IP Subnetting and Addressing

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Lecture 6: IP Subnetting and Addressing

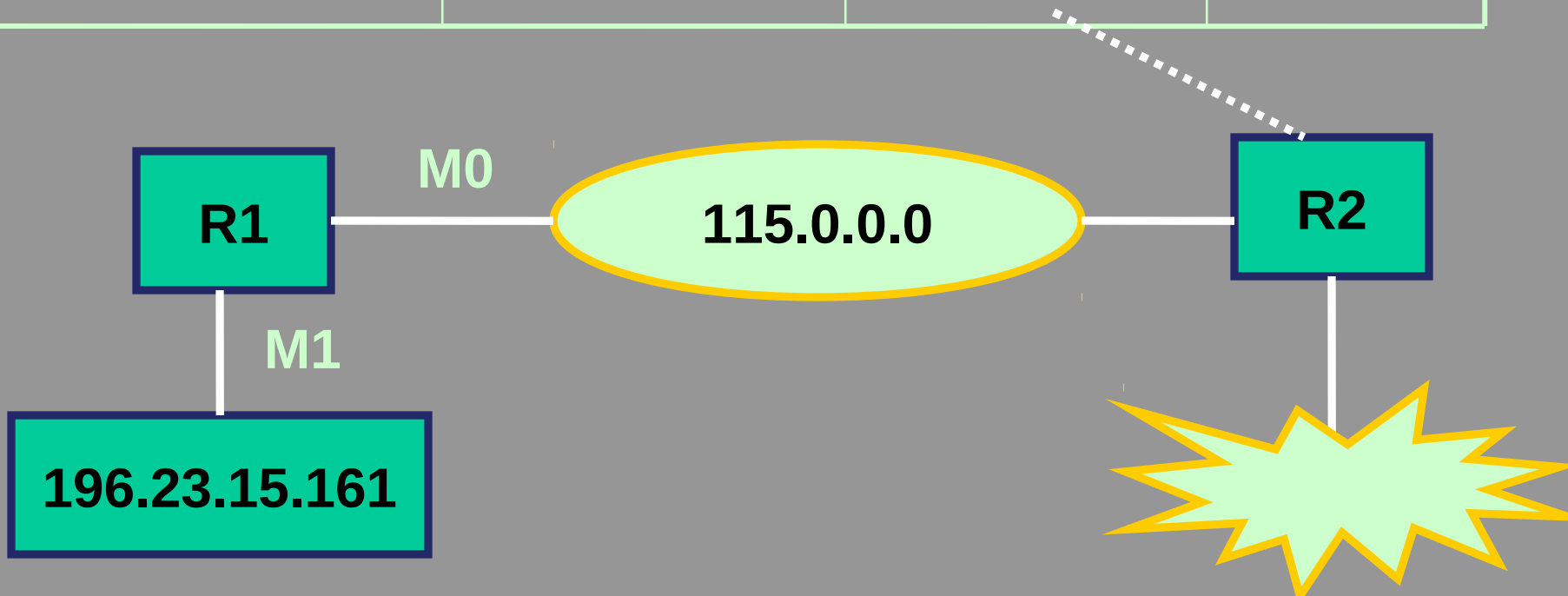
On completion, the student will be able to:

- Explain the concept of IP subnets, and subnet masks.
- Compare the benefits of using subnets against multiple address classes.
- Explain the concept of variable length subnet mask (VLSM) with example.
- Explain how classless inter-domain routing (CIDR) helps in better address assignment.

IP Subnetting

Example (Routing table for R1)

Mask	Dest	NextHop	Interface
255.0.0.0	115.0.0.0	--	M0
255.255.255.224	196.23.15.161	--	M1
0.0.0.0	0.0.0.0	112.11.35.18	M0



IP Subnet

- Basic concept:
  - A subset of a class A, B or C network.
- IP addresses that do not use subnets consists of
    - a network portion, and
    - a host portion.
  - Represents a static two-level hierarchical addressing model.

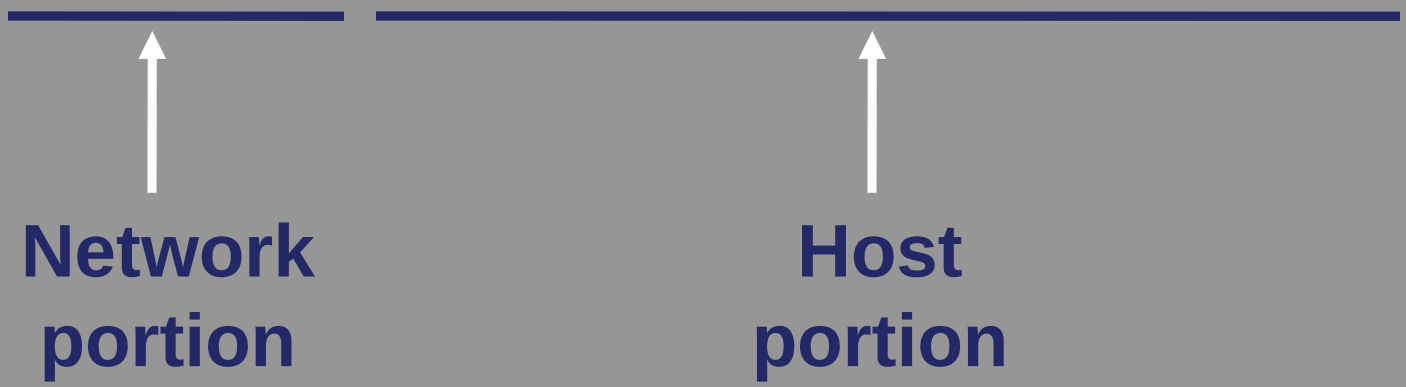
IP Subnet (contd.)

- IP subnets introduces a third level of hierarchy.
  - a network portion
  - a subnet portion
  - a host portion
  - Allow more efficient (and structured) utilization of the addresses.
  - Uses network masks.

Natural Masks

- Network mask 255.0.0.0 is applied to a class A network 10.0.0.0.
  - In binary, the mask is a series of contiguous 1's followed by a series of contiguous 0's.

    11111111 00000000 00000000 00000000



Natural Masks (contd.)

- Provide a mechanism to split the IP address 10.0.0.20 into
  - a network portion of 10, and
  - a host portion of 20.

	Decimal	Binary			
IP address:	10.0.0.20	00001010	00000000	00000000	00010100
Mask:	255.0.0.0	11111111	00000000	00000000	00000000
		Network		Host	

Natural Masks (contd.)

- Class A, B and C addresses
  - Have fixed division of network and host portions.
  - Can be expressed as masks.
    - Called **natural masks**.
- Natural Masks
  - Class A :: 255.0.0.0
  - Class B :: 255.255.0.0
  - Class C :: 255.255.255.0

Creating Subnets using Masks

- Masks are very flexible.
  - Using masks, networks can be divided into smaller subnets.
- How?
  - By extending the network portion of the address into the host portion.
- Advantage gained:
  - We can create a large number of subnets from one network.
  - Can have less number of hosts per network.

Example: Subnets

- Network mask 255.255.0.0 is applied to a class A network 10.0.0.0.
  - This divides the IP address 10.5.0.20 into
    - a network portion of 10,
    - a subnet portion of 5, and
    - a host portion of 20.
  - The 255.255.0.0 mask borrows a portion of the host space, and applies it to network space.

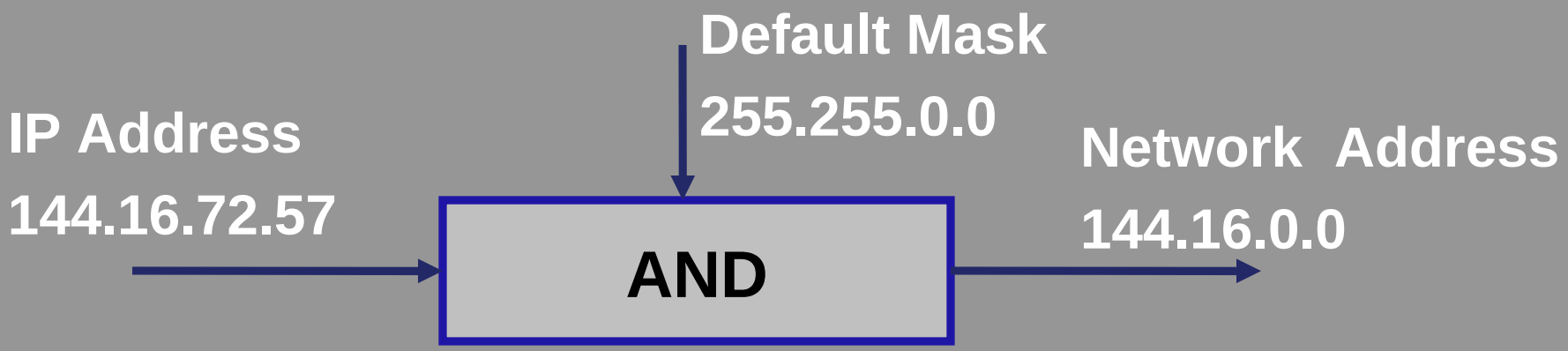
Subnets (contd.)

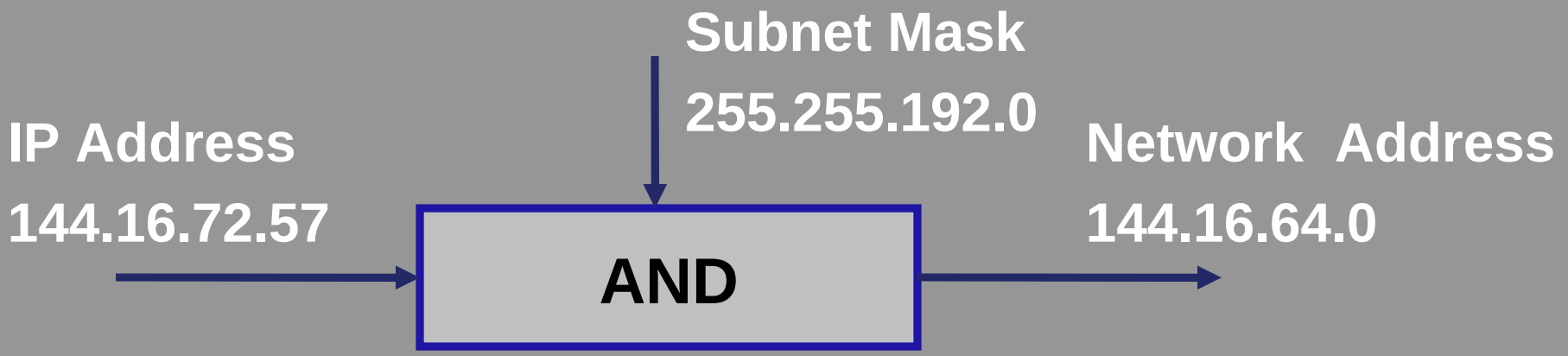
- What happens?
  - Initially it was a single large Class A network (2^{24}-2 hosts).
  - We have now split the network into 256 subnets.
    - From 10.0.0.0 to 10.255.0.0.
    - The hosts pet subnet decreases to 65,534.

Subnets (contd.)

	Decimal	Binary			
IP address:	10.5.0.20	00001010	00000101	00000000	00010100
Mask:	255.255.0.0	11111111	11111111	00000000	00000000
		Network	Subnet	Host	

Default Mask and Subnet mask



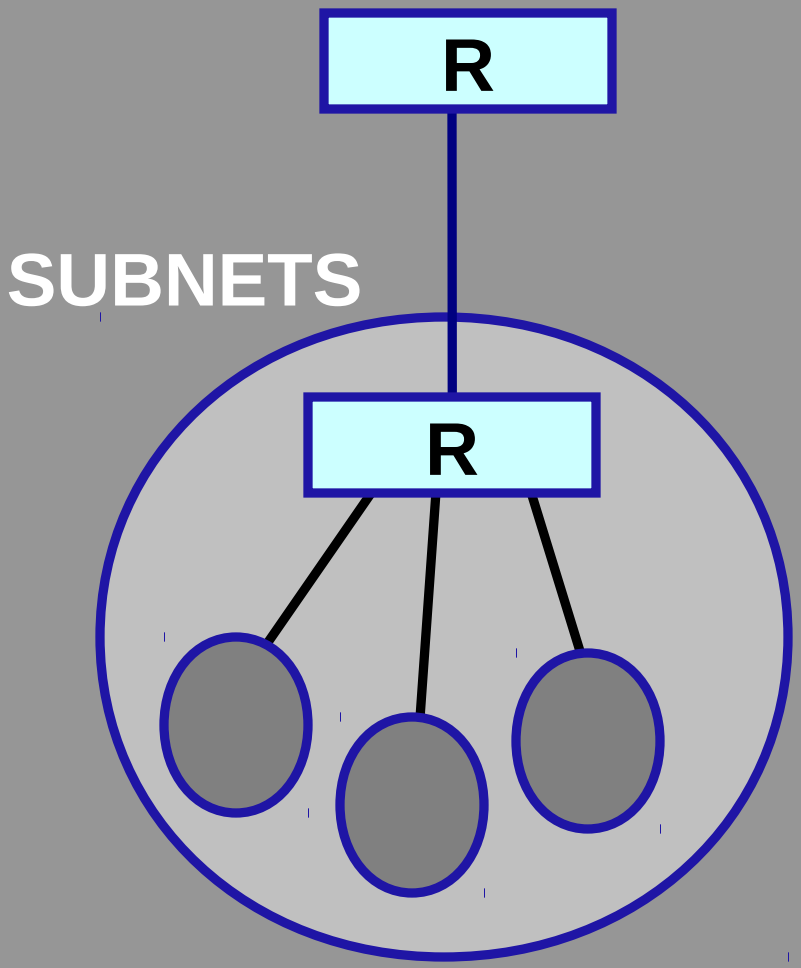


192: 1100 0000
72: 0100 1000

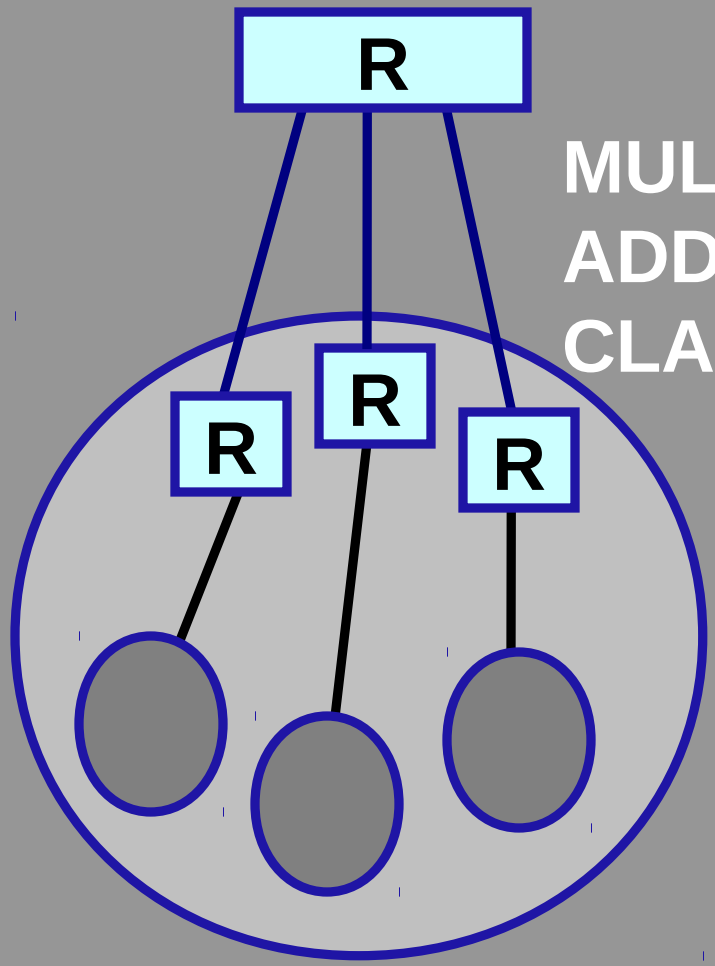
Subnets vrs Multiple Address Classes

- Subnets
  - Management of subnets is done by local network administrator.
  - Single entry in external router tables.
- Multiple Address Classes
  - Multiple entries in external router tables.
  - Additional overhead on the backbone (external) routers.

Comparison



SUBNETS



MULTIPLE ADDRESS CLASSES

Variable Length Subnet Masks (VLSM)

- Basic concept
  - The same network can be configured with different masks.
  - Can have subnets of different sizes.
  - Allows better utilization of available addresses.

Example: VLSM

- Suppose we are assigned a Class C network 192.203.17.0.
  - To be divided into three subnets.
    - Corresponding to three departments.
    - With 110, 45 and 50 hosts respectively.

The Example (contd.)

- Available subnet options
  - The network mask will be the Class C natural mask 255.255.255.0
  - Subnet masks of the form 255.255.255.X
    - Can be used to divide the network into more subnets.

The Subnet Options

X	X (in binary)	No. of Subnets	No. of Hosts
128	1000 0000	2	128
192	1100 0000	4	64
224	1110 0000	8	32
240	1111 0000	16	16
248	1111 1000	32	8
252	1111 1100	64	4

- Cannot satisfy the requirements.

The VLSM Option

- **Basic concept:**
  - **Use the mask 255.255.255.128 to divide the network address into two subnets with 128 hosts each.**
    - **192.203.17.0 (.0 to .127)**
    - **192.203.17.0 (.128 to .255)**

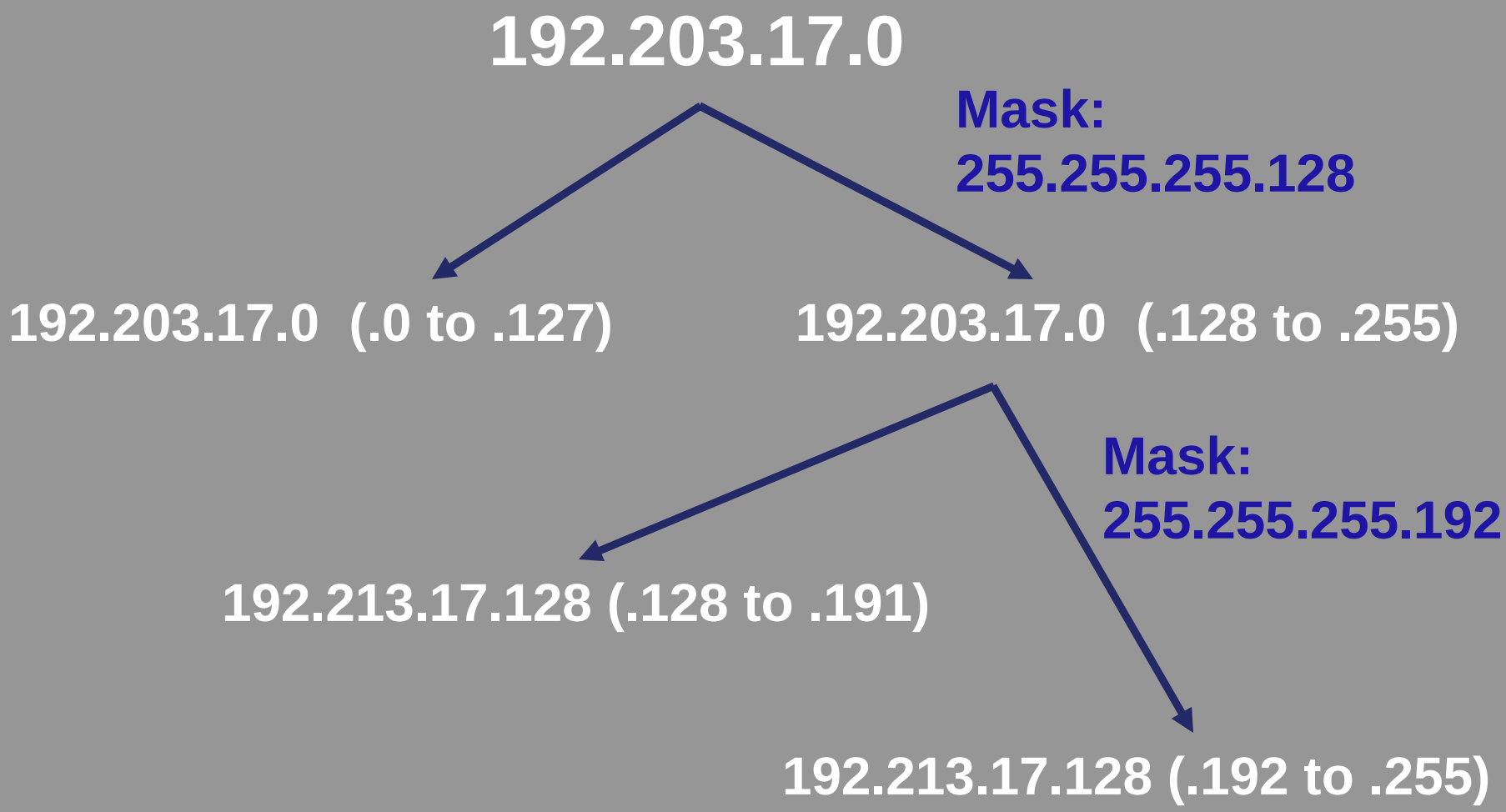
The VLSM Option (contd.)

- **Next subnet the second .128 subnet using a mask of 255.255.255.192.**
  - Creates two subnets, 64 hosts each

    192.213.17.128 (.128 to .191)

    192.213.17.128 (.192 to .255)

The VLSM Option (contd.)



HIDDEN SLIDE

Interface 1 :: 128 hosts
Network number: 192.203.17.0
Network mask: 255.255.255.128
Address: 192.203.17.0 -- .127

Interface 2 :: 64 hosts
Network number: 192.203.17.128
Network mask: 255.255.255.192
Address: 192.203.17.128 -- .191

Interface 3 :: 64 hosts
Network number: 192.203.17.192
Network mask: 255.255.255.192
Address: 192.203.17.192 -- .255

Running out of IP addresses

- Growing demand for IP addresses.
  - Severe strain on the classful model.
  - Due to wastage of address space.
- Measures taken:
  - Creative allocation of IP addresses.
  - Classless Inter-Domain Routing (CIDR).
  - Private IP addresses, and Network Address Translation (NAT).
  - IP version 6 (IPv6).

CIDR: Introduction

- The size of the global routing tables have grown very fast in recent years.
  - Caused routers to become saturated.
- CIDR is a new concept to manage IP networks.
  - Classless Inter Domain Routing.
  - No concept of class A, B, C networks.
  - Reduces sizes of routing tables.

Basic Idea Behind CIDR

- An IP address is represented by a prefix, which is the IP address of the network.
- It is followed by a slash, followed by a number M.
  - M: number of leftmost contiguous bits to be used for the network mask.
  - Example: 144.16.192.57 / 18

CIDR: An Important Rule

- The number of addresses in each block must be a power of 2.
- The beginning address in each block must be divisible by the number of addresses in the block.
  - A block that contains 16 addresses cannot have beginning address as 144.16.223.36.
  - But the address 144.16.192.64 is possible.

Example: CIDR

- An organization is allotted a block with beginning address:

  144.16.192.24 / 29

  What is the range of the block?

Start addr: 10010000 00011000 11000000 00011000

End addr: 10010000 00011000 11000000 00011111

There are 8 addresses in the block.

Recent Trend

- Move on to CIDR addressing.
  - Existing classful networks can also be represented using this notation.
    - Class A: W.X.Y.Z / 8
    - Class B: W.X.Y.Z / 16
    - Class C: W.X.Y.Z / 24
- Recent routers support CIDR.

End of Lecture 6

Thank You