



**ACIT 2620**

# **Principles of Enterprise Networking**

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# Internet Protocol Version 4

# TCP/IP Suite

- Internet Protocol (IP)
- Routing Protocols (Used in routing table generation)
- Dynamic Host Configuration Protocol (DHCP)
- Transport Control Protocol (TCP)
- User Datagram Protocol (UDP)
- Internet Control Message Protocol (ICMP)
- Address Resolution Protocol (ARP)

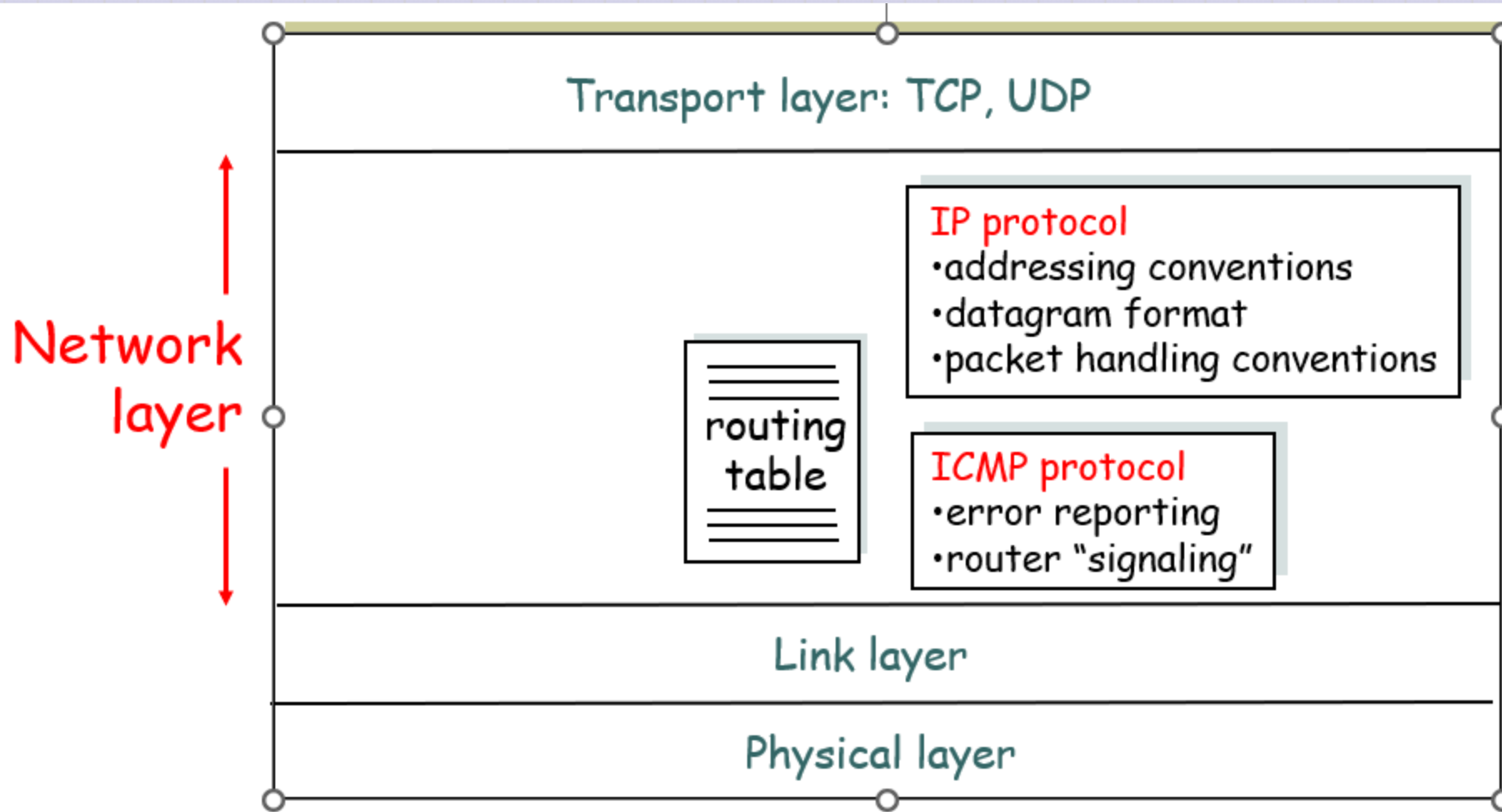
## Recap: Data-link layer

- Generally Ethernet
- Handles the movement of data between nodes on the same link
- Present on every network device
- Data Link Specific Devices: bridge, hub, switch

# Network Layer

- **Goal:** move packets for source to destination
  - **Path Determination:**  
the calculation of the route taken by packets -> routing
  - **Forwarding:**  
The movement of a packet from one network to the next appropriate network

# Network Layer functions





# Internet Protocol (IP)

- Provides information about how and where data should be delivered
- Responsible for **internetworking** (from where the term internet is derived)

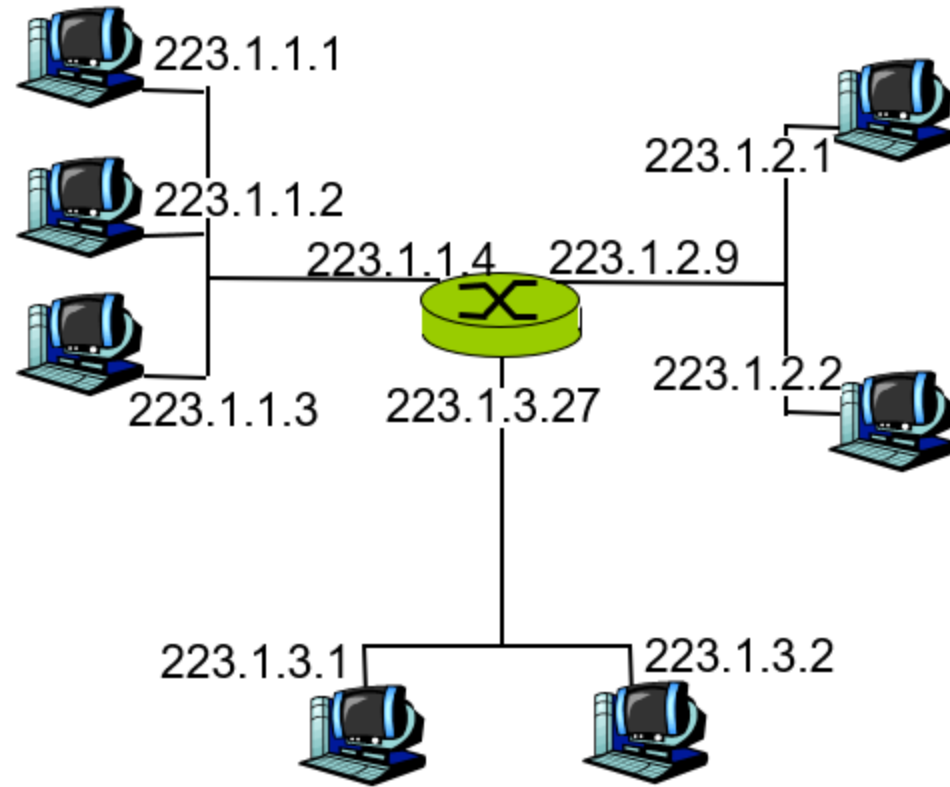
- To internetwork is to traverse more than one LAN segment and more than one type of network through a router
- In an internetwork, the individual networks that are joined together are called subnetworks



- IP is an unreliable, connectionless protocol, which means it does not guarantee delivery of data
- i.e IP will service a request without requesting verified session and without guaranteeing delivery of data, making it simpler and faster

# IP Addressing

- **IP address:** 32-bit identifier for host, router interface
- **interface:** connection between host, router and physical link
  - routers typically have multiple interfaces
  - host may have multiple interfaces
  - IP addresses associated with interface, not host, router



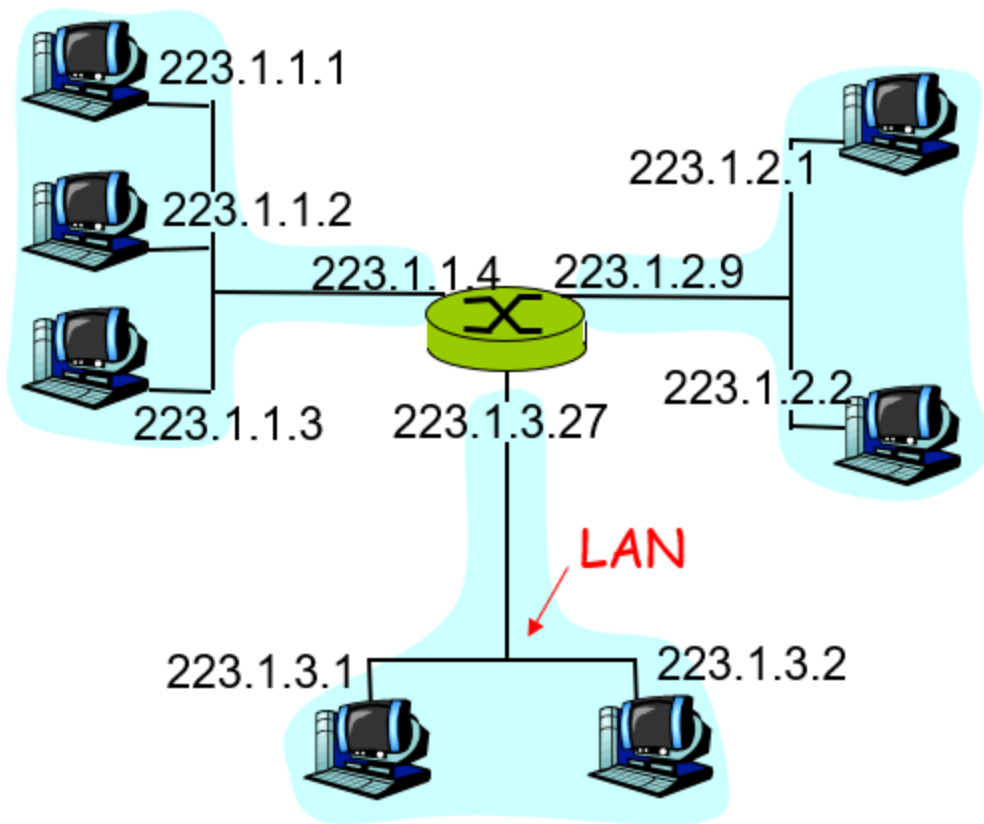
223.1.1.1 =  $\underbrace{11011111}_{223} \underbrace{00000001}_1 \underbrace{00000001}_1 \underbrace{00000001}_1$

## **Components of an IP address**

- network part (high order bits)
- host part (low order bits)

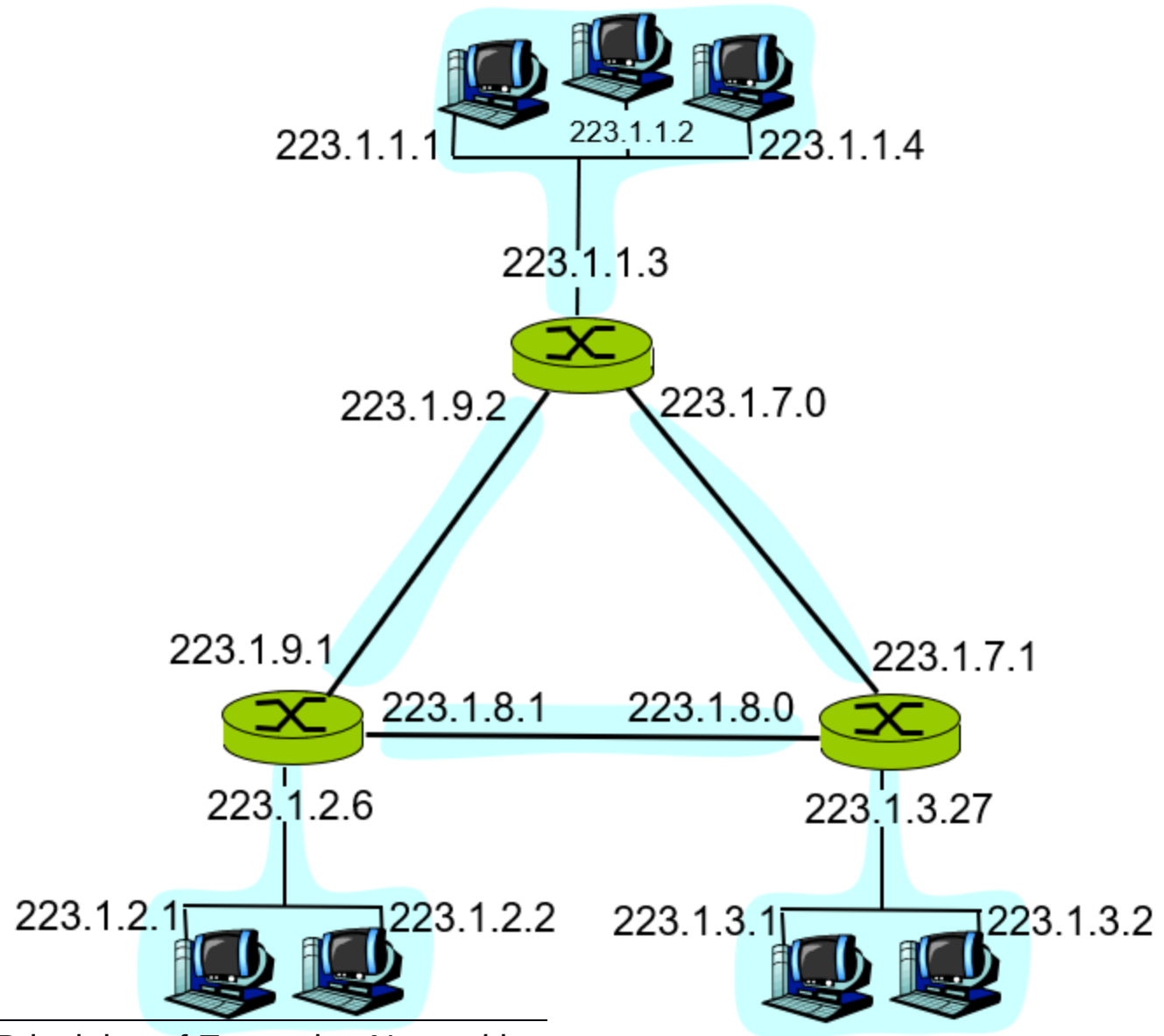
## IP Network

- device interfaces with same network part of IP address
- can physically reach each other without intervening router



network consisting of 3 IP networks  
(for IP addresses starting with 223,  
first 24 bits are network address)

# How many networks do you see?





# IP Address Space

"class-full" addressing:

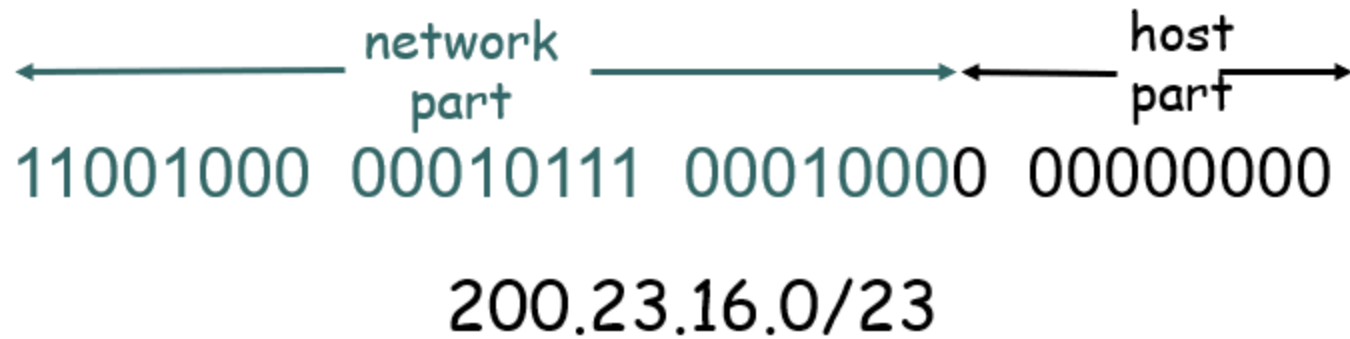
class

A	0	network		host		1.0.0.0 to 127.255.255.255
B	10		network		host	128.0.0.0 to 191.255.255.255
C	110		network		host	192.0.0.0 to 223.255.255.255
D	1110		multicast address			224.0.0.0 to 239.255.255.255

← 32 bits →

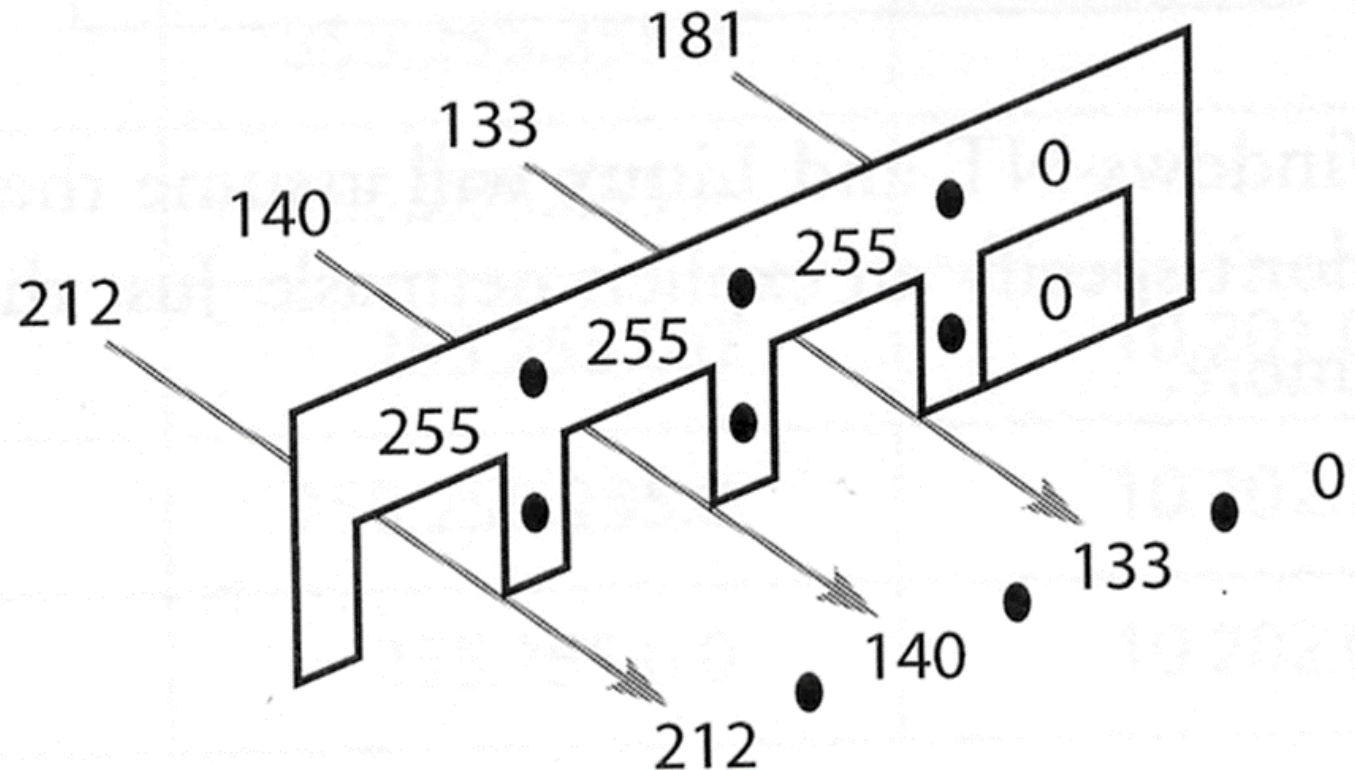
# IP range notations

- **CIDR:** Classless Inter Domain Routing
  - network portion of address of arbitrary length
  - address format: **a . b . c . d / x** , where **x** is # of bits in network portion of address
  - Also written as address + subnet mask



- CIDR using Subnet Mask
  - Usually written in dotted decimal notation reminiscent of an IP address

**Using mask 255.255.255.0**



# Special Addresses

- Private IP Addresses
  - 10.0.0.0 -> 10.255.255.255
  - 172.16.0.0 -> 172.31.255.255
  - 192.168.0.0 -> 192.168.255.255

- Documentation IP Addresses
  - 192.0.2.0 -> 192.0.2.255
- Self-Configured IP Addresses (often DHCP Failure)
  - 169.254.0.0 -> 169.254.255.255

- Unknown Address
  - 0.0.0.0
- Loopback Address
  - 127.0.0.1 (actually, 127.0.0.0/8)
- Network Address (All host bits set to 1)
  - E.g: 192.168.1.0, Subnet Mask = 255.255.255.0

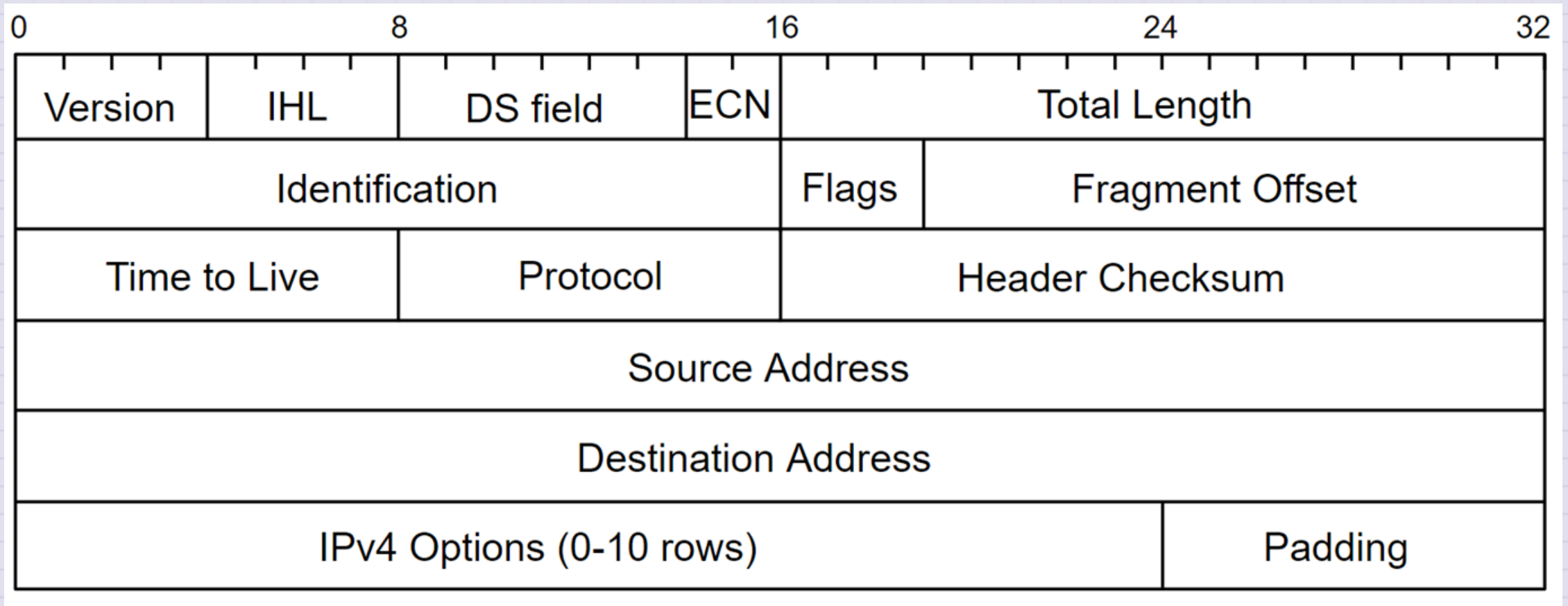
# Broadcasting and Multicasting

- Limited Broadcast
  - 255.255.255.255
  - Transmitted only on local segment -> not routed
- Network Broadcast Address
  - Network Address + All host bits set to one
    - Network Address = 192.168.1.x
    - Network Broadcast Address = 192.168.1.255



- Multicast Address
  - Lie within the 224.0.0.0 /4 network
  - <http://www.iana.org/assignments/multicast-addresses>

# IPv4 Header



# IPv4 routing: the basics

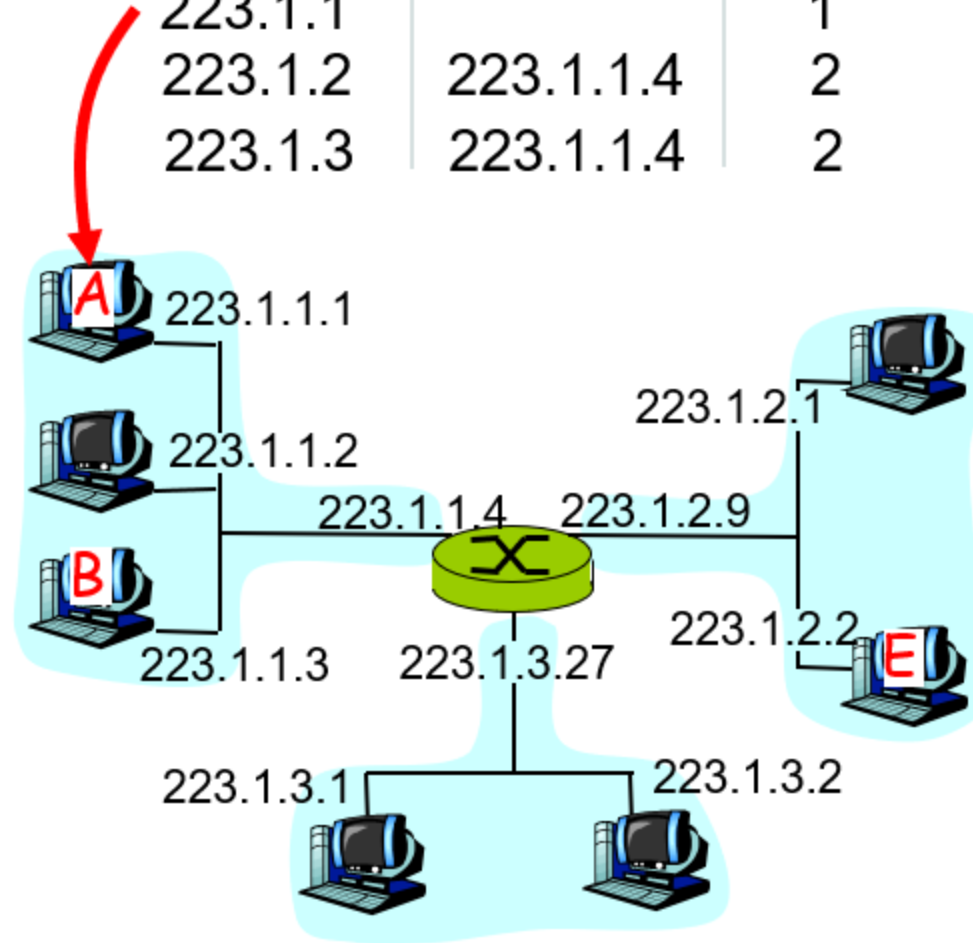
## IP datagram:

misc fields	source IP addr	dest IP addr	data
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- datagram remains unchanged, as it travels source to destination
- addr fields of interest here

## routing table in A

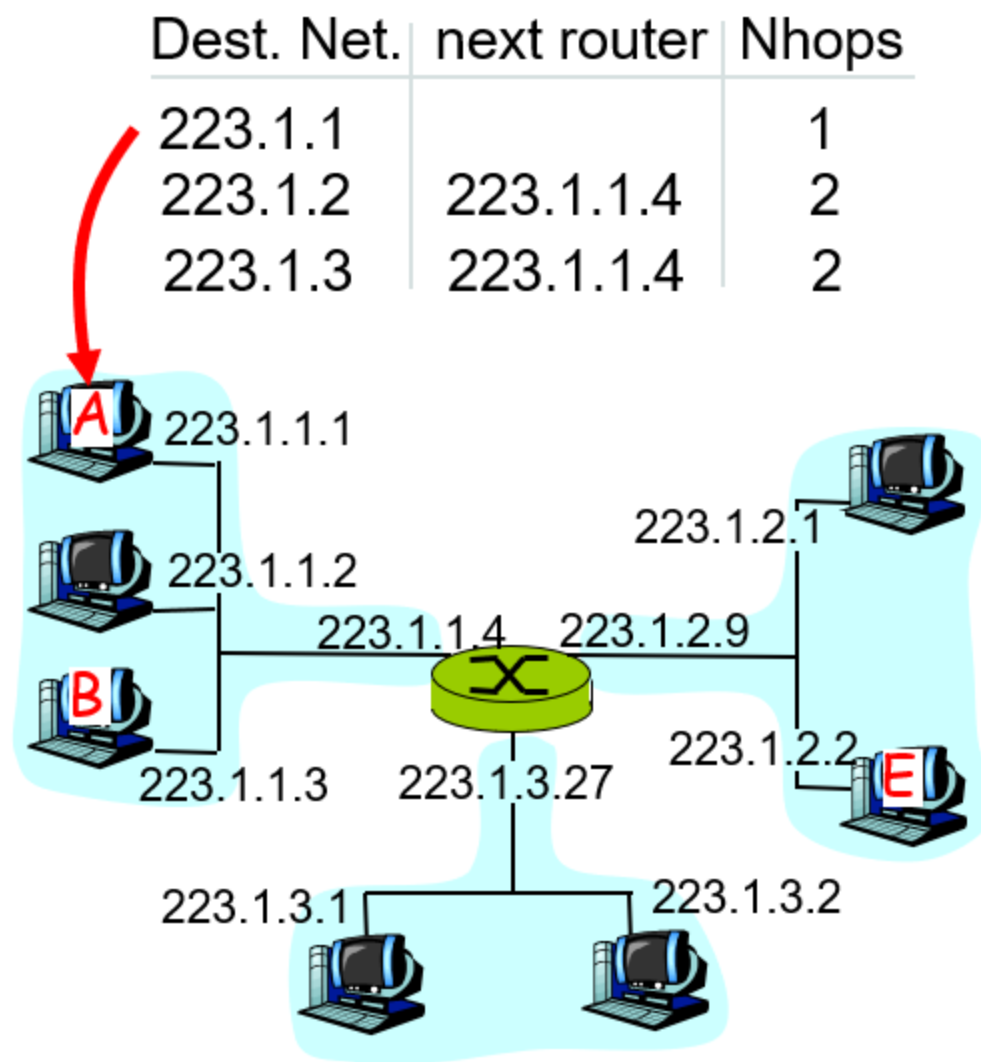
Dest. Net.	next router	Nhops
223.1.1		1
223.1.2	223.1.1.4	2
223.1.3	223.1.1.4	2



misc fields	223.1.1.1	223.1.1.3	data
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Starting at A, given IP datagram addressed to B:

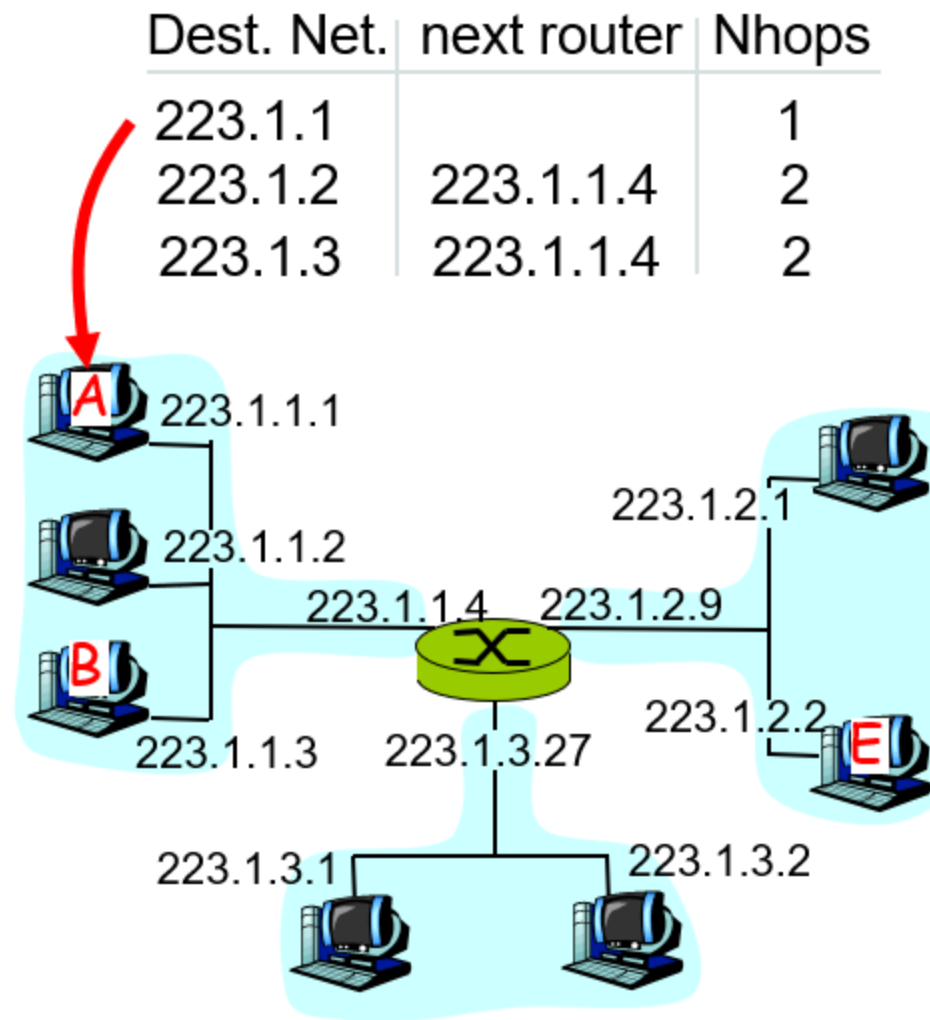
- look up net. address of B
- find B is on same net. as A
- link layer will send datagram directly to B inside link-layer frame
  - B and A are directly connected



misc fields	223.1.1.1	223.1.2.2	data
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### Starting at A, dest. E:

- look up network address of E
- E on *different* network
  - A, E not directly attached
- routing table: next hop router to E is 223.1.1.4
- link layer sends datagram to router 223.1.1.4 inside link-layer frame
- datagram arrives at 223.1.1.4
- continued.....

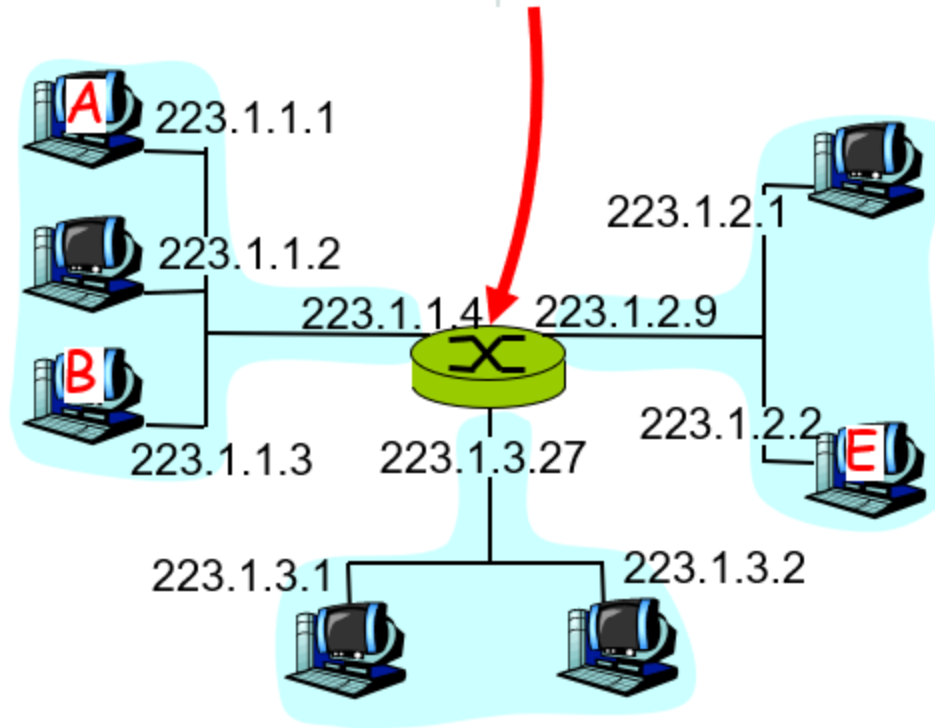


misc fields	223.1.1.1	223.1.2.2	data
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Arriving at 223.1.4, destined for 223.1.2.2

- look up network address of E
- E on *same* network as router's interface 223.1.2.9
  - router, E directly attached
- link layer sends datagram to 223.1.2.2 inside link-layer frame via interface 223.1.2.9
- datagram arrives at 223.1.2.2!!! (hooray!)

Dest. network	next router	Nhops	interface
223.1.1	-	1	223.1.1.4
223.1.2	-	1	223.1.2.9
223.1.3	-	1	223.1.3.27



**Next: IPv4 subnetting**



# Reading List

- IPv4 Subnets