IPv4 Addressing and Subnetting

Didn’t we already cover this?

- Why do a session on IPv4 Addressing and Subnetting?
- Wasn’t this already covered in the CCNA video series?

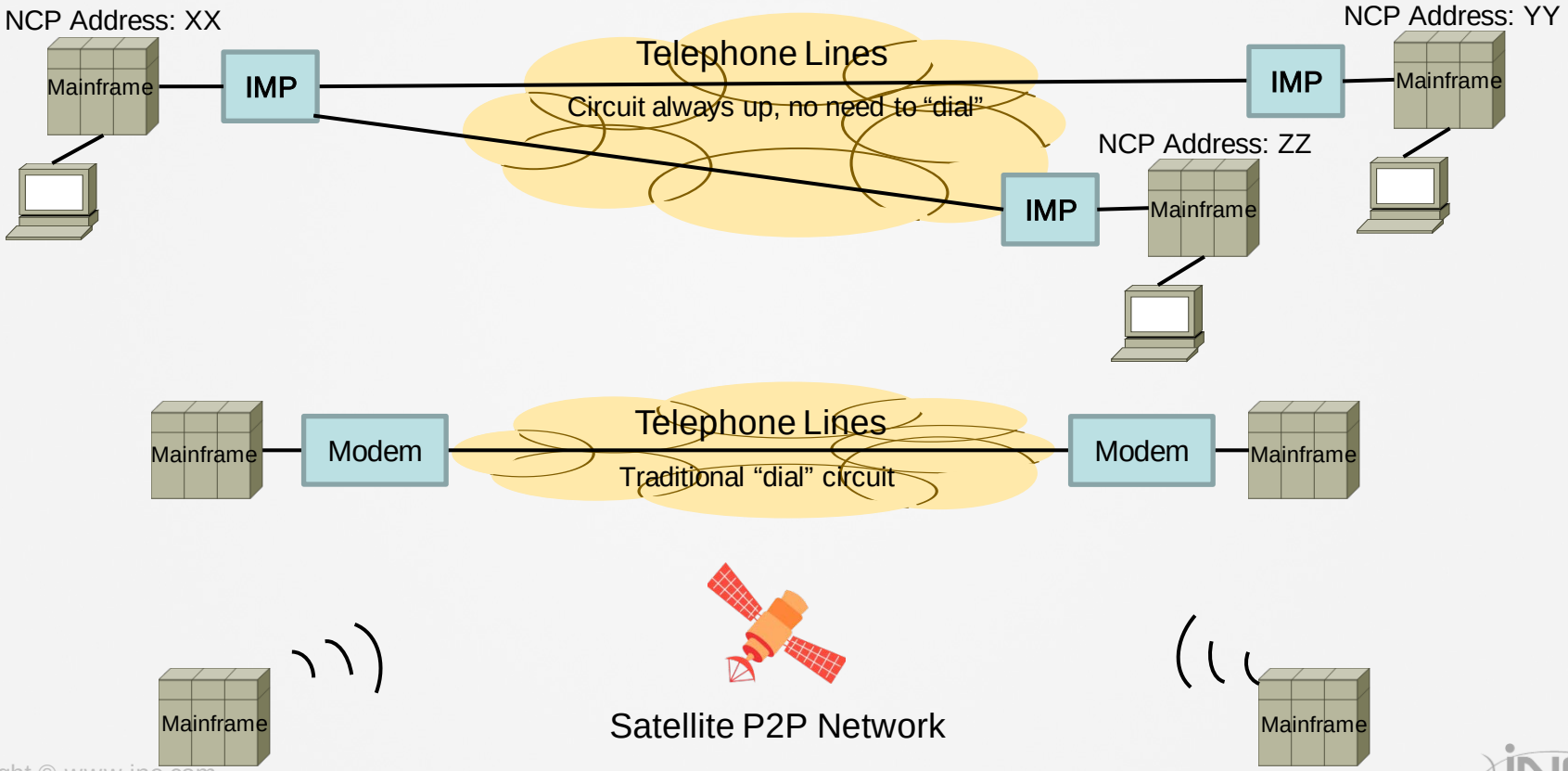
Agenda

- A Brief History of IPv4
- Communications within a Broadcast Domain
- Identifying classes and types of IPv4 Addresses
- IPv4 Governing Bodies
- Private vs Public Addresses
- IPv4 Subnet Masks
- Same-Length Subnetting
- VLSM
- IPv4 Address Summarization
- Supernetting

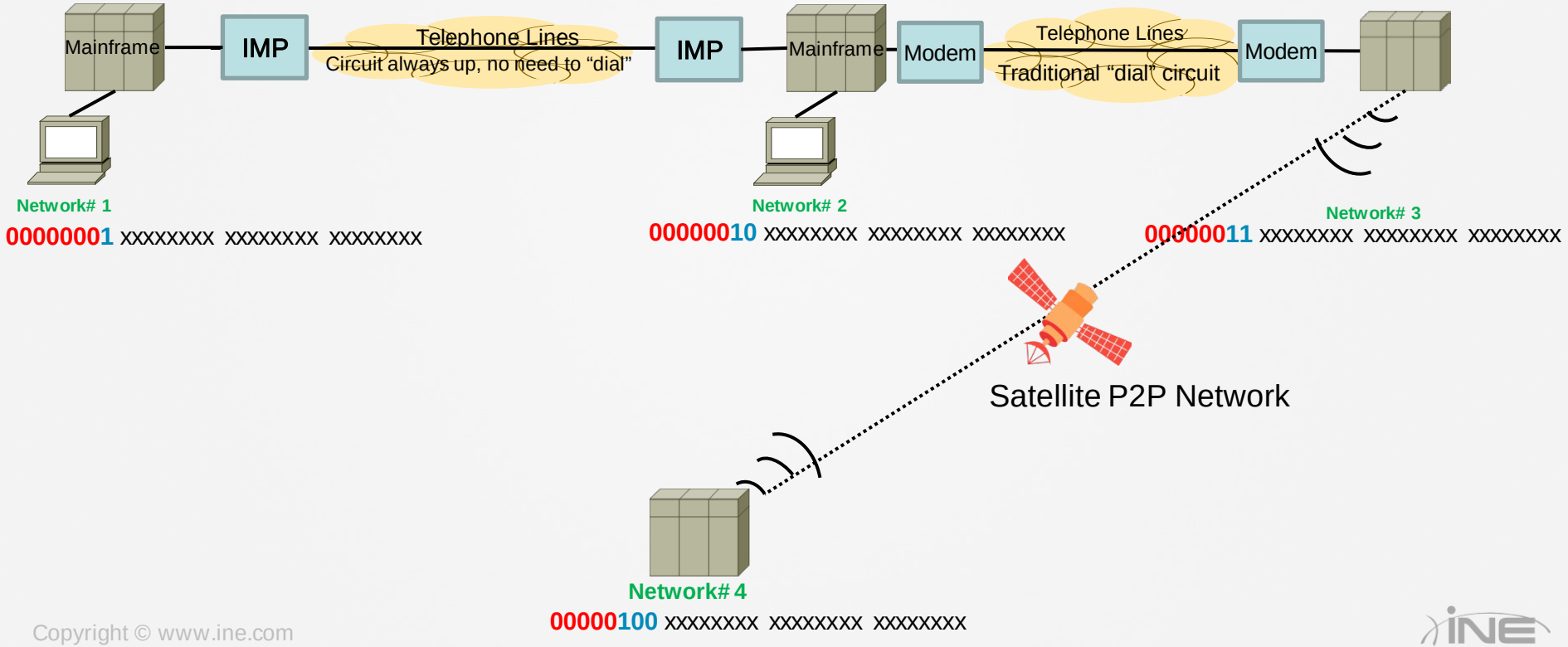
The Early Internet

- L3 Addressing was developed prior to L2 Addressing
- Early Internet History (1972):
  - There were no such things as LANs (Ethernet was in development at Xerox)
  - All communications were point-to-point using a variety of methods
    - Circuit Switching
    - Satellite Uplinks
    - Direct Cable connections
  - There was a need to develop a protocol so that hosts on these disparate networks (and networks yet to be invented) could communicate with each other.
  - Very few networks existed.

Separate and Unique Networks

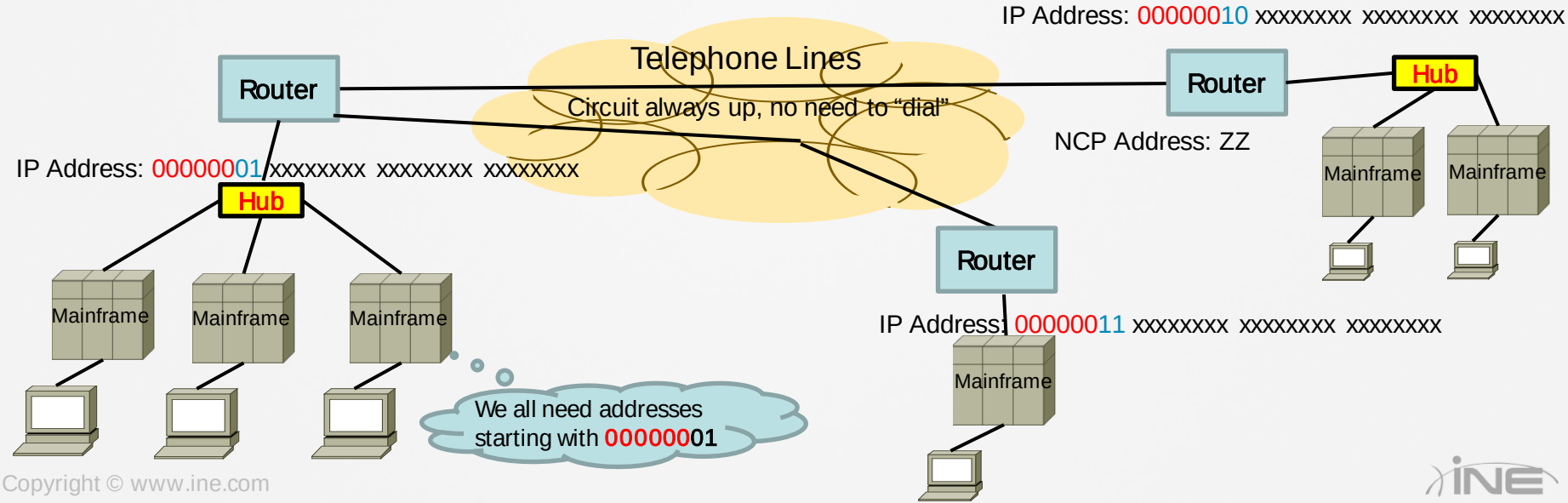


The Birth of TCP/IP



Addressing and Broadcast Domains

- With the popularity of Ethernet and Token Ring in late 1970s, the concept of multiple hosts all sharing a common gateway (a single Broadcast domain) was born.



Communications within Broadcast Domains

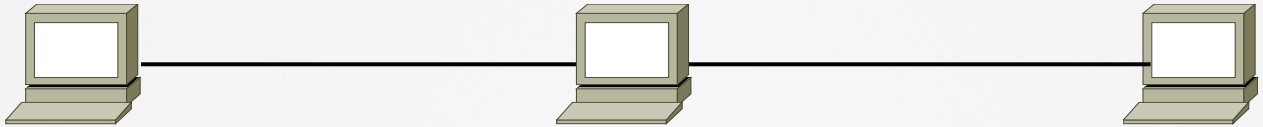
- Communications within a Broadcast Domain
  - Broadcast (needs no address)
  - Unicast (requires an address: MAC)
  - Multicast (requires an address: MAC with special format)
- Networked Software Applications fall into two categories:
  - Those that assume the destination is in same broadcast domain as the source (example= ARP).
  - Those capable of intra, or inter-broadcast domain communications.

So an IP Address = Broadcast Domain Address?

- Not quite…IP is used to address "networks", be they broadcast-based or Point-to-Point, or anything else.
- IP address = 2-parts
  - Network/ Broadcast Domain Address
  - Unique Host address within that broadcast domain.
- In this way, when sending to a remote host, we don't need to know their L2 address.
  - Packet is addressed to remote host's IP address
  - Frame is addressed to gateway's L2 address

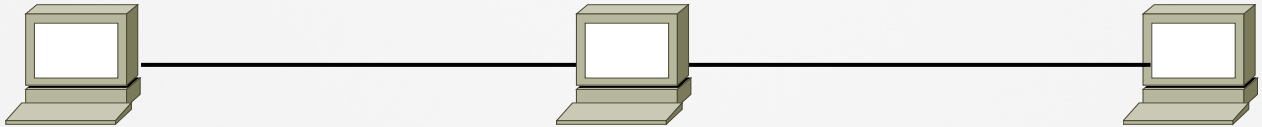
Host-ID and Broadcast Domains

LAN-1: 00000001 xxxxxxxx xxxxxxxx xxxxxxxx



00000001 00000000 00000000 00000001 00000001 00000000 00000000 00000010 00000001 00000000 00000000 00000011

LAN-2: 00000010 xxxxxxxx xxxxxxxx xxxxxxxx



00000010 00000000 00000000 00000001 00000010 00000000 00000000 00000010 00000010 00000000 00000000 00000011

What do these addresses look like?

MAC Address = 48-bits long

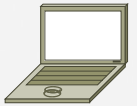
000000101110101001101011000100101010010111111111

IP Address = 32-bits long

00000010111010100110101100010010

Destination

Source



What does a computer see when it looks at incoming data?

10101101010110101011010101010101101010101010101111111111111010101010000000000000101011101010110101010100100000000000

So where are these addresses in all of this?

10101101010110101011010101010101101010101010101111111111111010101010000000000000101011101010110101010100100000000011

Bits 305-336
= Dest IP Address

8-bytes (64-bits) of
"Ethernet stuff"

Bits 65-112
= Destination MAC

Bits 113-160
= Source MAC

12-bytes (96-bits) of
"IP stuff"

Bits 273-304
= Source IP Address

2-bytes (16-bits) of
"Ethernet stuff"

IPv4 Addressing – a review of what we've learned

- 32-bit addressing system
- Logical address for a network defined by IANA
- IPv4 addresses are comprised of 4 octets
- Dotted decimal notation is used to segment the octet

This is not readable by us:	This is easier:
00000010111010100110101100010010	2. 234. 107. 18

IP Bit Patterns

- Multicast
  - **One-to-many** communication
  - **1110**xxxx. xxxxxxxx. xxxxxxxx. xxxxxxxx
- Broadcast
  - **One-to-all** communication
  - Host portion of address all ones…or entire address all ones.
  - Any.**11111111.11111111.11111111**
  - **11111111. 11111111. 11111111. 11111111**
- Unicast
  - **One-to-one** communication
  - All other patterns that do NOT start with 00000000

Classes of IPv4

- 1981 - Classes of Addresses Introduced:
  - Class A: 0.0.0.0 through 127.255.255.255
  - Class B: 128.0.0.0 through 191.255.255.255
  - Class C: 192.0.0.0 through 223.255.255.255
  - Class D: 224.0.0.0 through 239.255.255.255
  - Class E: 240.0.0.0 through 255.255.255.255
    - Note: 127 ranges are considered as loopbacks
    - Note: 169.254 ranges are considered as APIPA

Quiz-1

- Identify which of the IP addresses below belong to a Class-B network?

A. 01010111 00101011 11111111 01010000

B. 11010111 00101011 11111111 01010000

C. 10010111 00101011 11111111 01010000

D. 191.7.145.3

E. 126.57.135.2

F. 194.7.145.3

Answer-1

- Identify which of the IP addresses below belong to a Class-B network?

A. 01010111 00101011 11111111 01010000

B. 11010111 00101011 11111111 01010000

C. **10**010111 00101011 11111111 01010000

D. **191**.7.145.3

E. 126.57.135.2

F. 194.7.145.3

Quiz-2

- Identify which of the IP addresses below belong to a Class-C network?

A. 10010111 00101011 11111111 01010000

B. 11010111 00101011 11111111 01010000

C. 01010111 00101011 11111111 01010000

D. 136.7.145.3

E. 223.57.135.2

F. 101.7.145.3

Answer-2

- Identify which of the IP addresses below belong to a Class-C network?

A. 10010111 00101011 11111111 01010000

B. **110**10111 00101011 11111111 01010000

C. 01010111 00101011 11111111 01010000

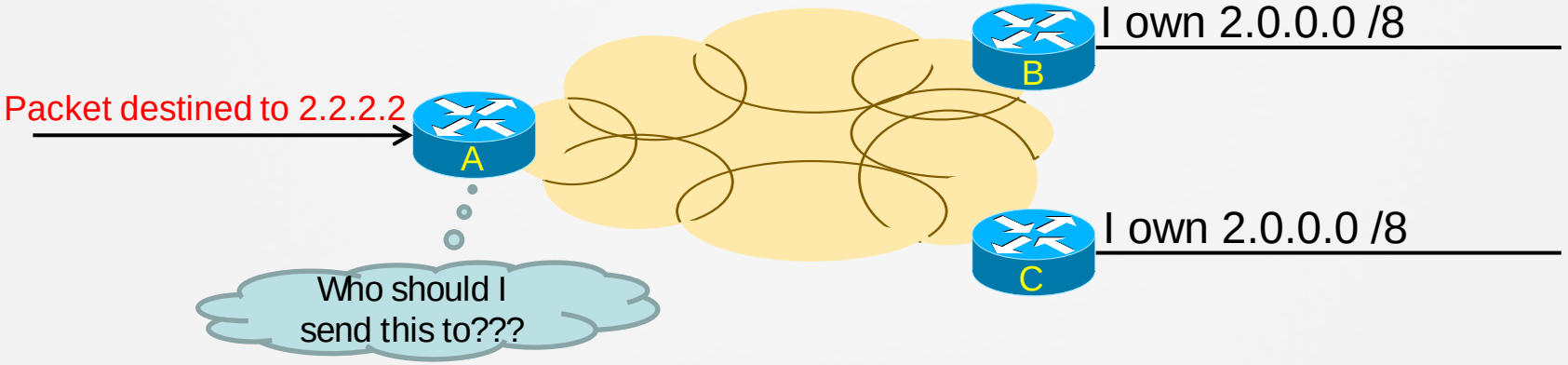
D. 136.7.145.3

E. **223**.57.135.2

F. 101.7.145.3

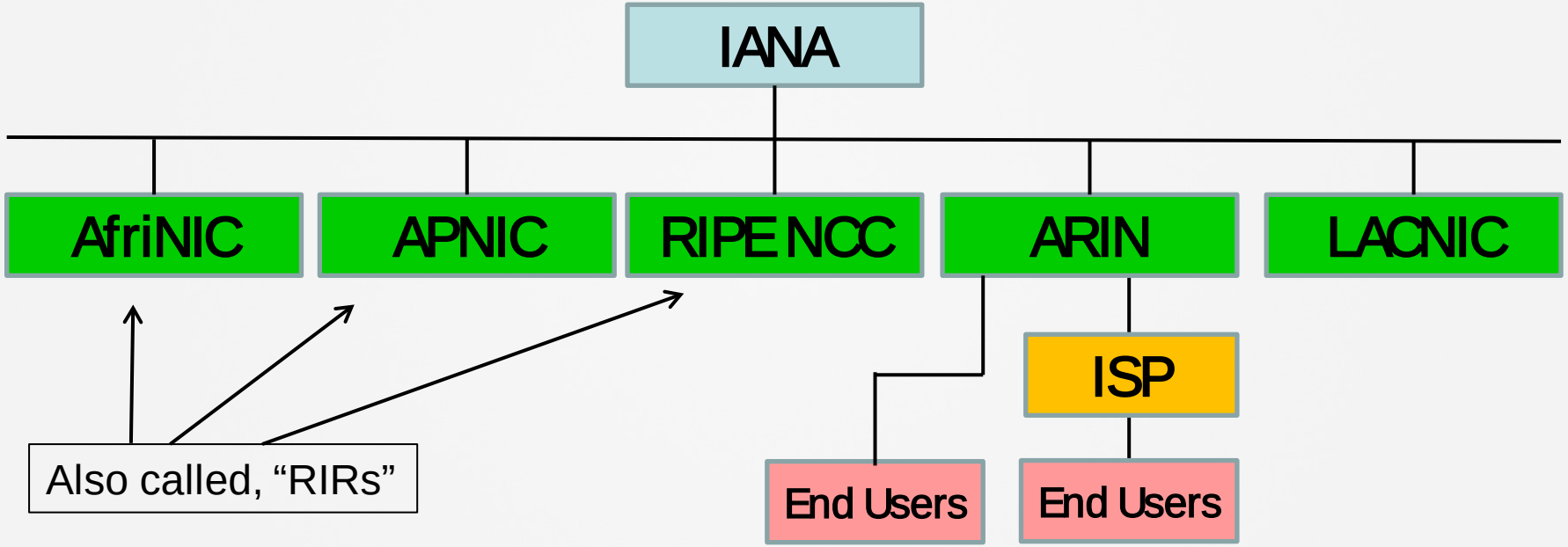
The need for governing bodies

- As new networks were created and connected to the Internet, there was a need for someone to govern the allocation of IP addresses.



IANA and RIRs

- Current IPv4 Addressing Allocation Structure



http://www.iana.org/assignments/ipv4-address-space/ipv4-address-space.xhtml

IPv4 Addresses: Public & Private

- IP addresses "leased" to a corporation (by an ISP or an RIR) are known as ***public IP addresses***.

- IP addresses that are unregistered and may overlap from one company to the next, are known as ***private IP addresses***.

IPv4 Addresses: Private

- Private IPv4 address:
  - Defined in RFC 1918
  - For internal use only
- Range of private address
  - Class A : 10.0.0.0 through 10.255.255.255
  - Class B : 172.16.0.0 through 172.31.255.255
  - Class C : 192.168.0.0 through 192.168.255.255

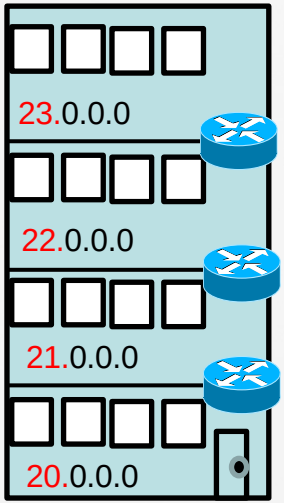
IPv4 Addresses: Public

- Public IPv4 addresses
  - Globally unique
  - Should be purchased
  - Usually used in Internet edge
  - Taken from Class-A, Class-B, and Class-C addressing space.
- Range of public addresses
  - Beyond the RFC 1918 space, all addresses are public

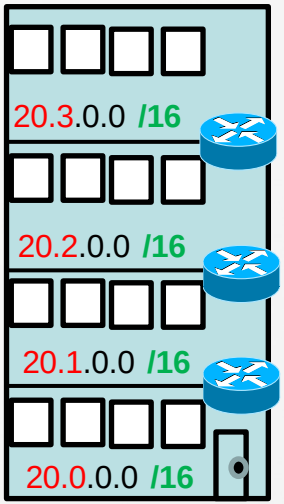
1985: Introduction of Subnets

- Soon became apparent that assigning multiple Classfull networks to each company would result in network depletion.
- A single Classfull network was assigned to each company with the expectation of **subnetting**.

From this…



To this…

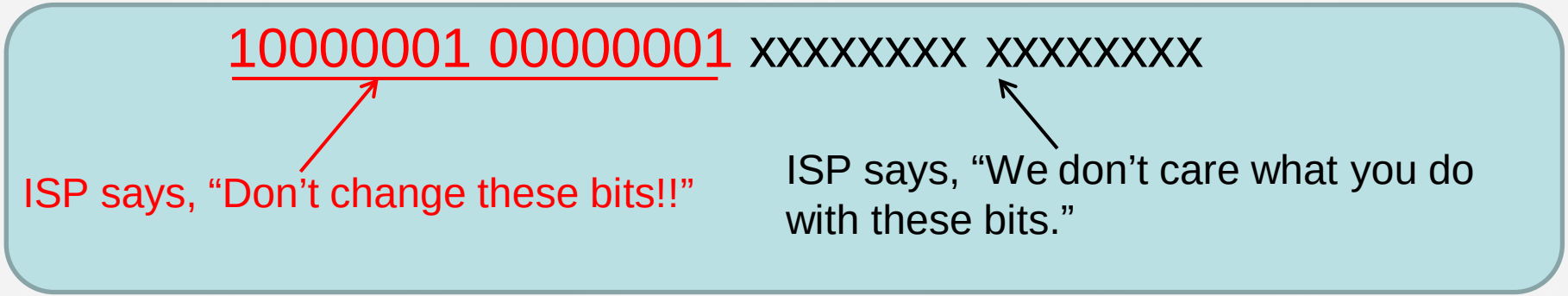


What IS subnetting? (1)

- With a network that has been assigned from an ISP you have two portions:
  - The “network” part
  - The “host” part
- ISP doesn’t care what you do with Host bits, but you are not allowed to modify the “network” bits.

What is Subnetting (2)

ISP leases you the following network: 129.1.0.0



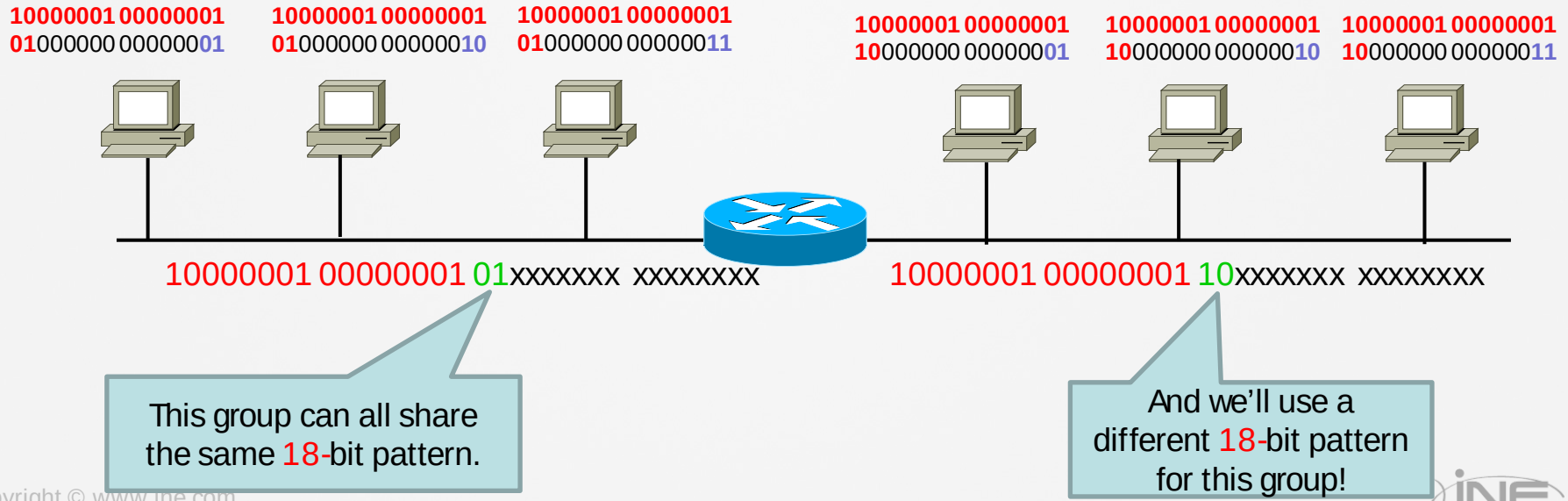
10000001 00000001 xxxxxxxx xxxxxxxx

Assumption is that ALL devices within a single broadcast domain will have this common, 16-bit pattern as their network. But what about OTHER broadcast domains?

What is Subnetting (2)

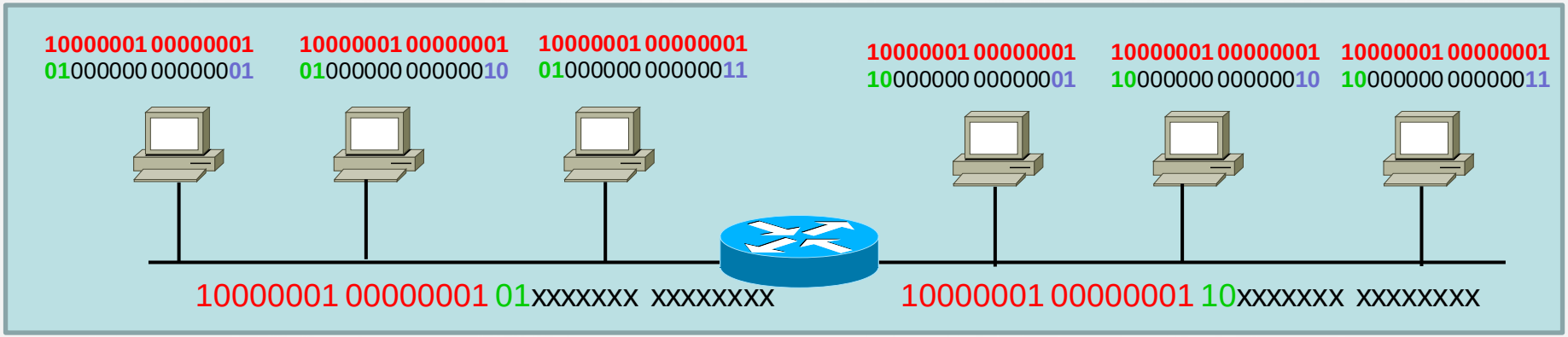
ISP leases you the following network: 129.1.0.0

10000001 00000001 xxxxxxxx xxxxxxxx



What is Subnetting (3)

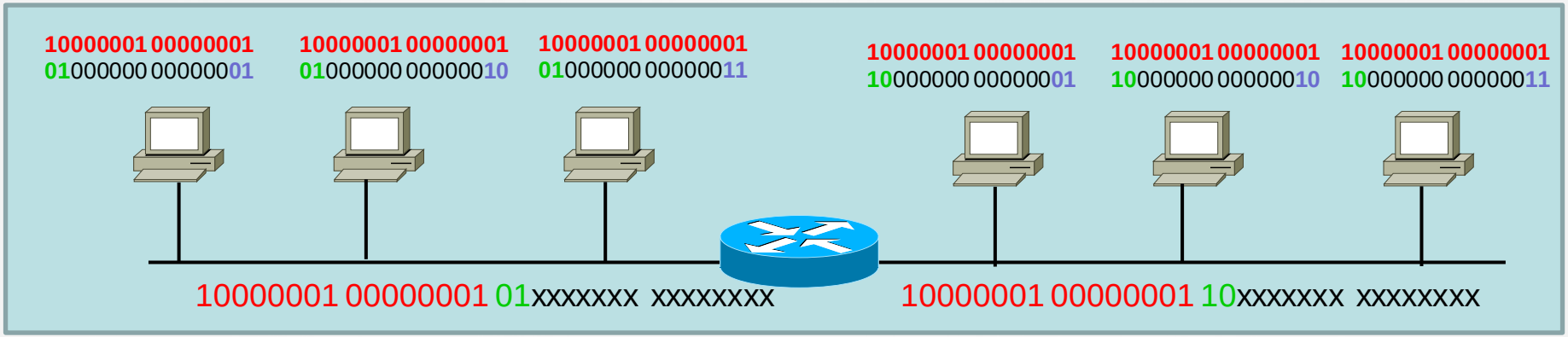
In this example, the “red bits” are the networking bits (unchangable), and the “green bits” (which used to be host bits) have been converted into subnet-bits.



10000001 00000001 xxxxxxxx xxxxxxxx

What is Subnetting (4)

- So how do these hosts KNOW how many bits represent the network?
- Answer – A Subnet Mask!!



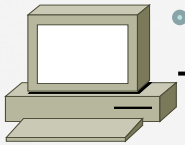
10000001 00000001 xxxxxxxx xxxxxxxx

How do computers use Subnet Masks? (1)

Systems with Classfull Addresses (prior to subnet masks)

My first two bits are a one and a zero…that means my network is 10000001 00000001 (129.1.x.x)

If I need to send a packet to anyone that does NOT match this pattern, I'll need to use my Default Gateway!



My IP Address = **10**000001 00000001 00000001 00000001

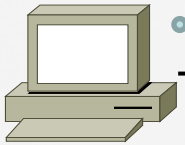
These are my unique "host-id bits" and no other devices in this Broadcast Domain can have my same pattern.

How do computers use Subnet Masks? (2)

Systems with Classfull Addresses (prior to subnet masks)

The full 32-bit number of my Broadcast Domain is 129.1.0.0

If I need to send a packet to everyone within my broadcast domain I'll send it to 10000001 00000001 11111111 11111111 (129.1.255.255)

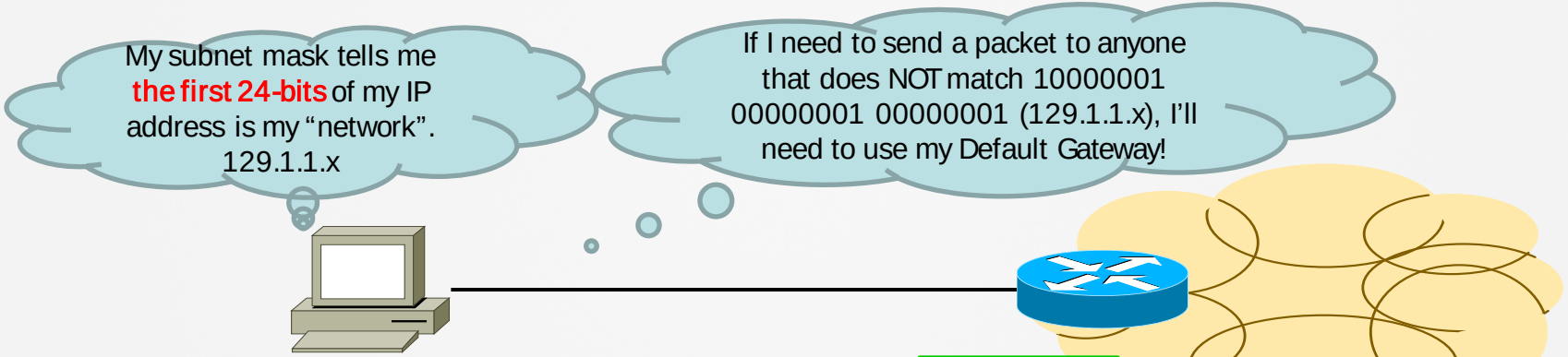


My IP Address = 10000001 00000001 00000001 00000001

These are my unique "host-id bits" and no other devices in this Broadcast Domain can have my same pattern.

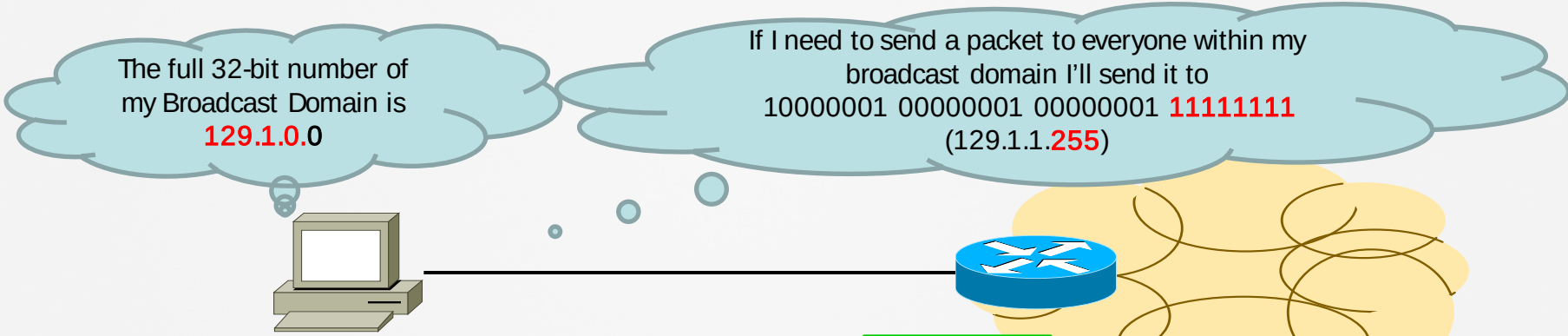
How do computers use Subnet Masks? (3)

Systems with Classfull Addresses (with subnet masks)



How do computers use Subnet Masks? (4)

Systems with Classfull Addresses (with subnet masks)



Subnet Mask

- Helps identify network and host portion of network
- Three representations:
  - Binary 11111111 11111111 00000000 00000000
  - Dotted Decimal: 255.255.0.0
  - Backslash (shorthand): /16
- Systems that utilize a subnet mask RELY on it to identify their local network.

Quiz-3

- Given the following subnet mask (in binary) what is the equivalent representation in dotted-decimal and shorthand?

Subnet Mask = 11111111 11111111 11110000 00000000

A. 255.255.0.0
B. 255.255.255.0
C. 255.255.192.0
D. 255.255.240.0
E. /16
F. /18
G. /20
H. /24

Answer-3

- Given the following subnet mask (in binary) what is the equivalent representation in dotted-decimal and shorthand?

Subnet Mask = 11111111 11111111 11110000 00000000

A. 255.255.0.0
B. 255.255.255.0
C. 255.255.192.0
D. 255.255.240.0
E. /16
F. /18
G. /20
H. /24

Quiz-4

- If the following subnet mask were to be applied to a PC's NIC, how many bits of the IP address would be interpretted as "networking bits"?

Subnet Mask = 255.255.255.248

A. 16-bits
B. 20-bits
C. 24-bits
D. 27-bits
D. 29-bits

Answer-4

- If the following subnet mask were to be applied to a PC's NIC, how many bits of the IP address would be interpretted as "networking bits"?

Subnet Mask = 255.255.255.248

A 16-bits
B 20-bits
C 24-bits
D 27-bits
D 29-bits

Quiz-5

- What subnet mask would be appropriate (in dotted-decimal) to indicate to a host that the first 26-bits of its IP address should be considered as the network?

A. 255.254.0.0
B. 255.255.255.192
C. 255.255.255.0
D. 255.255.0.0
D. 255.255.255.224

Answer-5

- What subnet mask would be appropriate (in dotted-decimal) to indicate to a host that the first 26-bits of its IP address should be considered as the network?

A 255.254.0.0
B **255.255.255.192**
C 255.255.255.0
D 255.255.0.0
D 255.255.255.224

Quiz-6

- Given the following IP address and Subnet Mask identify the subnetwork address of this host.

IP Address = 137.54.101.77

Subnet Mask = 255.255.224.0

A. 137.54.96.0
B. 137.54.0.0
C. 137.54.101.64
D. 137.54.224.0

Answer-6

- Given the following IP address and Subnet Mask identify the subnetwork address of this host.

IP Address = 137.54.101.77

Subnet Mask = 255.255.224.0

A **137.54.96.0**

B 137.54.0.0

C 137.54.101.64

D 137.54.224.0

Quiz-7

- Given the following IP address and Subnet Mask (in binary) identify which of the answers below provide for the broadcast address of this network.

IP Address = 01000011 00000011 01100000 00001101
Subnet Mask = 11111111 11111111 00000000 00000000

A. 67.3.96.255
B. 67.3.96.0
C. 67.3.255.255
D. 67.255.255.255

Answer-7

- Given the following IP address and Subnet Mask (in binary) identify which of the answers below provide for the broadcast address of this network.

IP Address = 01000011 00000011 01100000 00001101

Subnet Mask = 11111111 11111111 00000000 00000000

A. 67.3.96.255
B. 67.3.96.0
C. 67.3.255.255
D. 67.255.255.255

Quiz-8

- Given the following IP address and Subnet Mask identify which of the answers below provide for the broadcast address of this network.

IP Address = 130.54.6.99

Subnet Mask = 255.255.255.0

A. 130.255.255.255
B. 130.54.255.255
C. 130.54.6.255
D. 130.0.0.0

Answer-8

- Given the following IP address and Subnet Mask identify which of the answers below provide for the broadcast address of this network.

IP Address = 130.54.6.99

Subnet Mask = 255.255.255.0

A. 130.255.255.255
B. 130.54.255.255
C. 130.54.6.255
D. 130.0.0.0

Quiz-9

- Given the following IP address and Subnet Mask (in binary) identify which of the answers below provide for the broadcast address of this network.

IP Address = 01000011 00000011 01100000 00001101

Subnet Mask = 11111111 11111111 11110000 00000000

A. 67.3.96.255
B. 67.3.111.255
C. 67.3.0.255
D. 67.255.255.255

Answer-9

- Given the following IP address and Subnet Mask (in binary) identify which of the answers below provide for the broadcast address of this network.

IP Address = 01000011 00000011 01100000 00001101

Subnet Mask = 11111111 11111111 11110000 00000000

A. 67.3.96.255
B. 67.3.111.255
C. 67.3.0.255
D. 67.255.255.255

Quiz-10

- Given the following IP address and Subnet Mask identify which of the answers below provide for the broadcast address of this network.

IP Address = 77.42.200.101

Subnet Mask = 255.255.224.0

A. 77.0.0.0
B. 77.255.255.255
C. 77.42.255.255
D. 77.42.192.255
E. 77.42.223.255

Answer-10

- Given the following IP address and Subnet Mask identify which of the answers below provide for the broadcast address of this network.

IP Address = 77.42.200.101

Subnet Mask = 255.255.224.0

A. 77.0.0.0
B. 77.255.255.255
C. 77.42.255.255
D. 77.42.192.255
E. **77.42.223.255**

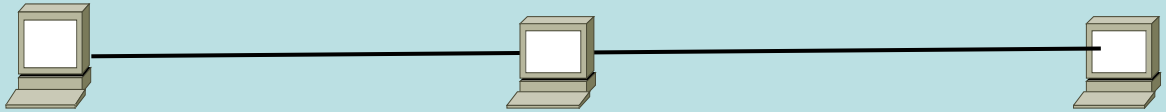
Subnet Masks and Byte Boundaries (1)

- Remember that while we (as humans) represent IP addresses as dotted decimal, computers see it simply as a long string of 32-bits.
- A subnet mask is another string of 32-bits that is used as a comparison tool against the IP address.
- The subnet mask can divide the IP address anywhere…it doesn't have to fall on an even byte boundary.

Subnet Masks and Byte Boundaries (2)

LAN: 00000001 00000011 hhhhhhhh hhhhhhhh /16

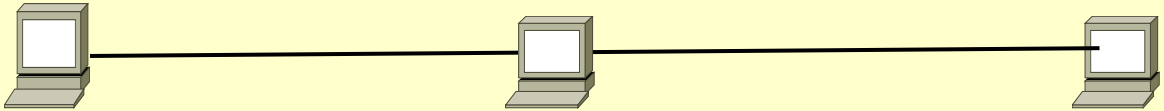
Example-1



00000001 00000011 00000000 00000001 00000001 00000011 00000000 00000010 00000001 00000011 00000000 00000011

LAN: 00000001 00000011 11000000 hhhhhhhh /24

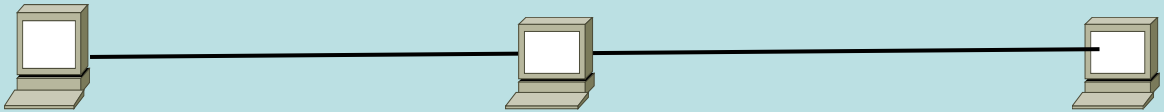
Example-2



00000001 00000011 11000000 00000001 00000001 00000011 11000000 00000010 00000001 00000011 11000000 00000011

LAN: 00000001 00000011 11000000 0111hhhh /28

Example-3



00000001 00000011 11000000 01110001 00000001 00000011 11000000 01110010 00000001 00000011 11000000 01110011

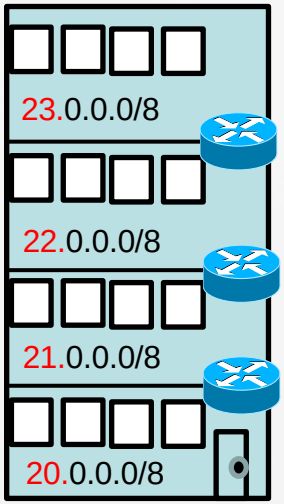
So why subnet?

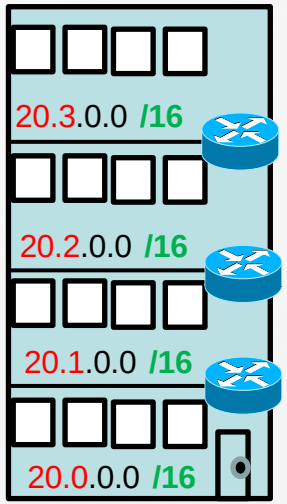
- Each IP network that is purchased is only good for a single broadcast domain (VLAN).
- Often unused/ unallocated host space within a given network.
- Subnetting = Dividing a single, allocated network into multiple sub-networks.
- Minor loss of available hosts addresses.

Subnetting Practicality

- Imagine if each network you “lease” from your ISP costs you $100.00/month.
- The building below requires four, distinct broadcast domains (i.e. Networks)

Using four, unique Classfull networks = $400.00/month





Using a single Classfull network, but dividing it via subnetting = $100.00/month

Determining Needed Subnets

Network Obtained from ISP = 180.1.0.0 /16

- Start with your base network (whatever you were given by ISP).
- Consider the base networking bits as "untouchable"…you cannot change them.
- How many host bits do you have?
- For every host bit that is "converted" into a subnet bit, you've just gained two additional FREE networks!

How many subnets are obtained by converting two (2) host bits?

180.1.sn sn h h h h h h . h h h h h h h h

A Formula to Remember!!

2^{sn} = Quantity of subnets you've created.
(where "sn" = subnetting bits)

Sn ≤ the quantity of "host-bits" in original network.

Quiz - 11

- You are leased the following network from your ISP: 45.0.0.0 / 8
- If you convert the first three host bits into subnetting bits..how many total subnets will you have available?

Answer - 11

- You are leased the following network from your ISP: 45.0.0.0 / 8
- If you convert the first three host bits into subnetting bits..how many total subnets will you have available?

2^{SN} = Quantity of available subnets
$2^{3} = 8$

Quiz - 12

- You are leased the following network from your ISP: 160.160.0.0 / 16
- If you convert the first six host bits into subnetting bits..how many total subnets will you have available?

Answer - 12

- You are leased the following network from your ISP: 160.160.0.0 / 16
- If you convert the first six host bits into subnetting bits..how many total subnets will you have available?

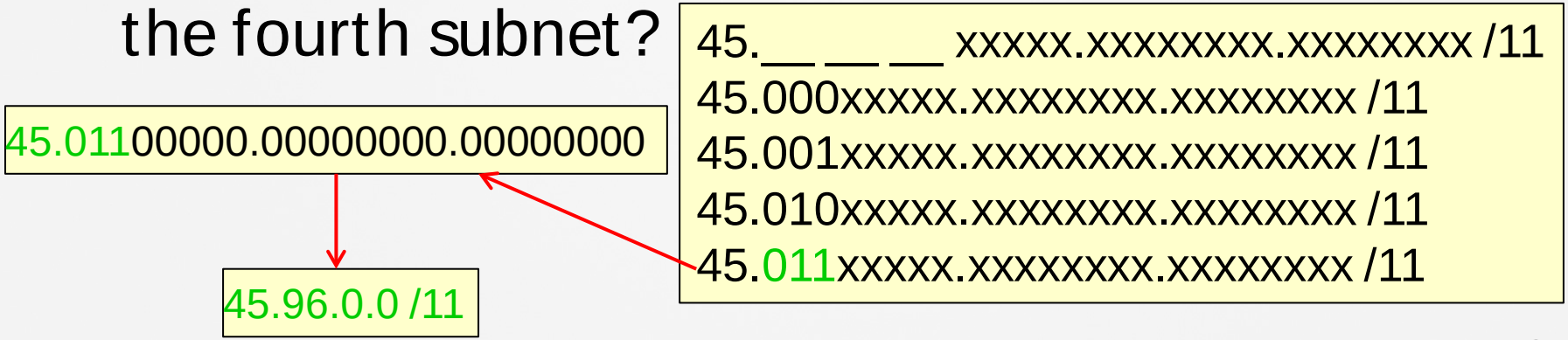
2^{SN} = Quantity of available subnets
2^{6} = 64

Quiz - 13

- You are leased the following network from your ISP: 45.0.0.0 / 8
- If you convert the first three host bits into subnetting bits…what will be the subnet address of the fourth subnet?

Answer - 13

- You are leased the following network from your ISP: 45.0.0.0 / 8
- If you convert the first three host bits into subnetting bits…what will be the subnet address of the fourth subnet?



Quiz - 14

- You are leased the following network from your ISP:
  199.0.0.0 / 24
- From this single network you need to create 7-subnets.
- What will be your new subnet mask?

A 255.255.255.240

B 255.255.255.252

C 255.255.255.224

D 255.255.255.192

Answer - 14

- You are leased the following network from your ISP:
  199.0.0.0 / 24
- From this single network you need to create 7-subnets.
- What will be your new subnet mask?

A 255.255.255.240

B 255.255.255.252

C 255.255.255.224

D 255.255.255.192

Quiz - 15

- You are leased the following network from your ISP:
  145.10.0.0 / 19
- From this single network you need to create 58-subnets.
- What will be your new subnet mask?

A 255.255.255.128

B 255.255.248.0

C 255.255.252.0

D 255.255.255.192

Answer - 15

- You are leased the following network from your ISP:
  145.10.0.0 / 19
- From this single network you need to create 58-subnets.
- What will be your new subnet mask?

A. 255.255.255.128
B. 255.255.248.0
C. 255.255.252.0
D. 255.255.255.192

Another Formula to Remember!!

$2^{sn} - 2$ = Quantity of hosts available per subnet.
(where “sn” = subnetting bits)

Remember that each subnet requires two, reserved bit-patterns:

- Network Address (host-bits all zeroes)
- Broadcast Address (host-bits all ones)

Quiz-16

- Given the following subnet mask, how many hosts can “fit” in this subnet?

  255.255.255.192

A. 60-hosts
B. 62-hosts
C. 64-hosts
D. 128-hosts
E. 126-hosts

Answer-16

- Given the following subnet mask, how many hosts can “fit” in this subnet?

  255.255.255.192

A. 60-hosts
B. **62-hosts**
C. 64-hosts
D. 128-hosts
E. 126-hosts

Quiz-17

- An ISP leases you the following network:

  140.10.0.0 / 23

You need to create 22-subnetworks from this single network. What will be your new Subnet Mask.. and how many hosts will be supported in each subnet?

A. 255.255.255.240
B. 255.255.255.0
C. 255.255.255.192
D. 6-hosts
E. 14-hosts
F. 30-hosts

Answer-17

- An ISP leases you the following network:

  140.10.0.0 / 23

You need to create 22-subnetworks from this single network. What will be your new Subnet Mask.. and how many hosts will be supported in each subnet?

A **255.255.255.240**

B 255.255.255.0

C 255.255.255.192

D 6-hosts

E **14-hosts**

F 30-hosts

Quiz-18

- An ISP leases you the following network:

  199.10.1.0 / 24

You need to create 22-subnetworks from this single network.

1. What will be your new subnet mask (dotted-decimal)? _____
2. How many hosts will be supported in each subnet? _____
3. What is the subnet address of the fourth subnet? _____
4. What is the broadcast address of the sixth subnet? _____

Answer-18

- An ISP leases you the following network:

  199.10.1.0 / 24

You need to create 22-subnetworks from this single network.

1. What will be your new subnet mask (dotted-decimal)? **255.255.255.248**
2. How many hosts will be supported in each subnet? **6-hosts**
3. What is the subnet address of the fourth subnet? **199.10.1.24**
4. What is the broadcast address of the sixth subnet? **199.10.1.47**

Quiz-19

- An ISP leases you the following network:

  139.10.8.0 / 21

You need to create 59-subnetworks from this single network.

1. What will be your new subnet mask (dotted-decimal)? _____
2. How many hosts will be supported in each subnet? _____
3. What is the subnet address of the fourth subnet? _____
4. What is the broadcast address of the sixth subnet? _____

Answer-19

- An ISP leases you the following network:

  139.10.8.0 /21

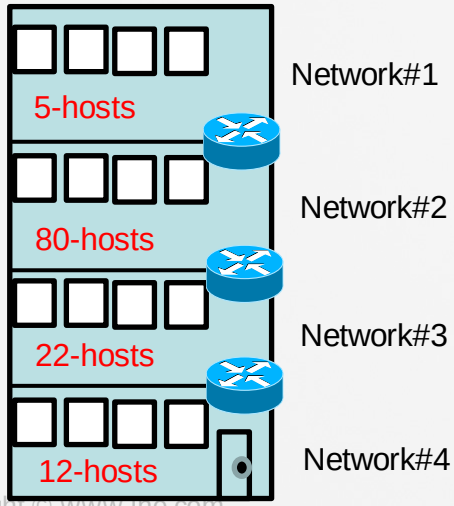
You need to create 59-subnetworks from this single network.

1. What will be your new subnet mask (dotted-decimal)? **255.255.255.224**
2. How many hosts will be supported in each subnet? **30-hosts**
3. What is the subnet address of the fourth subnet? **139.10.8.96**
4. What is the broadcast address of the sixth subnet? **139.10.8.191**

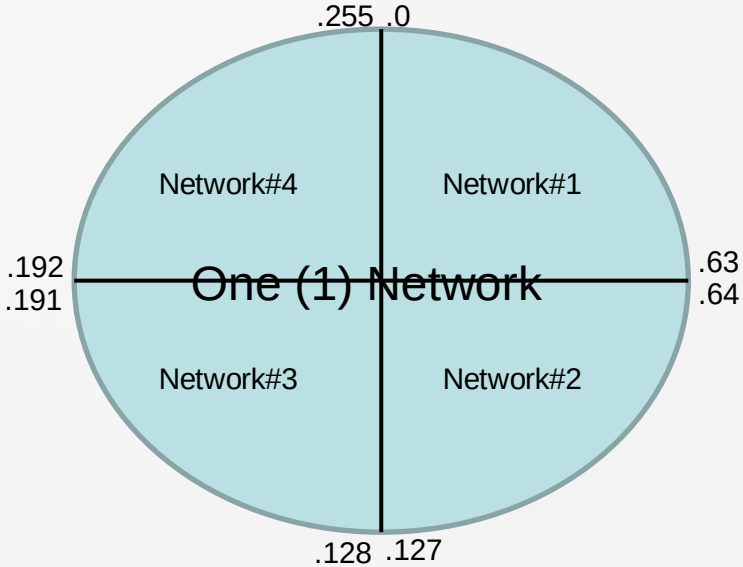
Same Length Subnetting – The Problem

Starting network is 199.199.199.0 /24

You need four sub-networks. $2^x \geq 4$ therefore "x" = 2 (subnetting bits)
199.199.199.0 /26 (/24 + 2-subnet bits = /26)



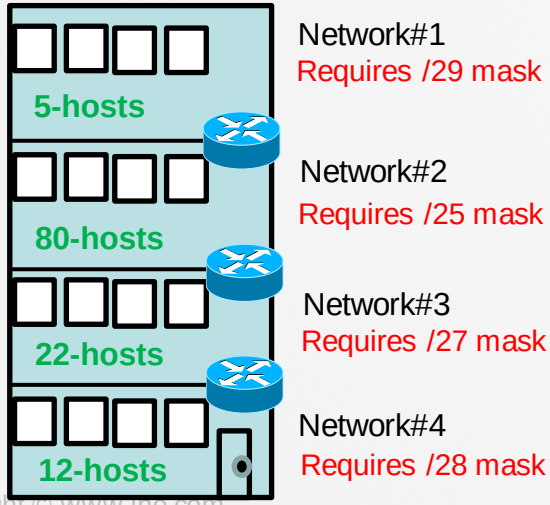
Host Bits available: x.x.x.**0** through x.x.x.**255**



The Solution - VLSM

Starting network is 199.199.199.0 /24

Create each subnet based on quantity of hosts required…NOT quantity of networks required.



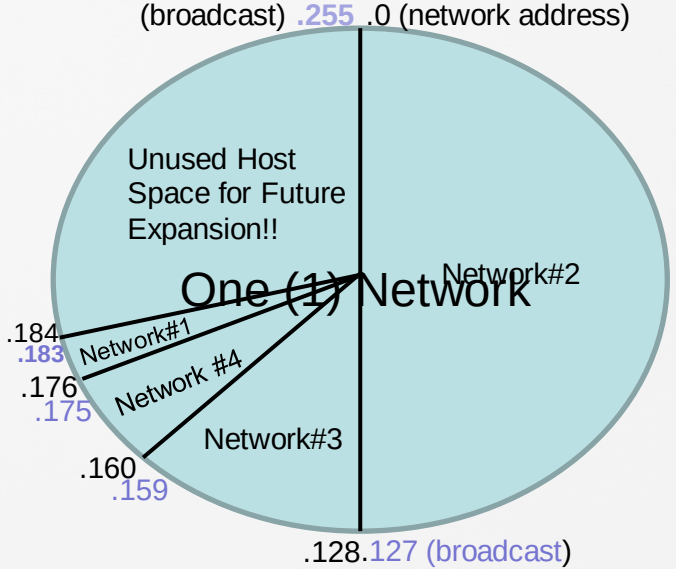
Network#1
Requires /29 mask

Network#2
Requires /25 mask

Network#3
Requires /27 mask

Network#4
Requires /28 mask

Host Bits available: x.x.x.**0** through x.x.x.**255**



VLSM & CIDR

- Same Length Subnet Masking
  - Each network utilizes the same mask.
- VLSM
  - Variable length subnet masking
  - Provides ability to allocate IPv4 **as per the host requirements**
  - Subnet mask can be variable
    - Ex: /25 , /26, /27 from /24 block

VLSM & CIDR

CIDR

- Classless Interdomain Routing
- Beyond the classful behavior
- Class A address can be treated as Class B & C or vice versa
- Ex: 199.50.0.0/16 [/16 is prefix-length from Class B]

Quiz-20

- Starting with the base network of 100.100.100.0/24, use VLSM to divide this single network into multiple subnetworks appropriate to fit the requirements shown below.

Network-1 (software engineering): 12-hosts _____

Network-2 (technical support): 49-hosts _____

Network-3 (marketing): 100-hosts _____

Network-4 (human resources): 19-hosts _____

Answer-20

- Starting with the base network of 100.100.100.0/24, use VLSM to divide this single network into multiple subnetworks appropriate to fit the requirements shown below.

Network-3 (marketing): 100-hosts **/25 (supports up to 126-hosts)**
100.100.100.0 /25 (next available network = 100.100.100.128)

Network-2 (technical support): 49-hosts **/26 (supports up to 62-hosts)**
100.100.100.128 /26 (next available network = 100.100.100.192)

Network-4 (human resources): 19-hosts **/27 (supports up to 30-hosts)**
100.100.100.192 /27 (next available network = 100.100.100.224)

Network-1 (software engineering): 12-hosts **/28 (supports up to 14-hosts)**
100.100.100.224 /27 (next available network = 100.100.100.240)

Quiz-21

- Starting with the base network of 140.140.0.0/22, use VLSM to divide this single network into multiple subnetworks appropriate to fit the requirements shown below.

Network-1 (software engineering): 6-hosts _____

Network-2 (technical support): 2-hosts _____

Network-3 (marketing): 45-hosts _____

Network-4 (human resources): 220-hosts _____

Answer-21

- Starting with the base network of 140.140.0.0/22, use VLSM to divide this single network into multiple subnetworks appropriate to fit the requirements shown below.

Network-4 (human resources): 220-hosts /24 (supports up to 254-hosts)
140.140.0.0/24 **(next available network = 140.140.1.0)**

Network-3 (marketing): 45-hosts /26 (supports up to 62-hosts)
140.140.1.**0**/26 **(next available network = 140.140.1.64)**

Network-1 (software engineering): 6-hosts /29 (supports up to 6-hosts)
140.140.1.**64**/29 **(next available network = 140.140.1.72)**

Network-2 (technical support): 2-hosts /30 (supports up to 2-hosts)
140.140.1.**72**/26 **(next available network = 140.140.1.76)**

IPv4 Summarization

- Process of combining multiple subnetworks into a single network advertisement.
- Network ID and subnet mask are referenced
- Usually called *aggregation*
- Efficient in large networks, provides addressing hierarchy

IPv4 Summarization - Example

- Example
  - Network : 10.10.32.0 / 20
  - Network: 10.10.48.0 / 20
  - Subnet mask: 255.255.240.0
- Conversion of network-id into bits
  - 10.10.0010hhhh.hhhhhhhh / 20
  - 10.10.0011hhhh.hhhhhhhh / 20
  - AND operation result : 10.10.001hhhhh.hhhhhhhh

"h" = Host Bit

10.10.32.0 / 19 (summarized network)

Quiz-22

- What single, summarized route can be created by summarizing the following subnets?

135.75.42.100 /30

135.75.42.108 /29

135.75.42.112 /28

Answer-22

- What single, summarized route can be created by summarizing the following subnets?

135.75.42.100 /30
135.75.42.0110xxxx

135.75.42.108 /29
135.75.42.0110xxxx

135.75.42.112 /28
135.75.42.0111xxxx

135.75.42.01100000 /27

135.75.42.96 /27

Summarization and Supernetting

IPv4 Summarization

- Aggregating multiple subnets into a single network advertisement.
- That advertisement does not break classfull boundaries.

IPv4 Supernetting

- Aggregating multiple networks (could be subnets or classfull networks) into a single network advertisement.
- That advertisement breaks classfull boundaries.

Example: 10.0.0.0 /7 is a Supernet

IPv4 Supernetting

- Example
  - Network : 192.168.1.0/24
  - Network: 192.168.2.0/24
- Conversion of network-id into bits
  - 192.168.**00000001**.hhhhhhhh
  - 192.168.**00000010**.hhhhhhhh
  - AND operation result : 192.168.**000000**hh.hhhhhhhh

    192.168.0.0/22 (Supernet)

IPv4 Summarization and Supernetting

- Some routers perform summarization by default.
- Supernetting can only be done manually.

- When performing summarization or supernetting ask yourself, "*what bits.. from left-to-right.. do all of these networks have in common?*"
  - Answer to the above question will determine new mask.

Any Questions?