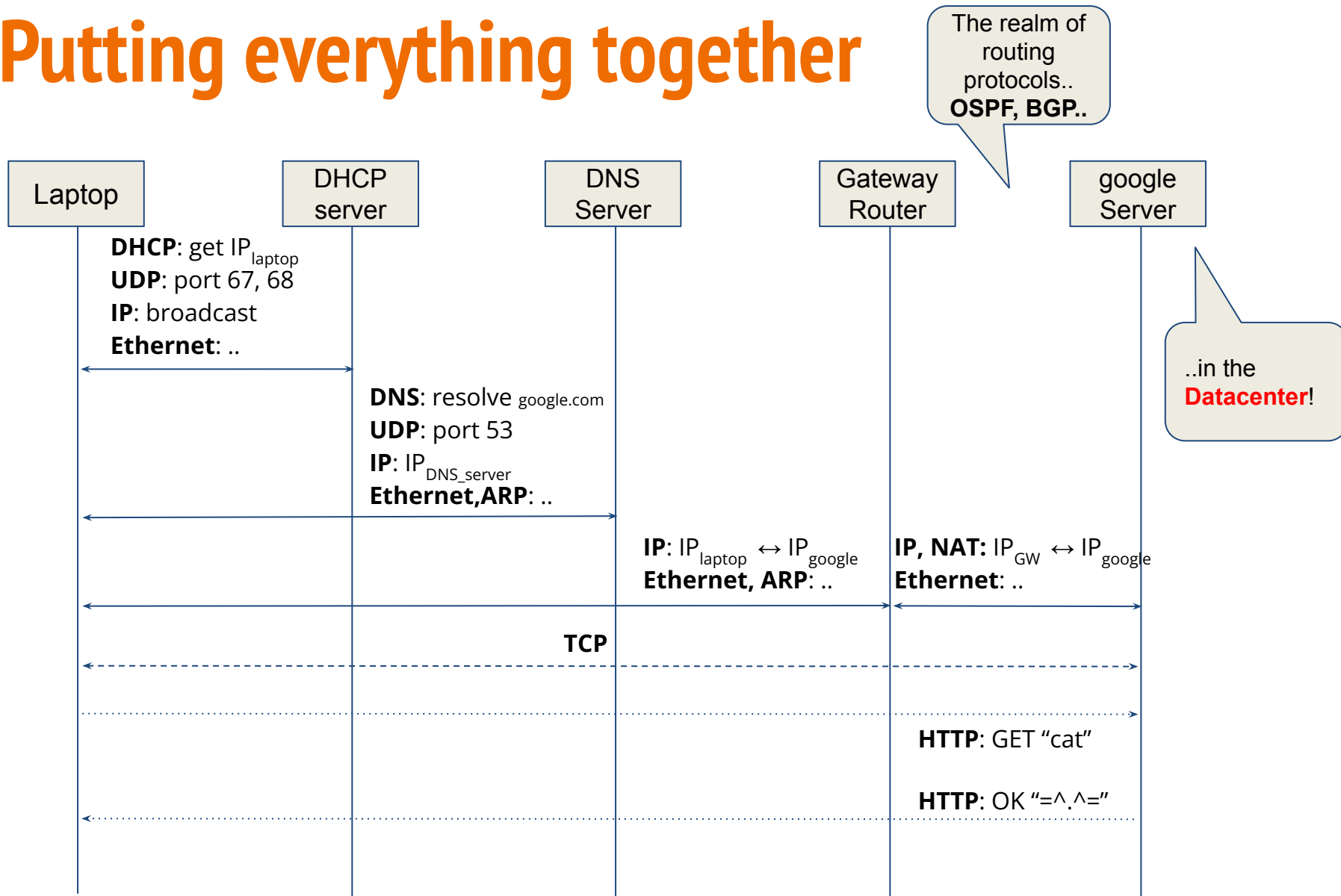


Dest Host

IP: a.b.c.d
Ethernet address:
40:11:11:11:11:11



Putting everything together



*Gateway router: the first- and last-hop router of the laptop, e.g., a router at home

Worksheet