

National University of Computer & Emerging Sciences

CS 3001 - COMPUTER NETWORKS

Lecture 18 Chapter 4

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Office Hours: 02:30 pm till 06:00 pm (Every Tuesday & Thursday)

Chapter 4

Network Layer

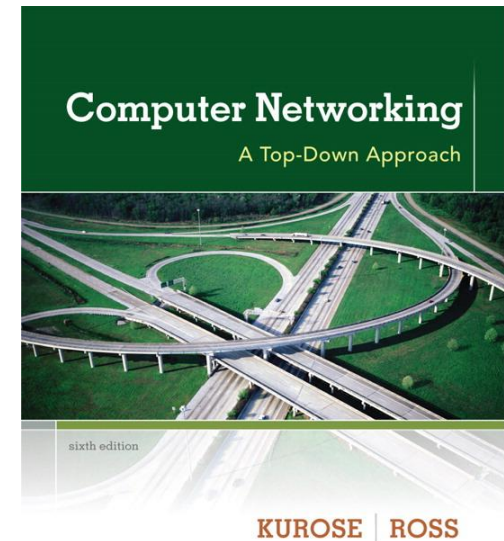
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Thanks and enjoy! JFK/KWR

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**Computer
Networking: A Top
Down Approach**
6th edition
Jim Kurose, Keith Ross
Addison-Wesley
March 2012

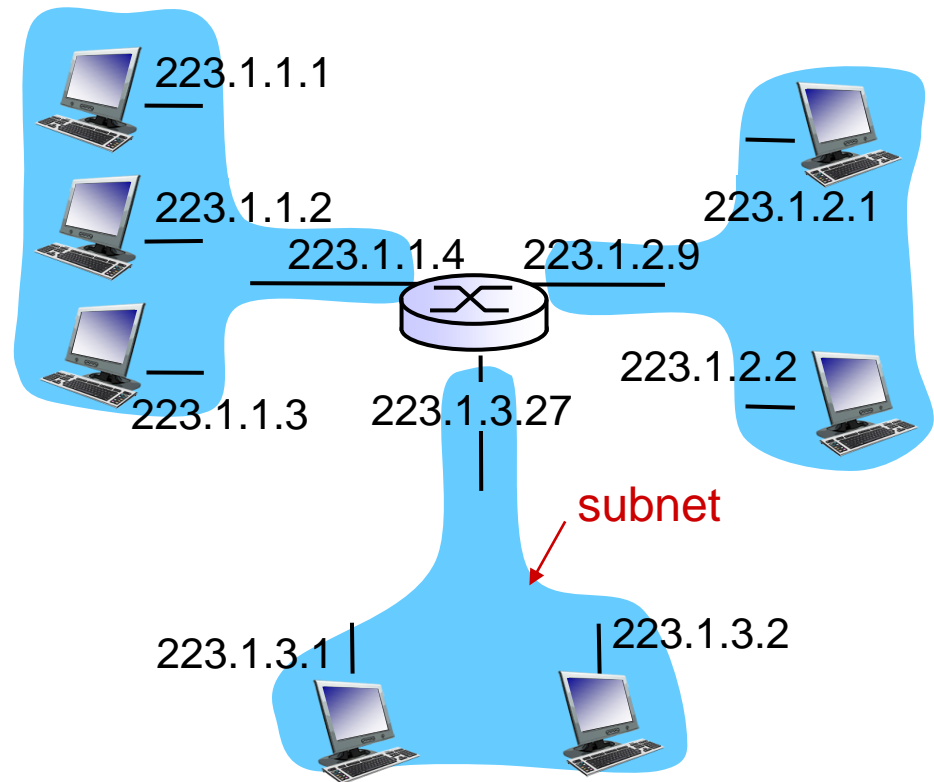
Subnets

❖ IP address:

- subnet part - high order bits
- host part - low order bits

❖ *what 's a subnet ?*

- Is a subnetwork
- device interfaces with same subnet part of IP address
- can physically reach each other *without intervening router*

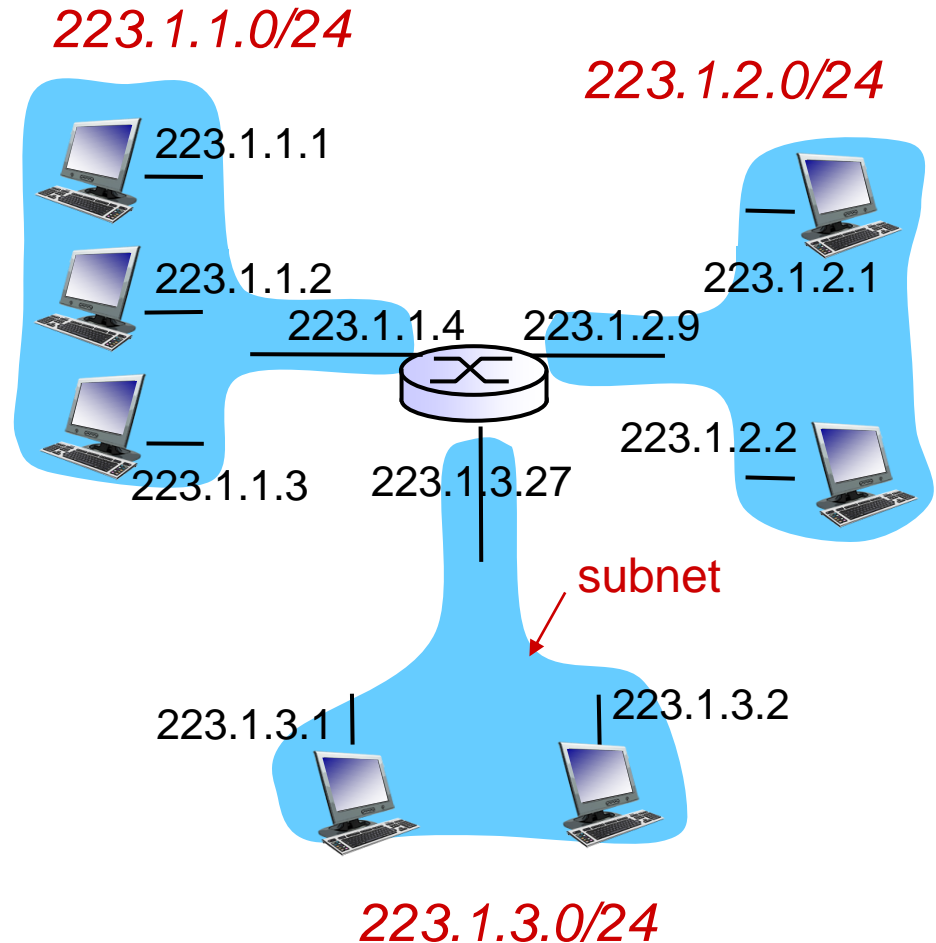


network consisting of 3 subnets

Subnets

recipe

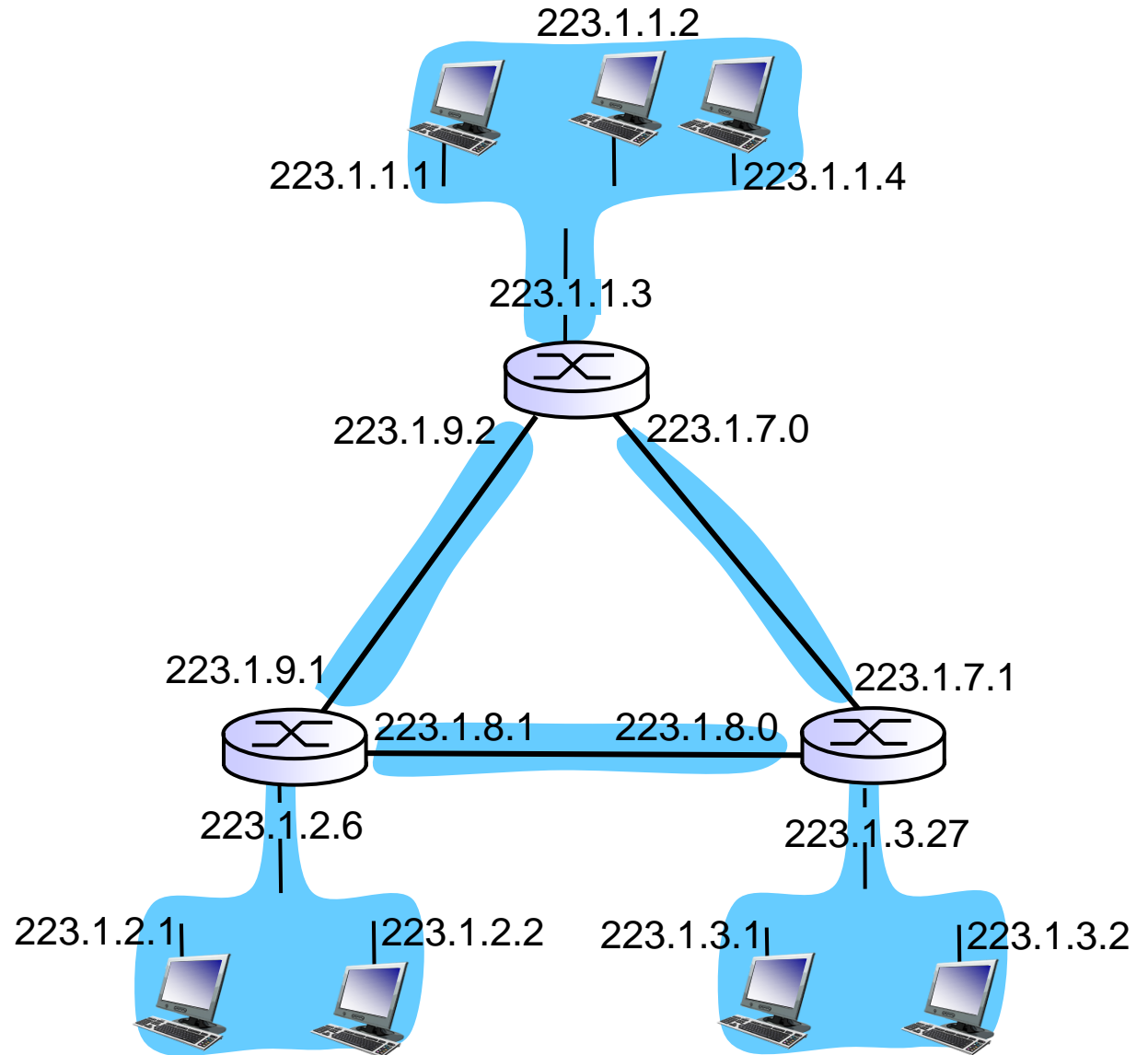
- ❖ to determine the subnets, detach each interface from its host or router, creating islands of isolated networks
- ❖ each isolated network is called a *subnet*



subnet mask: /24

Subnets

how many?



Subnetting

- Subnetting is the process of dividing a network (within a single IP network address space) into smaller sized networks called subnets
- It is transparent to the outside world, i.e. the outside world can only see one network and a single net ID, but internally, there can be multiple subnets, each having an ID similar to the parent network's net ID called subnet ID or network prefix or simply prefix
- Thus the tables in the routers of the internet are not affected, i.e. they don't need to have entries for any of the subnet, just the entry of the original (parent network) i.e., while only internal router of the corresponding network needs to have the subnet entries in its tables
- IP addresses in Class A, B & C have two levels of hierarchy, i.e. **IP address = (net ID, host ID)** Subnetting creates another level of hierarchy, i.e. **IP address = (net ID, subnet ID, host ID)** Again, this subnet ID is transparent to the outside world, i.e. they will still see **IP address = (net ID, host ID)**. Delivery of incoming IP packets from the internet to this network involves **three** steps now: delivery to the site router, delivery to the subnet router, delivery to the end host

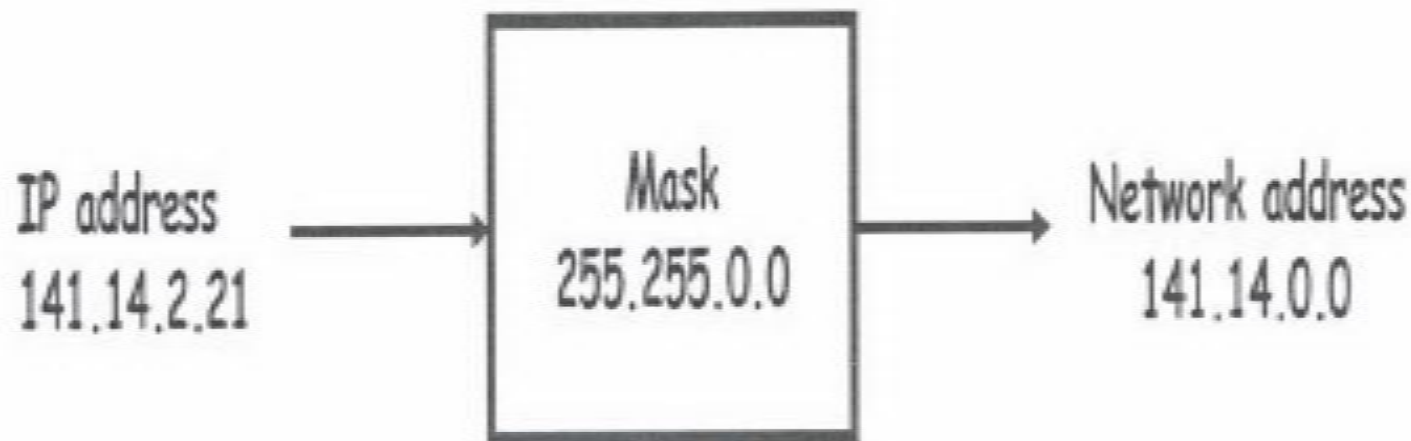
Subnet Mask (SM)

- **Masking** is the process of extracting the network address / net ID (if no subnetting is done) or subnet ID (if subnetting is done) from an IP address
- **SM** is a 32 bit **pattern / sequence** (not address) which has a "1" in **every network ID** & a "1" in **every subnet ID** (if any) bit location and a "0" in **every host ID** bit location.
- Subnet masking is performed (both at the host & the router) by applying "bit-wise-AND" operation between the IP Address & the subnet mask
- **Default masks (No subnetting)**: for Class A is 255.0.0.0, for Class B is 255.255.0.0, for Class C is 255.255.255.0, so from outer world (Global), subnet mask of unsubnetted network address 128.125.0.0 is 255.255.0.0 (since it is class B.)
- After subnetting network 128.125.0.0 network into 8 equal subnets, subnet mask will be 255.255.224.0 (visible only internally, invisible to the outside world.)
- All devices on the same subnet **must** have the same subnet mask. Furthermore, devices on different subnets **may** have the same subnet masks, but will have **different** subnet IDs
- When a host performs a **logical AND** between it's IP address & the subnet mask, it gets the net ID / subnet ID
- The network's internal router will have in it's forwarding table 3 entry columns, i.e. i) **subnet IDs of all the subnets**, ii) **their subnet masks** & iii) **their corresponding interfaces**
- **Question**: When a packet arrives at this router from the outside world for a host in one of the subnets, how does this router determine that the destination host resides on which subnet?
- **Answer**: The router performs a logical AND between the destination IP address it received and all the subnet masks in it's forwarding table. The result will be the subnet ID of one of the attached subnets. The router can now forward the incoming packet to this subnet.

Important Point: Net ID / Network Address of parent network (unsubnetted network) & first subnet may be the same, but their subnet masks will be different.

Subnet Mask (SM)

- Example 1: Class B network without subnetting
 - 141.14.2.21 10001101.00001110.00000010.00010101
 - 255.255.0.0 11111111.11111111.00000000.00000000
 - "Bit-wise and" 10001101.00001110.00000000.00000000



Difference between Classful, CIDR, FLSM & VLSM in IP Addressing

These four terms can be categorized into two categories:

- ❖ Classful and CIDR — these have to do with the size of networks as they are assigned from IANA (a sub function of ICANN).
- ❖ FLSM and VLSM — (i.e. Fixed Length Subnet mask & Variable Length Subnet Mask.) These have to do with how the administrator allocate your IP space within your networks (assignment by the local network administrator.)

“FLSM & VLSM refer to how IP address space is assigned within each organization (by their local network administrator.) Classful and CIDR refer to how IP address space is allocated (by ICANN - IANA.)”

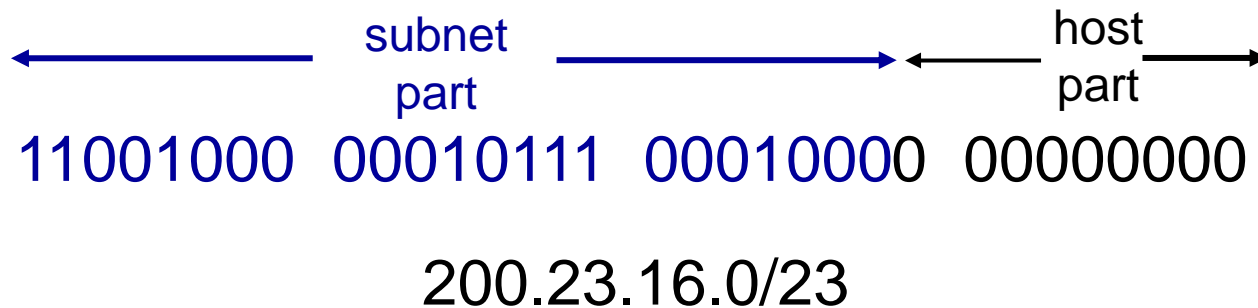
Summary

- ❑ Classful addressing is ICANN assigning IP space from Class A, B, or C blocks (legacy) & local administrator can then apply FLSM (if required)
- ❑ Classless is ICANN assigning IP space in any size block, as required (modern standard) and local administrator can then apply FLSM or VLSM (if required)
- ❑ CIDR is simply classless, but VLSM already applied by ICANN and then assigned to an organization.
- ❑ FLSM mandates that every IP subnet within your deployment be the same size (legacy).
- ❑ VLSM allows IP subnets within your deployment to be of different sizes (modern standard.)

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



Examples of Classless IP Addressing

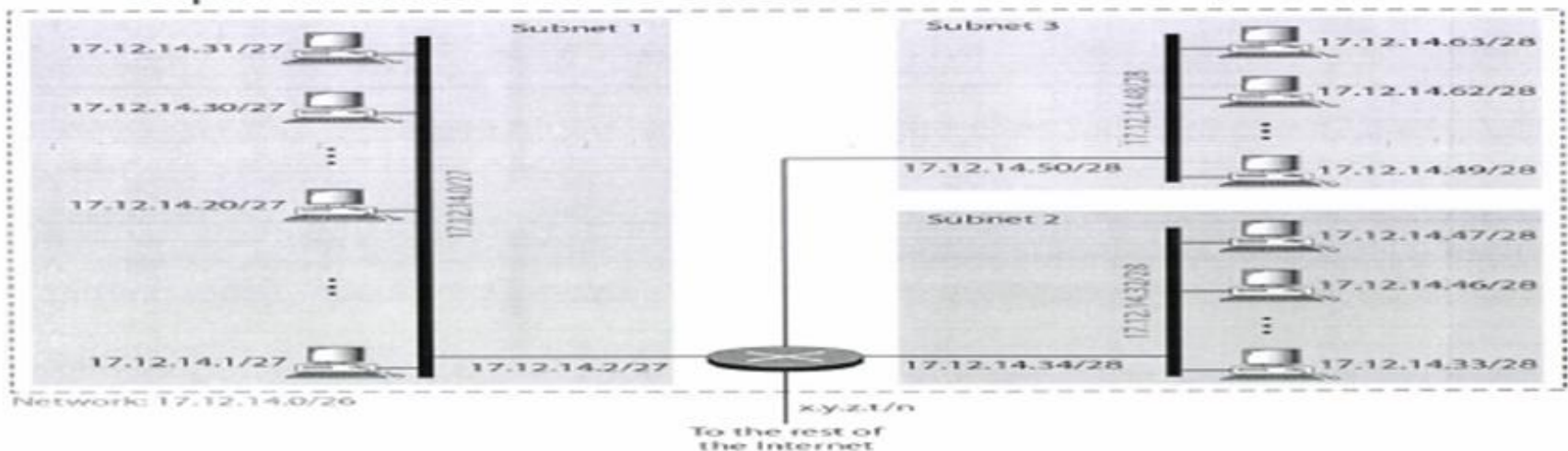
Example of Classless IP Addressing

- An ISP gets a block of IP addresses. The Block is 200.23.16.0/20. The size of the block is $2^{12} = 4096$. The ISP has 8 customers (organizations), each requiring a "block" of size 512

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

Example of Classless IP Addressing

- Organization was assigned a block 17.12.14.0/26 (Size of block is 64). Organization has three departments. Three subnets of sizes 32, 16 and 16



Fixed Length Subnet Mask (FLSM) - Example Video (Watch First)

- For revision of **FLSM** discussed in the Class, please watch and review my video shared via **Google Classroom**. (Please watch the complete video, where I explain & solve an example of FLSM in detail.)

Variable Length Subnet Mask (VLSM) - Example Video (Watch Second)

- For revision of **VLSM** discussed in the Class, please watch and review my video shared via **Google Classroom**. (Please watch the complete video, where I explain & solve an example of VLSM in detail.)

Very Important topic of Computer Networks
!!!!!!!