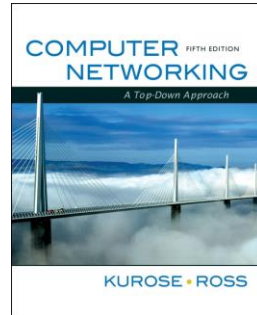# RSC
Part II: Network Layer
3. IP addressing

Redes y Servicios de Comunicaciones
Universidad Carlos III de Madrid

These slides are, mainly, part of the companion slides to the book "Computer Networking: A Top Down Approach" generously made available by their authors (see copyright below). The slides have been adapted, where required, to the teaching needs of the subject above.

Computer Networking: A Top Down Approach 5th edition.
Jim Kurose, Keith Ross
Addison-Wesley, April 2009.

RSC Part II: Network Layer

IP Addressing: introduction

☐ IP address: 32-bit identifier for host, router *interface*
2³²: 4.294.967.296 hosts

☐ *interface*: connection between host/router and physical link
  ○ router's typically have multiple interfaces
  ○ host typically has one interface
  ○ IP addresses associated with each interface

223.1.1.1

223.1.1.2

223.1.1.4   223.1.2.9
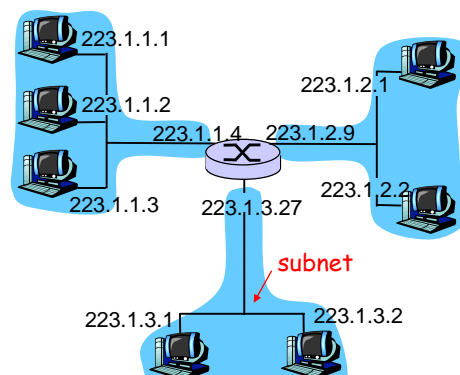
223.1.1.3   223.1.3.27

223.1.2.1

223.1.2.2

223.1.3.1   223.1.3.2

223.1.1.1 = 11011111 00000001 00000001 00000001

    223   1   1   1

Network Layer II-3
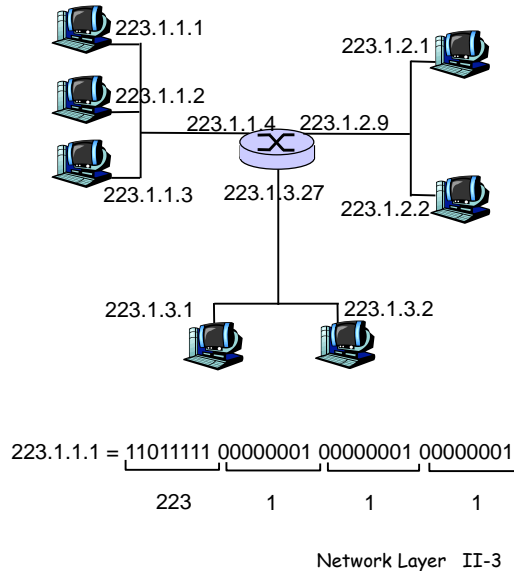
Subnets

☐ IP address:
  ○ subnet part (high order bits)
  ○ host part (low order bits)

☐ *What's a subnet ?*
  ○ device interfaces with same subnet part of IP address
  ○ can physically reach

223.1.1.1

223.1.1.2

223.1.1.4   223.1.2.9

223.1.1.3   223.1.3.27

223.1.2.1

223.1.2.2

subnet

223.1.3.1   223.1.3.2

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.
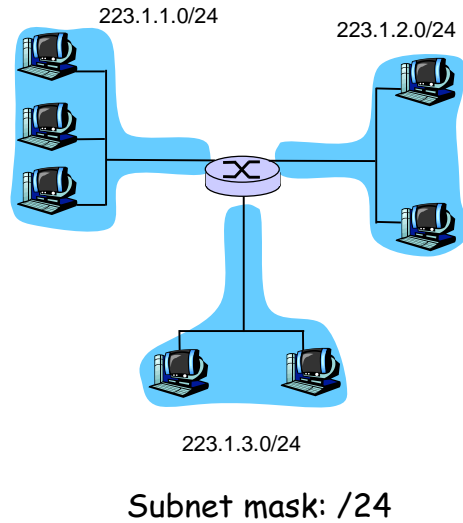
223.1.1.0/24   223.1.2.0/24

223.1.3.0/24

Subnet mask: /24

Subnets

How many?

223.1.1.2

223.1.1.1   223.1.1.4

223.1.1.3

223.1.9.2   223.1.7.2

223.1.9.1   223.1.7.1

223.1.8.1   223.1.8.0

IP addresses: how to get one?

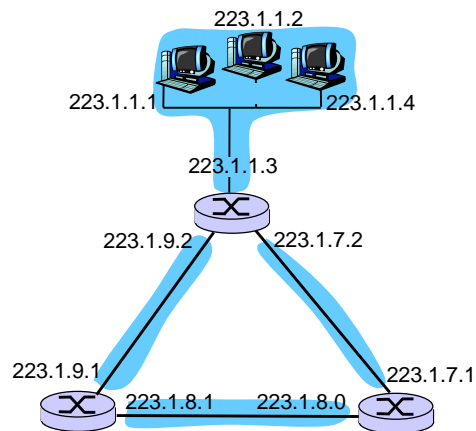Q: How does *network* get subnet part of IP addr?
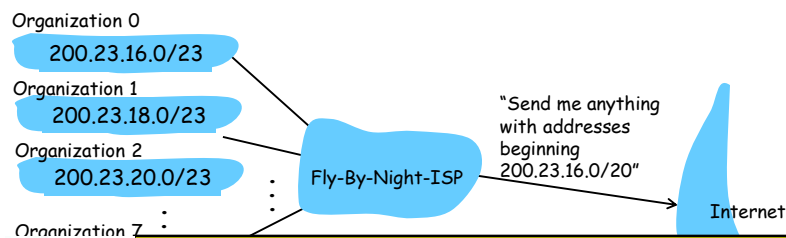
A: gets allocated portion of its provider ISP's address space

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:

Organization 0
200.23.16.0/23

Organization 1
200.23.18.0/23

Organization 2
200.23.20.0/23

Fly-By-Night-ISP

Organization 7

"Send me anything with addresses beginning 200.23.16.0/20"

Internet

IP addressing: CIDR

CIDR: Classless InterDomain Routing

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

Network part
(network prefix)   host part

11001000 00010111 00010000 00000000

200.23.16.0/23
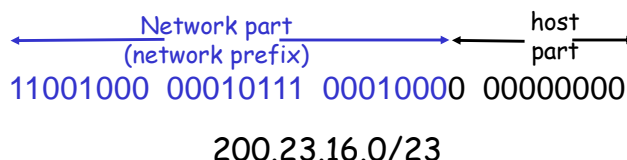
Network Layer II-9

Subnetting

223.1.1.0/24   223.1.2.0/24

network   subnet   host

11011111 00000001 000000 | XX | XXXXXXXX

22 bits   2 bits   8 bits

Subnet mask: 255.255.255.0 or /24 -> 254 interfaces

223.1.3.0/24

□ **A little bit more complex, Variable length subnet mask:**

network   subnet   host

11011111 00000001 000000 | XX | XXXXXXXX

22 bits   2 bits   8 bits

223.1.3.0/25
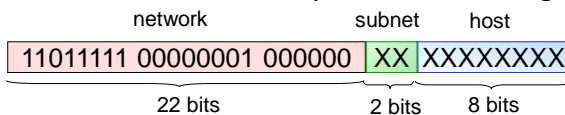
Subnet mask: 255.255.255.0 or /24:

223.1.0.0/24, 223.1.1.0/24 y 223.1.2.0/24
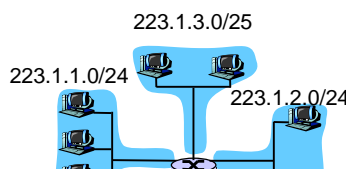
223.1.1.0/24   223.1.2.0/24

CLASES PARTICULARES, TUTORÍAS TÉCNICAS ONLINE
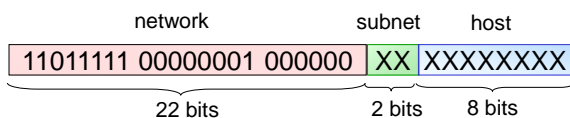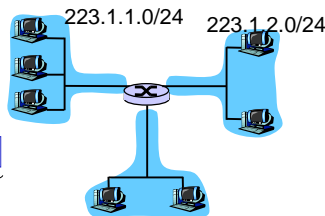LLAMA O ENVÍA WHATSAPP: 689 45 44 70

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Subnetting

☐ Special values:
- ❍ All 0's in host part
  - • Subnet
- ❍ All 1's in host part
  - • Broadcast address

network	subnet	host
XXXXXXXXXXXXXXXX XXXXX	XXX	00000000
	s bits	h bits

network	subnet	host
XXXXXXXXXXXXXXXX XXXXX	XXX	11111111
	s bits	h bits
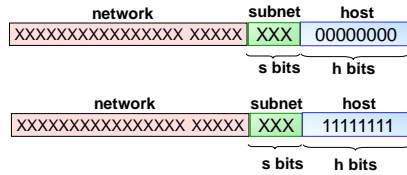
(2^h-2) possible interfaces in a subnet

- ❍ 0.0.0.0/0
  - • Default
- ❍ 127.0.0.0/8, 127.0.0.1/32
  - • Loopback
- ❍ 224.0.0.0/4
  - • Multicast

Network Layer II-11

Forwarding

Network	Mask	Gateway	Interface
223.1.1.0	255.255.255.0		223.1.1.3
223.1.9.0	255.255.255.0		223.1.9.2
223.1.7.0	255.255.255.0		223.1.7.2
223.1.2.0	255.255.255.0	223.1.9.1	223.1.9.2
0.0.0.0	0.0.0.0	223.1.7.1	223.1.7.2

223.1.1.1   223.1.1.2   223.1.1.4

223.1.1.3

223.1.9.2   223.1.7.2

CLASES PARTICULARES, TUTORÍAS TÉCNICAS ONLINE
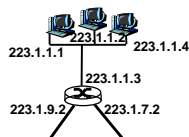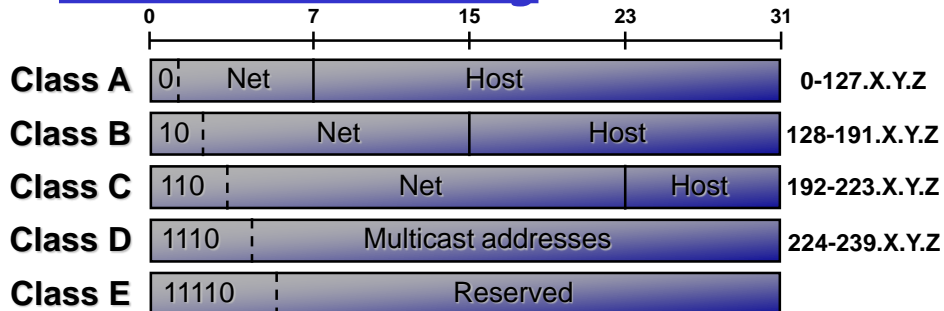LLAMA O ENVÍA WHATSAPP: 689 45 44 70

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Classful addressing

Class A	0 Net	Host	**0-127.X.Y.Z**
Class B	10 Net	Host	**128-191.X.Y.Z**
Class C	110 Net	Host	**192-223.X.Y.Z**
Class D	1110 Multicast addresses		**224-239.X.Y.Z**
Class E	11110 Reserved		

Bit positions: 0, 7, 15, 23, 31

- Disadvantages:
  - Too rigid: Class B too large for most organizations (65634 hosts), class C too small (254 hosts)
  - Either poor space address utilization or multiple entries in routing tables -> solution CIDR
  - Interesting for historical reasons
  - 224.0.0.0/4 still are multicast addresses

Addresses and names

- For humans, it is convenient to manage names instead of numbers
  - We can associate a name to an address:
    - Eg. **163.117.144.202** - **it002.lab.it.uc3m.es**
  - A distributed application: *Domain Name System* (DNS), resolves names into addresses
    - DNS names are hierarchical to distribute their management
  - Nodes connected to the network need the address of a DNS server to resolve names
    - Manual configuration or DHCP