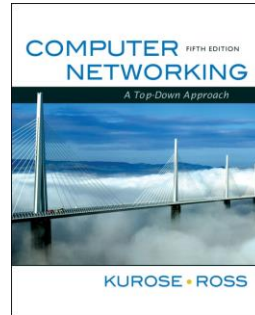


RSC

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.

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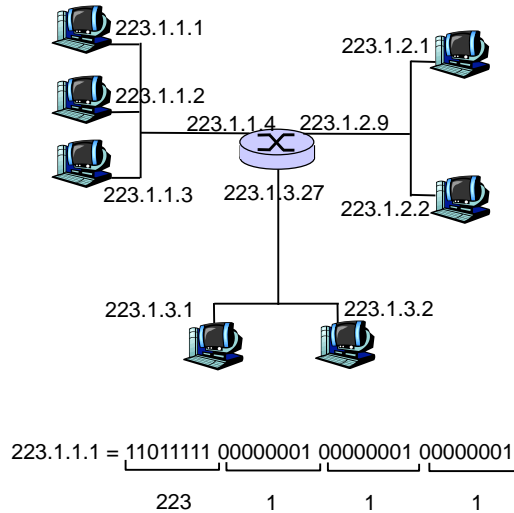
*Computer Networking:
A Top Down Approach
5th edition.*
Jim Kurose, Keith Ross
Addison-Wesley, April
2009.

RSC Part II: Network Layer

- II. 1 Basic Network layer concepts
- II.2 Introduction to IP
 - Datagram format
 - ICMP
- **II.3 IP addressing**
- II.4 IP in operation
 - ARP
- II.5 Network routing
 - Link state
 - Distance Vector
 - Hierarchical routing
- II.6 Routing in the Internet
 - RIP
 - OSPF
 - BGP
 - Broadcast and multicast

IP Addressing: introduction

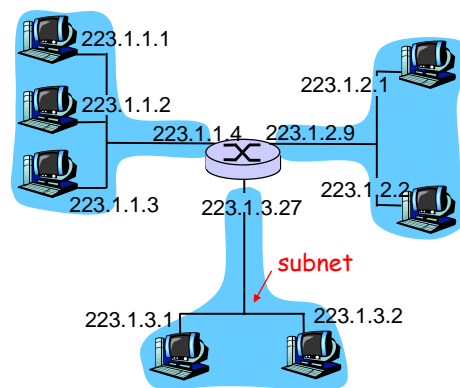
- **IP address:** 32-bit identifier for host, router *interface*
 2^{32} : 4.294.967.296 hosts
- **interface:** connection between host/router and physical link
 - router's typically have multiple interfaces
 - host typically has one interface
 - IP addresses associated with each interface



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 each other without intervening router

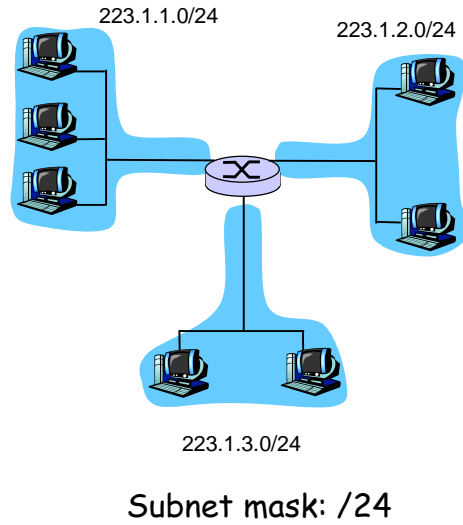


Network Layer II-4

Subnets

Recipe

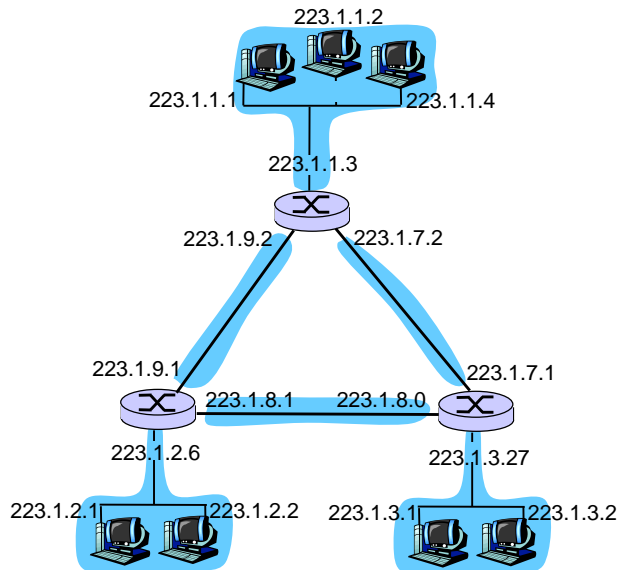
- To determine the subnets, detach each interface from its host or router, creating islands of isolated networks. Each isolated network is called a **subnet**.



Network Layer II-5

Subnets

How many?



Network Layer II-6

IP addresses: how to get one?

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

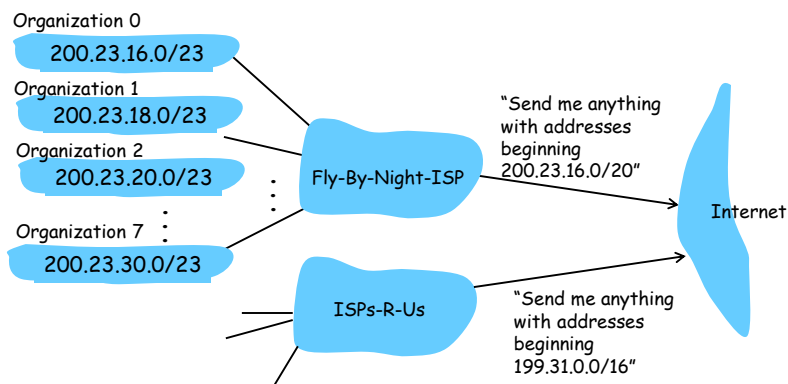
A: gets allocated portion of its provider ISP's address space

ISP's block	<u>11001000</u>	<u>00010111</u>	<u>00010000</u>	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

Network Layer II-7

Hierarchical addressing: route aggregation

Hierarchical addressing allows efficient advertisement of routing information:

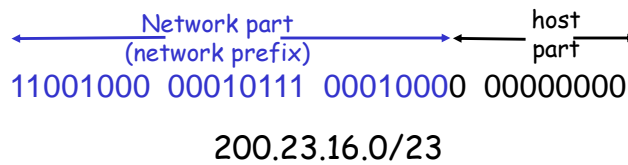


Network Layer II-8

IP addressing: CIDR

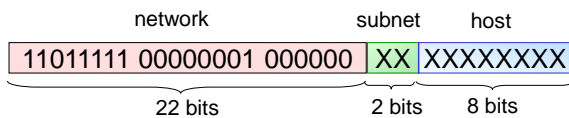
CIDR: Classless InterDomain Routing

- 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

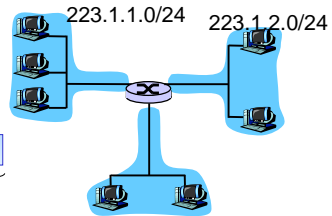


Network Layer II-9

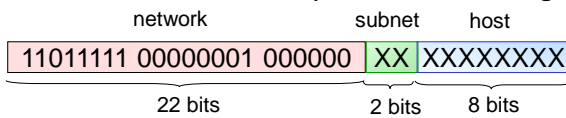
Subnetting



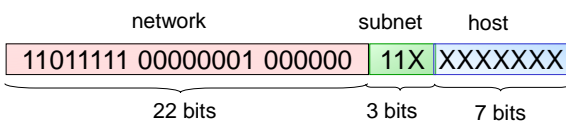
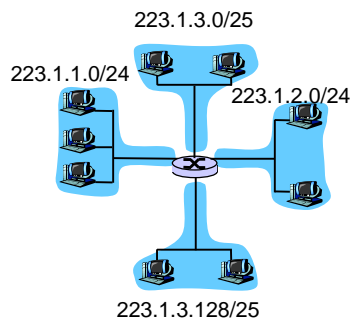
Subnet mask: 255.255.255.0 or /24 -> 254 interfaces



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



Subnet mask: 255.255.255.0 or /24:
223.1.0.0/24, 223.1.1.0/24 y 223.1.2.0/24

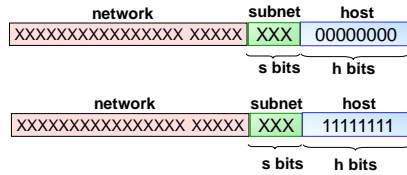


Subnet mask: 255.255.255.128 or /25 -> 126 interfaces

Subnetting

Special values:

- All 0's in host part
 - Subnet
- All 1's in host part
 - Broadcast address



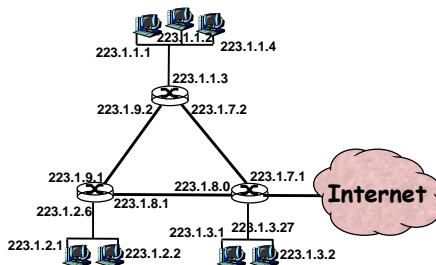
$(2^h - 2)$ possible interfaces in a subnet

- 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

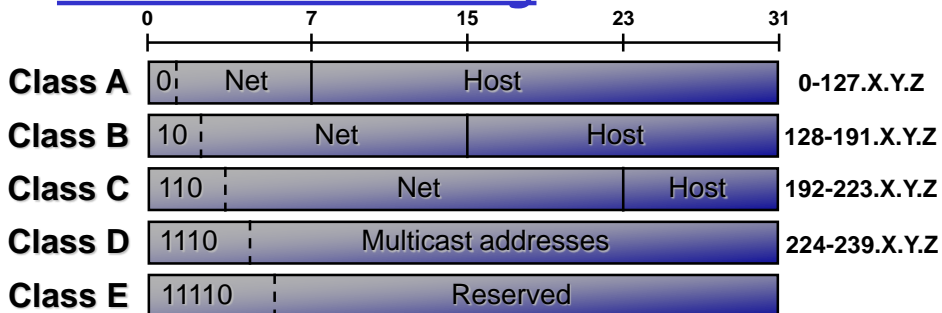
Forwarding

<u>Network</u>	<u>Mask</u>	<u>Gateway</u>	<u>Interface</u>
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



Network Layer II-12

Classful addressing



- 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

Network Layer II-13

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
- This is the idea, DNS is a complex application that will be studied in future courses

Network Layer II-14