



CD4002/CN4002
Computer Systems and Networks

Topic:
IPv4 Addressing

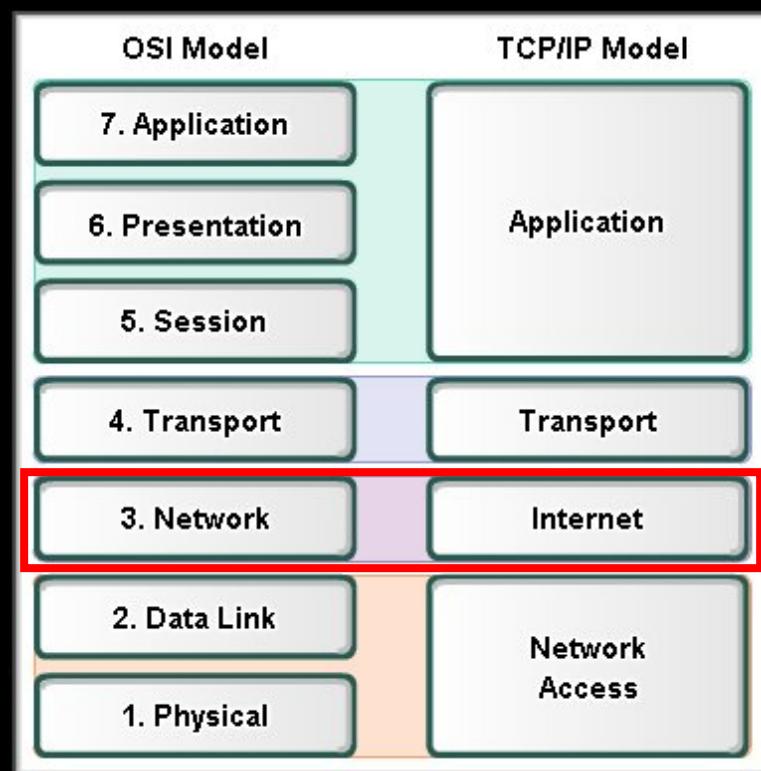
Objectives

- Explain the difference between classful and classless addressing.
- Describe the structure of an IPv4 address.
- Understand the methods to assign IP addresses.



Addressing the Network: IPv4

Legacy IPv4 Addressing



Legacy IPv4 Addressing

- In the early 1980's, unicast address ranges were grouped into specific sizes or **classes** of address.
- Each class defined:
 - A specifically sized network.
 - Specific address blocks for these networks.

Class	High Order Bits	First Octet Range	Number of Network Bits	Number of Host Bits	Number of Networks	Number of Hosts per Network
A	0	0-127	8	24	128	16,777,216
B	10	128-191	16	16	16,384	65,536
C	110	192-223	24	8	2,097,152	256
D	1110	224-239	Used for Multicasting to multiple hosts.			
E	1111	240-255	Reserved for research and development.			

IPv4 Classful Addressing

- Devices examined the **first octet** of the address and could determine the address range.
- The high order bits never change for each class.
 - **Classful Addressing:**
 - 192.168.23.2 is in the Class C range
 - Therefore – 24 network bits and 8 hosts bits.

Class	High Order Bits	First Octet Range	Number of Network Bits	Number of Host Bits	Number of Networks	Number of Hosts per Network
A	0	0-127	8	24	128	16,777,216
B	10	128-191	16	16	16,384	65,536
C	110	192-223	24	8	2,097,152	256

IPv4 Classful Addressing

- In the early 1990s, the **subnet mask** was added to IPv4.
 - The subnet mask allowed networks to subdivided or subnetted.
 - Each class was assigned a default subnet mask.

Class	First Octet Range	Number of Network Bits	Number of Host Bits	Default Subnet Mask	Number of Networks	Number of Hosts per Network
A	0-127	8	24	255.0.0.0	128	16,777,216
B	128-191	16	16	255.255.0.0	16,384	65,536
C	192-223	24	8	255.255.255.0	2,097,152	256

IPv4 Classful Addressing

- Let's quickly review....
 - *In order to function properly with network devices, every IP network must contain three types of addresses:*
 - Network Address:
 - All **HOST BITS** are set to **0**.
 - Host Address: **HOST BITS** will vary.
 - Broadcast Address:
 - All **HOST BITS** are set to **1**.
 - *For a host to communicate directly with another host on the same network, they must have the same network portion.*

IPv4 Classful Addressing

- SO:
 - For every IP address range that we assign to a network segment, we automatically lose two addresses....
 - One for the **network address** (sometimes called the **wire address** or **subnetwork address**)
 - One for the **broadcast address** for that network.

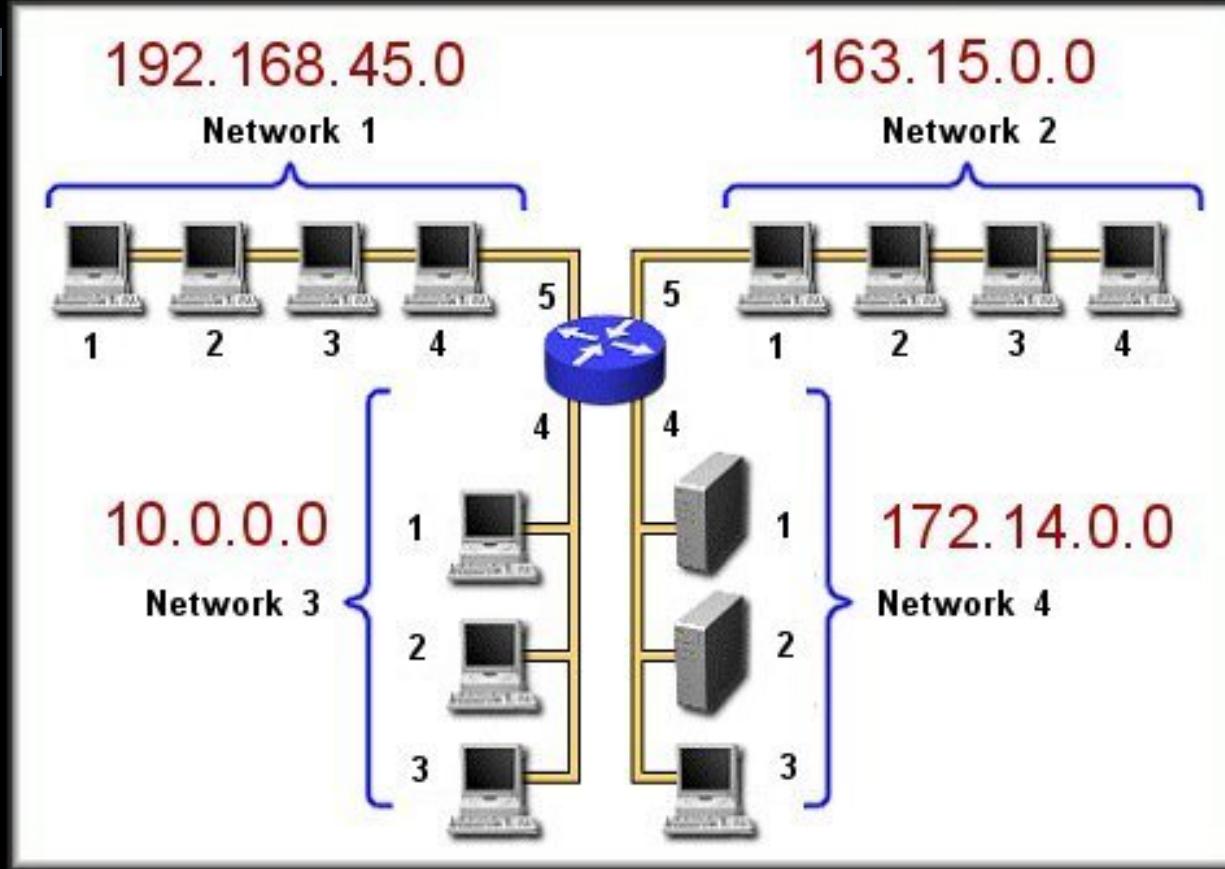
IPv4 Classful Addressing

- Our numbers for the number of hosts per network have to change to allow for the special use of the network number and broadcast addresses.

Class	Number of Network Bits	Number of Host Bits	Number Hosts Per Network	Number of <u>Useable</u> Hosts per Network
A	8	24	$2^{24} = 16,777,216$	$2^{24} - 2 = 16,777,214$
B	16	16	$2^{16} = 65,536$	$2^{16} - 2 = 65,534$
C	24	8	$2^8 = 256$	$2^8 - 2 = 254$

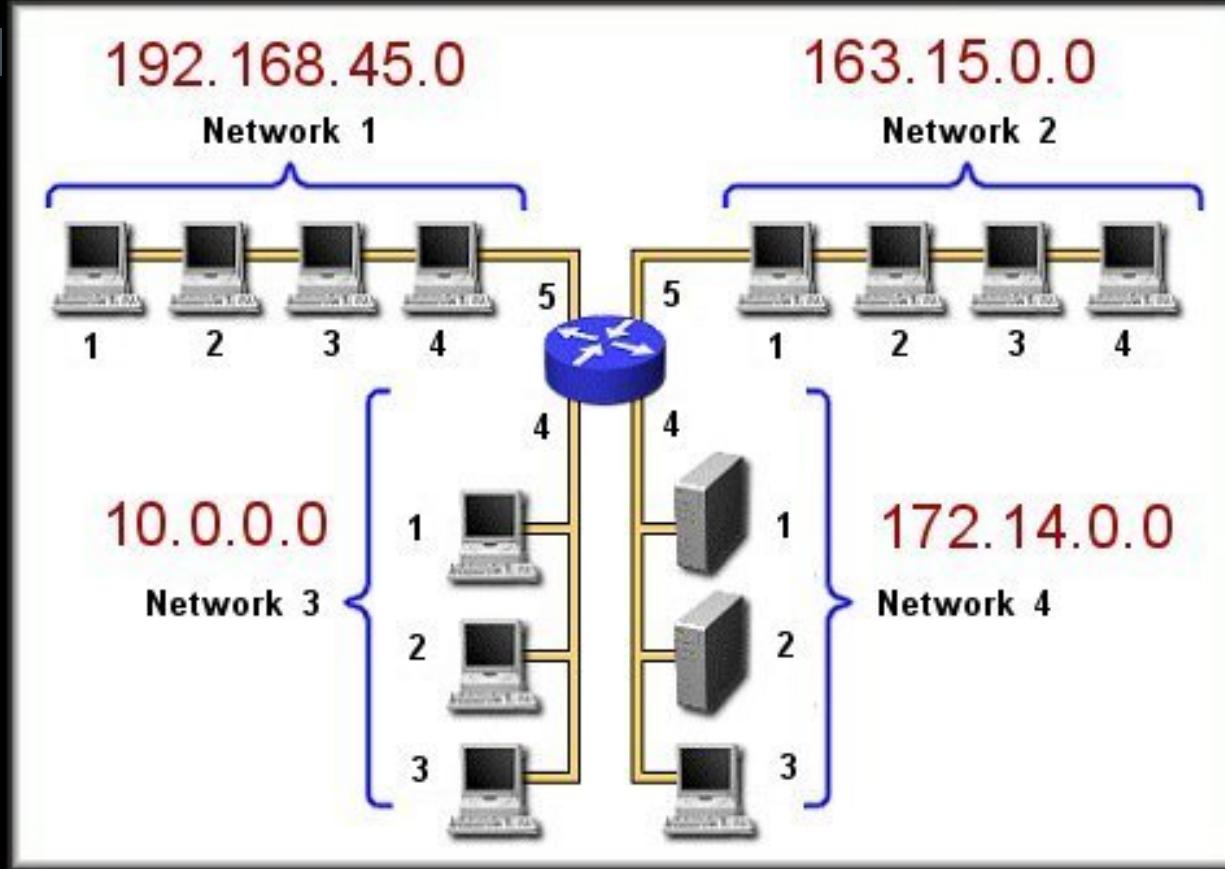
- As we will see, the formula ($2^{\text{number_of_bits}} - 2$ or $2^n - 2$) is an important part of assigning an IP address range to a network segment.

The Network Number



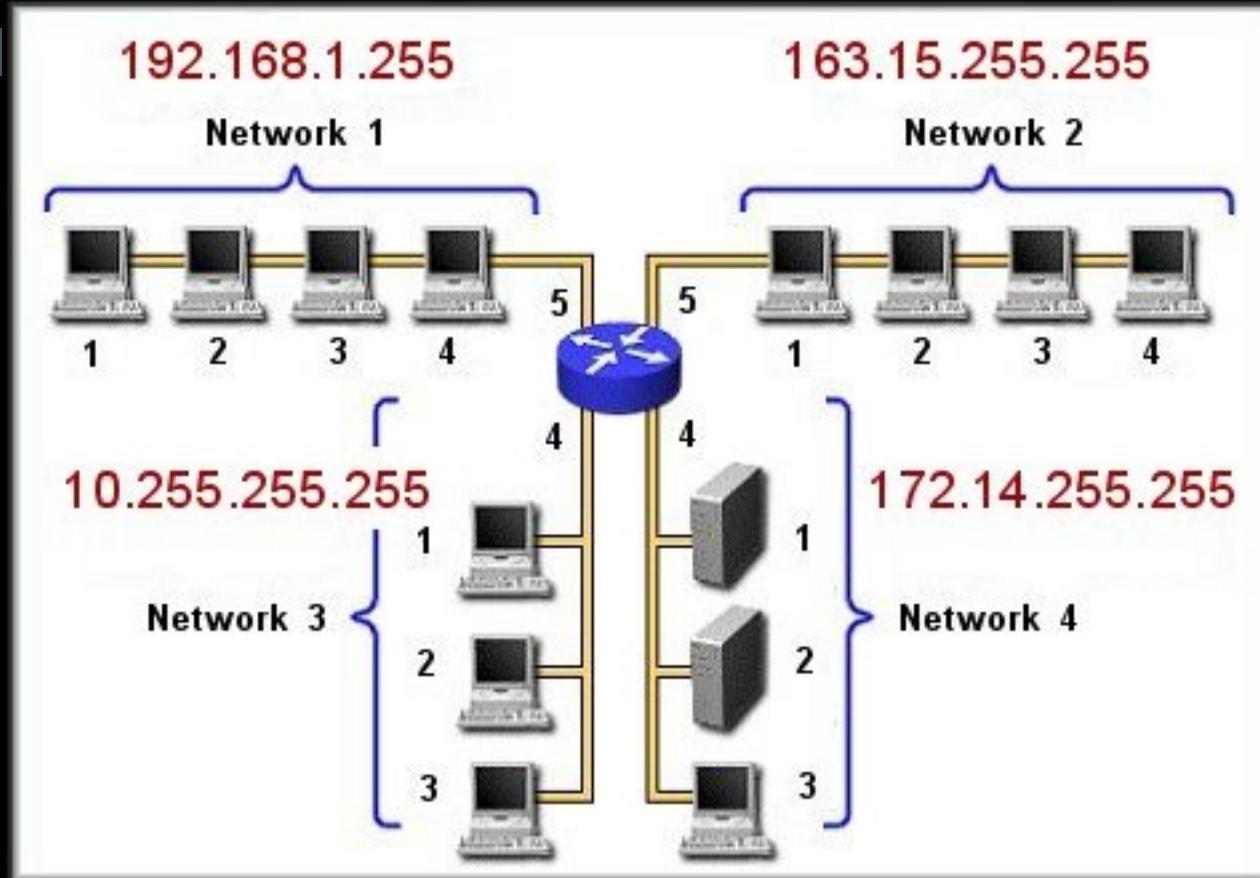
- A host on a network can communicate **directly** with other devices **on the same network**, only if all the devices have the **same network number** and the **same subnet mask**.

The Network Number



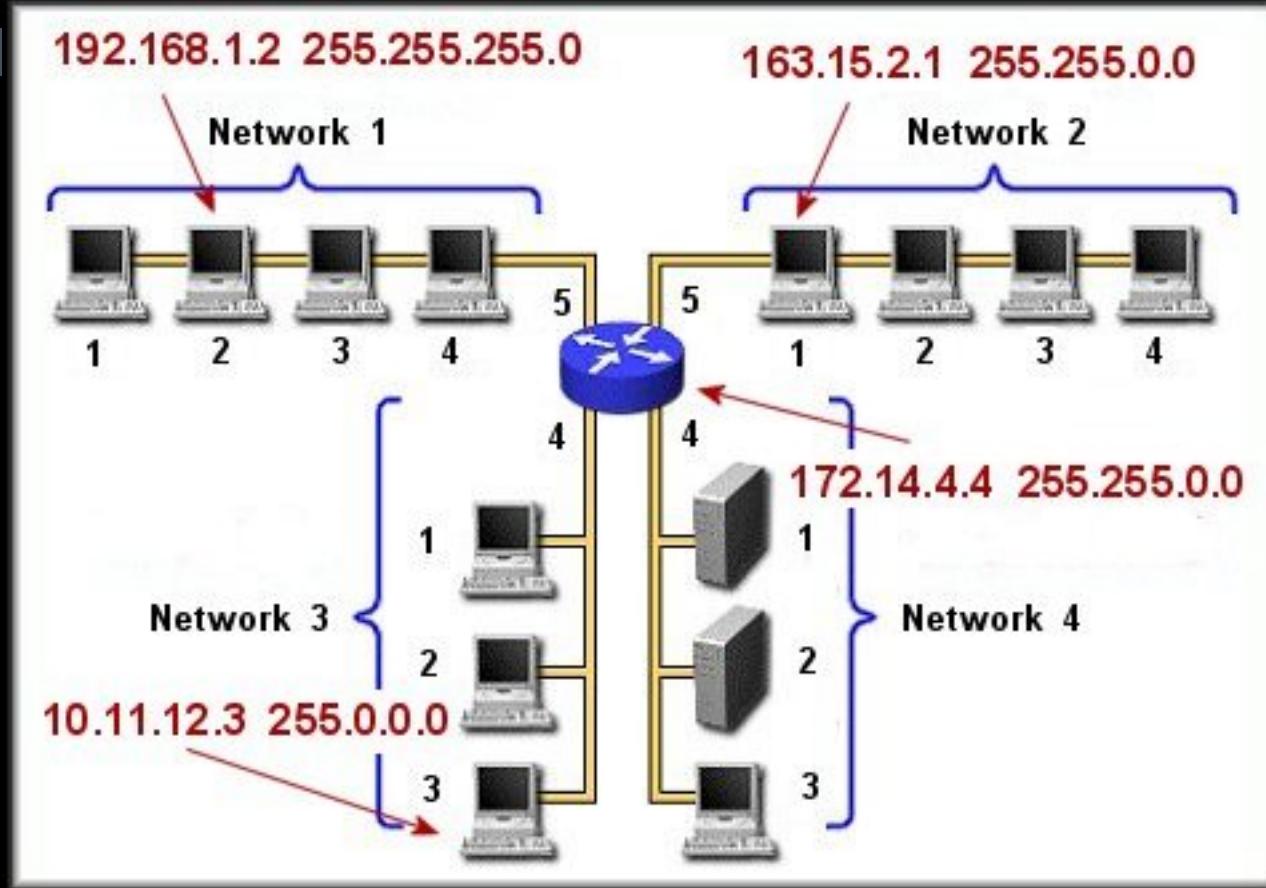
- Routers use the network number to build their routing tables so it **cannot be used for a host**.
- The IP address that indicates the network number has all **0 bits** in the **host portion** of the IP Address.

The Broadcast



- If a host needs to send a **broadcast**, it also uses the network number with all of the **host bits set to 1**.
- A broadcast address is used for that purpose only and **cannot be assigned to a host**.

The Host Number



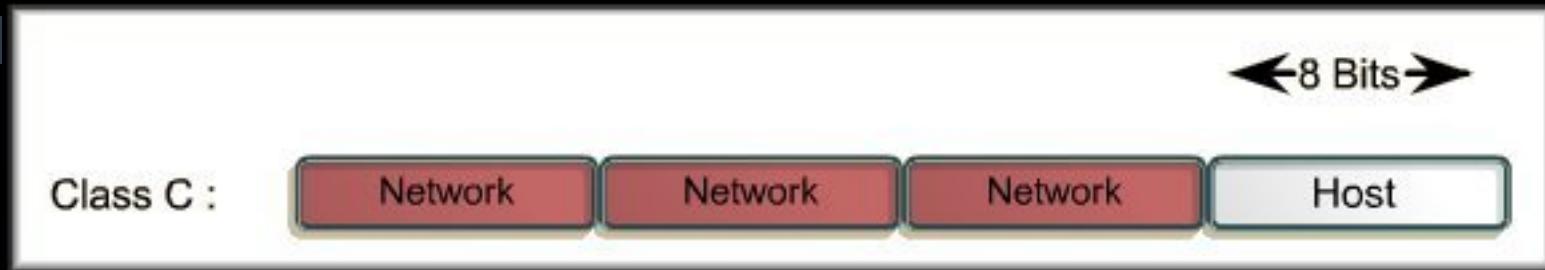
- The host number is the portion of the IP address that uniquely identifies the individual host on that network.

The Subnet Mask

- **Subnet Mask:**
 - Let's not forget about the subnet mask.
 - Each class has a **default** or "natural" subnet mask based on the default number of bits used for the network and host portion.

Class	Number of Network Bits	Number of Host Bits	Default Prefix	Default Subnet Mask
A	8	24	/8	255.0.0.0
B	16	16	/16	255.255.0.0
C	24	8	/24	255.255.255.0

Classful IP Addressing – Class C



- Class C:
 - Address range: 192 - 223
 - Number of network bits: 24
 - Number of networks: 2,097,152
 - Number of host bits: 8
 - Number of hosts per network:
 - $2^8 = 256$
 - Number of Useable Hosts per network:
 - $2^8 - 2 = 254$
 - Default Subnet Mask: 255.255.255.0 or /24

Classful IP Addressing – Class C

- We know from the Class C subnet mask (255.255.255.0):
 - The first 24 bits are the network number and the last 8 bits are the host numbers.
- The first host address (all 0's) is reserved for the network address.

11010010	00010100	01001101	00000000
210.	20.	77.	0

- The last host address (all 1's) is reserved for the broadcast address.

11010010	00010100	01001101	11111111
210.	20.	77.	255

Classful IP Addressing – Class C

- Because the host portion of the subnet mask is all zero's (255.255.255.0), the remaining host addresses can be used for individual hosts on the network.
 - The number of **usable** host addresses for the entire network is $2^8 - 2 = 254$

The range of available addresses is:

11010010	00010100	01001101	00000001
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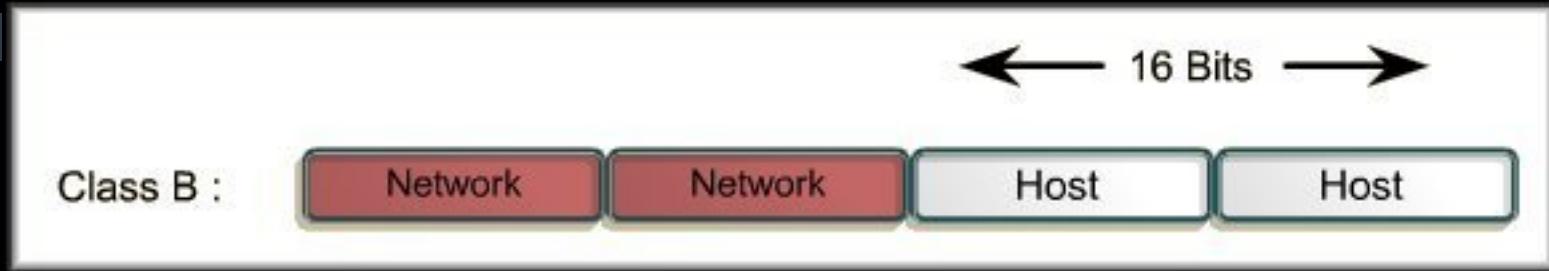
210.	20.	77.	1
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⋮

11010010	00010100	01001101	11111110
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210.	20.	77.	254
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Classful IP Addressing – Class B



- Class B:
 - Address range: 128 - 191
 - Number of network bits: 16
 - Number of networks: 16,384
 - Number of host bits: 16
 - Number of hosts per network:
 - $2^{16} = 65,536$
 - Number of **Useable** Hosts per network:
 - $2^{16} - 2 = 65,534$
 - Default Subnet Mask: 255.255.0.0 or /16

Classful IP Addressing – Class B

- We know from the Class B subnet mask (255.255.0.0):
 - The first 16 bits are the network number and the last 16 bits are the host numbers.
- The first host address (all 0's) is reserved for the network address.

10010010	01010100	00000000	00000000
146.	84.	0.	0

- The last host address (all 1's) is reserved for the broadcast address.

10010010	01010100	11111111	11111111
146.	84.	255.	255

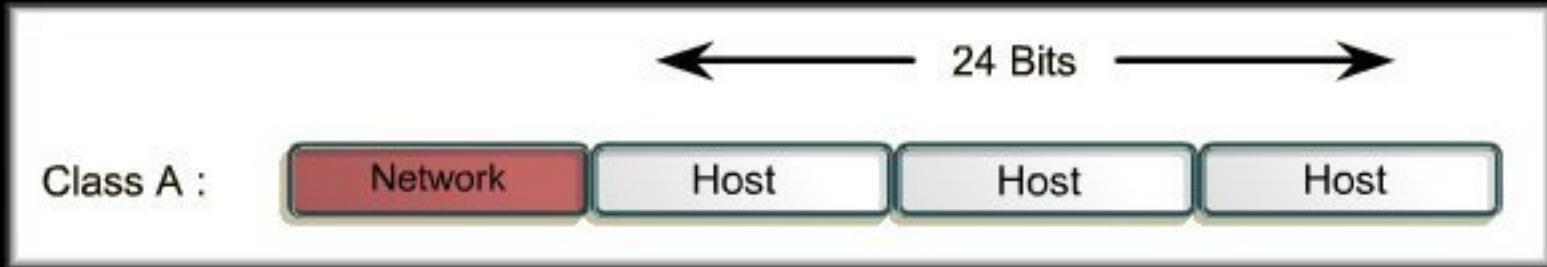
Classful IP Addressing – Class B

- Because the host portion of the subnet mask is all zero's (255.255.0.0), the remaining host addresses can be used for individual hosts on the network.
 - The number of **usable** host addresses for the entire network is $2^{16} - 2 = 65,534$

The range of available addresses is:

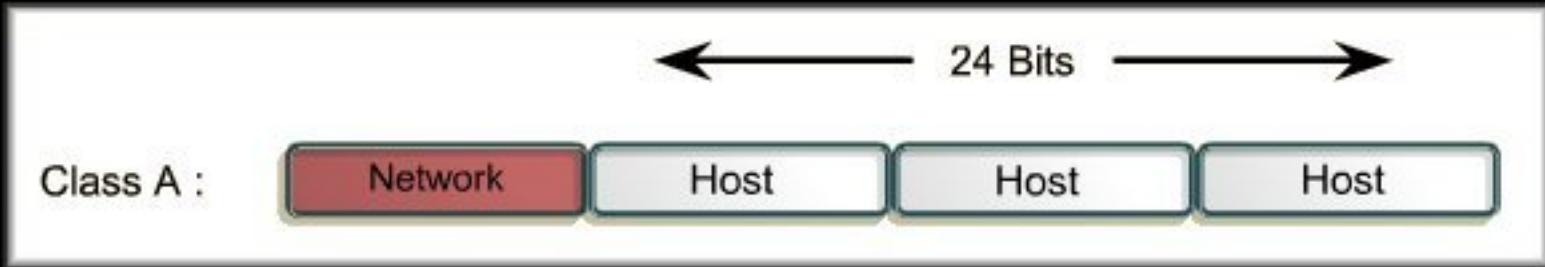
10010010	01010100	00000000	00000001
146.	84.	0.	1
•	•	•	•
10010010	01010100	11111111	11111110
146.	84.	255.	254

Classful IP Addressing – Class A



- Class A:
 - Address range: 0 - 127
 - Number of network bits: 8
 - Number of networks: 126
 - Number of host bits: 24
 - Number of hosts per network:
 - $2^{24} = 16,777,216$
 - Number of Useable Hosts per network:
 - $2^{24} - 2 = 16,777,214$
 - Default Subnet Mask: 255.0.0.0 or /8

Classful IP Addressing – Class A



- Class A (Usable Networks):
 - An address range of 0 –127 is 128 networks. The actual number of **usable** networks for Class A is **126**.
 - **Network 0** is reserved for special use for default routes.
 - **Network 127** is reserved as a loopback network.
 - The address **127.0.0.1** is automatically available in every device after TCP/IP has been installed.
 - If you "ping" that address and get a good response, it means that TCP/IP is installed correctly.

Classful IP Addressing – Class A

- We know from the Class A subnet mask (255.0.0.0):
 - The first 8 bits are the network number and the last 24 bits are the host numbers.
- The first host address (all 0's) is reserved for the network address.

01000010	00000000	00000000	00000000
66.	0.	0.	0

- The last host address (all 1's) is reserved for the broadcast address.

01000010	11111111	11111111	11111111
66.	255.	255.	255

Classful IP Addressing – Class A

- Because the host portion of the subnet mask is all zero's (255.255.0.0), the remaining host addresses can be used for individual hosts on the network.
 - The number of **usable** host addresses for the entire network is $2^{24} - 2 = 16,777,216$

The range of available addresses is:	01000010	00000000	00000000	00000001
	66.	0.	0.	1
		⋮	⋮	
	01000010	11111111	11111111	11111110
	66.	255.	255.	254

Classful IP Addressing

- IP Address: 130.61.22.204 / 16

Address Class: B

Subnet Mask: 255.255.0.0

Network Address is: 130.61.0.0

Broadcast Address is: 130.61.255.255

Number of Useable host addresses: $2^{16} - 2 = 65,534$

What are they? 130.61.0.1 - 130.61.255.254

Classful IP Addressing

- IP Address: 197.101.28.83 / 24

Address Class: C

Subnet Mask: 255.255.255.0

Network Address is: 197.101.28.0

Broadcast Address is: 197.101.28.255

Number of Useable host addresses: $2^8 - 2 = 254$

What are they? 197.101.28.1 - 197.101.28.254

Classful IP Addressing

- IP Address: 64.133.65.101 / 8

Address Class: A

Subnet Mask: 255.0.0.0

Network Address is: 64.0.0.0

Broadcast Address is: 64.255.255.255

Number of Useable host addresses: $2^{24} - 2 = 16,777,214$

What are they? 64.0.0.1 - 64.255.255.254