

CSCI 491-01

Topics: Internet Programming

Fall 2008

Network Layer

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Chapter 4: Roadmap

4.1 Introduction

4.2 Virtual circuit and datagram networks

4.3 What's inside a router

4.4 IP: Internet Protocol

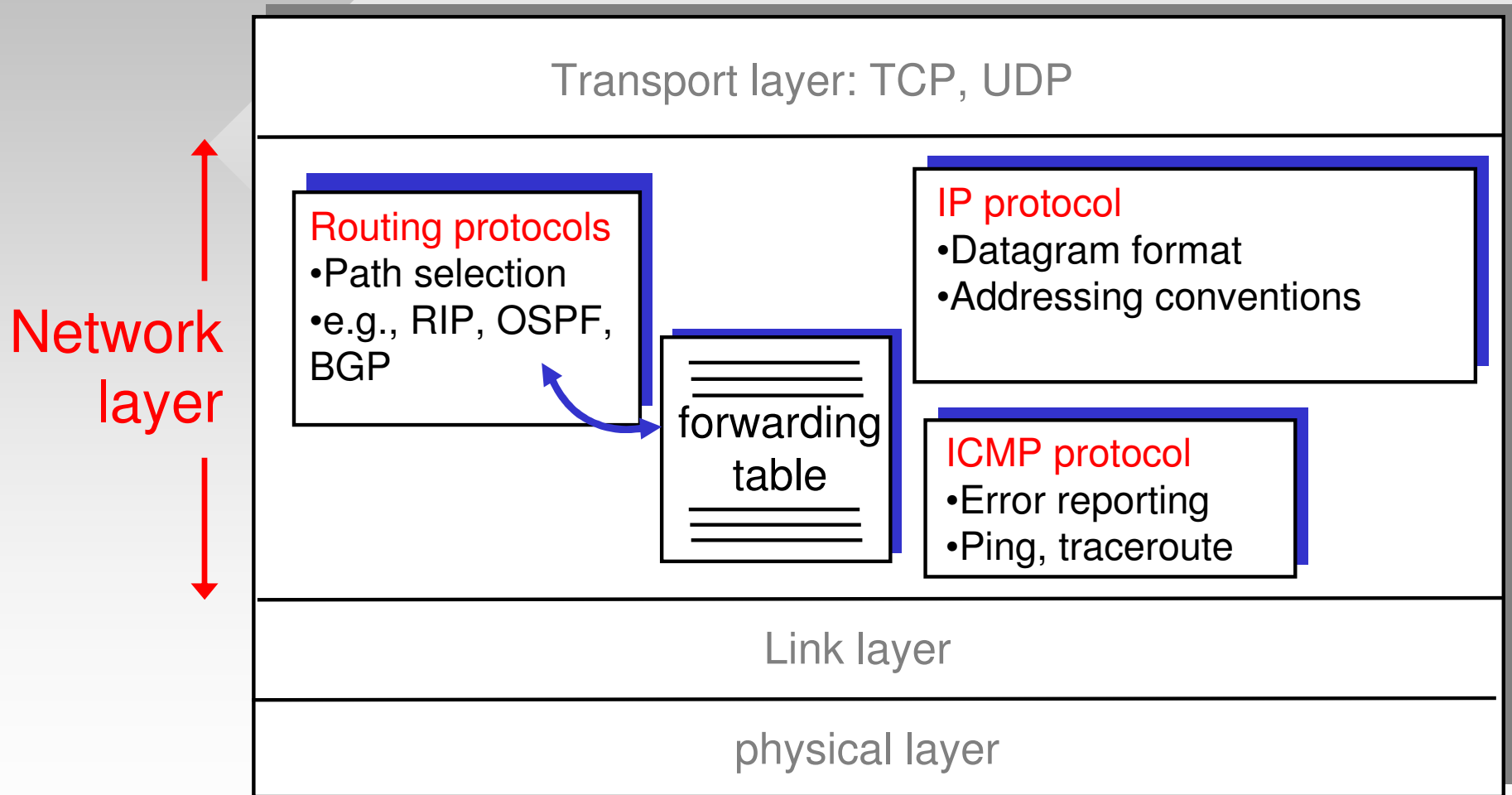
4.5 Routing algorithms

4.6 Routing in the Internet

4.7 Broadcast and multicast routing

The Internet Network Layer

Host and router network layer functions:



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- Datagram format
- IPv4 addressing
- ICMP
- IPv6

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IP datagram Format

IP protocol version number

Header length (in 4-byte words)

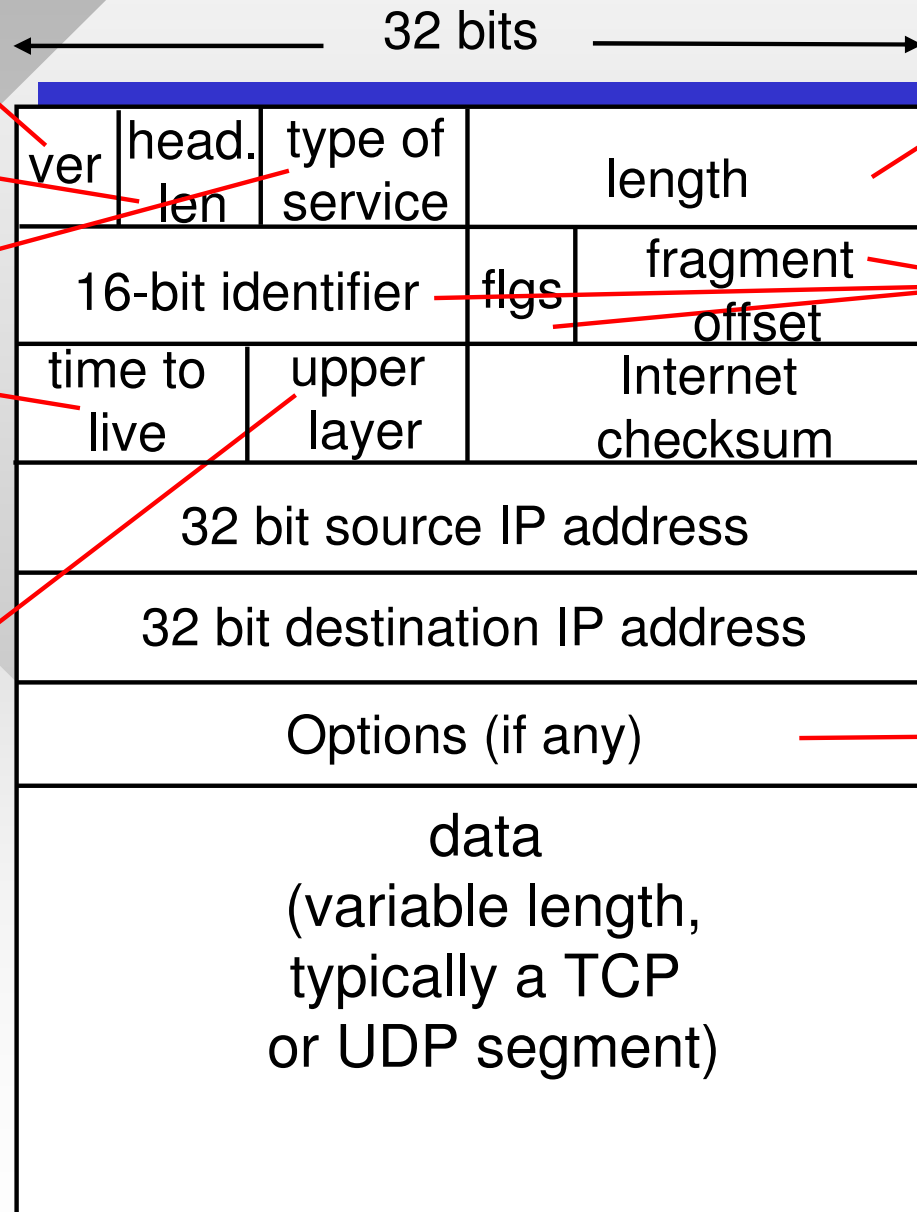
“Type” of data

Max number remaining hops (decremented at each router)

Upper layer protocol to deliver payload to

How much overhead with TCP?

- 20 bytes of TCP
- 20 bytes of IP
- = 40 bytes



Total datagram length (bytes)

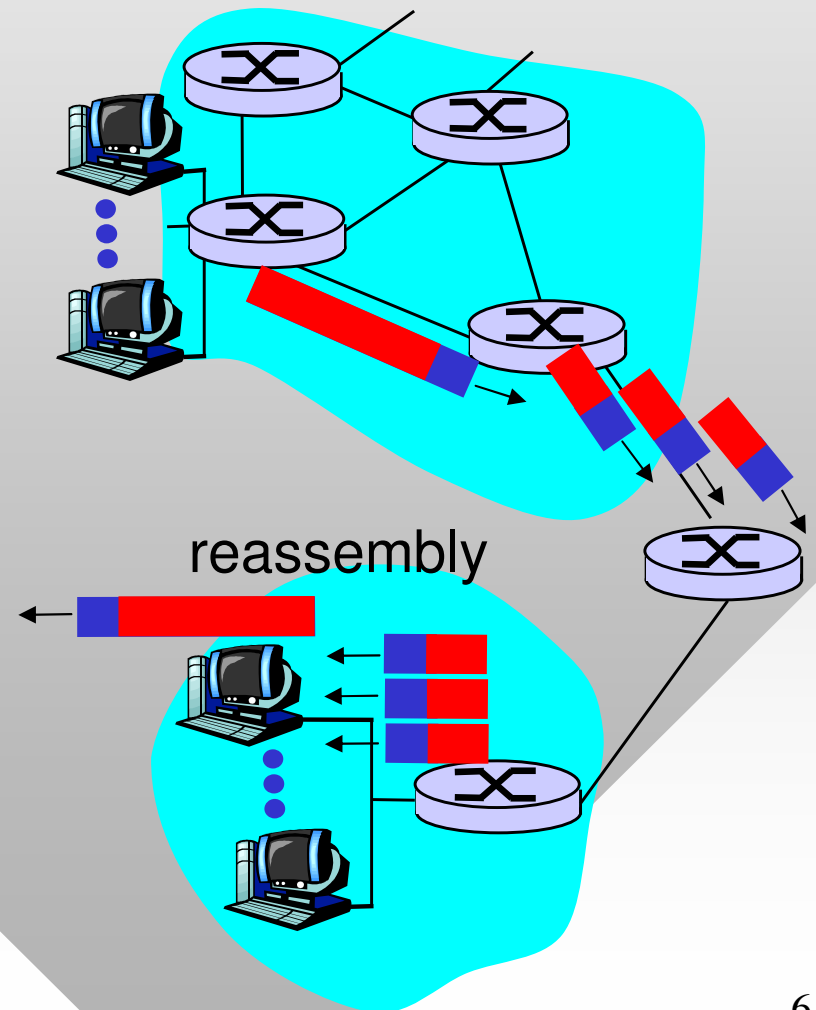
For fragmentation/reassembly

E.g. timestamp, record route taken, specify list of routers to visit

IP Fragmentation & Reassembly

- Network links have MTU (maximum transmission unit)
 - largest possible link-level frame
 - Different link types, different MTUs (most common 1500)
- Large IP datagram divided (“fragmented”) within network
 - One datagram becomes several datagrams
 - “Reassembled” only at final destination
 - IP header bits used to identify, order related fragments

fragmentation:
in: one large datagram
out: 3 smaller datagrams



IP Fragmentation and Reassembly

Example

- 4000 byte datagram (including IP header)
- MTU = 1500 bytes

	length	ID	fragflag	offset	
	=4000	=x	=0	=0	

One large datagram becomes several smaller datagrams

1480 bytes in data field

offset is in 8-byte words: $185 = 1480/8$

	length	ID	fragflag	offset	
	=1500	=x	=1	=0	

	length	ID	fragflag	offset	
	=1500	=x	=1	=185	

	length	ID	fragflag	offset	
	=1040	=x	=0	=370	

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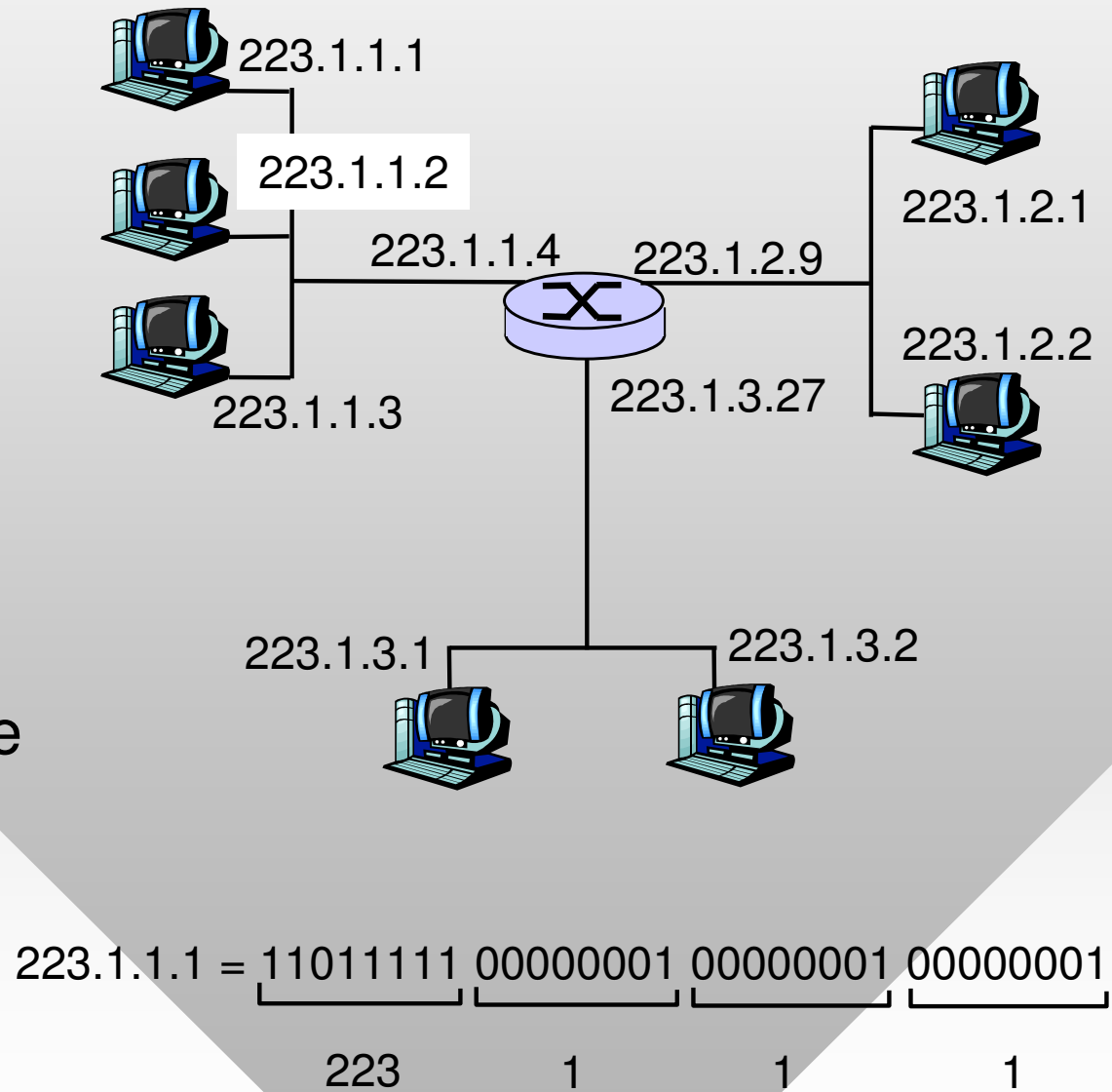
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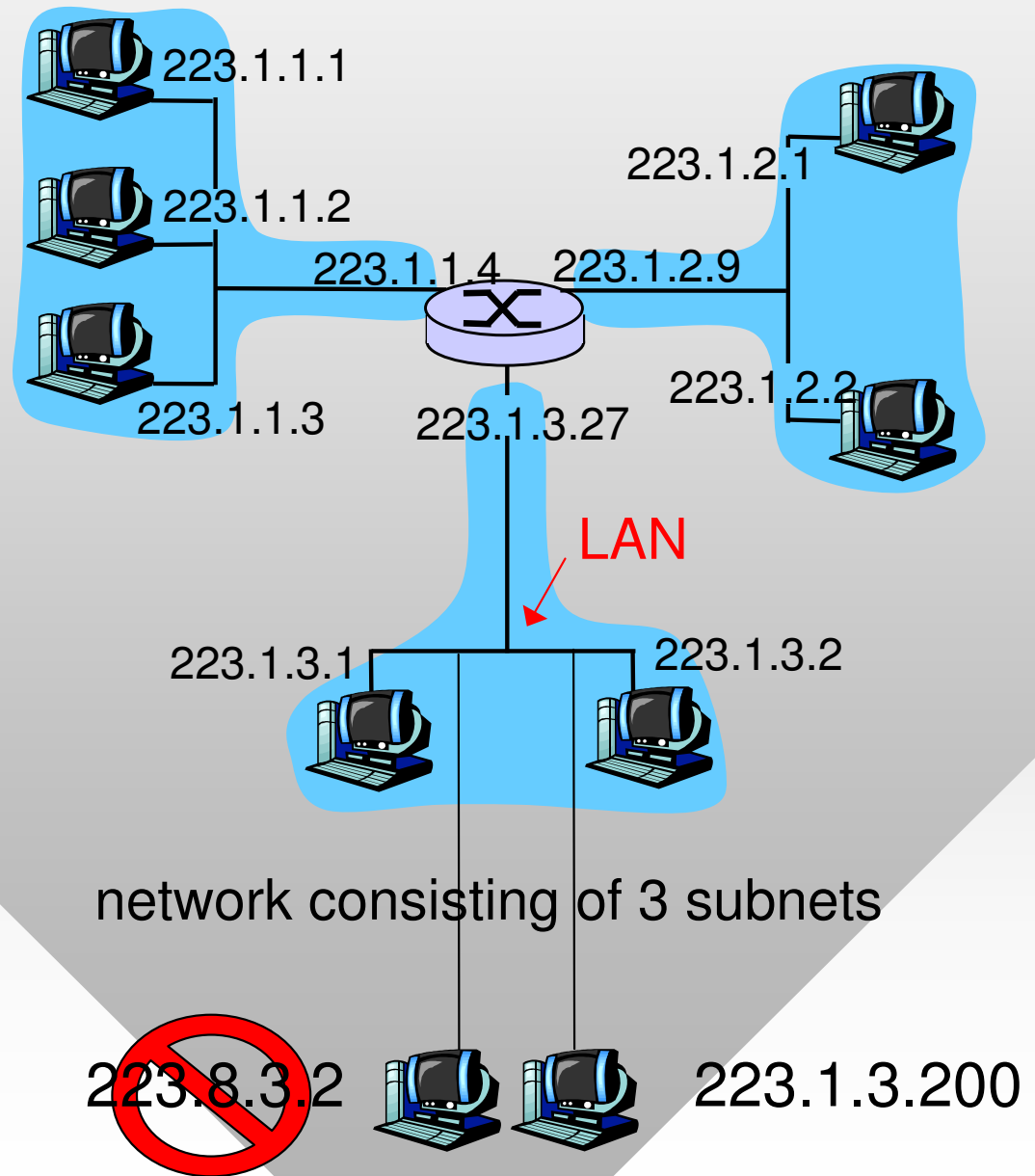
IP Addressing: Introduction

- **IP address:** 32-bit identifier for host or router *interface*
- *Interface:* connection between host/router and physical link
 - Also called a **port**
 - Router's typically have multiple interfaces
- Can hosts have multiple interfaces?
 - Yes, it's called **multi-homing**



Subnets

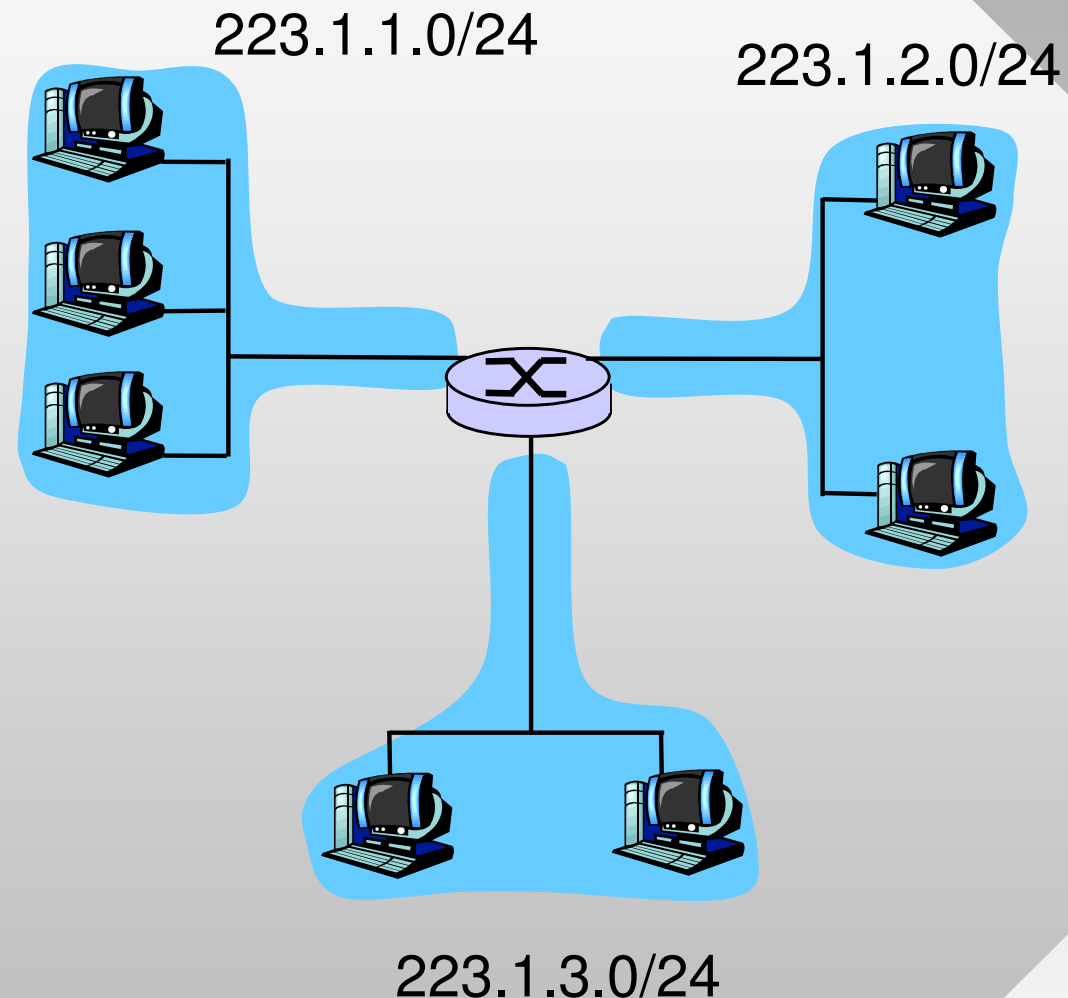
- IP address:
 - Subnet prefix (high-order bits)
 - Host suffix (low-order bits)
- *What's a subnet?*
 - Network composed of devices with the same subnet part of IP address
 - Can physically reach each other without intervening router



Subnets

Recipe

- To determine the subnets, detach each interface from its host or router, creating islands of isolated networks
- Each isolated network is a **subnet**

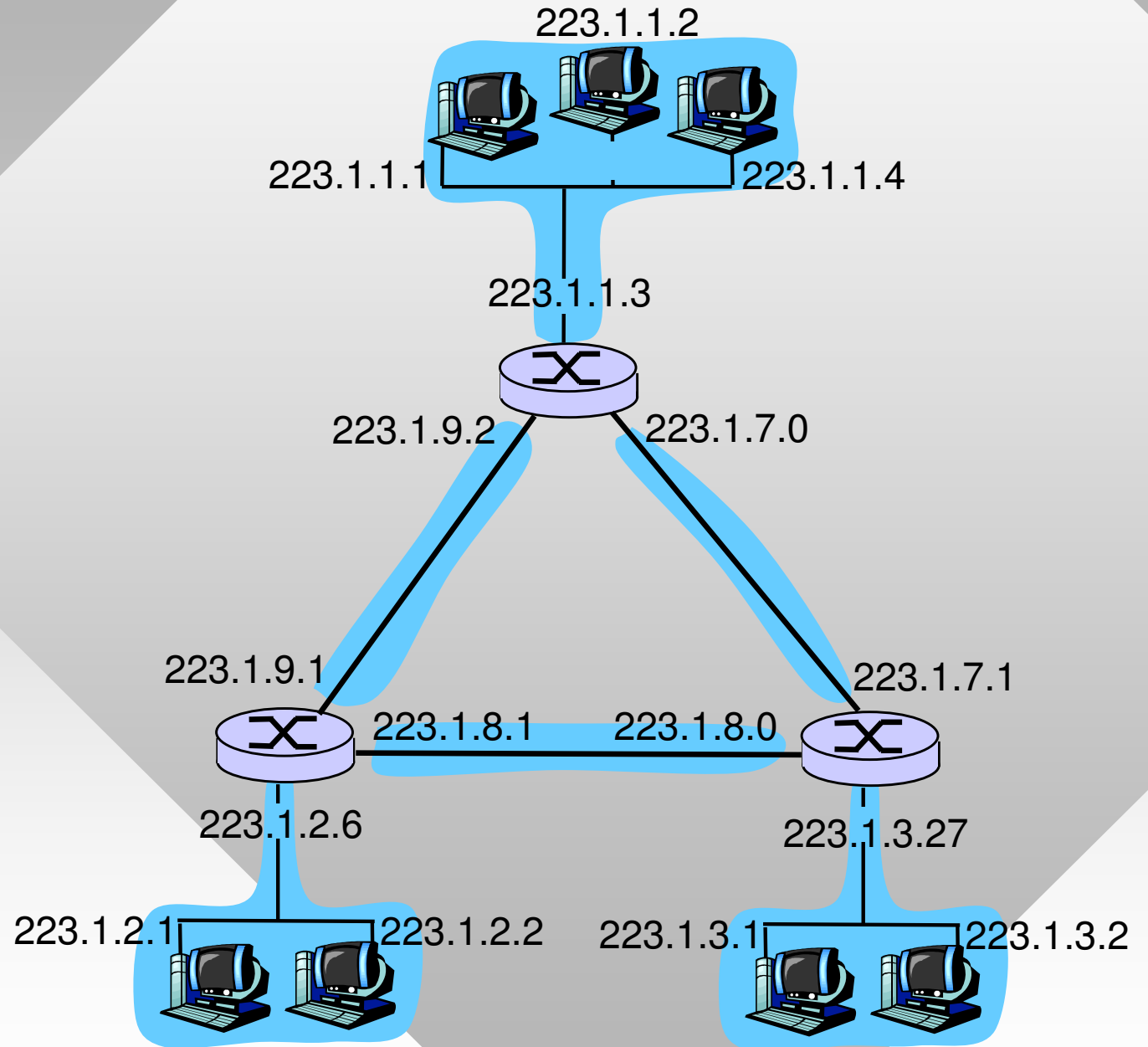


Subnet mask:

- 255.255.255.0
- or /24

Subnets

How many?

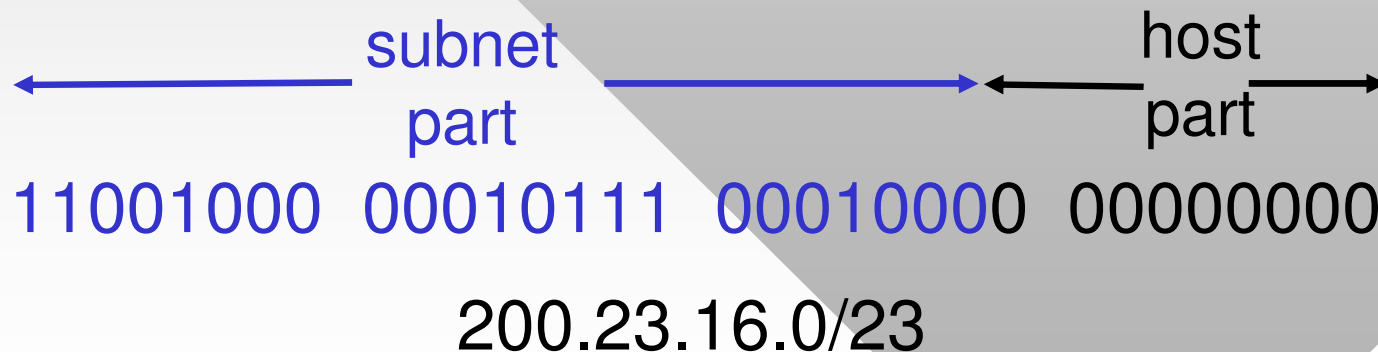


IP Addressing: CIDR

- In the early Internet, only subnets of 8, 16, or 24 bits were allowed (so-called “class A, B, C” addresses)
- This was inflexible and wasteful as well

CIDR: Classless InterDomain Routing

- Subnet portion of address of arbitrary length
- Address format: **a.b.c.d/x**, where x is # bits in the subnet portion of address



IP Addresses: How to Get One?

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

- Hard-coded by system admin in a file
 - Windows: Control-panel → network → configuration → tcp/ip → properties
 - Linux: /etc/rc.config
- **DHCP: Dynamic Host Configuration Protocol:** dynamically get address from as server
 - “Plug-and-play” (more in Chapter 5)