



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)

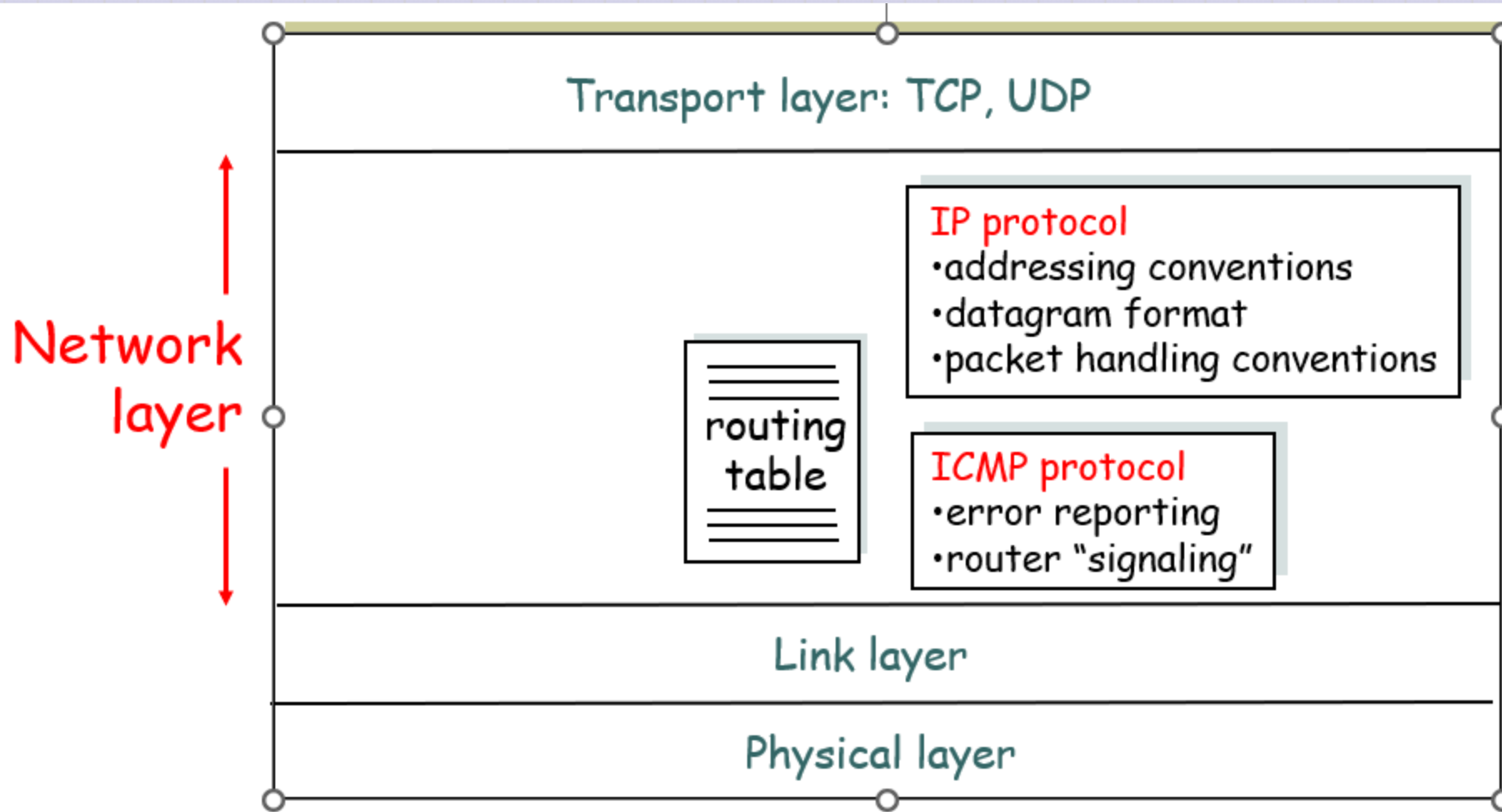
Recap: Data-link layer

- 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)

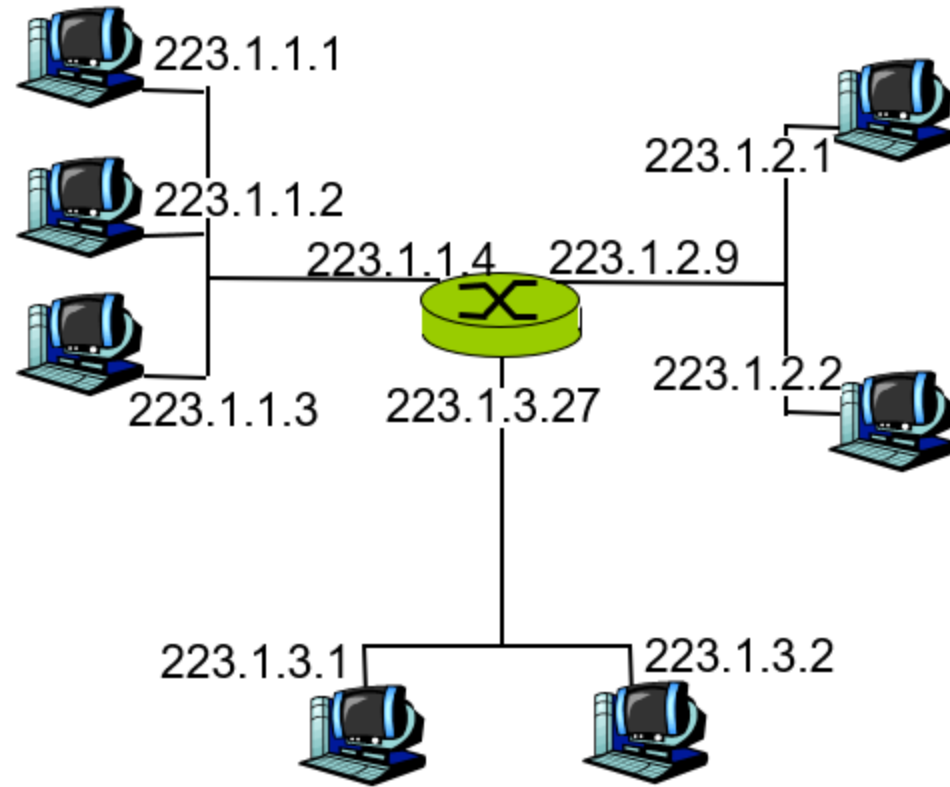
- Provides information about how and where data should be delivered
- Responsible for **internetworking** (from where the term internet is derived)

- 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



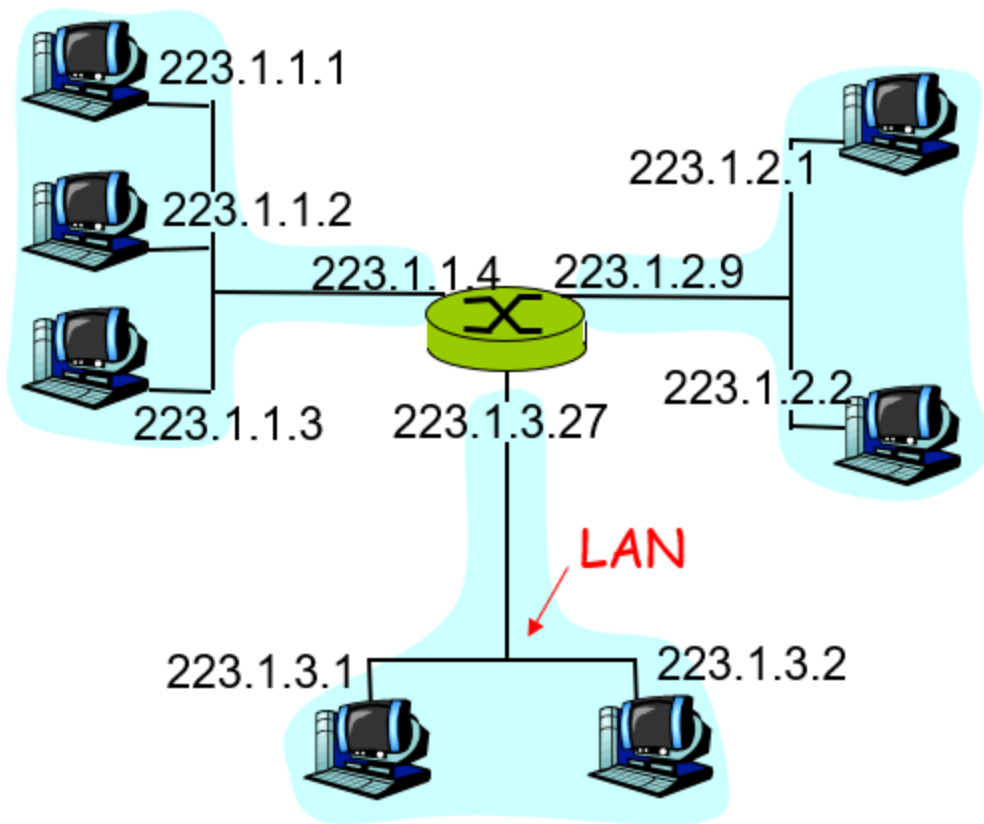
223.1.1.1 = $\underbrace{11011111}_{223} \underbrace{00000001}_1 \underbrace{00000001}_1 \underbrace{00000001}_1$

Components of an IP address

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

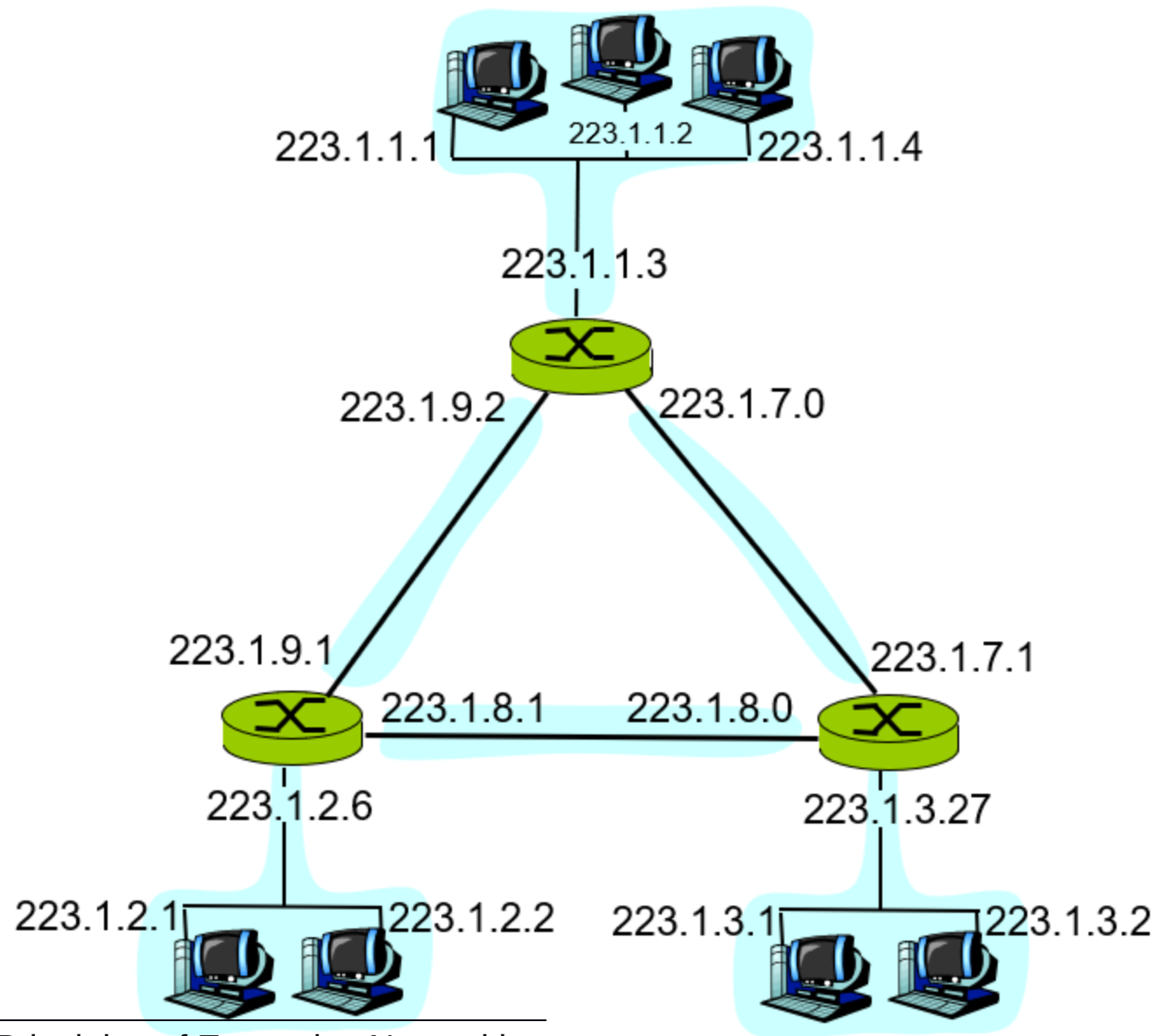
IP Network

- 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:

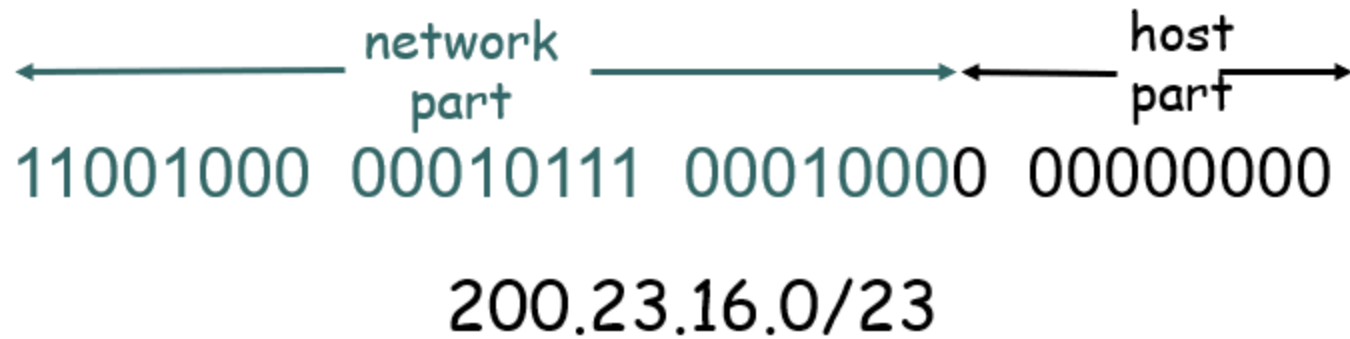
class

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 →

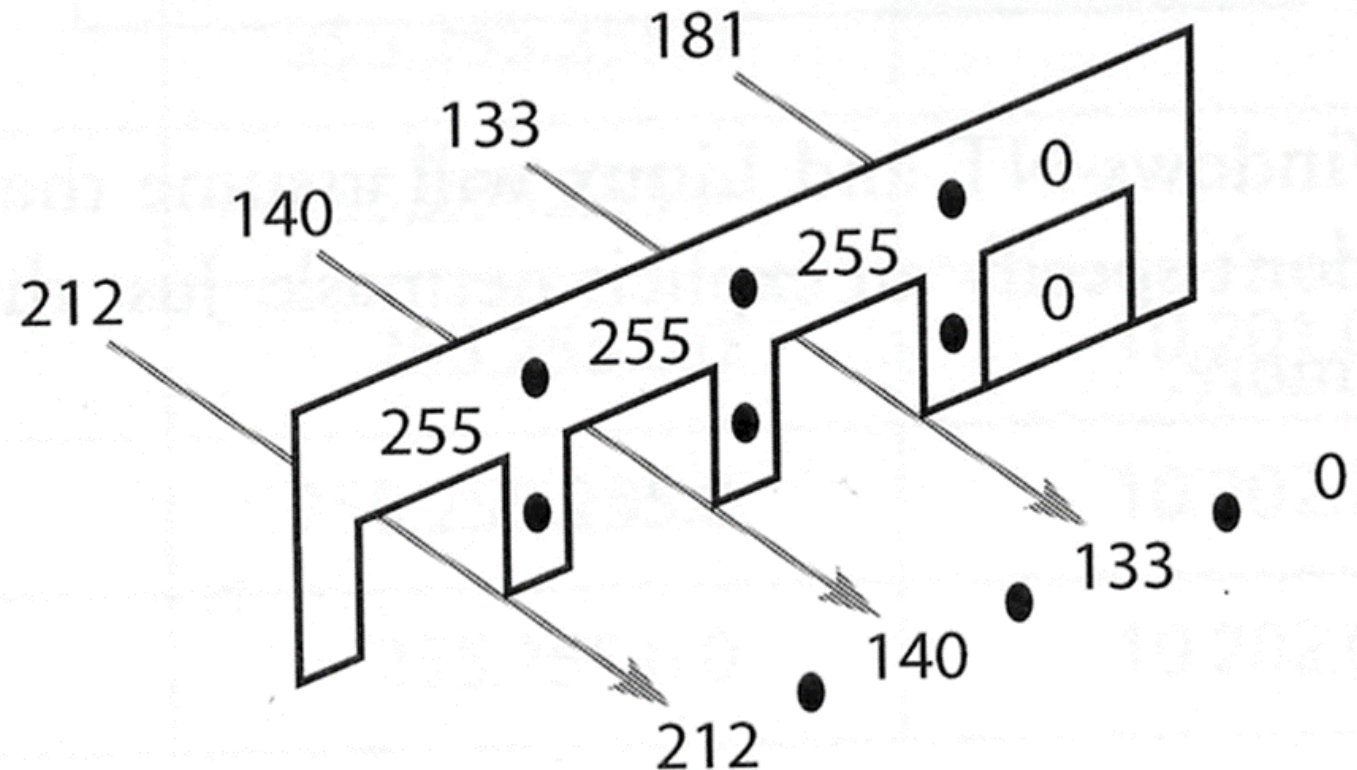
IP range notations

- **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

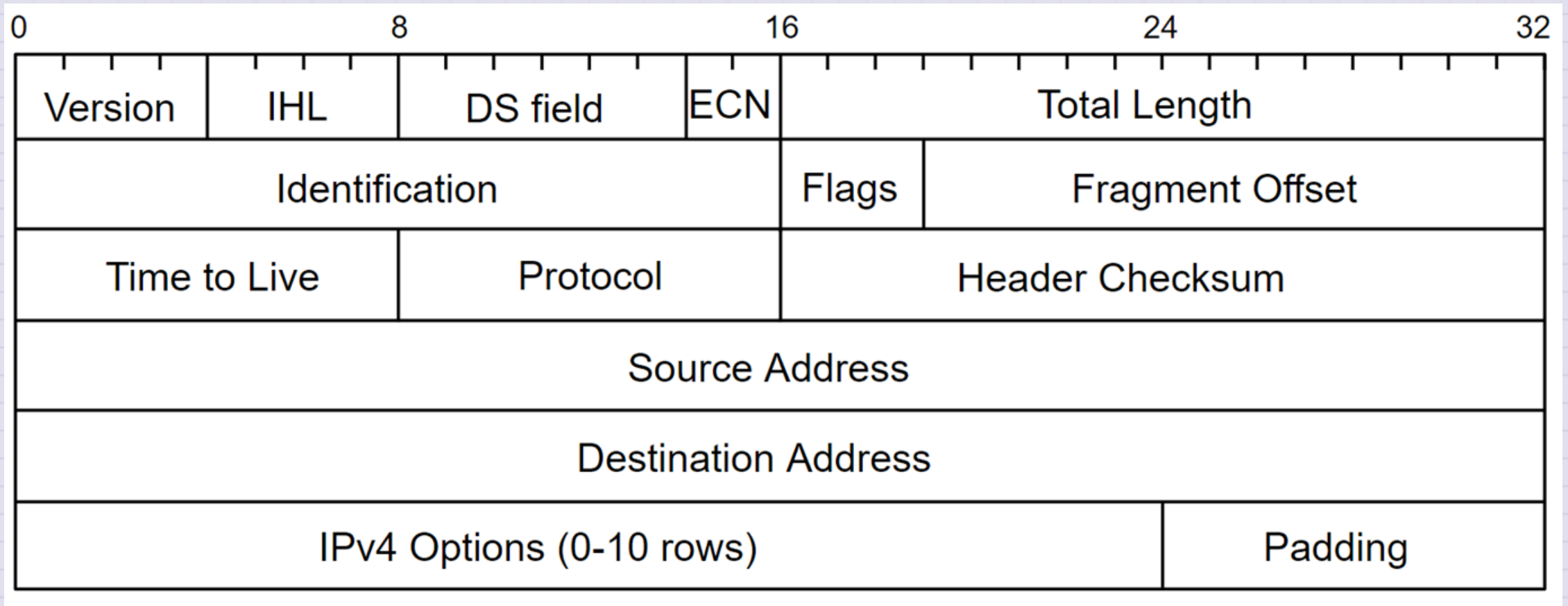
- Unknown Address
 - 0.0.0.0
- Loopback Address
 - 127.0.0.1 (actually, 127.0.0.0/8)
- Network Address (All host bits set to 1)
 - E.g: 192.168.1.0, Subnet Mask = 255.255.255.0

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

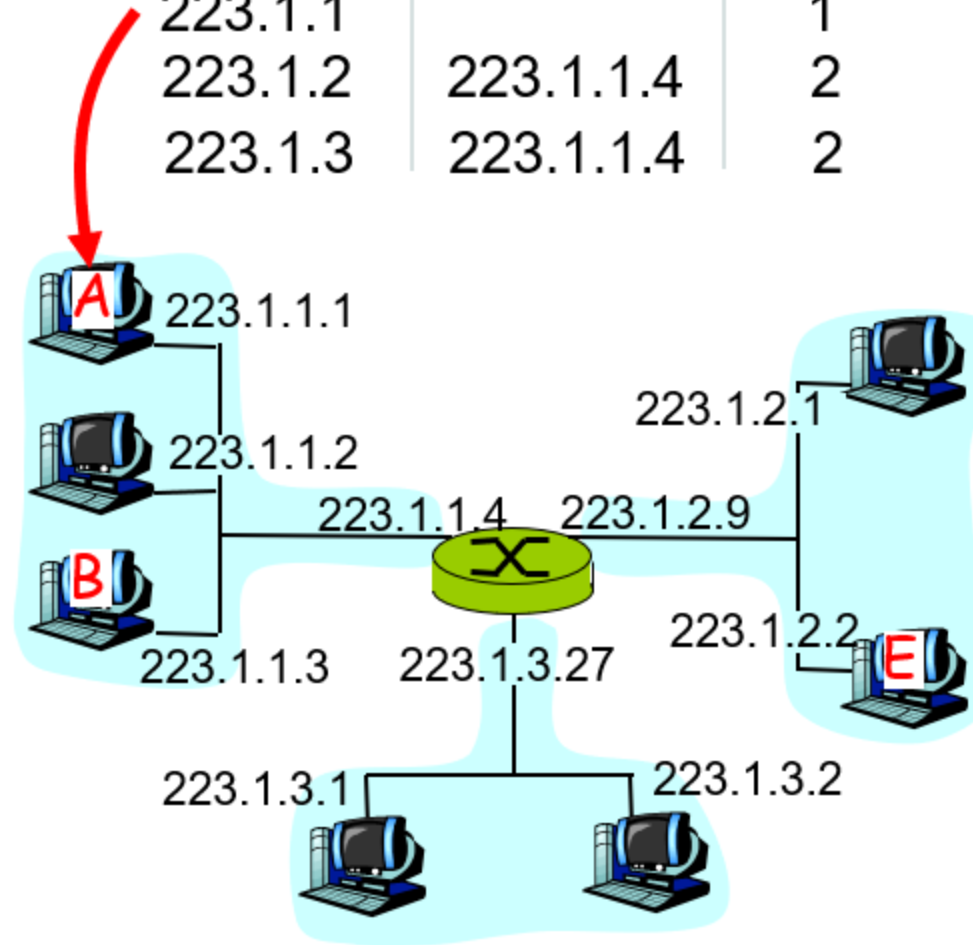
IP datagram:

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

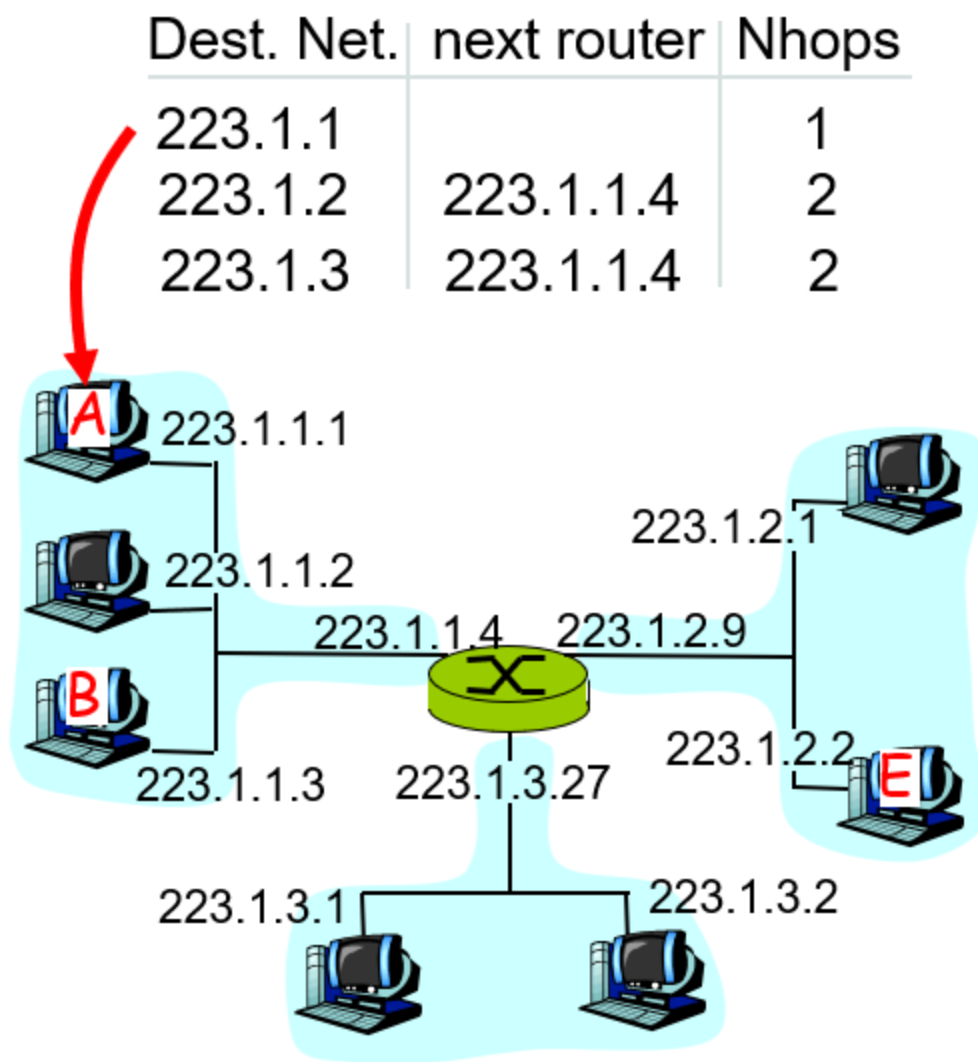
Dest. Net.	next router	Nhops
223.1.1		1
223.1.2	223.1.1.4	2
223.1.3	223.1.1.4	2



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

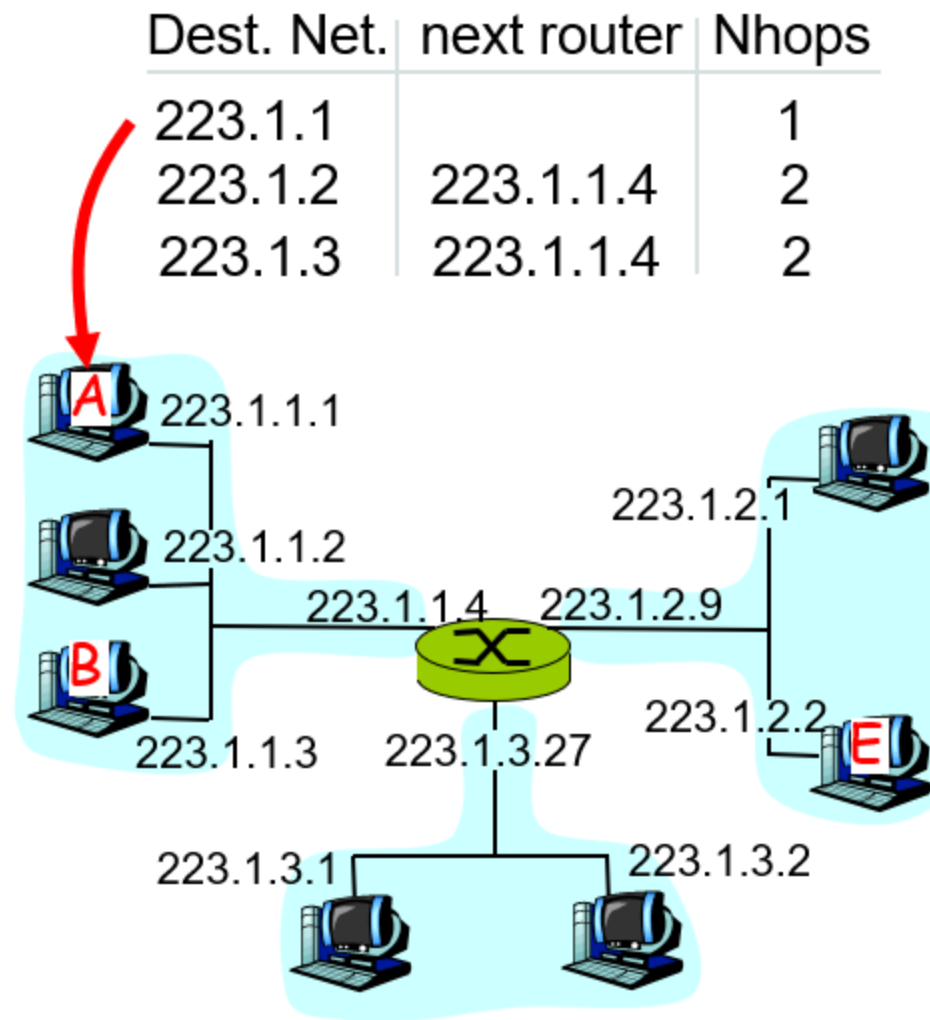
- look up net. address of B
- find B is on same net. as A
- link layer will send datagram directly to B inside link-layer frame
 - B and A are directly connected



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.....

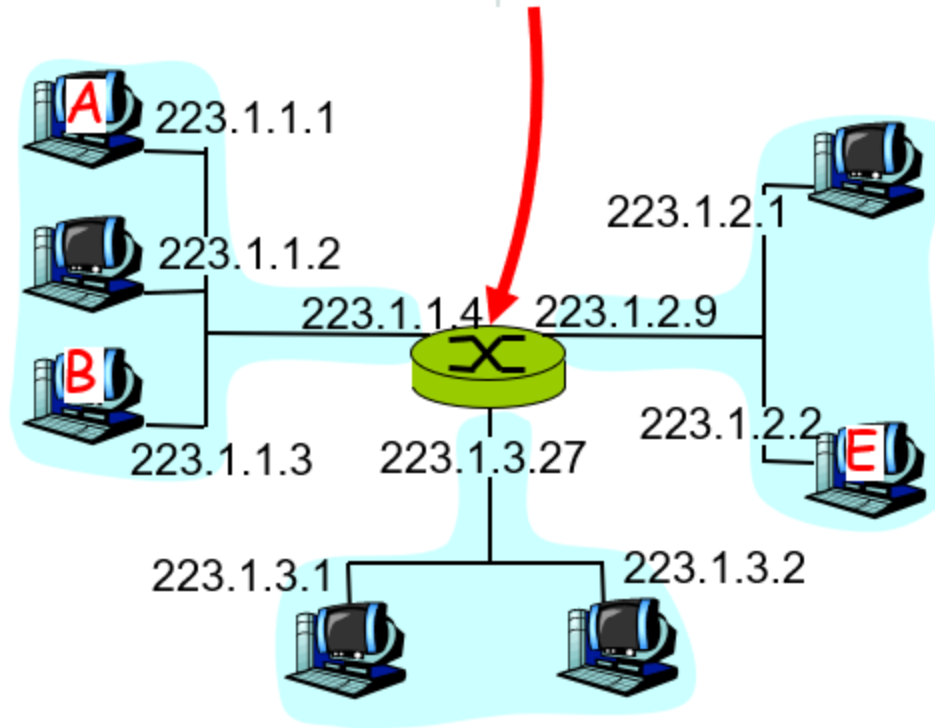


misc fields	223.1.1.1	223.1.2.2	data
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Arriving at 223.1.4, destined for 223.1.2.2

- 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