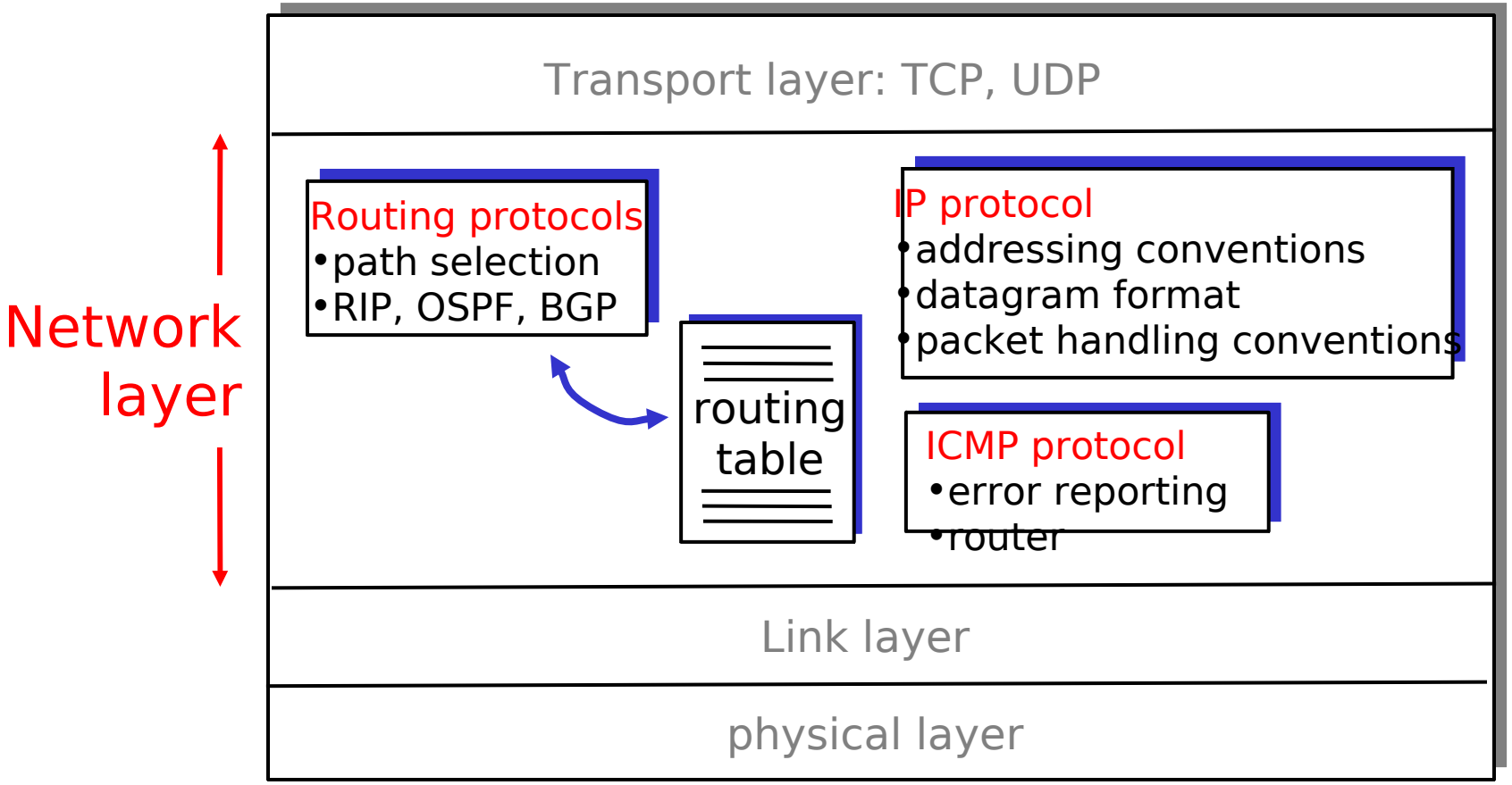
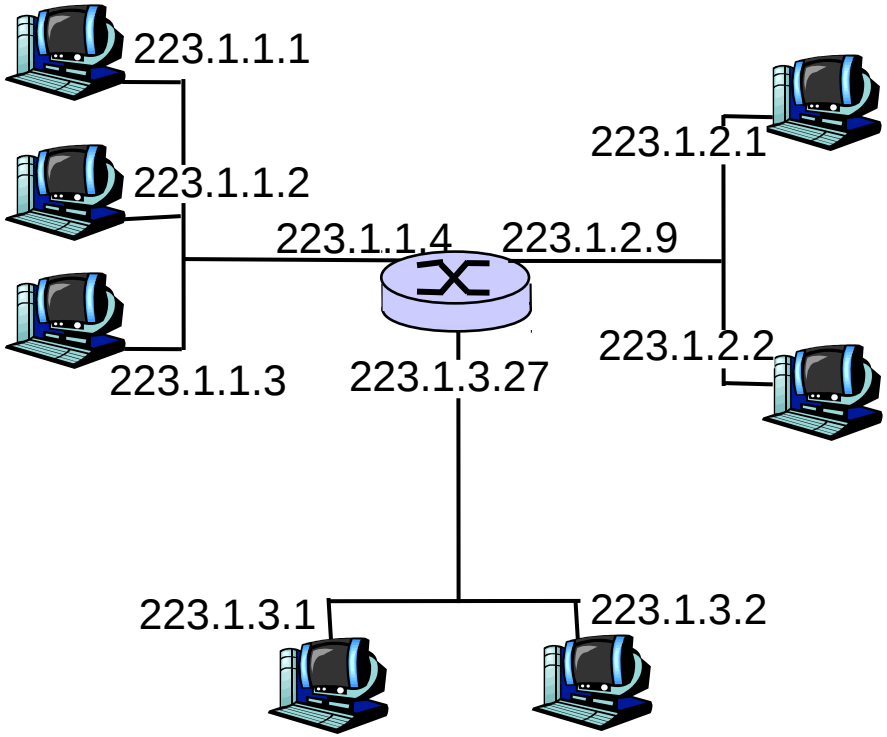
The Internet Network layer: IP Addressing

Host, router network layer functions:



IP Addressing: introduction

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



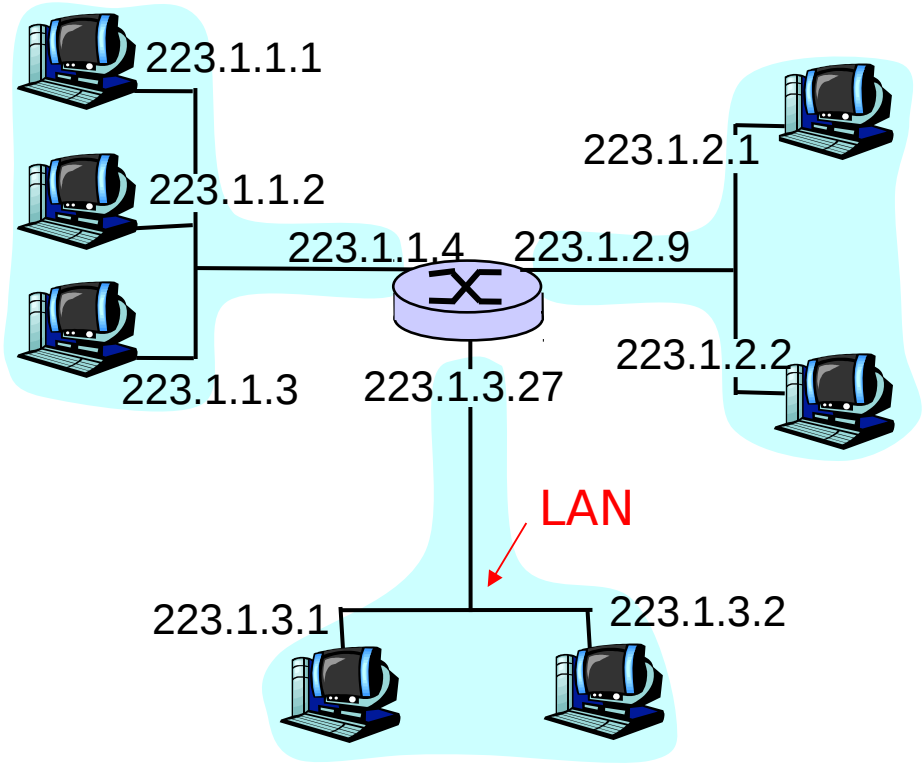
223.1.1.1 = 11011111 00000001 00000001 00000001

223 1 1 1

IP Addressing

- IP address:
  - network part (high order bits)
  - host part (low order bits)
- *What is a network ?*

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

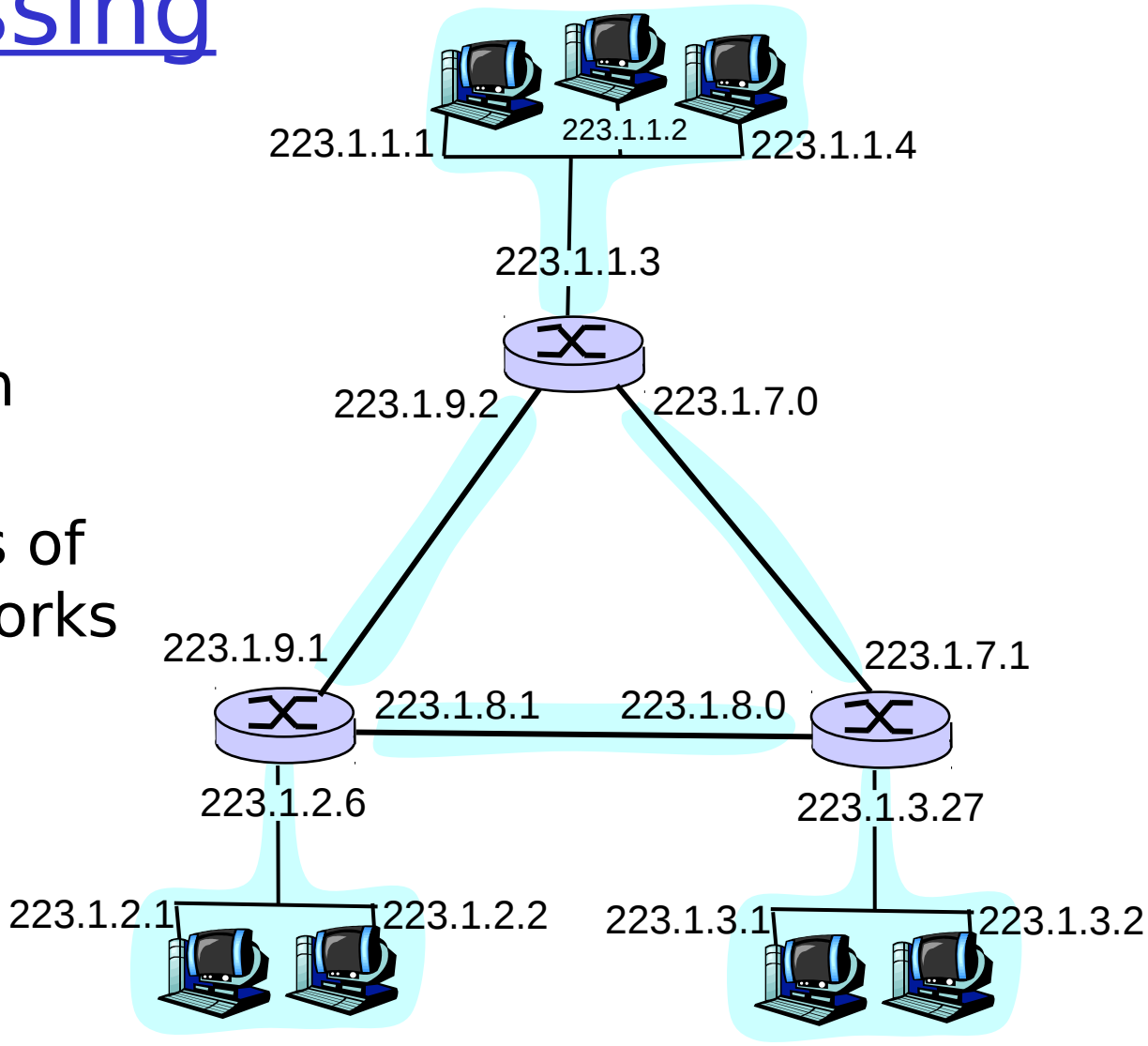


network consisting of 3 IP networks (for IP addresses starting with 223, first 24 bits are network address)

IP Addressing

How to find the networks?

- Detach each interface from router, host
- create islands of isolated networks

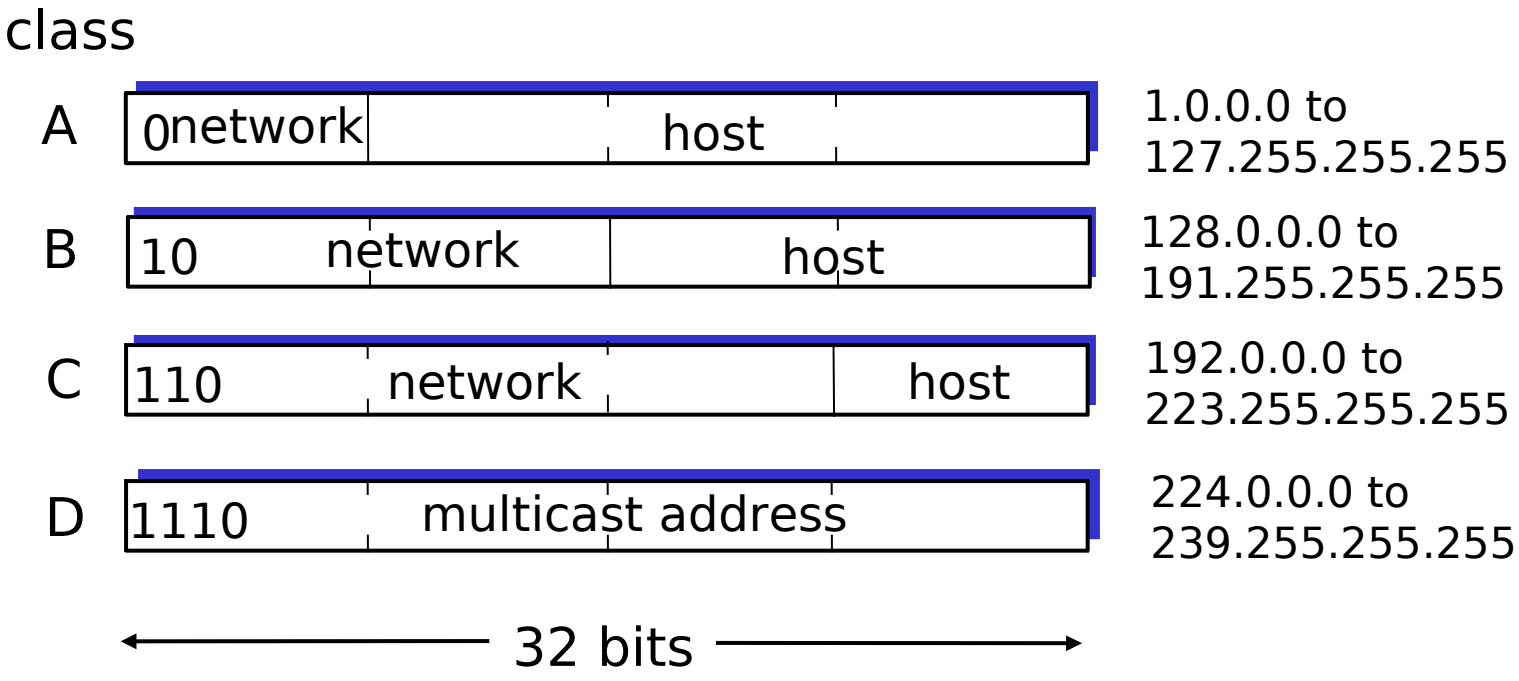


Interconnected system consisting of six networks

IP Addresses

given notion of network, let's re-examine IP addresses:

class-full addressing:



IP addressing: CIDR

- classful addressing:
  - inefficient use of address space, address space exhaustion
  - e.g., class B net allocated enough addresses for 65K hosts, even if only 2K hosts in that network
- CIDR: Classless InterDomain Routing
  - network portion of address of arbitrary length
  - address format: a.b.c.d/x, where x is # bits in network portion of address

200.23.16.0/23

IP addressing: Masks

- Masks are commonly used in some configuration files/sw
- Simply convert the mask to binary and check which is the network part and which is the host part
- e.g., for a 23 bits network and 9 bits host, the mask would be
  - 255.255.254.0
  - Or 1111 1111 1111 1111 1111 1110 0000 0000
- Possible values for masks are combinations where there are only 1's at the left side and 0's on the right side of the mask

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IP addresses: how to get one?

Hosts (host portion):

- hard-coded by system admin in a file
- DHCP: Dynamic Host Configuration Protocol: dynamically get address: plug-and-play
  - 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

IP addresses: how to get one?

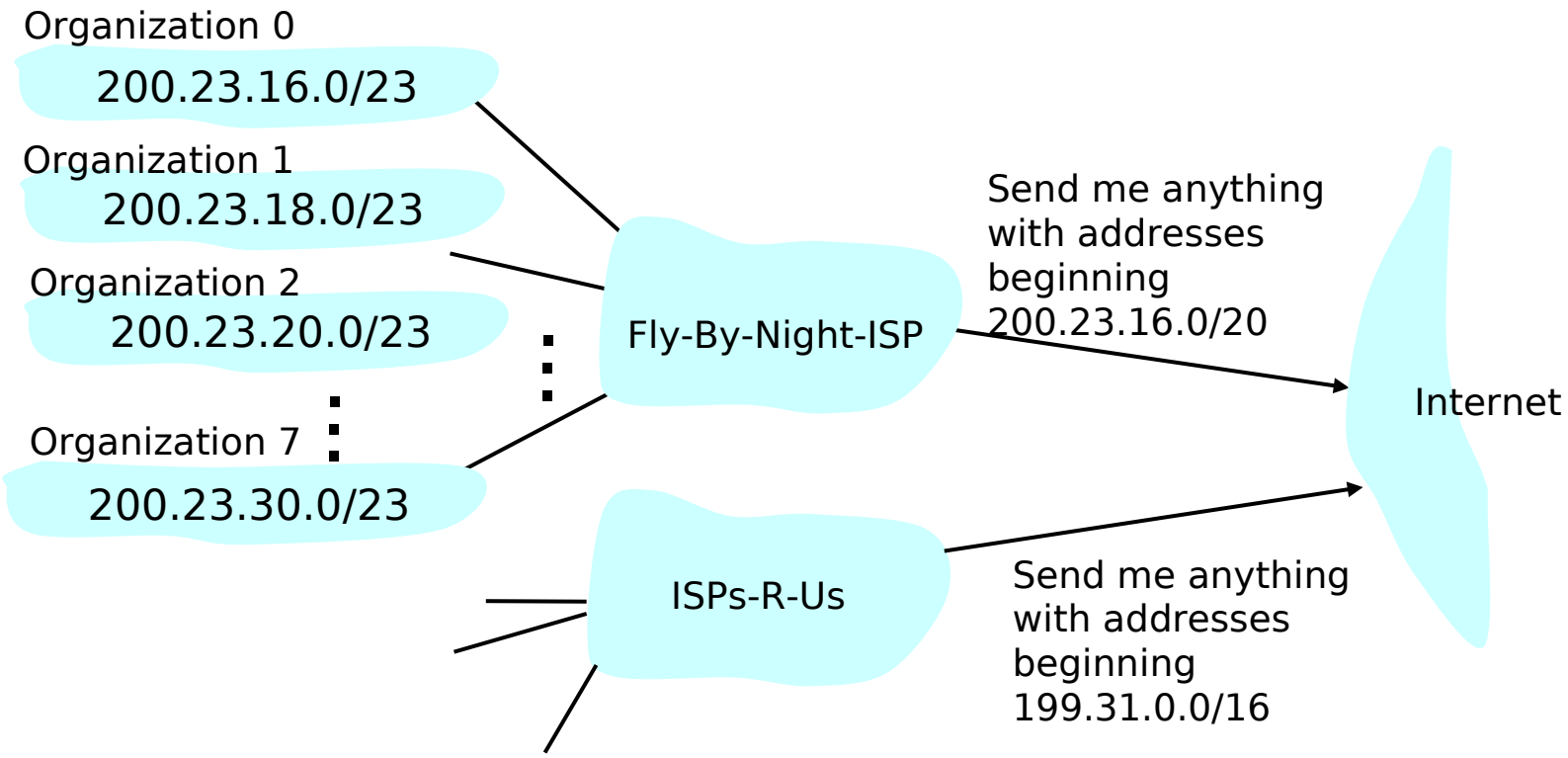
Network (network portion):

- get allocated portion of ISP's address space:

ISP's block	11001000 00010111 00010000	00000000	200.23.16.0/20
Organization 0	11001000 00010111 0001000**0**	00000000	200.23.16.0/23
Organization 1	11001000 00010111 0001001**0**	00000000	200.23.18.0/23
Organization 2	11001000 00010111 0001010**0**	00000000	200.23.20.0/23
...	.....	....	....
Organization 7	11001000 00010111 0001111**0**	00000000	200.23.30.0/23

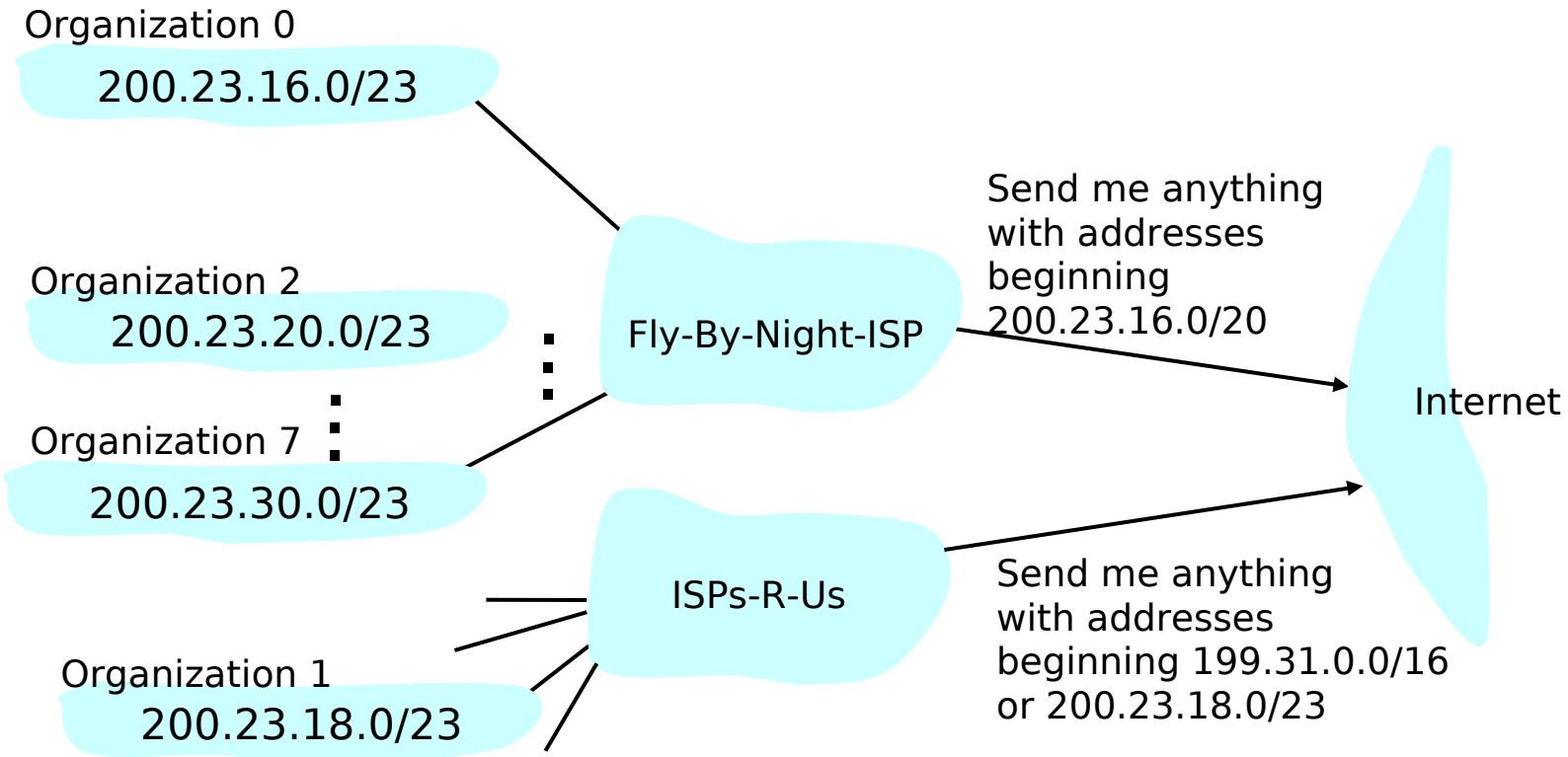
Hierarchical addressing: route aggregation

Hierarchical addressing allows efficient advertisement of routing information:



Hierarchical addressing: more specific routes

ISPs-R-Us has a more specific route to Organization 1



IP addressing: the last word...

Q: How does an ISP get block of addresses?

A: ICANN: Internet Corporation for Assigned Names and Numbers

- allocates addresses
- manages DNS
- assigns domain names, resolves disputes

Getting a datagram from source to dest.

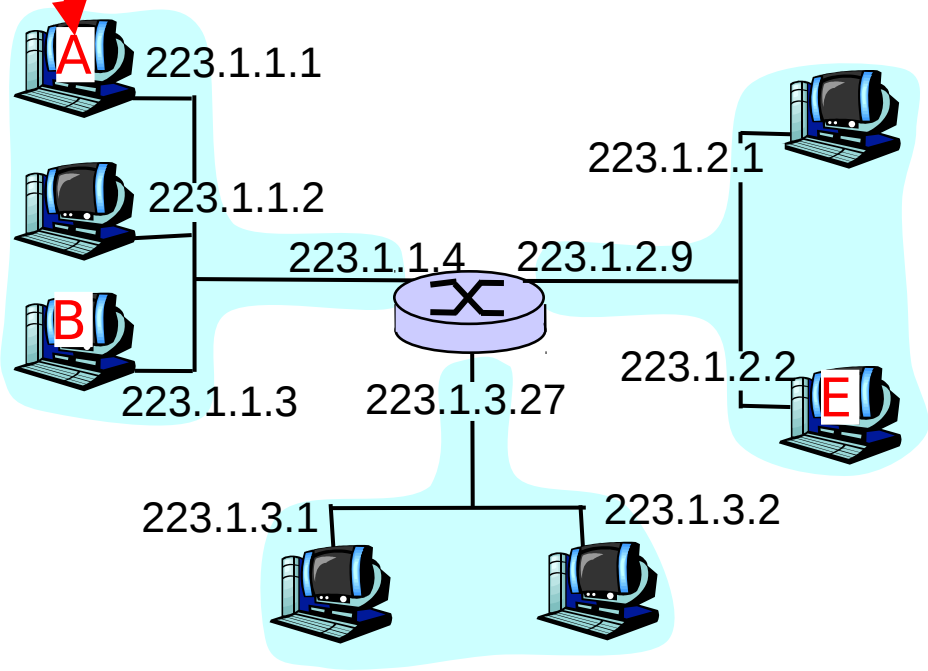
routing table in A

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

IP datagram:

misc fields	source IP addr	dest IP addr	data

- datagram remains unchanged, as it travels source to destination
- address fields of interest here



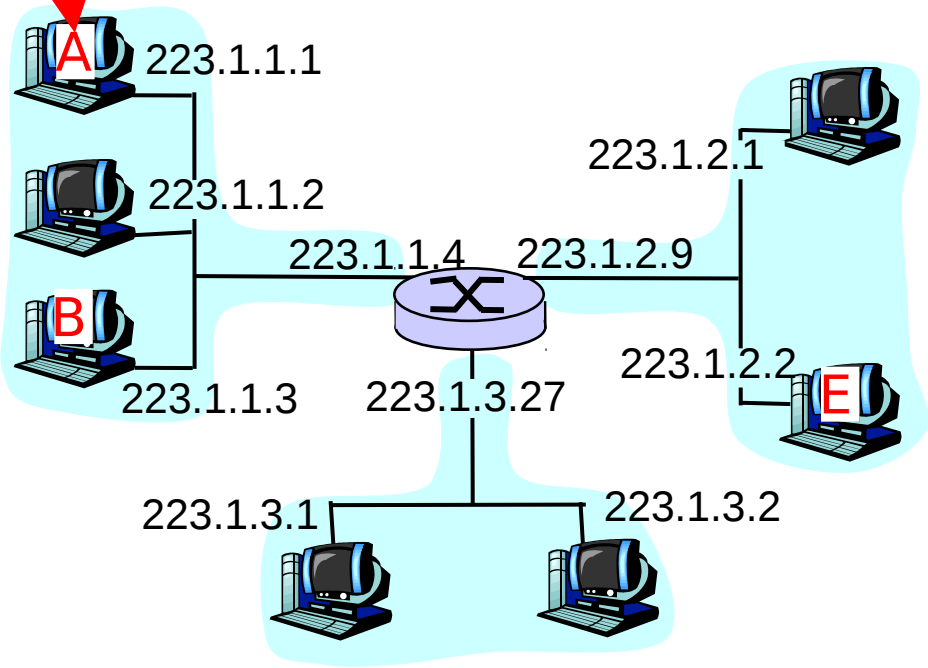
Getting a datagram from source to dest.

misc fields	223.1.1.1	223.1.1.3	data

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

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



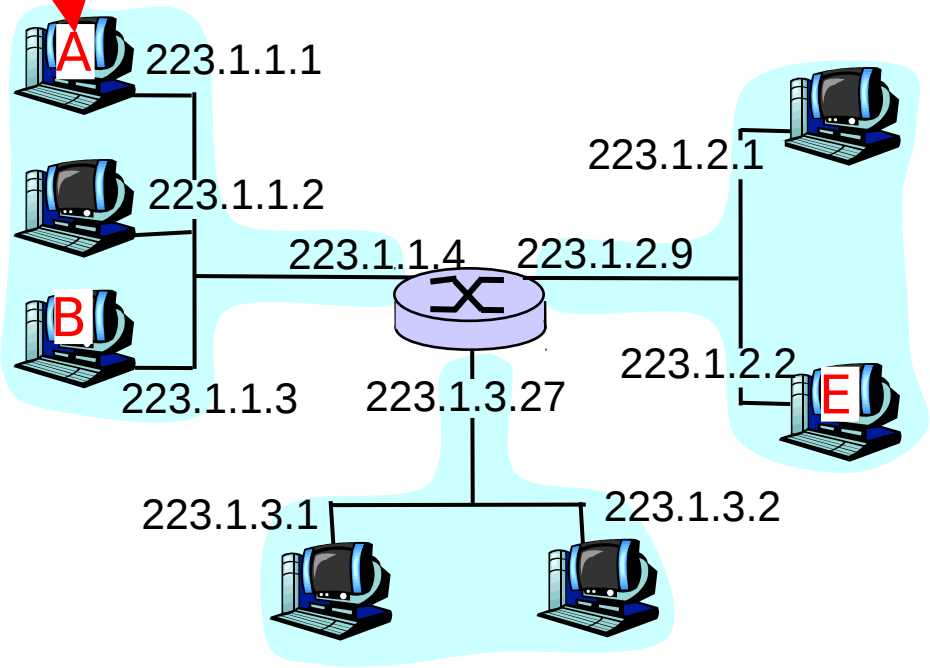
Getting a datagram from source to dest.

misc fields	223.1.1.1	223.1.2.3	data

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…..

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



Getting a datagram from source to dest.

misc fields	223.1.1.1	223.1.2.3	data

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!!!

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