This lecture will be recorded!!

Welcome to

CS 3516: Computer Networks

Prof. Yanhua Li

Time: 9:00am –9:50am M, T, R, and F
Zoom Lecture
Fall 2020 A-term

Updates

Quiz 7

Grading by next Mon

Project 2

Due next Monday.

Extra office hour:

today 10:30AM -11:30AM Prof Li

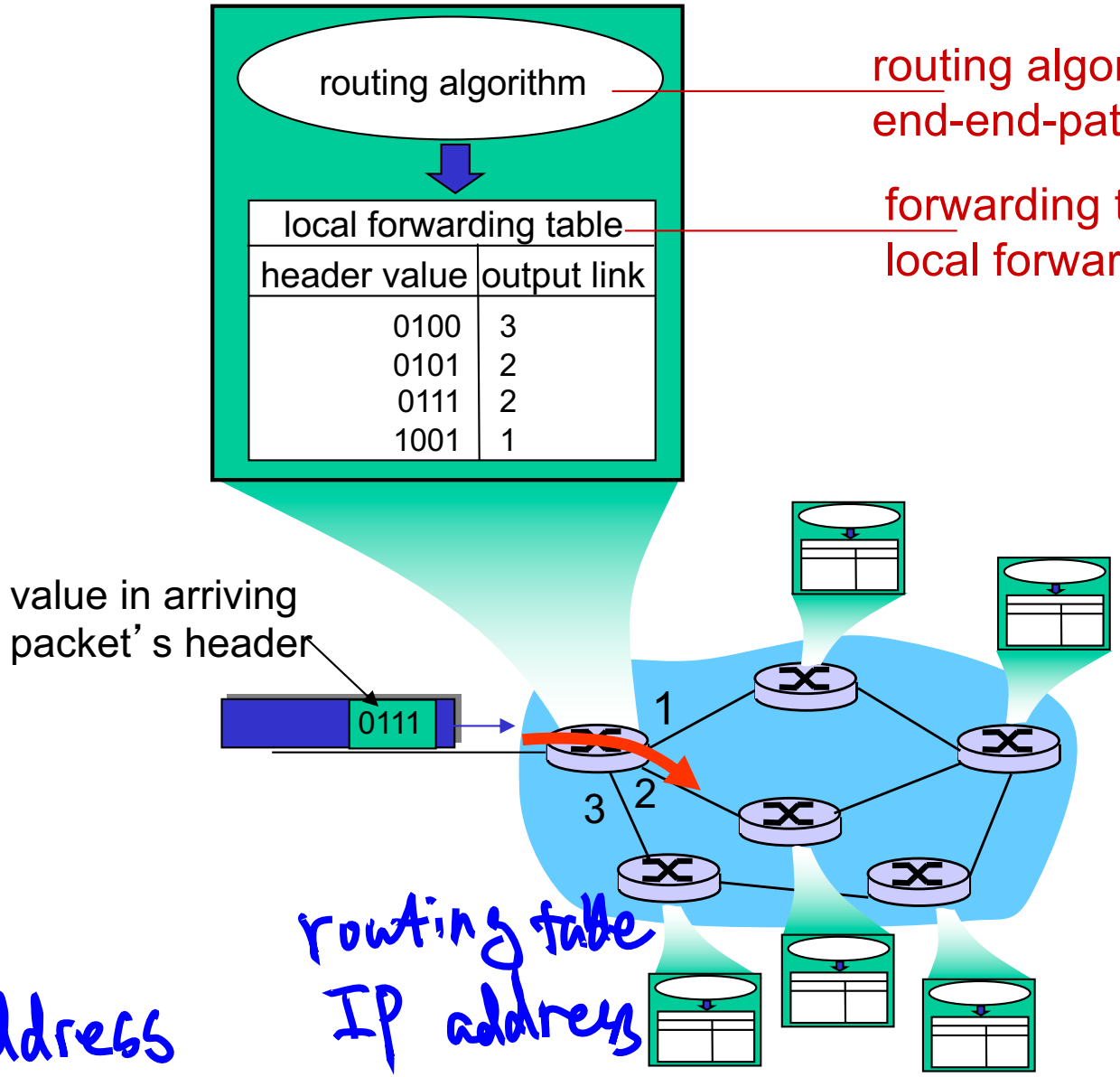
Next Monday, 11:30AM-12:30PM by Heshan

Chapter 4-5: network layer

chapter goals:

- understand principles behind network layer services:
  - network layer service models
  - forwarding versus routing
  - IP addressing
    - datagram format
    - IPv4 addressing
      - Classful addressing
      - Classless Inter-Domain Routing
  - routing (path selection)

Interplay between routing and forwarding



logistics

Home address

routing table

IP address

best effort

IP addressing: Classful addressing

Number system:

Unitary	0
Binary	0, 1
Octal	0, ..., 7
Decimal	0, ..., 9
Hexadecimal	0, ..., 9, A, ..., F

symbols

IP address

32 bits {0, 1} e.g.

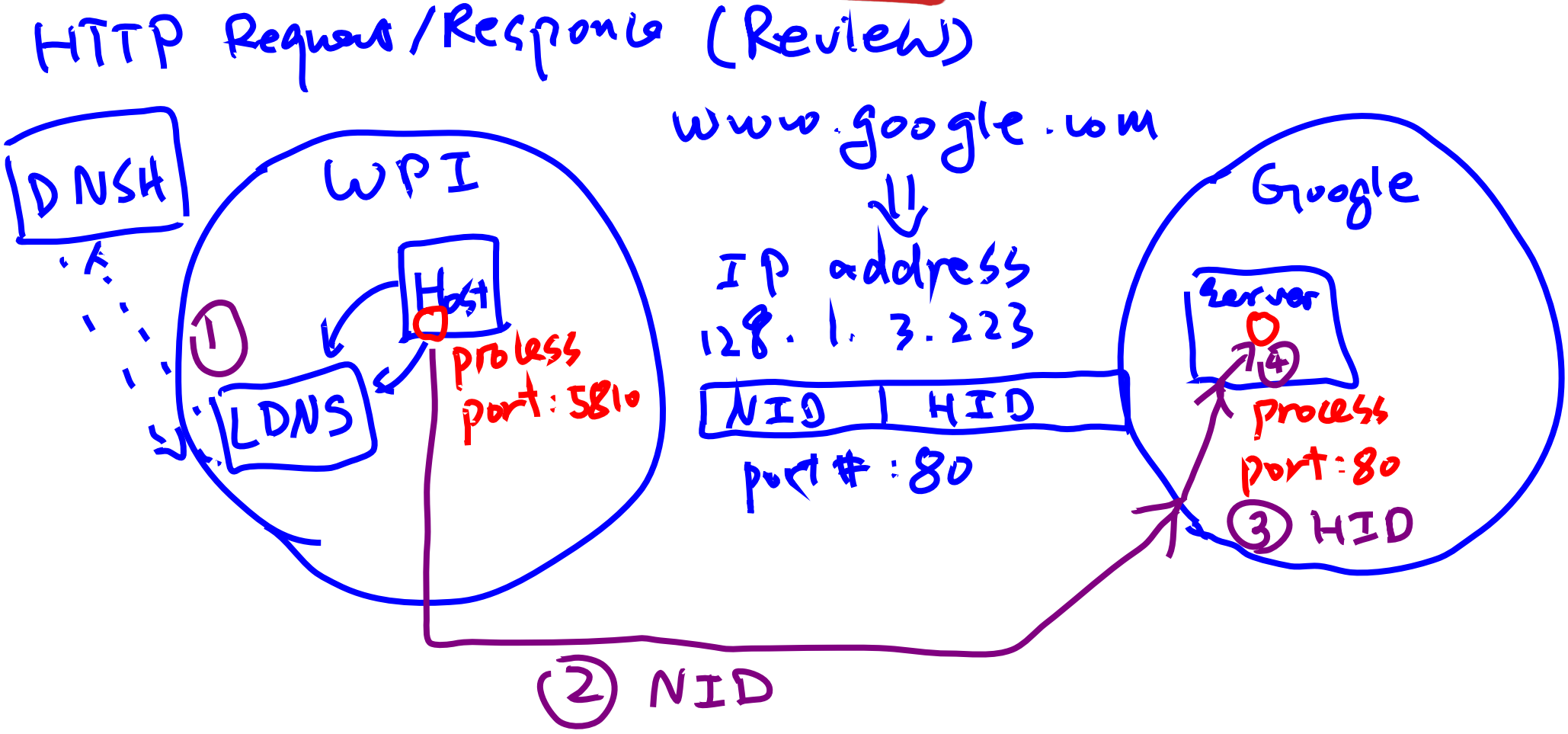
00000001 10000000 10000001 00000011

Dotted Decimal

1 . 128 . 129 . 3

White board

IP addressing: Classful addressing

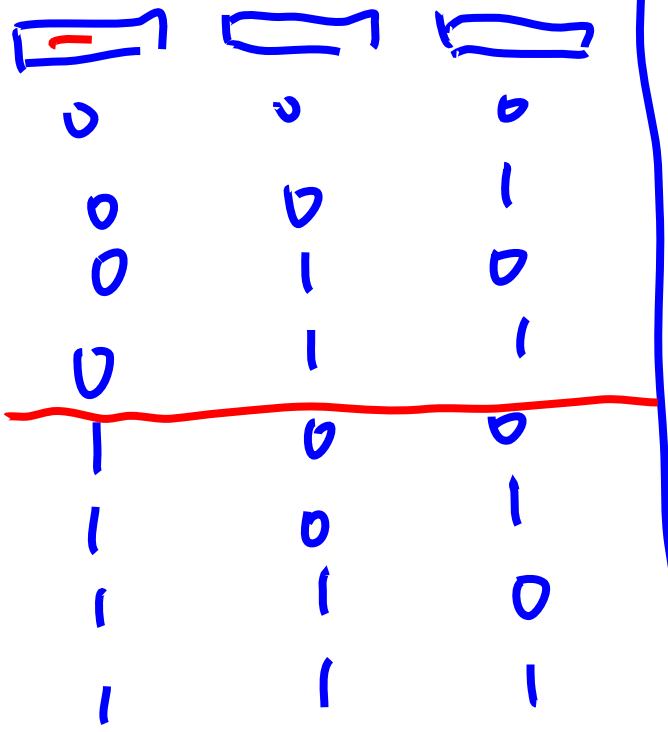


White board

IP addressing: Classful addressing

Number system & Ip address

3 bits 8 numbers



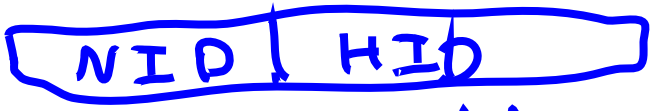
n bits 2^n numbers

2^k parts

each part : $\frac{2^n}{2^k} = 2^{n-k}$ numbers

2^{32} addresses

32 bits IP addresses



8 bits 24 bits

$2^8 = 256$ parts

each part :

2^{24} IP addresses

1980's
NOT SCALABLE
e.g. NASA

White board

Updates

Quiz 7

Graded

Project 2

due today

Project 3

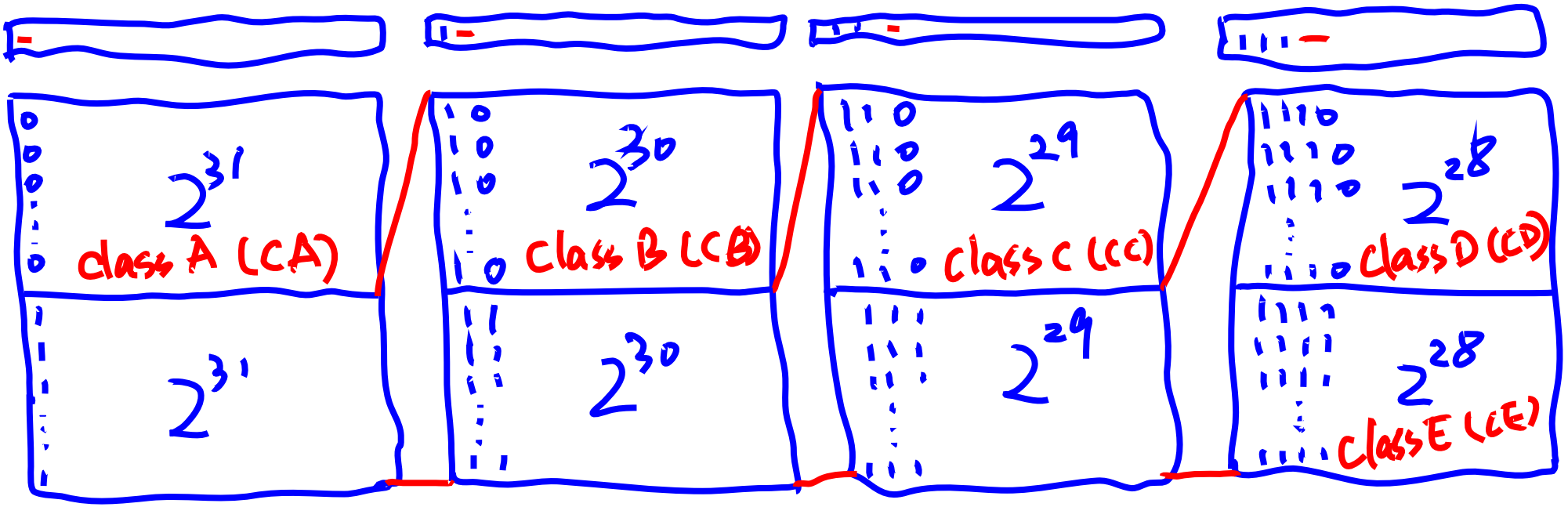
available. We will do a demo tomorrow

Quiz 8

10/9 Friday

Classful addressing | 8 | 8 | 8 | 8 | dotted decimal IP

IP addressing: Classful addressing



2^7 networks
2^{24} Ip addresses per net

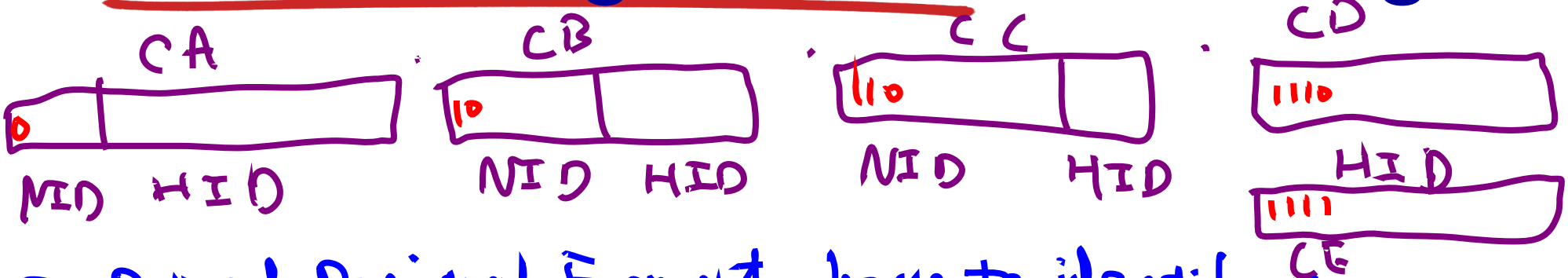
$2^{14} \approx 16k$ networks
2^{16} Ips per net

$2^{21} \approx 2M$ nets
$2^8 = 256$ Ips per net

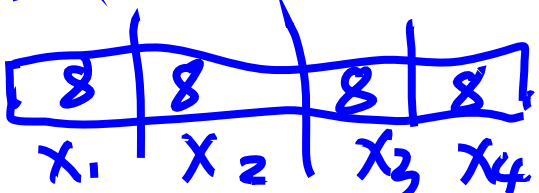
CD: 2^{28} Ips
CE: 2^{28} Ips

White board

IP addressing: Classful addressing



In Dotted Decimal Format, how to identify the class of an IP address?



x_1 0 ~ 127 | x_1 = 128 ~ 191 | x_1 = 192 - 223 | x_1 = 224 ~ 239 (D)
x_1 = 240 ~ 255 (E)

In practice

x_1 : 1 ~ 126

since 0 & 127 are reserved.

For a network, e.g., x_1 = 121 in CA.
All IPs are below: (2^{24} IPs)

121.0.0.0 → (reserved for network IP)
121.0.0.1
⋮
121.255.255.255 → (reserved for broadcasting)

White board

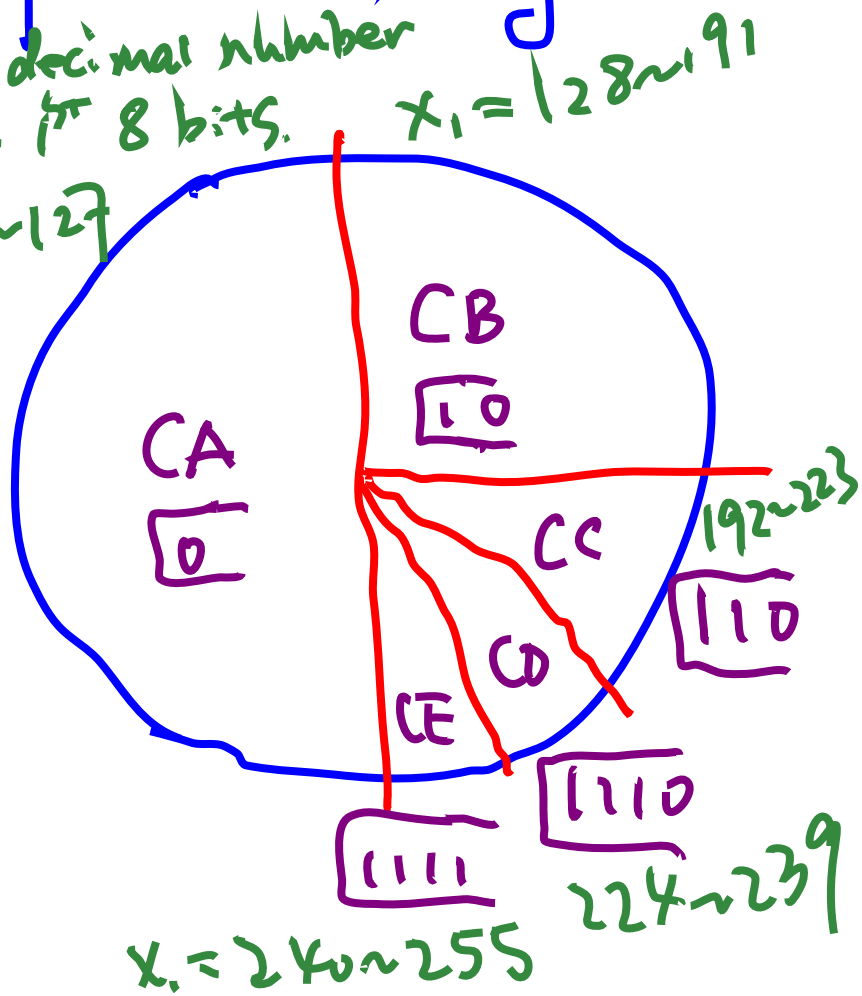
IP addressing: Classful addressing

1980's IP addressing

NID	HID
8	24

$2^8 = 256$ Nets,
each net: $2^{24} \approx 16M$ IPs

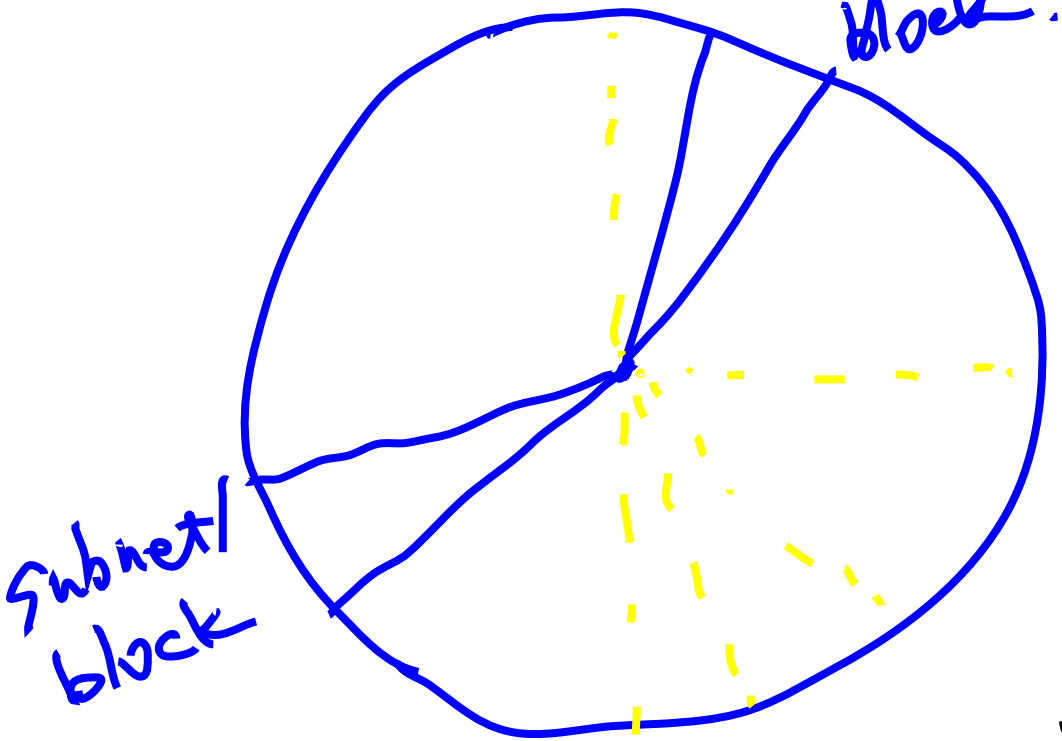
Classful addressing
x_1: the decimal number of the 1st 8 bits.

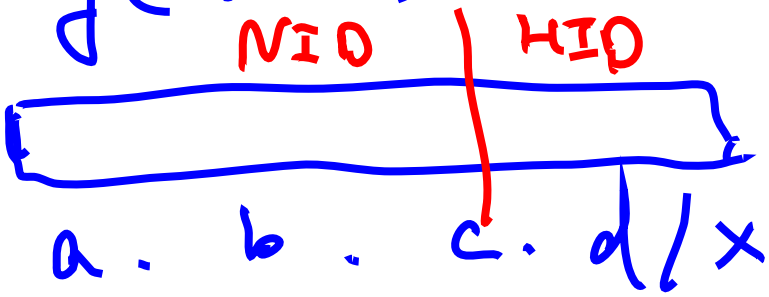


White board

IP addressing: Classful addressing

Classless Interdomain Routing (CIDR)





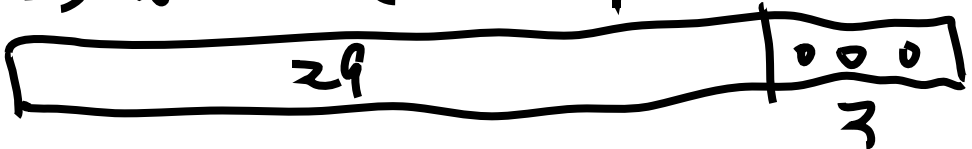
Any number of NID=x and HID.

Rules:

① IPs in a subnet are continuous.

② 2^n IPs a subnet.

③ First IP in a subnet is with the HID part to be 0



example:

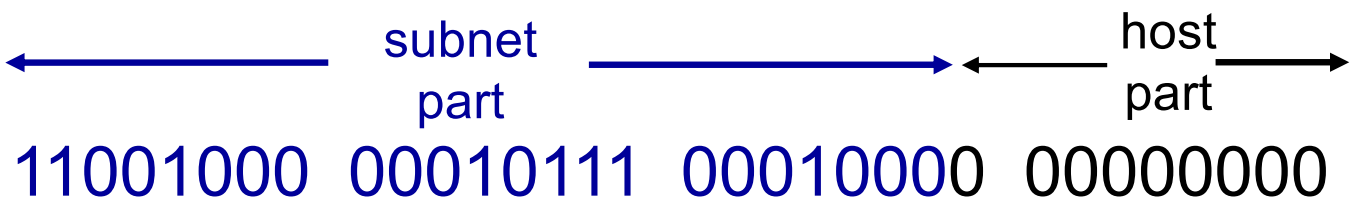
20.10.50.100/20

White board

IP addressing: CIDR

CIDR: Classless InterDomain Routing

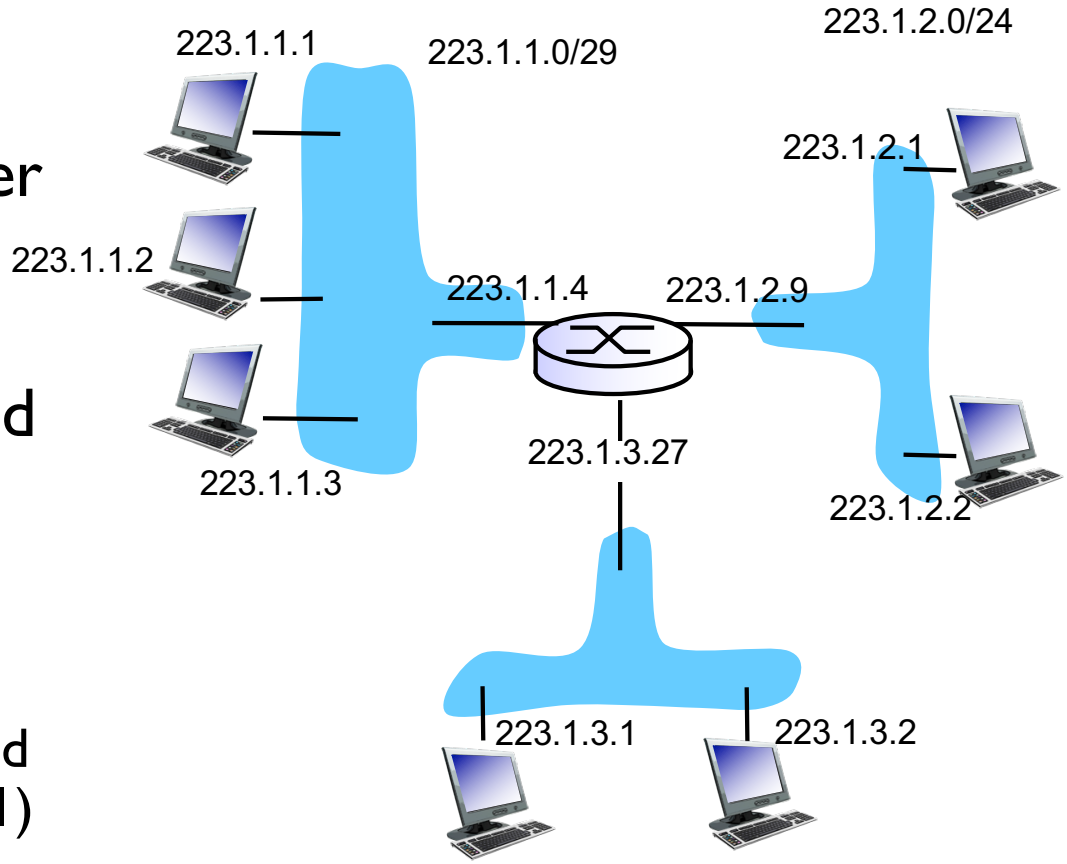
- subnet portion of address of arbitrary length
- address format: a.b.c.d/x, where x is # bits in subnet portion of address



200.23.16.0/23

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 typically has one or two interfaces (e.g., wired Ethernet, wireless 802.11)
- *IP addresses associated with each interface*
  - a subnet
  - = a group of IP addresses
  - = a group of interfaces

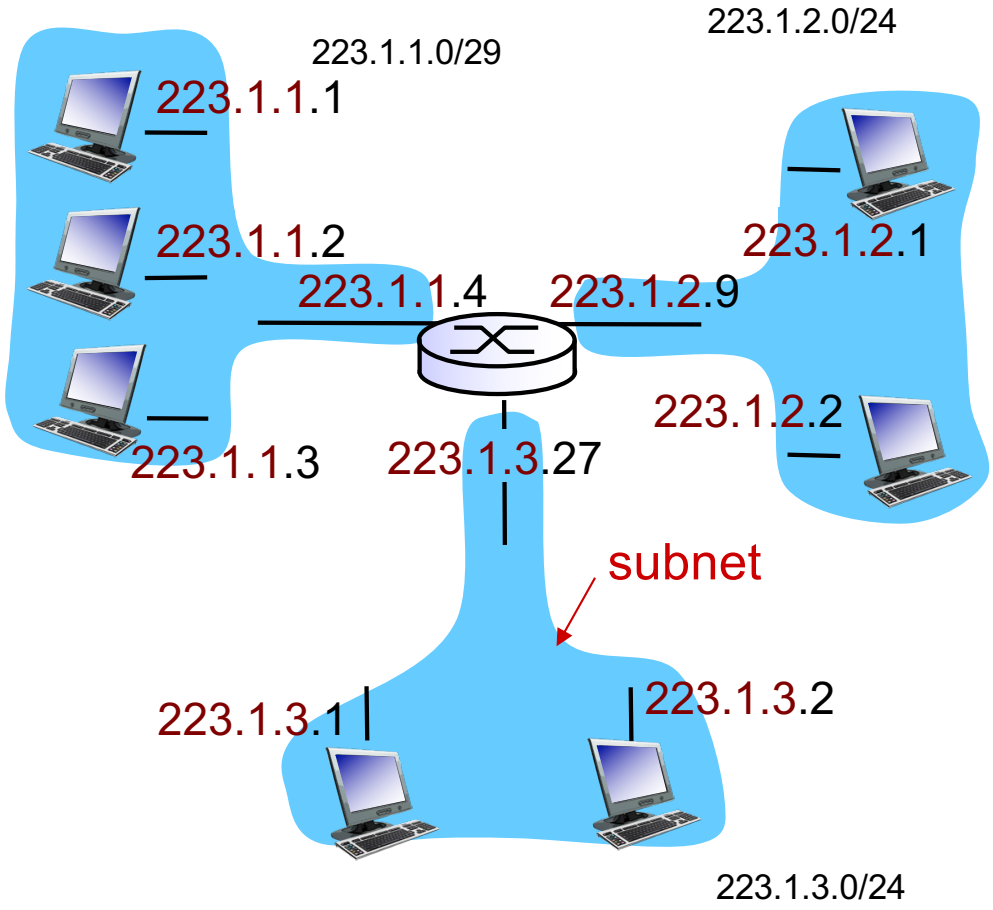


223.1.1.1 = 11011111 00000001 00000001 00000001

223 1 1 1

Subnets

- IP address: a.b.c.d/x
  - subnet part - high order bits
  - host part - low order bits
- *what's a subnet ?*
  - can physically reach each other *without intervening router*
  - device interfaces with same subnet part of IP address

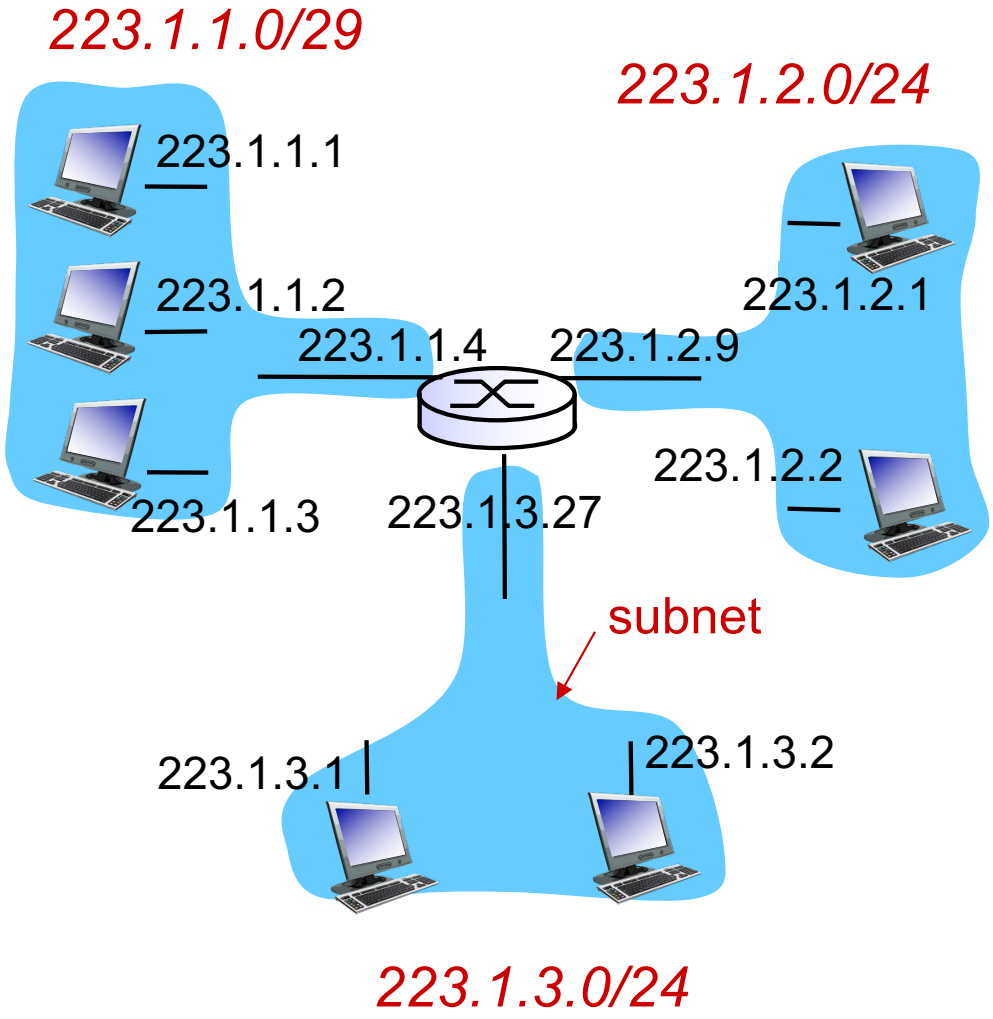


network consisting of 3 subnets

Subnets

recipe

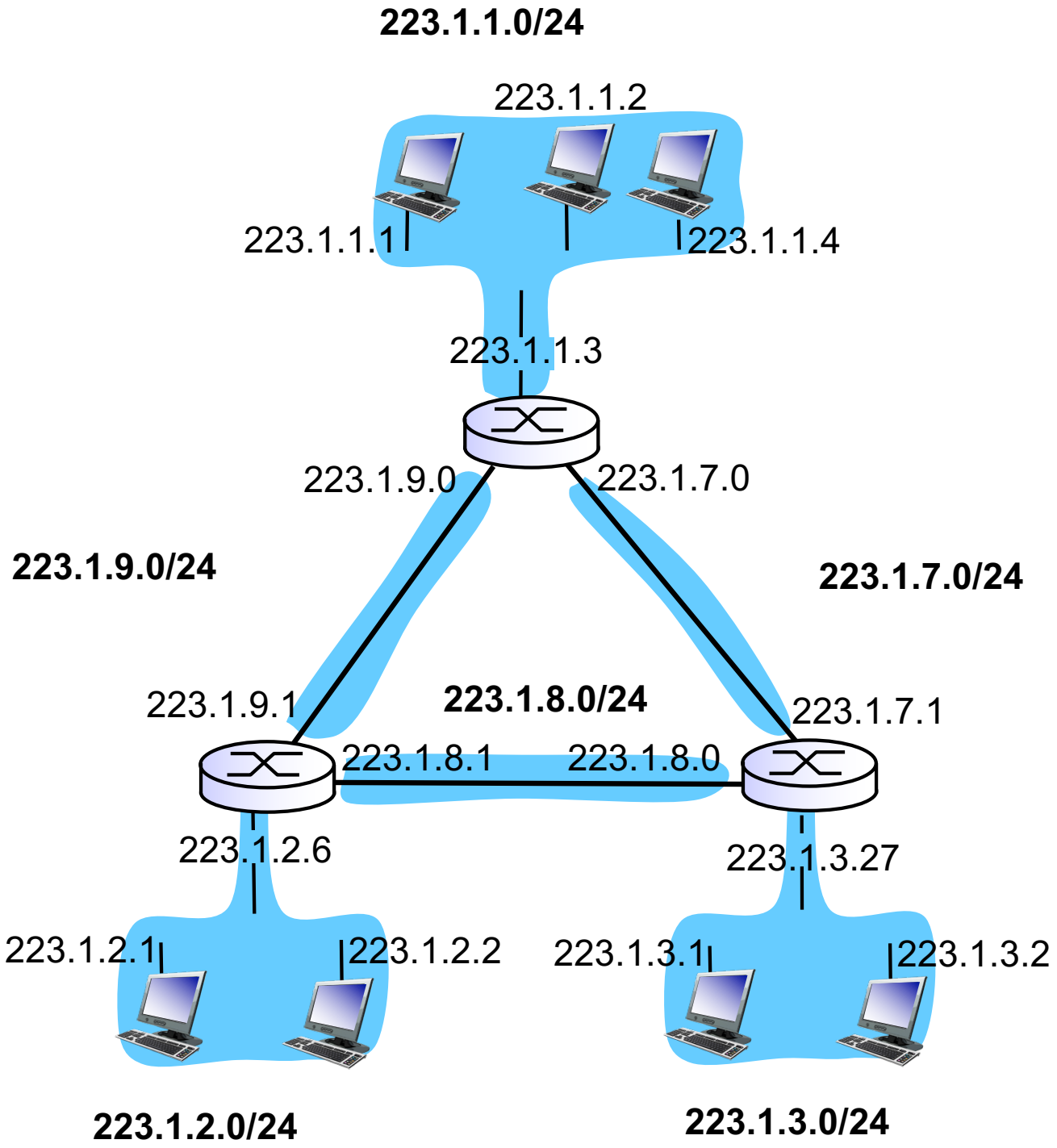
- to determine the subnets, detach each interface from its host or router, creating islands of isolated networks
- each isolated network is called a *subnet*



subnet mask: /24 and /29

Subnets

how many?



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
  - "plug-and-play"

DHCP: Dynamic Host Configuration Protocol

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

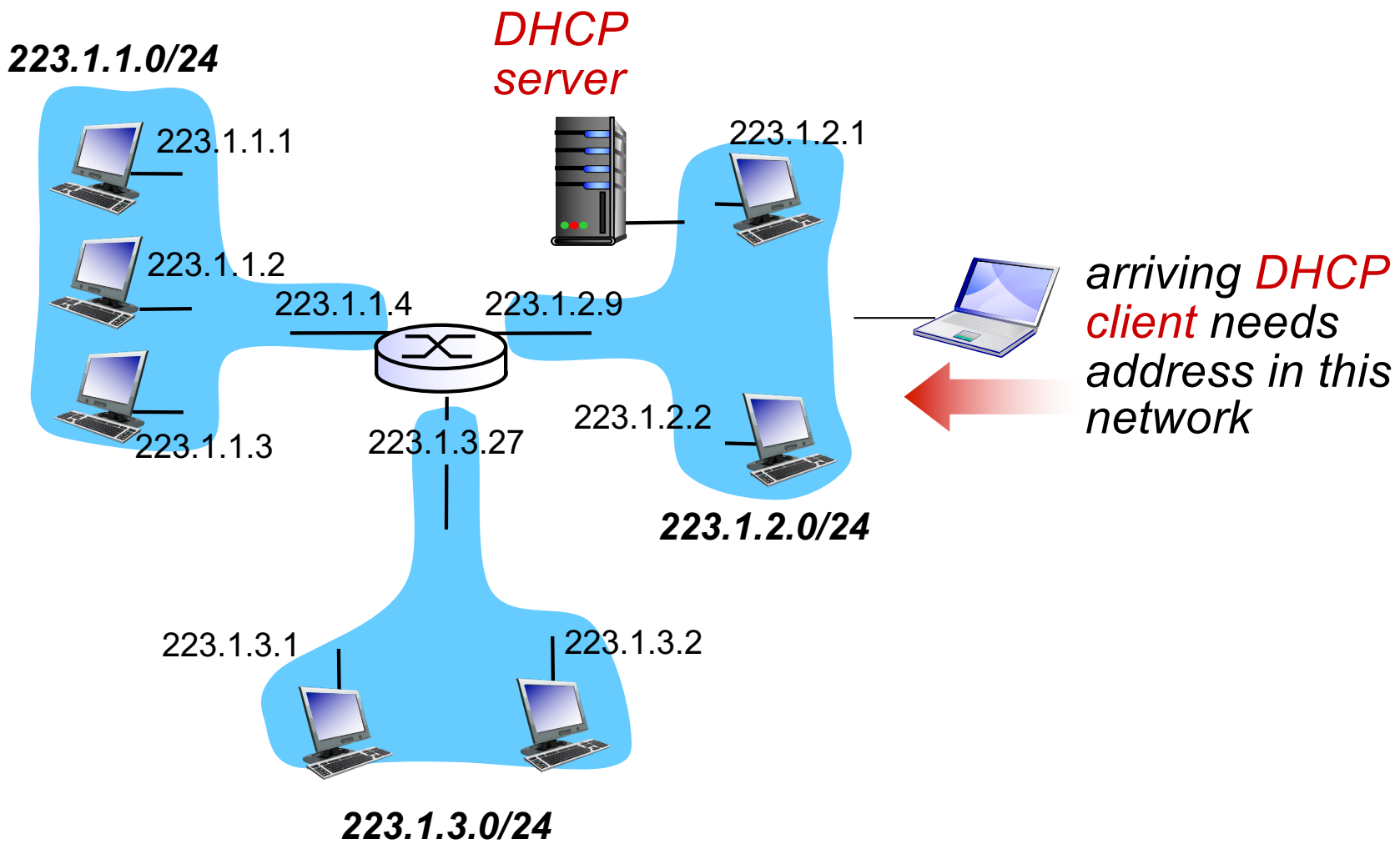
- can renew the lease
- allows reuse of addresses
- support for mobile users

DHCP overview:

- host broadcasts "DHCP discover" msg [optional]
- DHCP server responds with "DHCP offer" msg [optional]

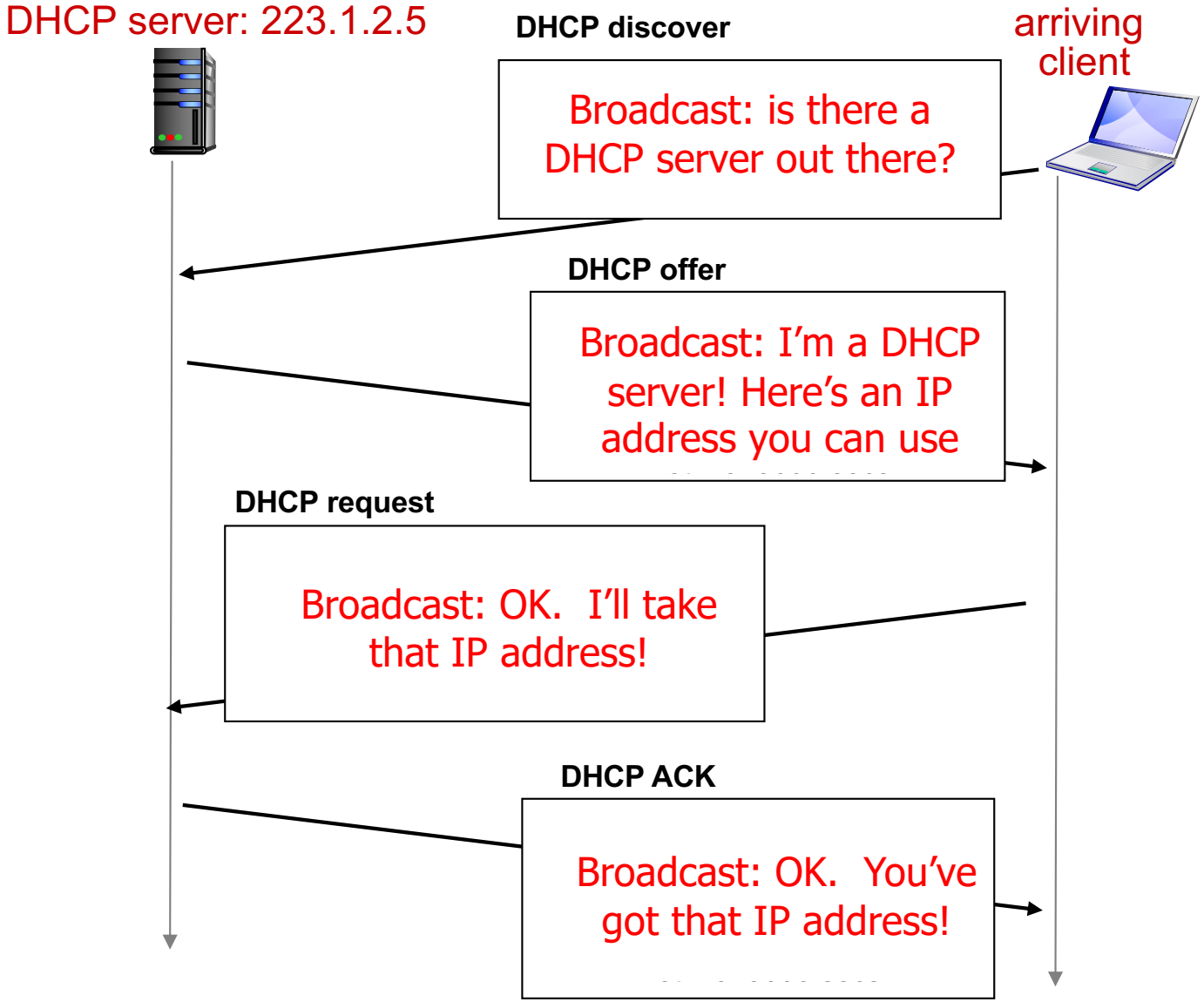
- host requests IP address: "DHCP request" msg
- DHCP server sends address: "DHCP ack" msg

DHCP client-server scenario



DHCP client-server scenario

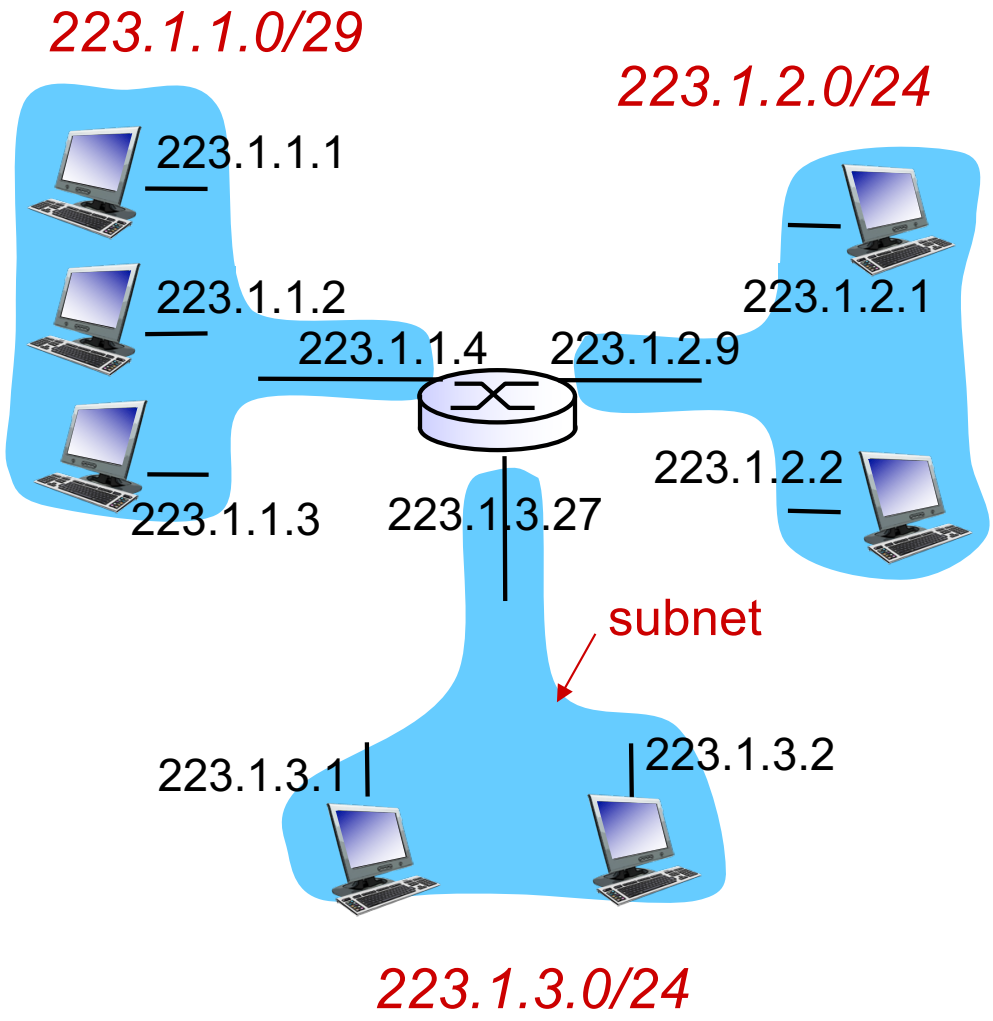
Transport Layer protocol: UDP



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 LDNS sever
- network mask (indicating network versus host portion of address)



subnet mask: /24 and /29

IP addresses: how to get one?

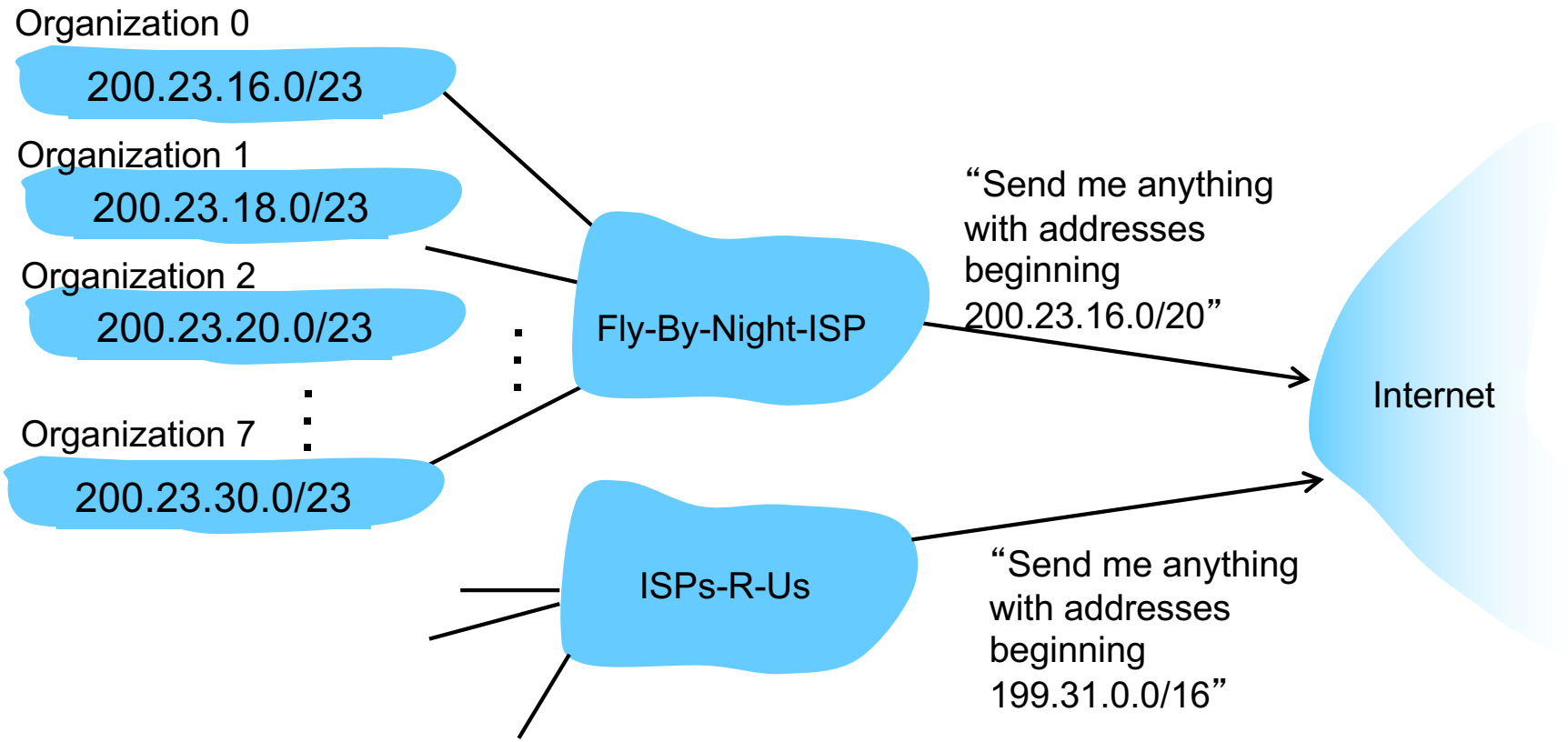
Q: how does *network* get subnet part of IP addr?

A: gets allocated portion of its provider ISP's address space

ISP's block	11001000 00010111 00010000	00000000	200.23.16.0/20
Organization 0	11001000 00010111 00010000	00000000	200.23.16.0/23
Organization 1	11001000 00010111 00010010	00000000	200.23.18.0/23
Organization 2	11001000 00010111 00010100	00000000	200.23.20.0/23
...	.....	....	....
Organization 7	11001000 00010111 00011110	00000000	200.23.30.0/23

Hierarchical addressing: route aggregation

hierarchical addressing allows efficient advertisement of routing information:



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
- http://www.icann.org/

Questions