

# Chapter 4

## Network Layer:

### The Data Plane

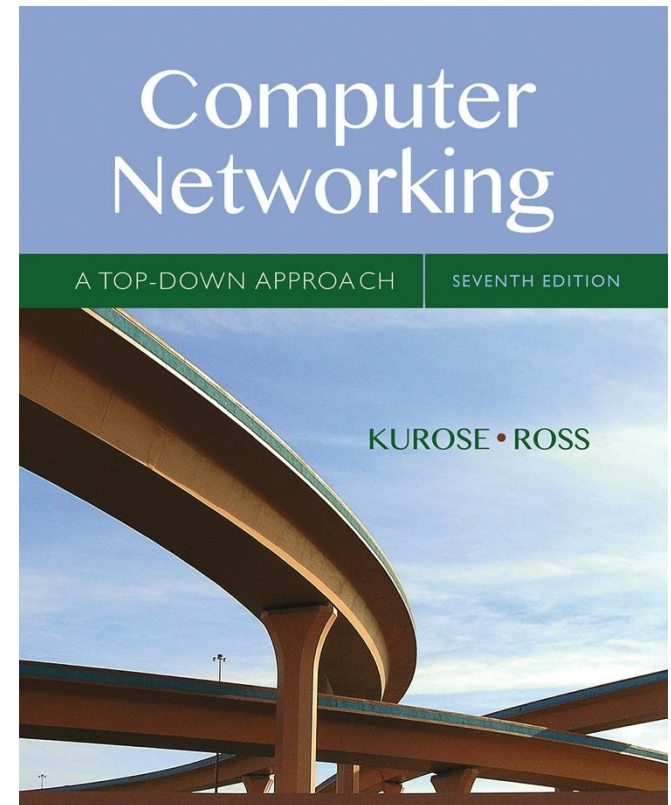
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## *Computer Networking: A Top Down Approach*

7<sup>th</sup> edition

Jim Kurose, Keith Ross

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# IP addresses: how to get one?

**Q:** How does a *host* get IP address?

- hard-coded by system admin in a file
  - Windows: control-panel->network->configuration->tcp/ip->properties
  - UNIX: /etc/rc.config
- **DHCP: Dynamic Host Configuration Protocol:** dynamically get address from DHCP server
  - “plug-and-play”

# DHCP: Dynamic Host Configuration Protocol

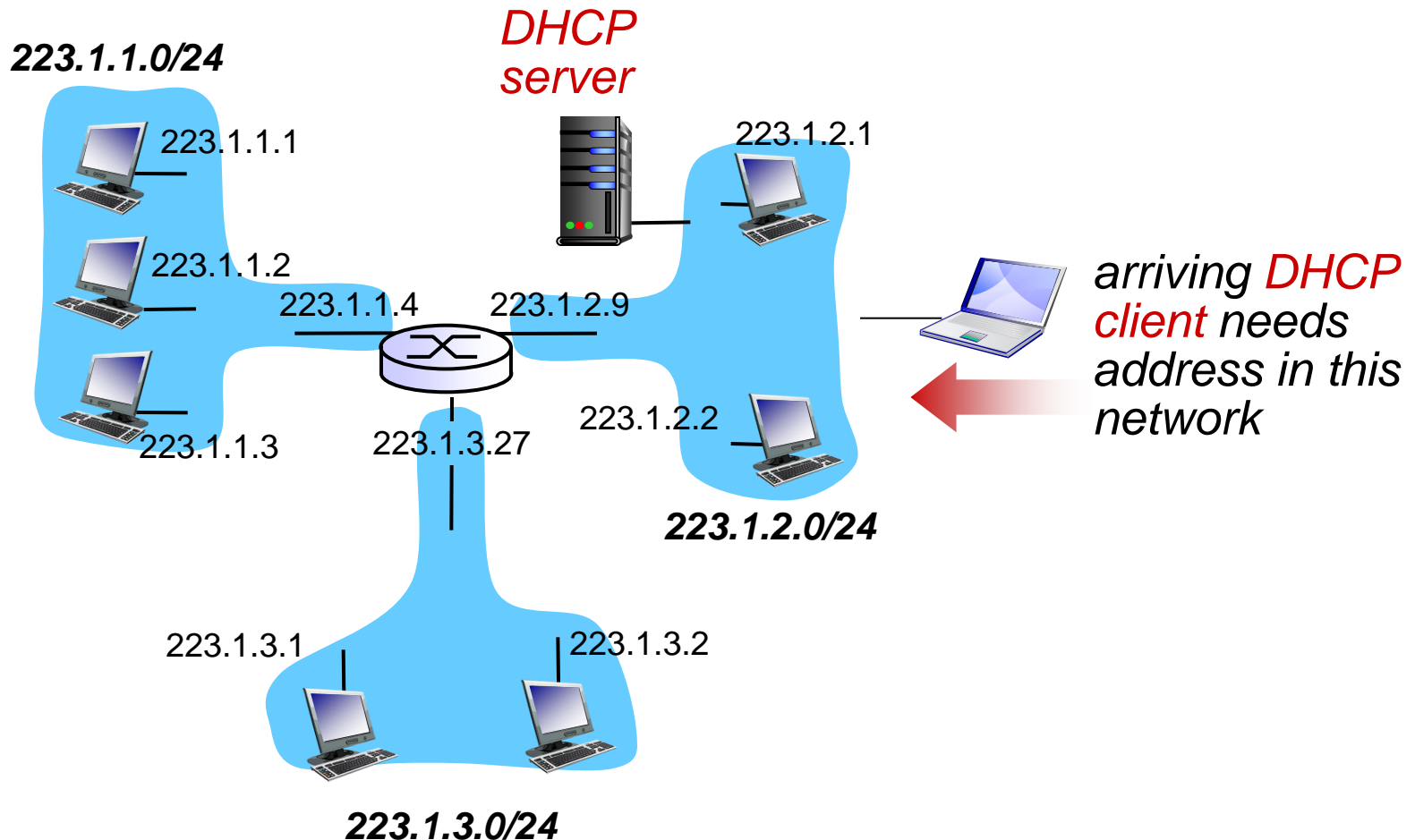
*goal:* allow host to *dynamically* obtain its IP address from network server when it joins network

- can renew its lease on address in use
- allows reuse of addresses (only hold address while connected/“on”)
- support for mobile users who want to join network (more shortly)

## *DHCP overview:*

- Arriving host broadcasts “DHCP discover” msg
- DHCP server responds with “DHCP offer” msg
- host requests IP address: “DHCP request” msg
- DHCP server sends address: “DHCP ack” msg

# DHCP client-server scenario



# DHCP client-server scenario

DHCP server: 223.1.2.5

**DHCP discover**

src : 0.0.0.0, 68  
dest.: 255.255.255.255, 67  
yiaddr: 0.0.0.0  
transaction ID: 654

arriving  
client



**DHCP offer**

src: 223.1.2.5, 67  
dest: 255.255.255.255, 68  
yiaddr: 223.1.2.4  
transaction ID: 654  
lifetime: 3600 secs

**DHCP request**

src: 0.0.0.0, 68  
dest.: 255.255.255.255, 67  
yiaddr: 223.1.2.4  
transaction ID: 655  
lifetime: 3600 secs

**DHCP ACK**

src: 223.1.2.5, 67  
dest: 255.255.255.255, 68  
yiaddr: 223.1.2.4  
transaction ID: 655  
lifetime: 3600 secs



# DHCP client-server scenario

DHCP server: 223.1.2.5



DHCP discover

Broadcast: is there a  
DHCP server out there?

arriving  
client



DHCP offer

Broadcast: I'm a DHCP  
server! Here's an IP  
address you can use

DHCP request

Broadcast: OK. I'll take  
that IP address!

DHCP ACK

Broadcast: OK. You've  
got that IP address!

# DHCP: more than IP addresses

DHCP can return more than just allocated IP address on subnet:

- address of first-hop router for client
- name and IP address of DNS sever
- network mask (indicating network versus host portion of address)

# Chapter 4: outline

## 4.1 Overview of Network layer

- data plane
- control plane

## 4.2 What's inside a router

## 4.3 IP: Internet Protocol

- datagram format
- fragmentation
- IPv4 addressing
- network address translation
- IPv6



# IPv6: motivation

- *initial motivation*: 32-bit address space soon to be completely allocated.
- additional motivation:
  - header format helps speed processing/forwarding
  - header changes to facilitate QoS

## *IPv6 datagram format:*

- fixed-length 40 byte header
- no fragmentation allowed

# IPv6 datagram format

*priority*: identify priority among datagrams in flow

*flow Label*: identify datagrams in same “flow.”

(concept of “flow” not well defined).

*next header*: identify upper layer protocol for data

ver	pri	flow label	
payload len		next hdr	hop limit
source address (128 bits)			
destination address (128 bits)			
data			

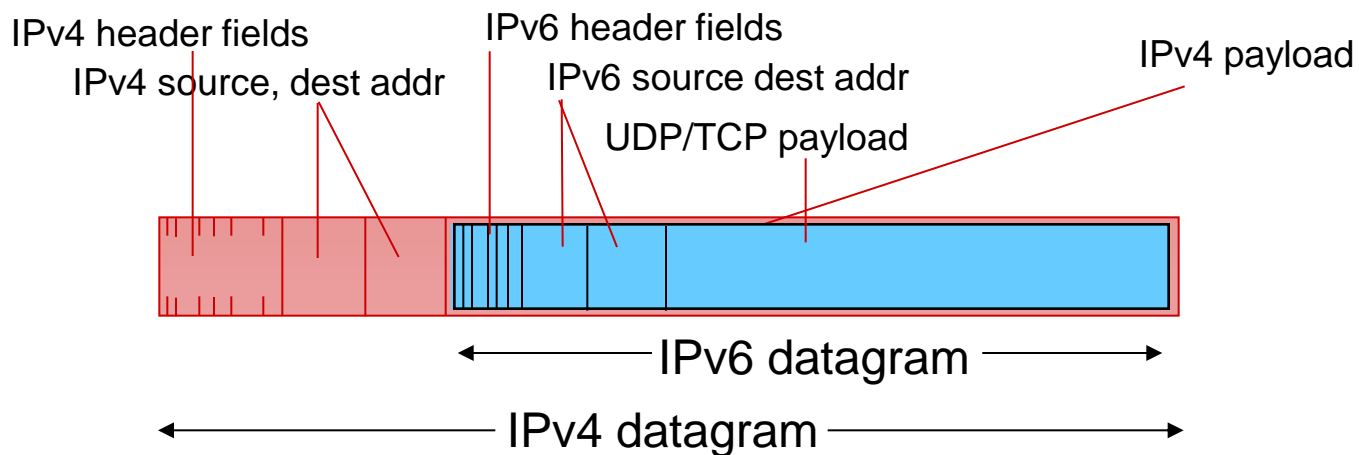
# Other changes from IPv4

- *checksum*: removed entirely to reduce processing time at each hop
- *ICMPv6*: new version of ICMP
  - additional message types, e.g. “Packet Too Big”
  - multicast group management functions
- IPv6 is *128 bits*. It has eight octet pairs, each with 16 bits and written in hexadecimal as follows:

2b63:1478:1ac5:37ef:4e8c:75df:14cd:93f2

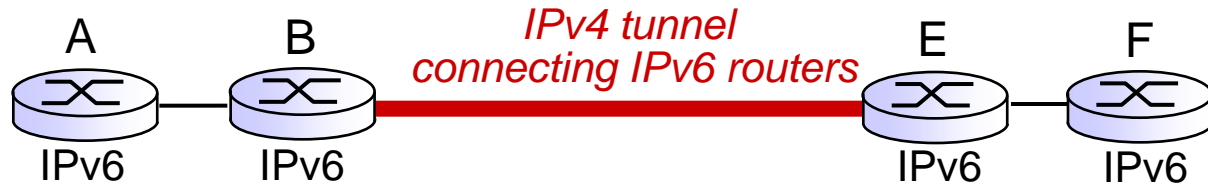
# Transition from IPv4 to IPv6

- not all routers can be upgraded simultaneously
  - no “flag days”
  - how will network operate with mixed IPv4 and IPv6 routers?
- **tunneling**: IPv6 datagram carried as *payload* in IPv4 datagram among IPv4 routers

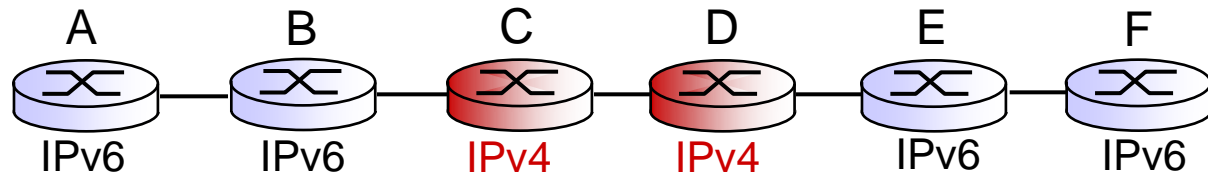


# Tunneling

logical view:

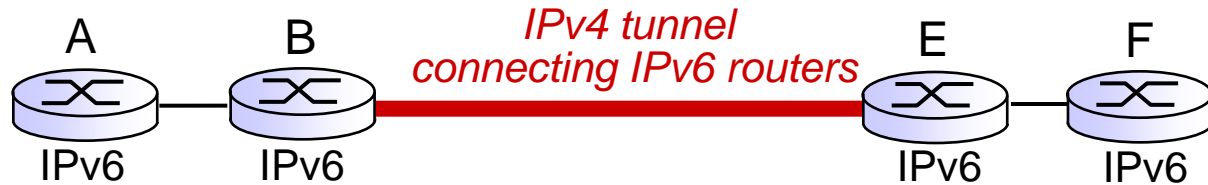


physical view:

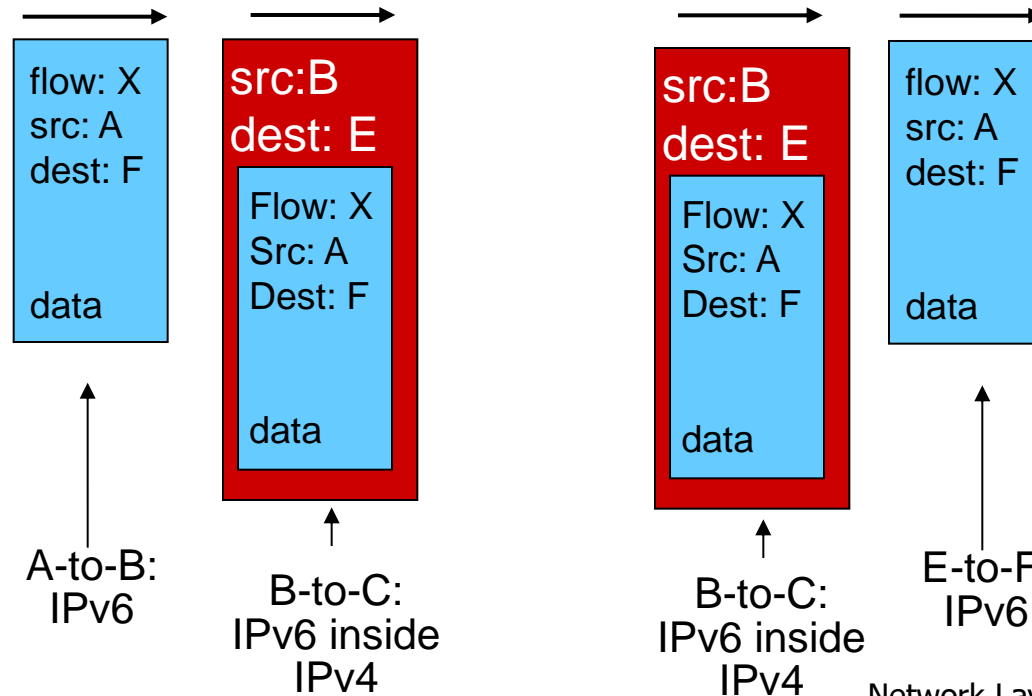
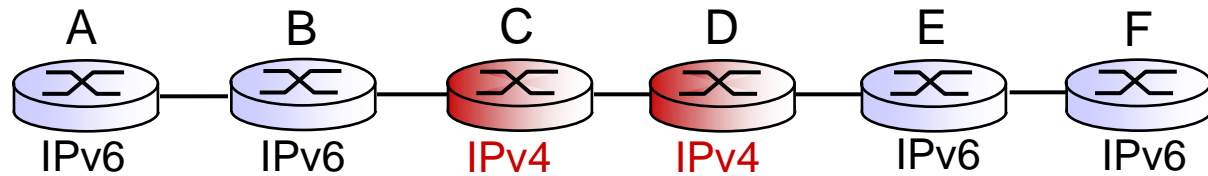


# Tunneling

logical view:



physical view:



# IPv6: adoption

- Google: 8% of clients access services via IPv6
- NIST: 1/3 of all US government domains are IPv6 capable
- *Long (long!) time for deployment, use*
  - 20 years and counting!
  - think of application-level changes in last 20 years: WWW, Facebook, streaming media, Skype, ...

# Chapter 4: done!

4.1 Overview of Network layer: data plane and control plane

4.2 What's inside a router

4.3 IP: Internet Protocol

- datagram format
- fragmentation
- IPv4 addressing
- NAT
- IPv6

*Question:* how do forwarding tables (destination-based forwarding) or flow tables (generalized forwarding) computed?

*Answer:* by the control plane (next chapter)