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Addressing the Network – IPv4



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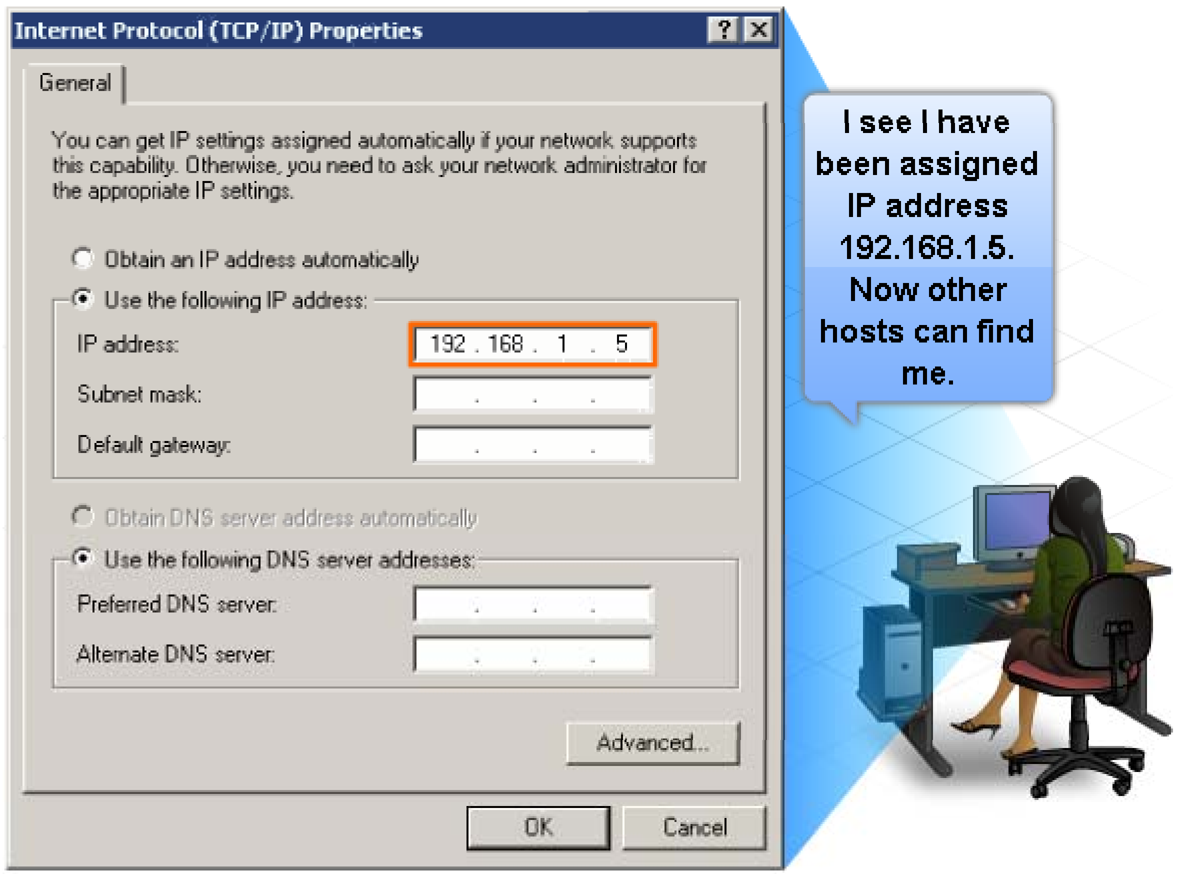
Objectives

- Explain the structure IP addressing and demonstrate the ability to convert between 8-bit binary and decimal numbers.
- Given an IPv4 address, classify by type and describe how it is used in the network
- Explain how addresses are assigned to networks by ISPs and within networks by administrators
- Determine the network portion of the host address and explain the role of the subnet mask in dividing networks.
- Given IPv4 addressing information and design criteria, calculate the appropriate addressing components.
- Use common testing utilities to verify and test network connectivity and operational status of the IP protocol stack on a host.

Introduction

- Addressing is a key function of Network layer protocols that enables data communication between hosts on the same network or on different networks.
- Designing, implementing and managing an effective IPv4 addressing plan ensures that our networks can operate effectively and efficiently.



IP version 4 (IPv4) is the current form of addressing used on the Internet.

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IPv4 Addresses

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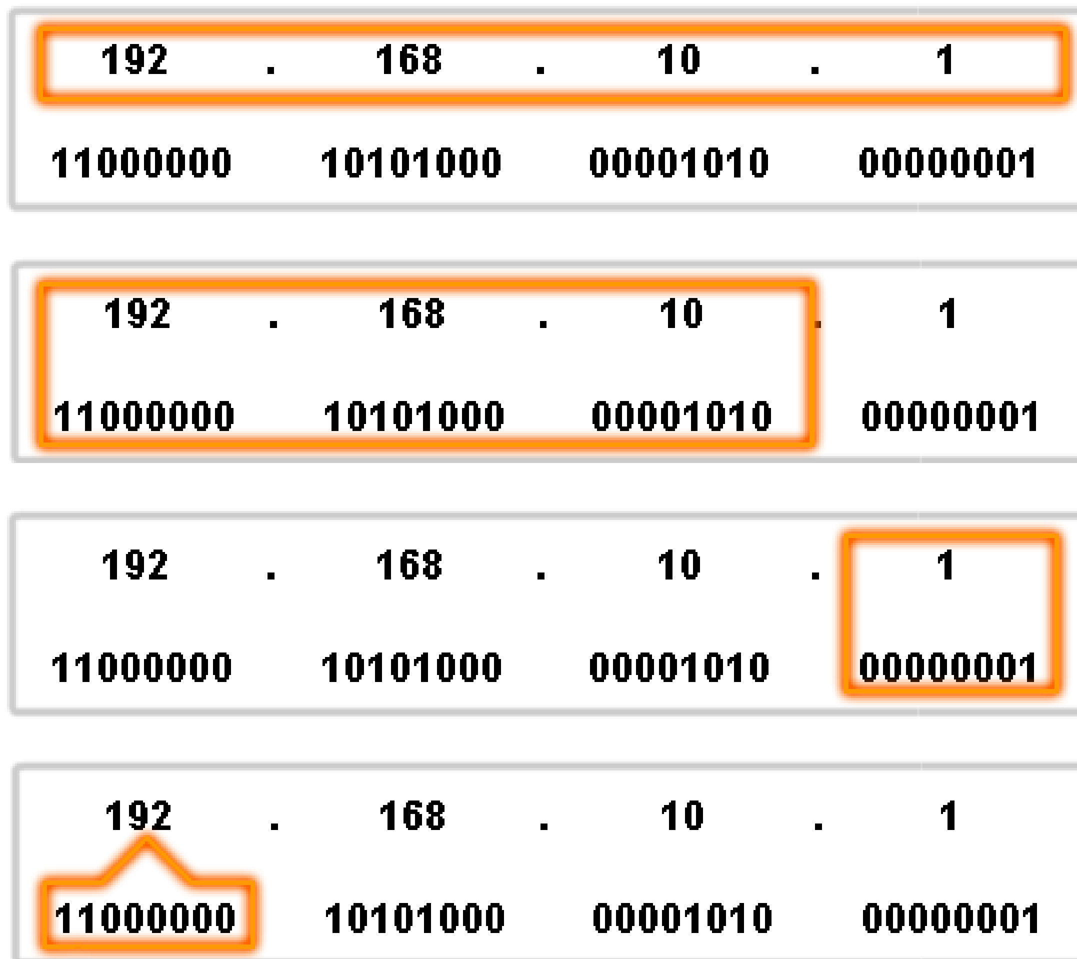
IP Addressing Structure

- **32-bit address** is expressed in **Dotted decimal**
- Network portion
- Host portion
- Octet

The computer using this IP address is on network 192.168.10.0.



Binary to Decimal Conversions

- **Convert 8-bit binary to decimal**: using positional notation, means a digit represents different values depending on the position the digit occupies.

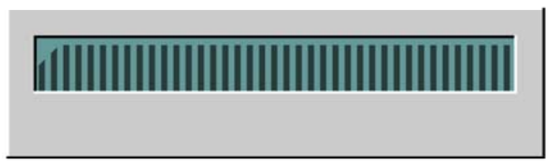
Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Position	128	64	32	16	8	4	2	1
Bits	1	1	1	1	0	1	0	1
	1 BYTE / 1 Octet							
Add these numbers together	128 +	64 +	32 +	16 +	0 +	4 +	0 +	1
Decimal	245							

A 1 in this position means 64 is added to the total.

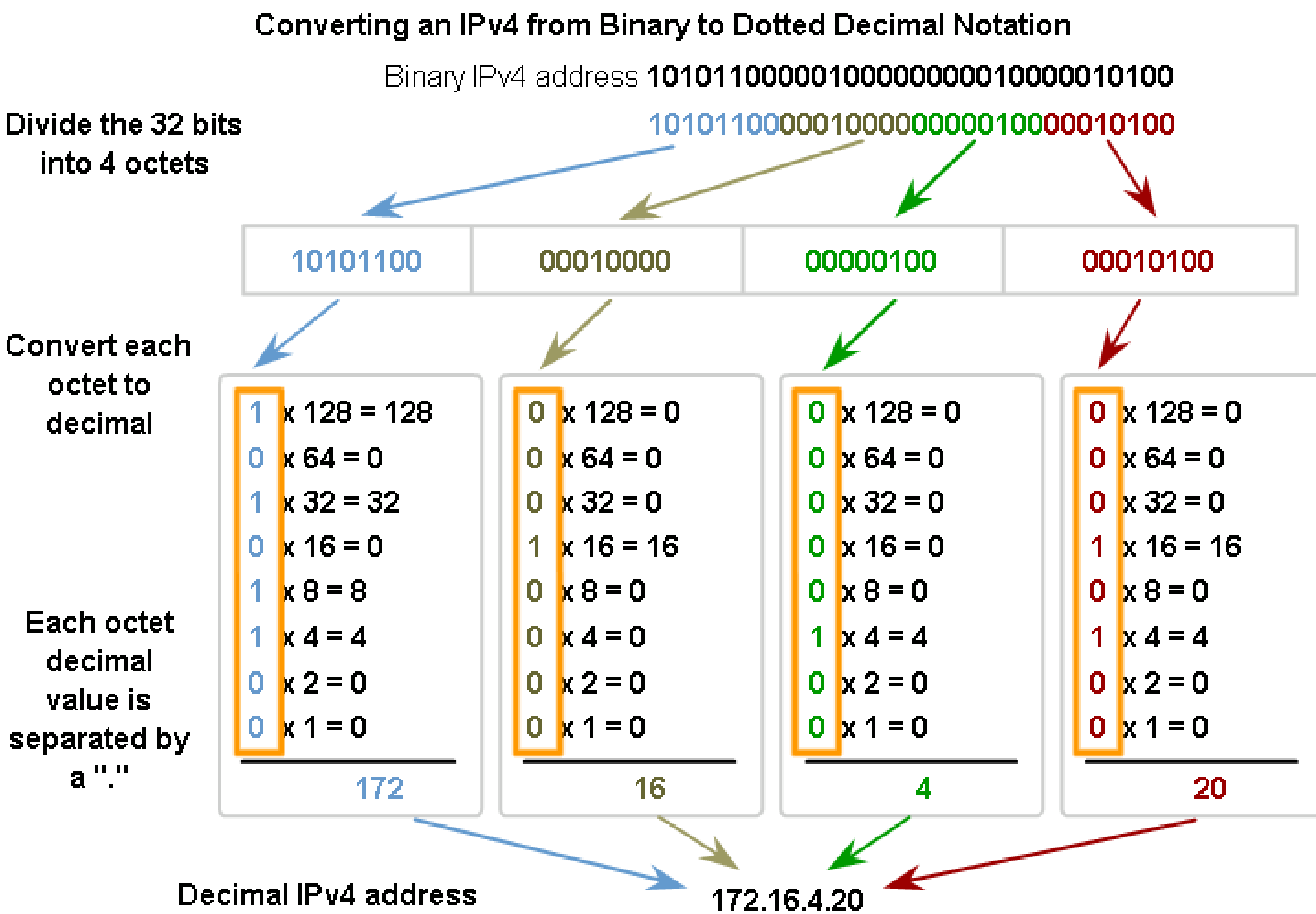
A 0 in any position means that 0 is added to the total.

11110101 in Binary = Decimal Number 245

Binary to Decimal Conversions

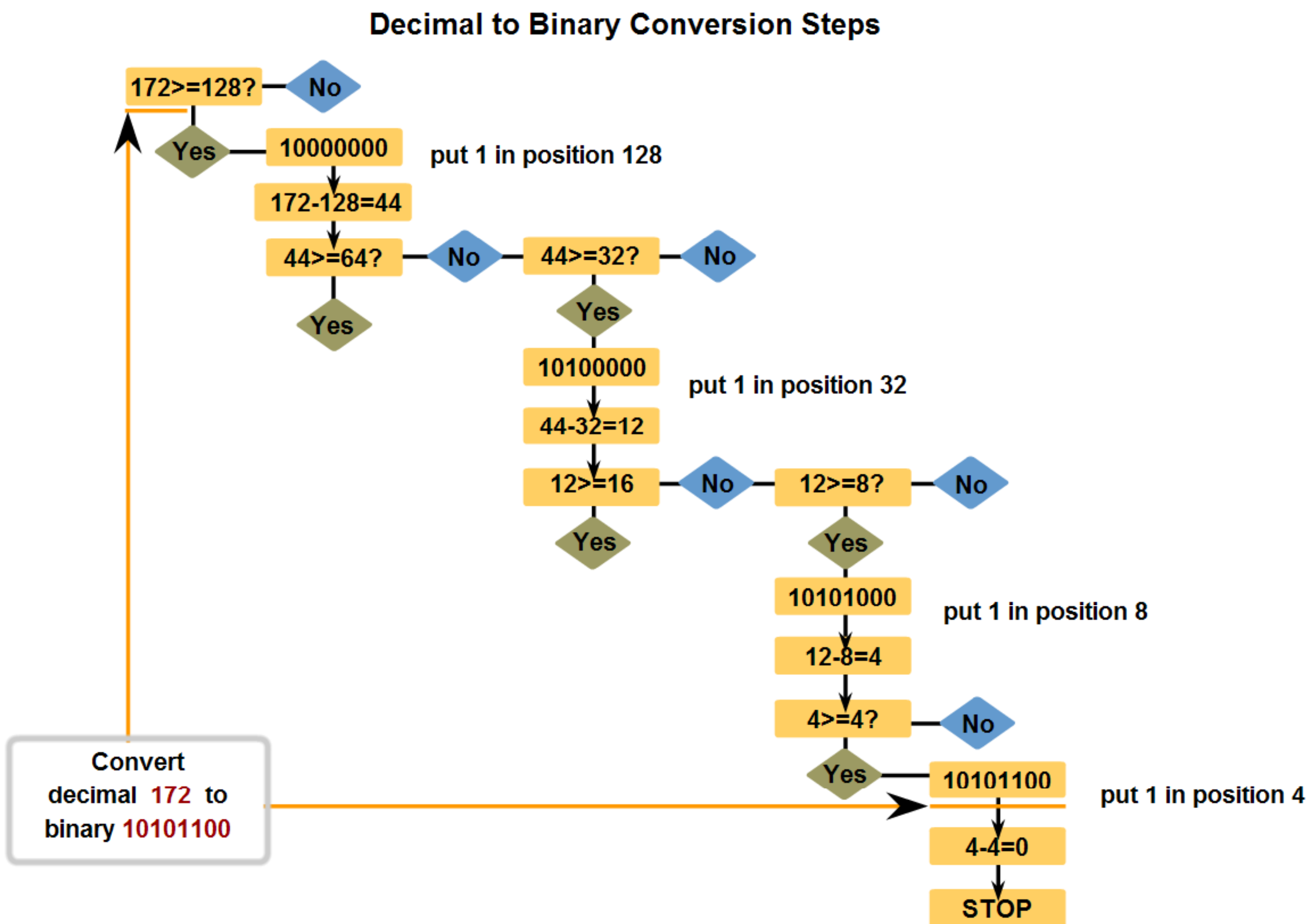


Binary to Decimal Conversions



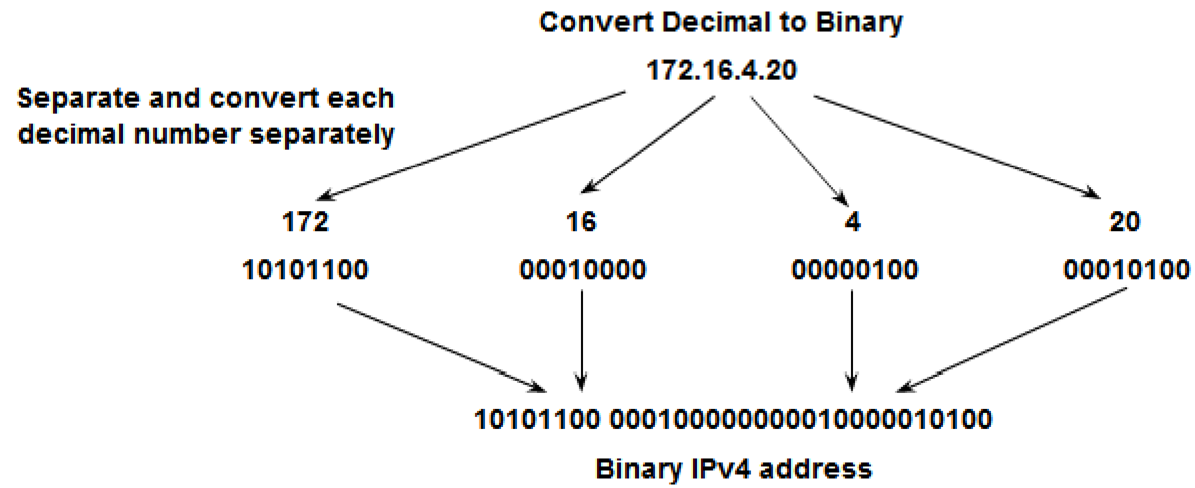
Decimal to Binary Conversions

- Convert decimal to 8-bit binary



Decimal to Binary Conversions

- Convert decimal to 8-bit binary



Decimal to Binary Conversion Activity

Given a decimal value, enter the correct binary values for each positon.

Decimal Value	209							
Exponent	2^7th	2^6th	2^5th	2^4th	2^3rd	2^2nd	2^1st	2^0
Position	128	64	32	16	8	4	2	1
Bit								

Enter numbers for these 8 positions.

Convert IP address

Convert Decimal to Binary

Decimal IPv4 address 172.16.4.20

Separate and convert each decimal number separately

Convert 172

172 - 128 = 44	→ 1 x 128
44 < 64 = 0	→ 0 x 64
44 - 32 = 12	→ 1 x 32
12 < 16 = 0	→ 0 x 16
12 - 8 = 4	→ 1 x 8
4 - 4 = 0	→ 1 x 4
0 < 2 = 0	→ 0 x 2
0 < 1 = 0	→ 0 x 1

10101100

Convert 16

16 < 128	→ 0 x 128
16 < 64	→ 0 x 64
16 < 32	→ 0 x 32
16 - 16 = 0	→ 1 x 16
0 < 8	→ 0 x 8
0 < 4	→ 0 x 4
0 < 2	→ 0 x 2
0 < 1	→ 0 x 1

00010000

Convert 4

4 < 128	→ 0 x 128
4 < 64	→ 0 x 64
4 < 32	→ 0 x 32
4 < 16	→ 0 x 16
4 < 8	→ 0 x 8
4 - 4 = 0	→ 1 x 4
0 < 2	→ 0 x 2
0 < 1	→ 0 x 1

00000100

Convert 20

20 < 128	→ 0 x 128
20 < 64	→ 0 x 64
20 < 32	→ 0 x 32
20 - 16 = 4	→ 1 x 16
4 < 8	→ 0 x 8
4 - 4 = 0	→ 1 x 4
0 < 2	→ 0 x 2
0 < 1	→ 0 x 1

00010100

Binary IPv4 address **10101100 00010000000001000010100**

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Addressing the Network – IPv4



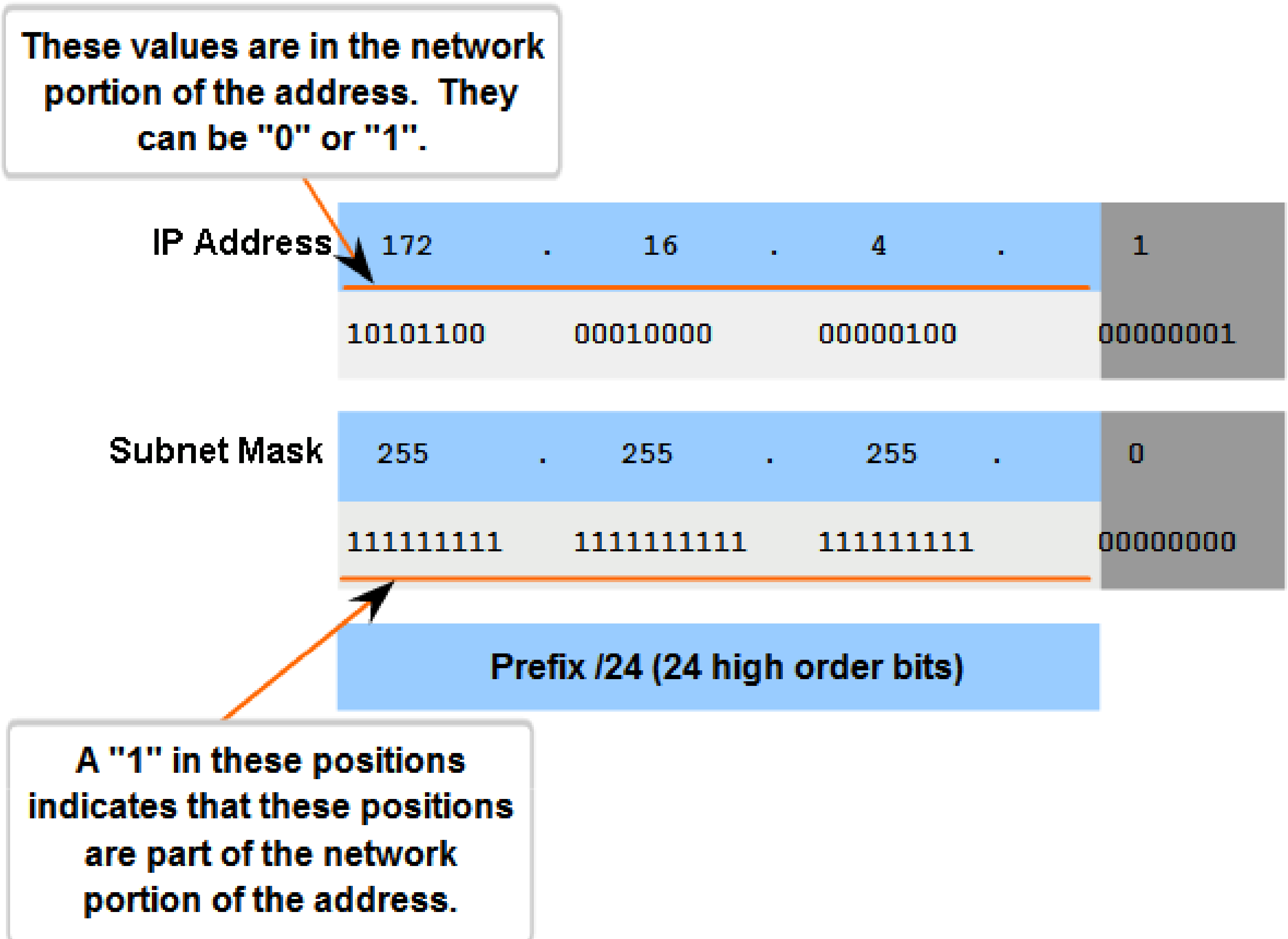
Subnet Mask

Defining the Network and Host Portions

- The subnet mask is 32-bit pattern and created by placing a **binary 1** in each bit position that represents the **network portion** and placing a **binary 0** in each bit position that represents the **host portion**.
- The prefix and the subnet mask are different ways of representing the same thing - the network portion of an address.
- In 8-bit pattern, there are:

00000000 = 0	11110000 = 240
10000000 = 128	11111000 = 248
11000000 = 192	11111100 = 252
11100000 = 224	11111110 = 254
	11111111 = 255

Defining the Network and Host Portions



Defining the Network and Host Portions

These values are in the host portion of the address. They can be "0" or "1".

IP Address	172	.	16	.	4	.	1
	10101100		00010000		00000100		00000001
Subnet Mask	255	.	255	.	255	.	0
	111111111		1111111111		111111111		00000000

Prefix /24 (24 high order bits)

A "0" in these positions indicates that these positions are part of the host portion of the address.

Defining the Network and Host Portions

- ANDing process: extracts the network address from the IP address.
- Logical AND:

  1 AND 1 = 1

  1 AND 0 = 0

  0 AND 1 = 0

  0 AND 0 = 0

A device with address 192.0.0.1 belongs to network 192.0.0.0

	High order bits Prefix /16		Low order bits	
	192 .	0 .	0 .	1
Host Address	11000000	00000000	00000000	00000001
Subnet Mask	255	255	0	0
	11111111	11111111	00000000	00000000
Network Address	11000000	00000000	00000000	00000000
Network	192 .	0 .	0 .	0

Defining the Network and Host Portions

Use the subnet mask to determine the network address for the host 173.16.132.70/20.

Host Address	172 .	16 .	132 .	70
Binary Host Address	10101100	00010000	10000100	01000110
Binary Subnet Mask	11111111	11111111	11110000	00000000
Binary Network Address	10101100	00010000	10000000	00000000
Network Address	172 .	16 .	128 .	0

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Addressing the Network – IPv4



Addresses for Different Purposes

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Type of Address in an IPv4 Network

Three types of addresses:

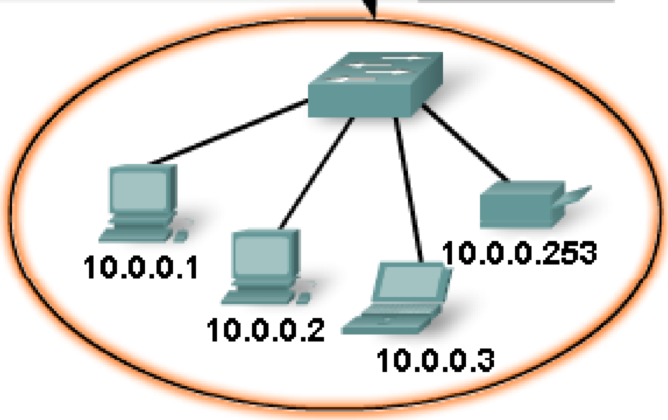
- **Network address** - The address by which we refer to the network. All hosts in a network will have the same network bits.
- **Broadcast address** - A special address used to send data to all hosts in the network. The broadcast address uses the highest address in the network range. This is the address in which the bits in the host portion are all 1s. This address is also referred to as the directed broadcast.
- **Host addresses** - The addresses assigned to the end devices in the network

Type of Address in an IPv4 Network

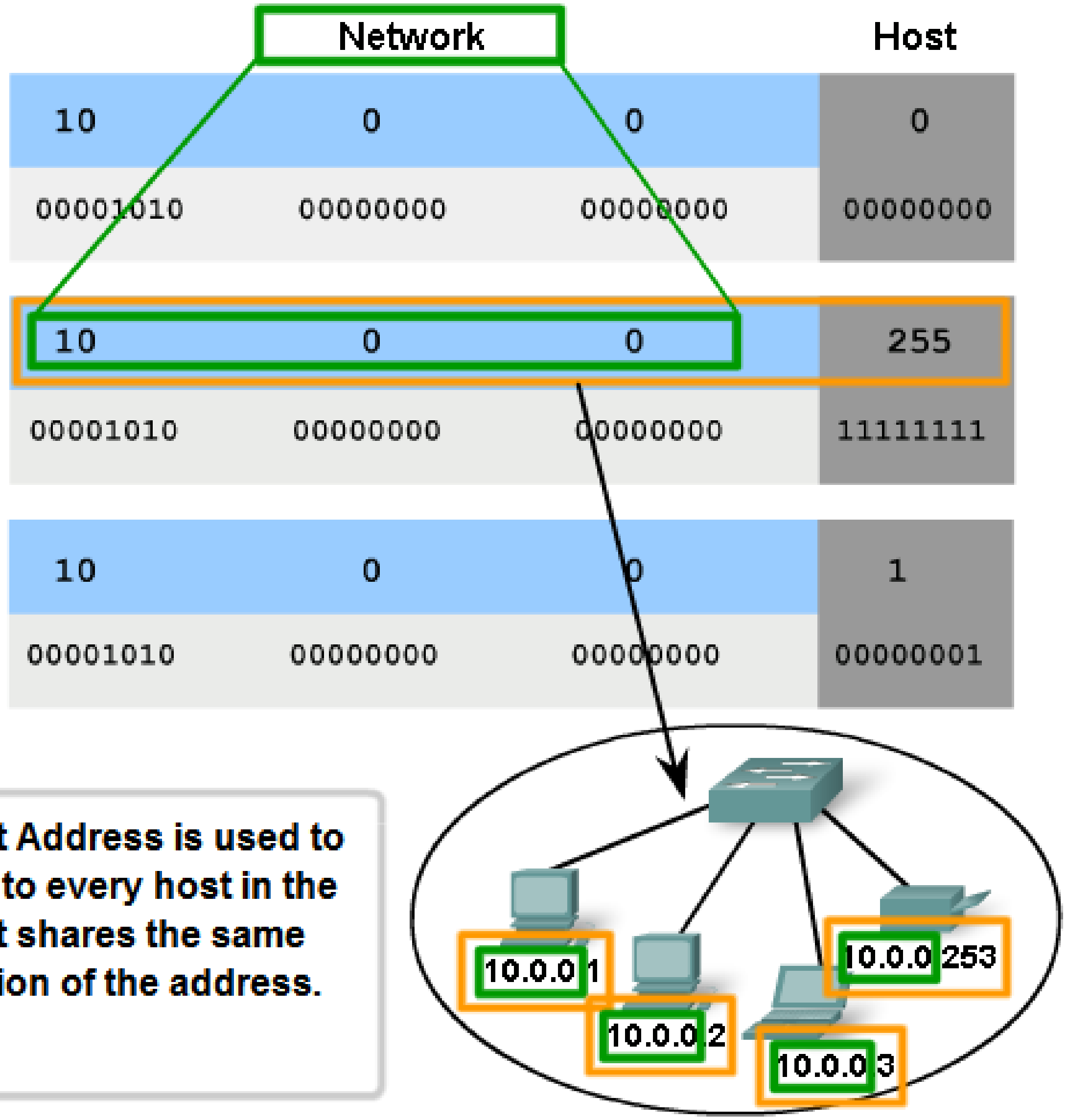
Network Address

Network			Host
10	0	0	0
00001010	00000000	00000000	00000000
10	0	0	255
00001010	00000000	00000000	11111111
10	0	0	1
00001010	00000000	00000000	00000001

10.0.0.0 is used to refer to the network as a whole. All devices in this network have the same network address bits.



Type of Address in an IPv4 Network



Broadcast Address

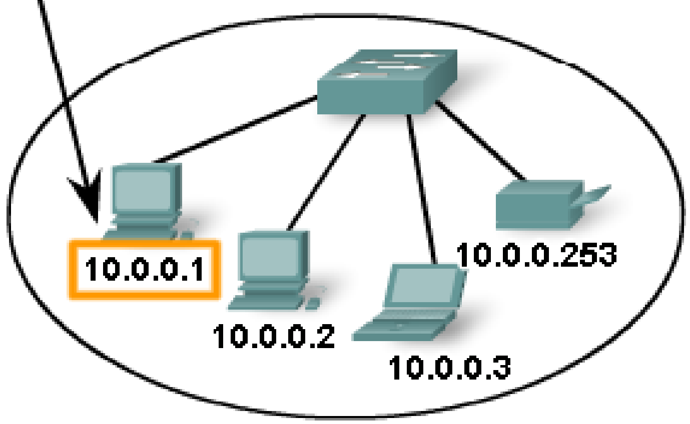
The Broadcast Address is used to send packets to every host in the network that shares the same network portion of the address.

Type of Address in an IPv4 Network

Network			Host
10	0	0	0
00001010	00000000	00000000	00000000
10	0	0	255
00001010	00000000	00000000	11111111
10	0	0	1
00001010	00000000	00000000	00000001

Host Address

Each host in this network has a unique address.



Type of Address in an IPv4 Network

Using Different Prefixes for the 172.16.4.0 Network

Network	Network address All Hosts Bits (Red) = 0	Host range Represents all combinations of host bits except where host bits are all zeros or all ones	Broadcast address All Host Bits (in Red) = 1
172.16.4.0 /24	172.16.4.0	172.16.4.1 - 172.16.4.254	172.16.4.255
Binary Representation 24 Network Bits	10101100.00010000.00000100.00000000	10101100.00010000.00000100.00000001	
		10101100.00010000.00000100.00000010	
		10101100.00010000.00000100.00000011	10101100.00010000.00000100.1111111
		10101100.00010000.00000100.11111110	
172.16.4.0 /25	172.16.4.0	172.16.4.1 - 172.16.4.126	172.16.4.127
Binary Representation 25 Network Bits	10101100.00010000.00000100.00000000	10101100.00010000.00000100.00000001	
		10101100.00010000.00000100.00000010	10101100.00010000.00000100.01111111
		10101100.00010000.00000100.00000011	
		10101100.00010000.00000100.01111110	
172.16.4.0 /27	172.16.4.0	172.16.4.1 - 172.16.4.30	172.16.4.31
Binary Representation 27 Network Bits	10101100.00010000.00000100.00000000	10101100.00010000.00000100.00000001	10101100.00010000.00000100.00011111
		10101100.00010000.00000100.00000010	
		10101100.00010000.00000100.00000011	
		10101100.00010000.00000100.00011110	

SAME NETWORK ADDRESS ALL PREFIXES

DIFFERENT BROADCAST ADDRESS EACH PREFIX

Calculate address

Network address

172 . 16. 20. 0 /25

10101100.00010000.00010100.00000000

|--------------Network -------------|- host -|

0+0+0+0+0+0+0+0=0

Network address = 172.16.20.0

Step 1

First host address

172 . 16. 20. 1

10101100.00010000.00010100.00000001

|--------------Network -------------|- host -|

0+0+0+0+0+0+0+1=1

Lowest host address = 172.16.20.1

Step 2

Broadcast address

172 . 16. 20. 127

10101100.00010000.00010100.01111111

|--------------Network -------------|- host -|

0+64+32+16+8+4+2+1=127

Broadcast address = 172.16.20.127

Step 3

Last host address

172 . 16. 20. 126

10101100.00010000.00010100.01111110

|--------------Network -------------|- host -|

0+64+32+16+8+4+2+0=126

Highest host address = 172.16.20.126

Step 4

Network, Hosts & Broadcast Addresses

Given address/prefix of **172.16.4.32/28**

For each row, enter the values ...

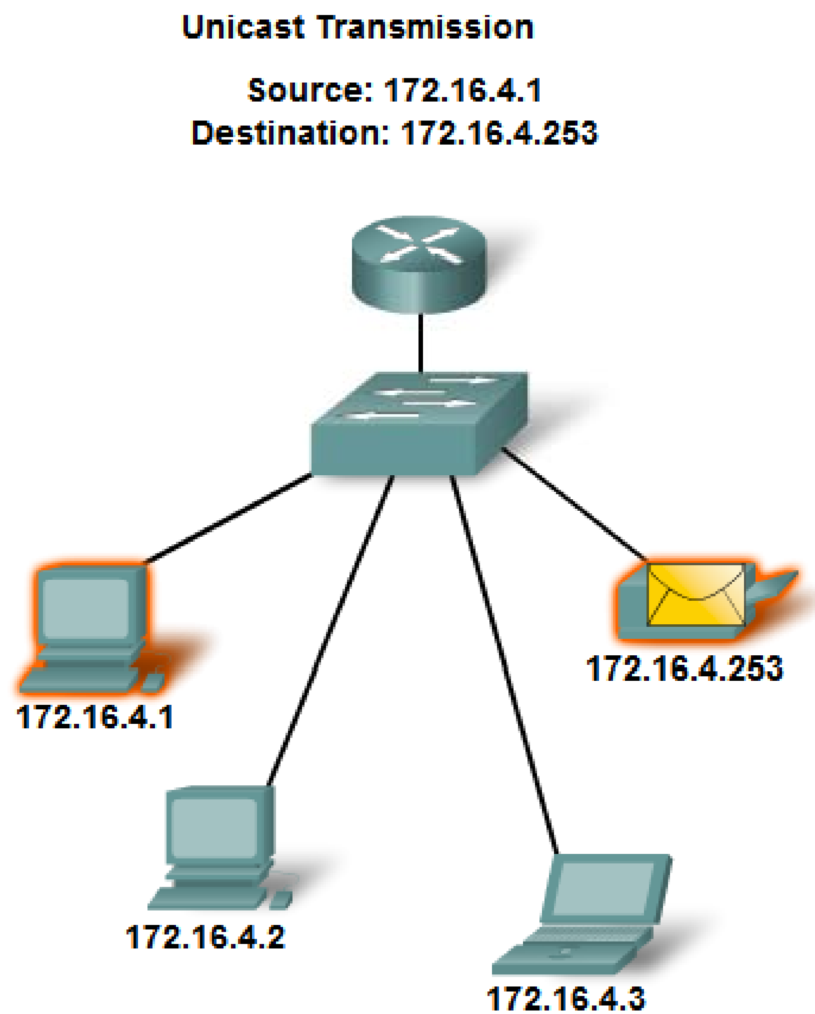
Type of Address	Enter LAST octet in binary	Enter LAST octet in decimal	Enter full address in decimal
Network			
Broadcast			
First Usable Host Address			
Last Usable Host Address			

Type of Communication

- Three types: Unicast, Broadcast, Multicast

Unicast:

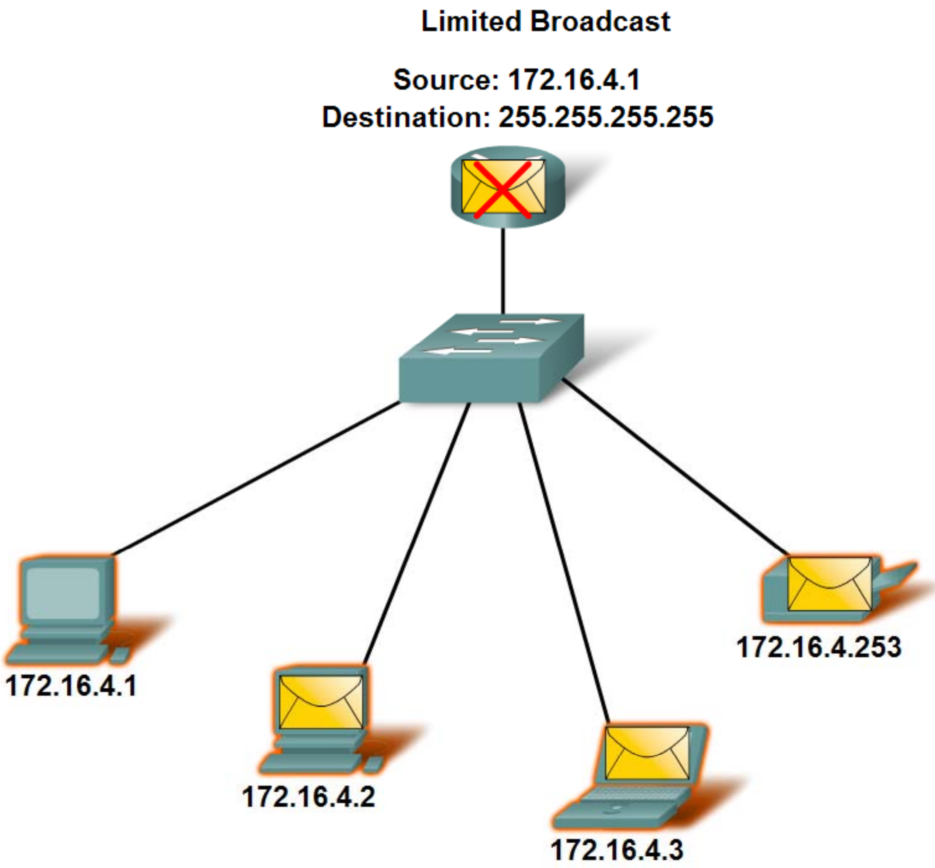
- Is used for the normal host-to-host communication in both a client/server and a peer-to-peer network.
- Uses the host address of the destination device as the destination address and can be routed through an internetwork.



Type of Communication

Broadcast:

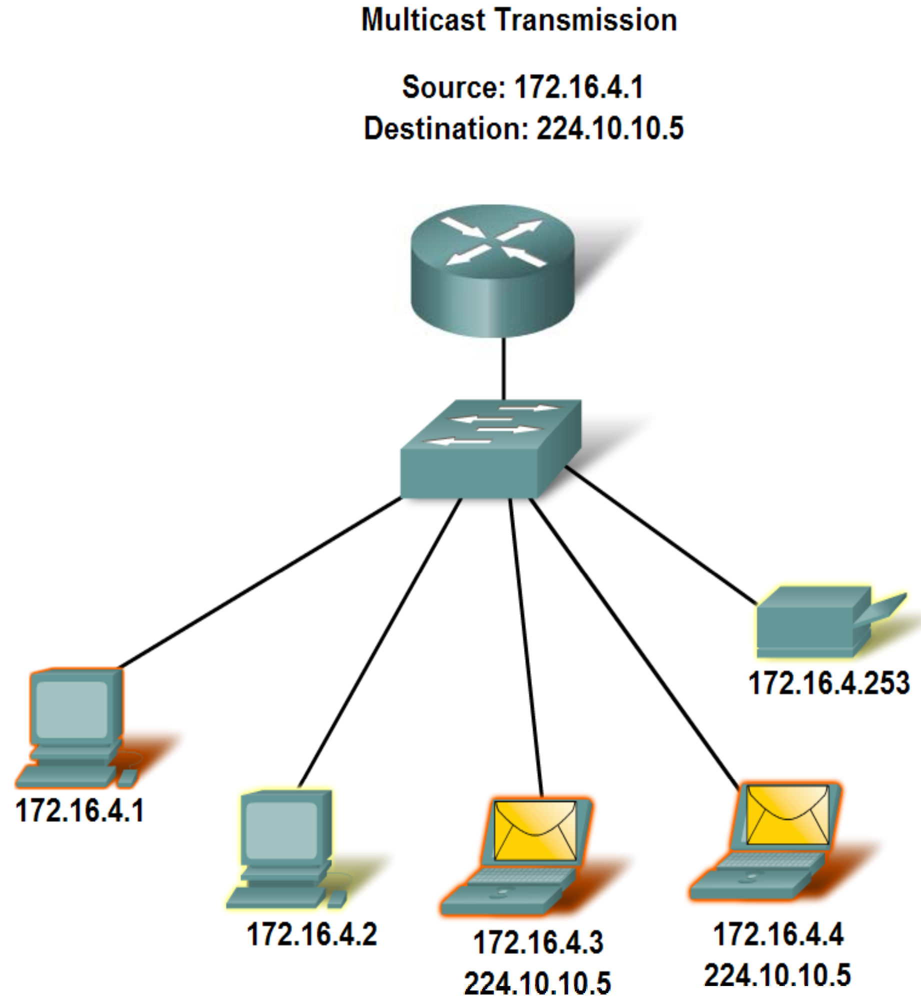
- The process of sending a packet from one host to all hosts in the network
- Host processes a broadcast address destination packet like unicast address.
- A **directed broadcast** is sent to all hosts on a specific network.
- The **limited broadcast** is used for communication that is limited to the hosts on the local network.



Type of Communication

Multicast:

- The process of sending a packet from one host to a selected group of hosts.
- Multicast transmission is designed to conserve the bandwidth of the IPv4 network.
- The multicast clients use services initiated by a client program to subscribe to the multicast group.

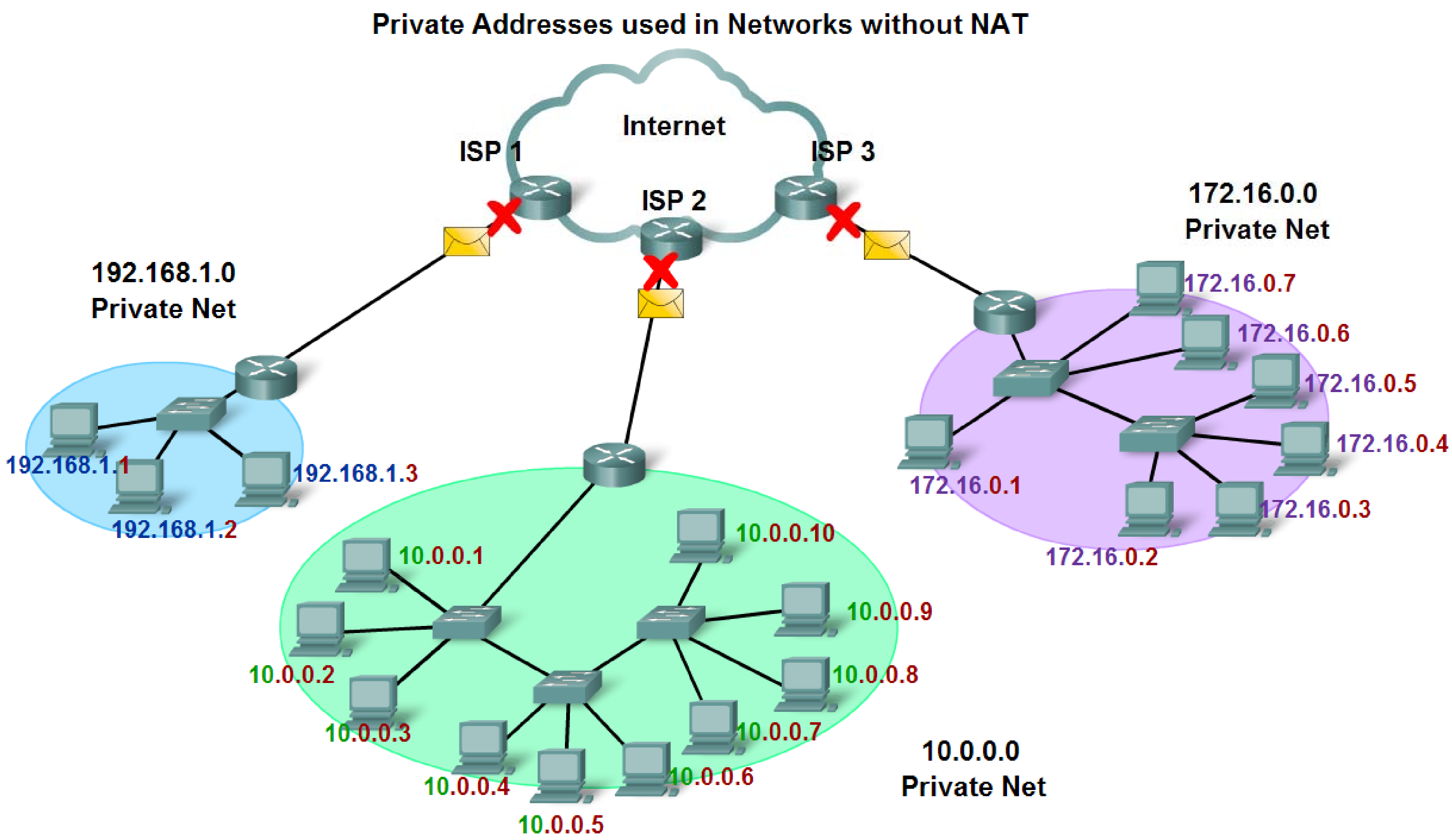


Reserved IPv4 Address Ranges

Reserved IPv4 Address Ranges

Type of Address	Usage	Reserved IPv4 Address Range	RFC
Host Address	used for IPv4 hosts	0.0.0.0 to 223.255.255.255	790
Multicast Addresses	used for multicast groups on a local network	224.0.0.0 to 239.255.255.255	1700
Experimental Addresses	• used for research or experimentation • cannot currently be used for hosts in IPv4 networks	240.0.0.0 to 255.255.255.254	1700 3330

Public and Private addresses

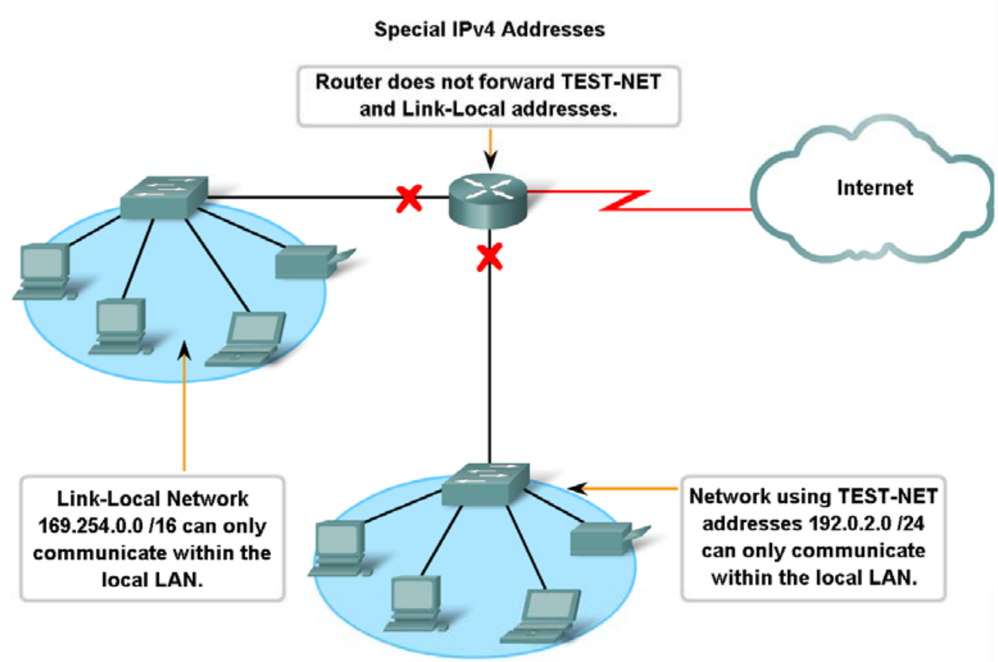


Public and Private addresses

- **Private Addresses:** are set aside for use in private networks.
  - 10.0.0.0 to 10.255.255.255 (10.0.0.0 /8)
  - 172.16.0.0 to 172.31.255.255 (172.16.0.0 /12)
  - 192.168.0.0 to 192.168.255.255 (192.168.0.0 /16)
- **Public Addresses:** are designed to be used in the hosts that are publicly accessible from the Internet.
- **Network Address Translation (NAT):** is used to translate private addresses to public addresses, be implemented on a device at the edge of the private network.

Special IPv4 Addresses

- **Network Addresses**
- **Broadcast Addresses**
- **Default Route**
  - 0.0.0.0.
- **Link-Local Addresses**
  - 169.254.0.0 to 169.254.255.255 (169.254.0.0 /16)
  - These addresses can be automatically assigned



- **TEST-NET Addresses**
  - The address block 192.0.2.0 to 192.0.2.255 (192.0.2.0 /24) is set aside for teaching and learning purposes. These addresses can be used in documentation and network examples. Unlike the experimental addresses, network devices will accept these addresses in their configurations

Legacy IPv4 Addressing

IP Address Classes

Address Class	1st octet range (decimal)	1st octet bits (green bits do not change)	Network(N) and Host(H) parts of address	Default subnet mask (decimal and binary)	Number of possible networks and hosts per network
A	1-127**	00000000-01111111	N.H.H.H	255.0.0.0	128 nets (2^7) 16,777,214 hosts per net (2^24-2)
B	128-191	10000000-10111111	N.N.H.H	255.255.0.0	16,384 nets (2^14) 65,534 hosts per net (2^16-2)
C	192-223	11000000-11011111	N.N.N.H	255.255.255.0	2,097,150 nets (2^21) 254 hosts per net (2^8-2)
D	224-239	11100000-11101111	NA (multicast)		
E	240-255	11110000-11111111	NA (experimental)		

** All zeros (0) and all ones (1) are invalid hosts addresses.

Legacy IPv4 Addressing

- **Classful addressing**: A company or organization was assigned an entire class A, class B, or class C address block.
- **Limits to the Class-based System**
  - Classful allocation of address space often wasted many addresses, which exhausted the availability of IPv4 addresses.
- **Classless Addressing**
  - Address blocks appropriate to the number of hosts are assigned to companies or organizations without regard to the unicast class.

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Addressing the Network – IPv4

Assigning Addresses

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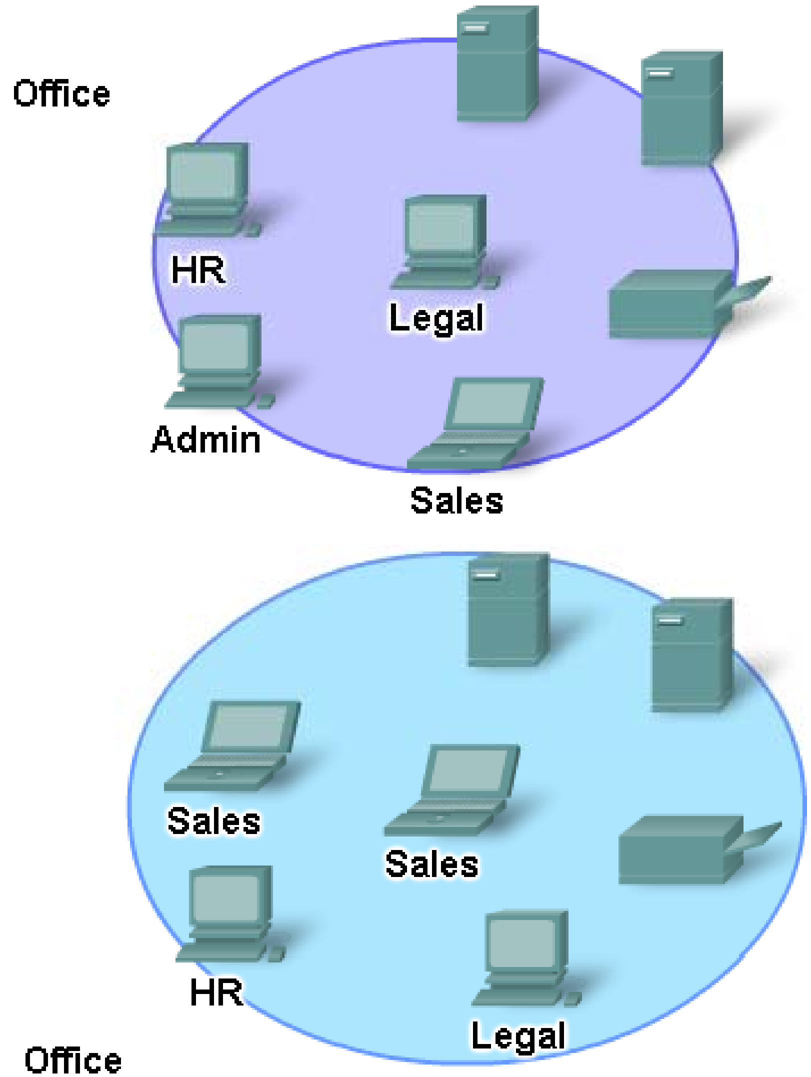
Planning to Address the Network

- The allocation of these addresses inside the networks should be planned and documented for the purpose of:
- **Preventing duplication of addresses**: each host in an internetwork must have a unique address.
- **Providing and controlling access**: Some hosts provide resources to the internal network as well as to the external network. If the addresses for these resources are not planned and documented, the security and accessibility of the devices are not easily controlled.
- **Monitoring security and performance**: As part of the monitoring process, we examine network traffic looking for addresses that are generating or receiving excessive packets.

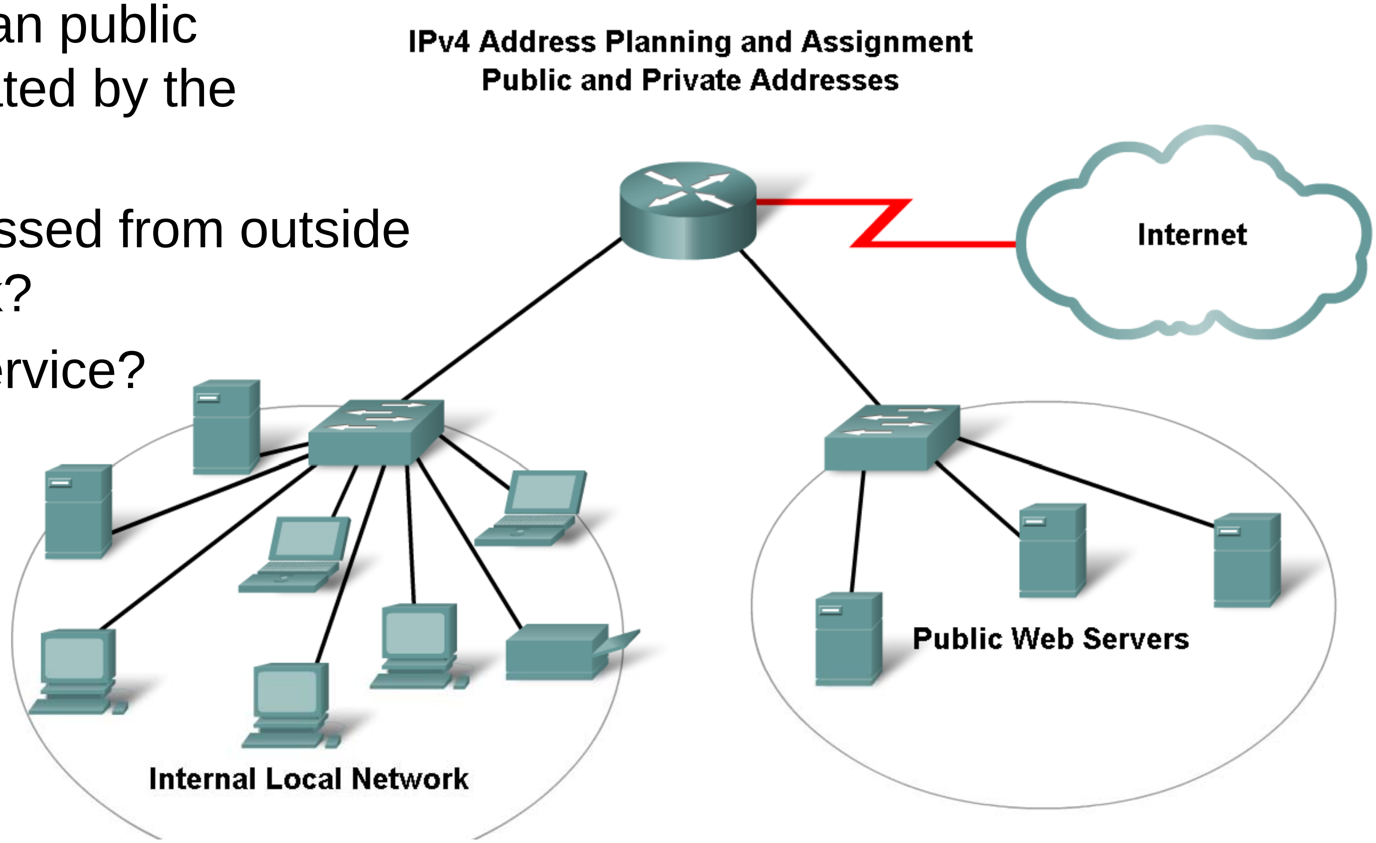
Planning to Address the Network

- Within a network, there are different types of hosts:
  - End devices for users
  - Servers and peripherals
  - Hosts that are accessible from the Internet
  - Intermediary devices

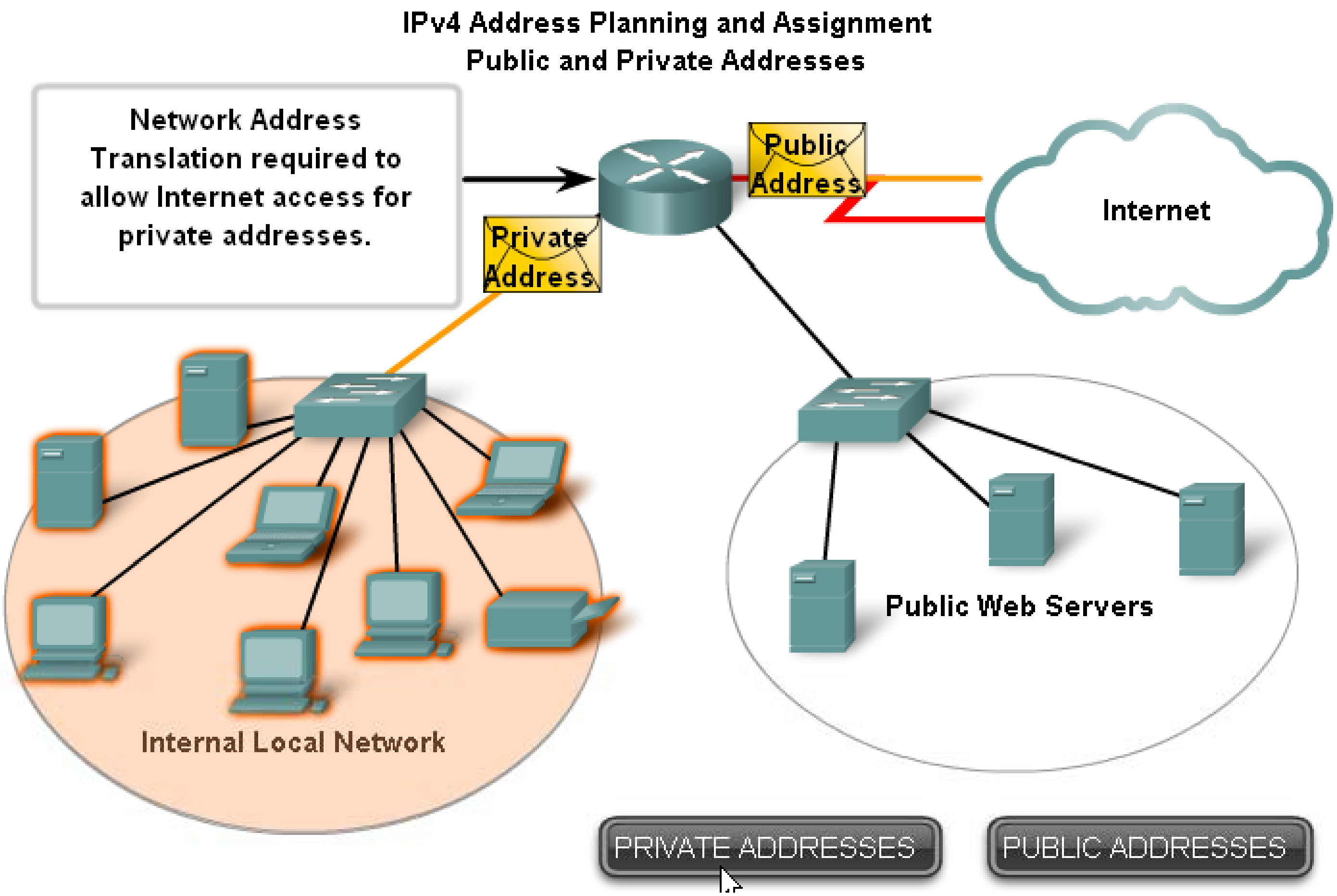


Planning to Address the Network

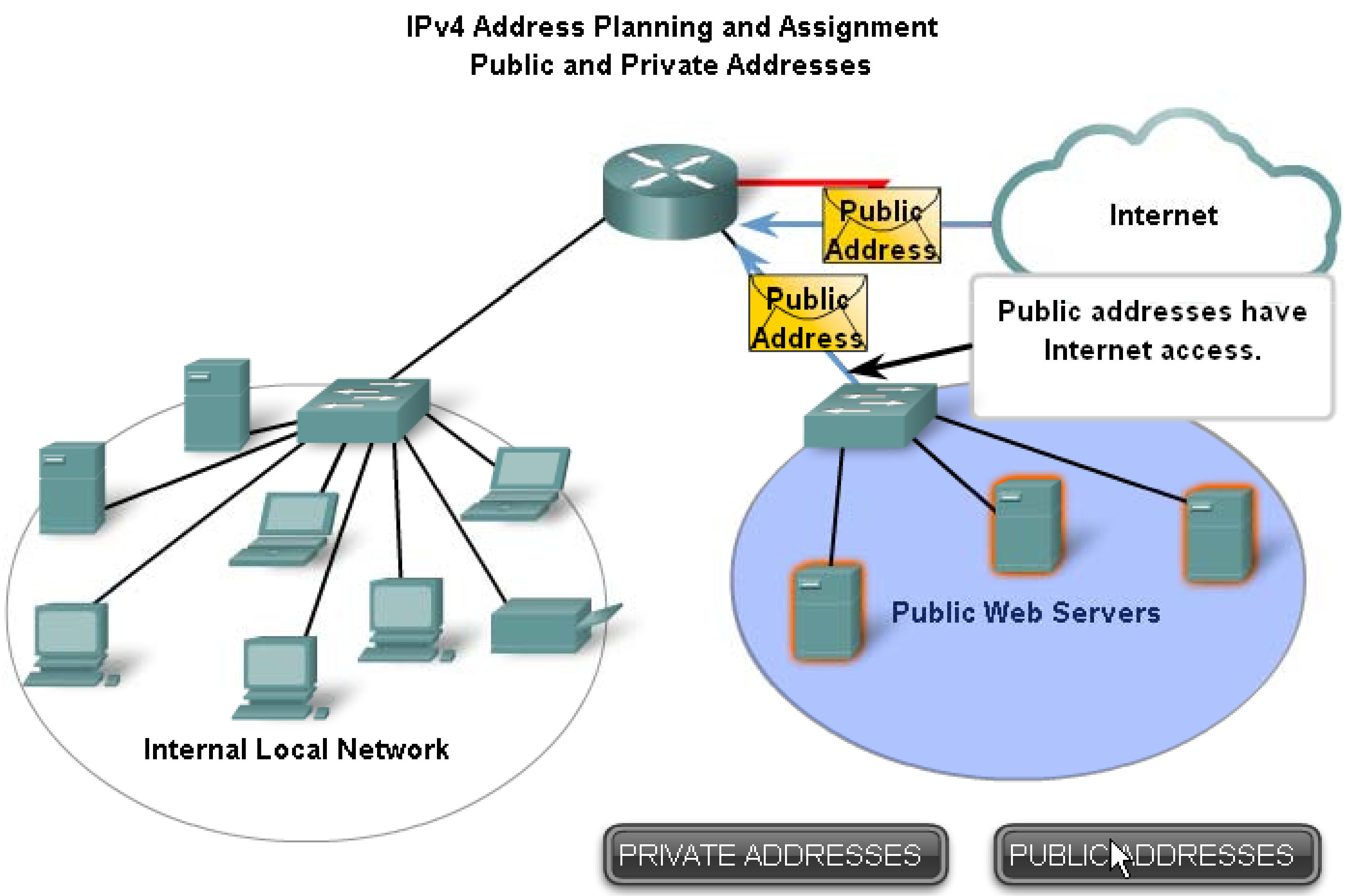
- An important part of planning an IPv4 addressing scheme is deciding when private addresses are to be used and where they are to be applied. Considerations:
- Number of devices connected to the network more than public addresses allocated by the network's ISP?
- Need to be accessed from outside the local network?
- Supports NAT service?



Planning to Address the Network

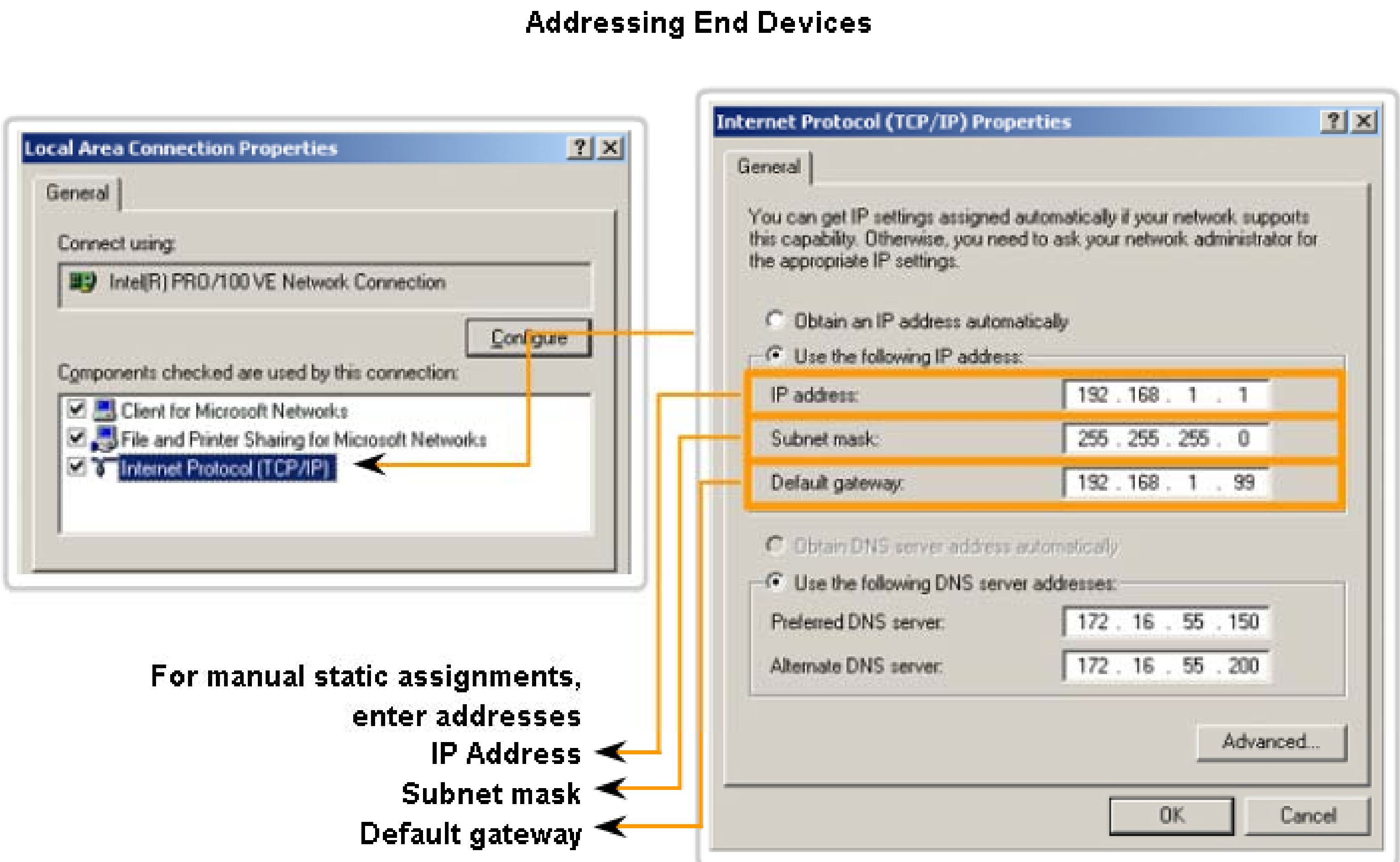


Planning to Address the Network



Assigning Addresses

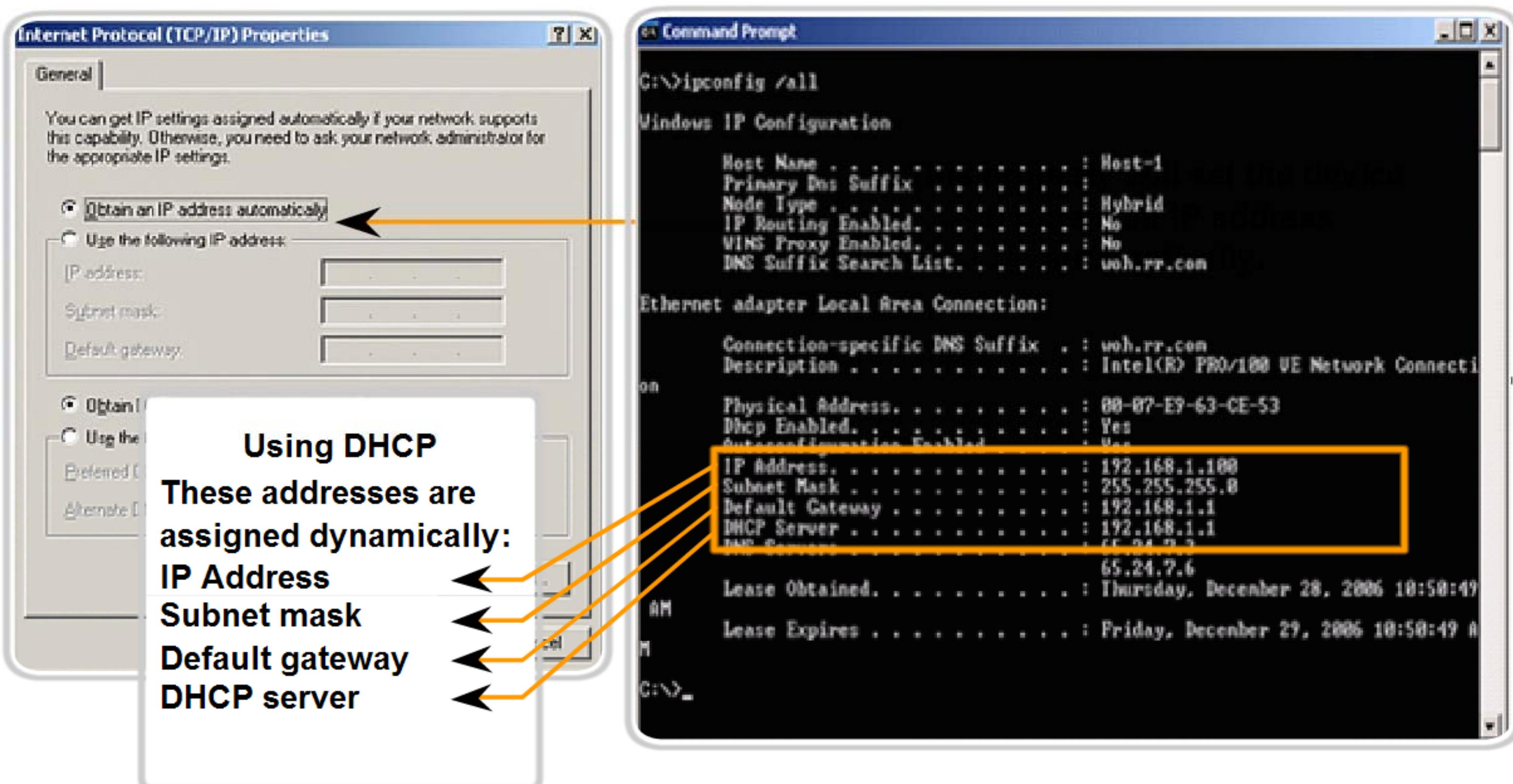
- Static Assignment: The network administrator must manually configure the network information for a host.



Assigning Addresses

- **Dynamic Host Configuration Protocol (DHCP)**: enables the automatic assignment of addressing information such as IP address, subnet mask, default gateway, and other configuration information.

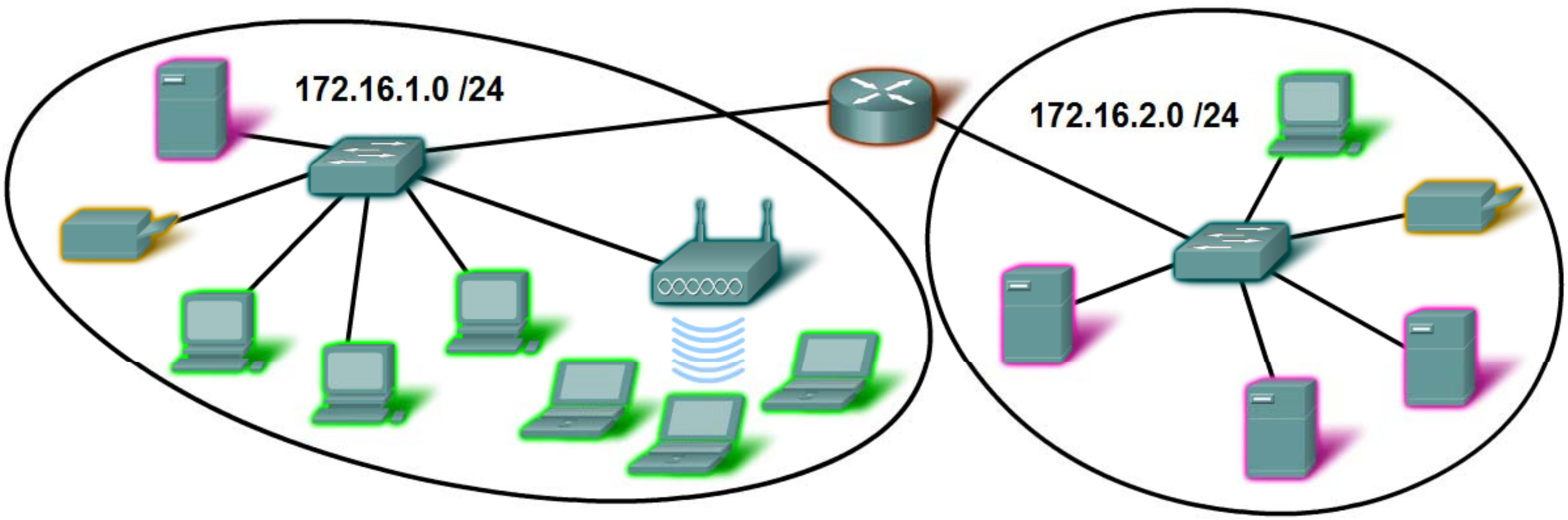
Assigning Dynamic Addresses



Assigning Addresses to Other Devices

Devices IP Address Ranges

Use	First Address	Last Address	Summary Address
Network Address	172.16.x.0	.....	172.16.x.0 /25
User hosts (DHCP pool)	172.16.x.1	172.16.x.127	
Servers	172.16.x.128	172.16.x.191	172.16.x.128 /26
Peripherals	172.16.x.192	172.16.x.223	172.16.x.192 /27
Networking devices	172.16.x.224	172.16.x.253	172.16.x.224 /27
Router (gateway)	172.16.x.254	.....	
Broadcast	172.16.x.255	.....	



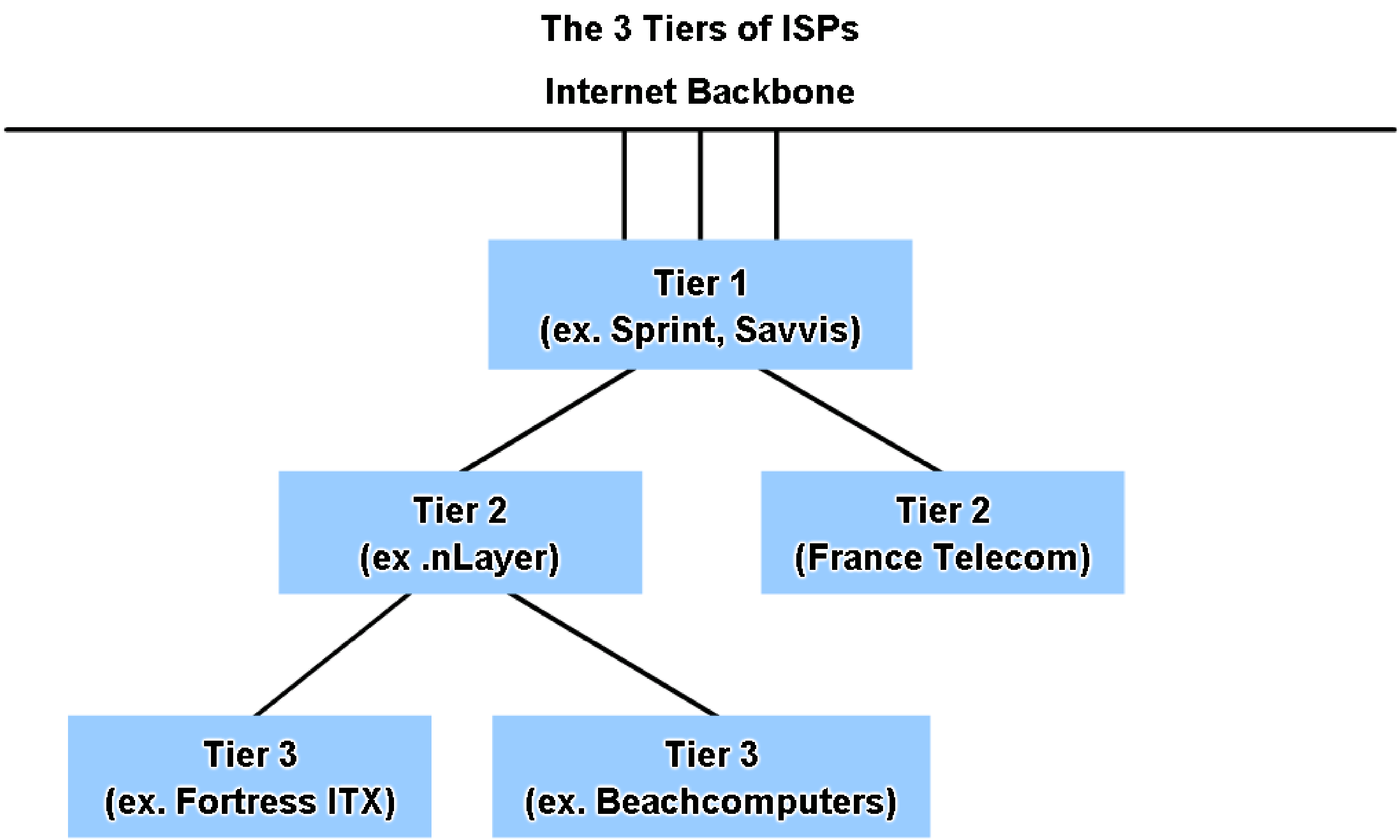
Assigning Addresses

- Internet Assigned Numbers Authority (IANA) (http://www.iana.net) is the master holder of the IP addresses.

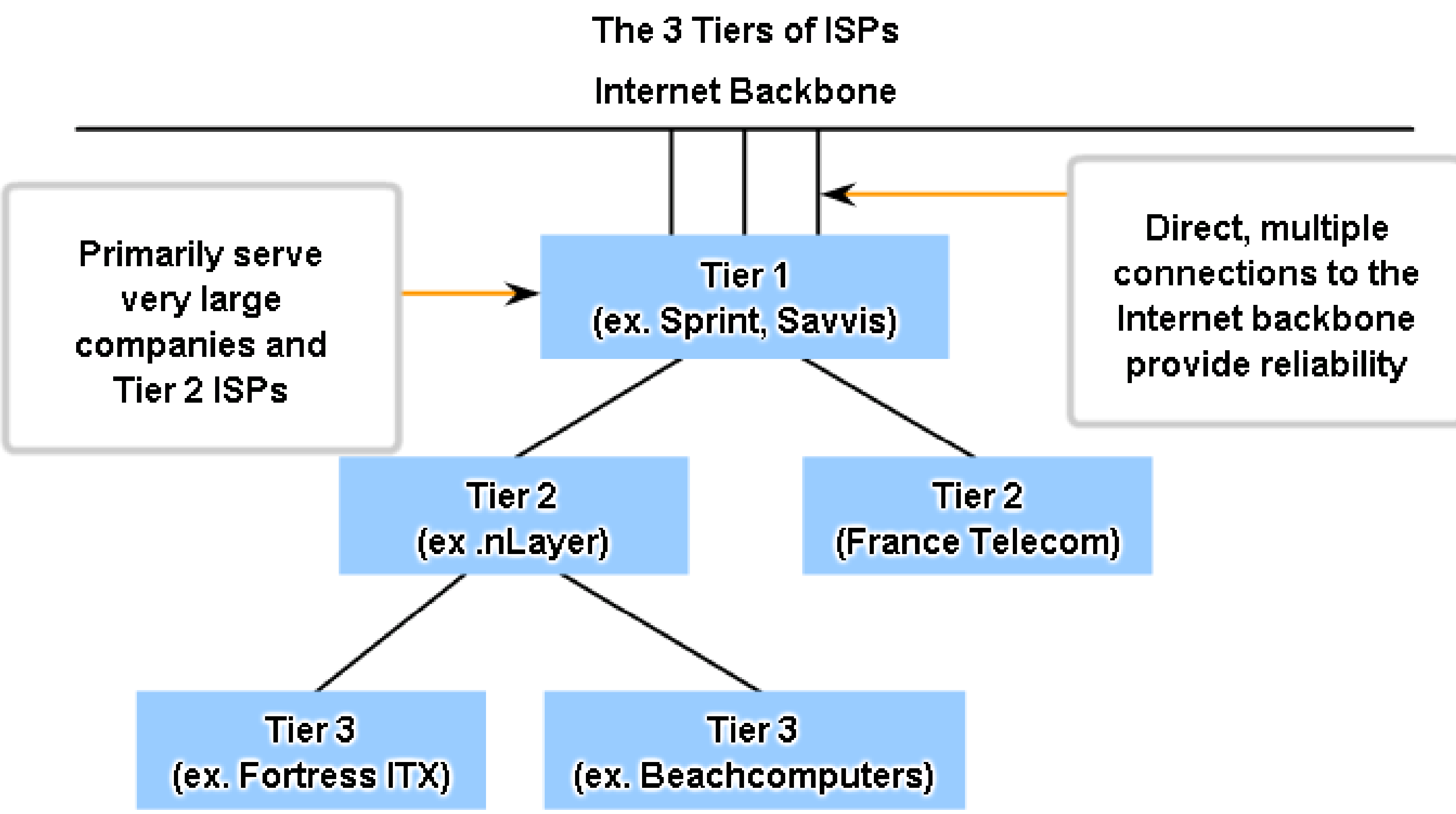
Entities that Oversee IP Address Allocation

Global	**IANA**				
Regional Internet Registries	**AfriNIC** Africa Region	**APNIC** Asia/ Pacific Region	**LACNIC** Latin America And Caribbean Region	**ARIN** North America Region	**RIPE NCC** Europe, Middle East, Central Asia Region

ISPs

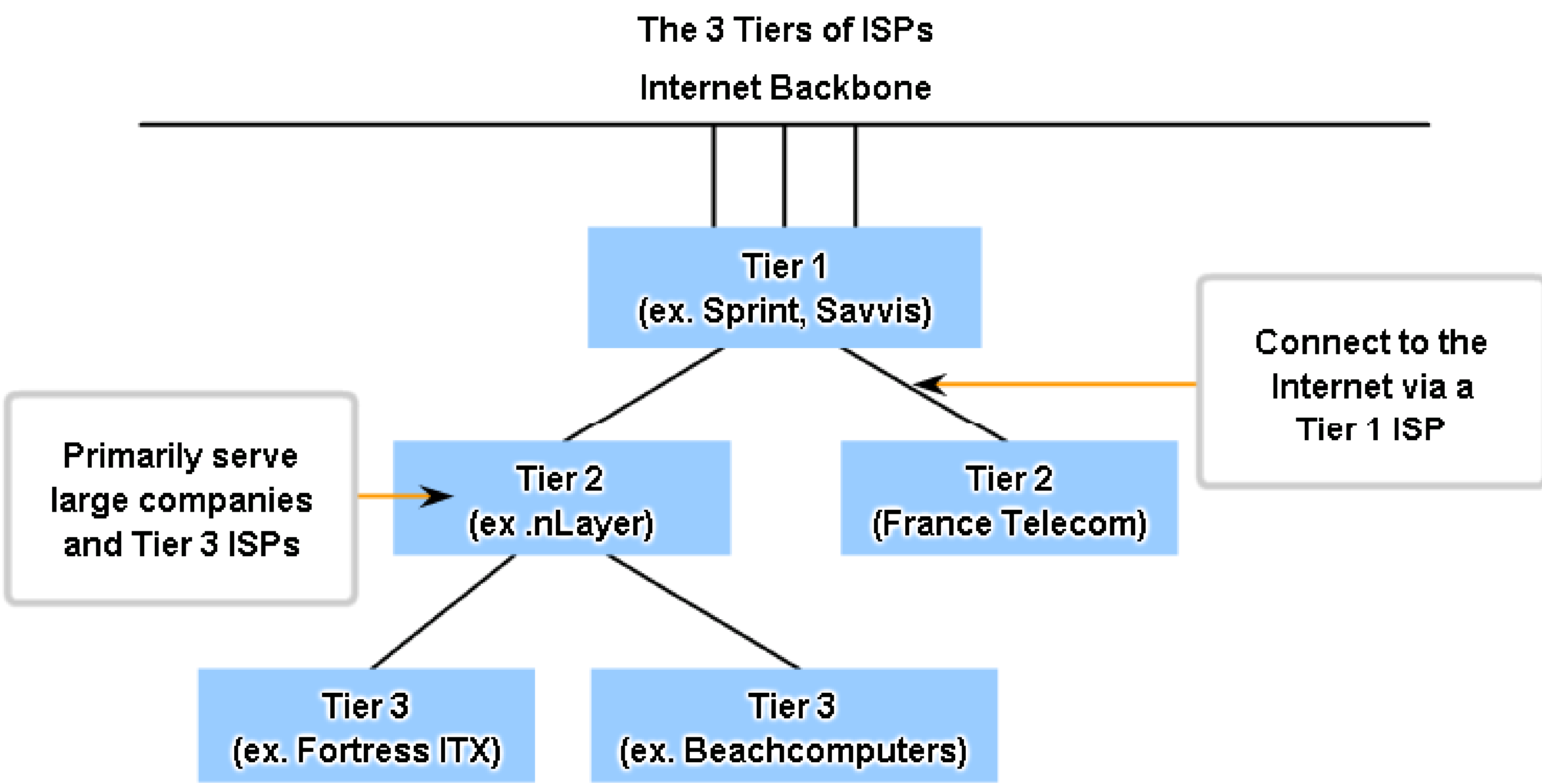

The 3 Tiers of ISPs
Internet Backbone
Tier 1
(ex. Sprint, Savvis)
Tier 2
(ex .nLayer)
Tier 2
(France Telecom)
Tier 3
(ex. Fortress ITX)
Tier 3
(ex. Beachcomputers)

ISPs: Tier 1



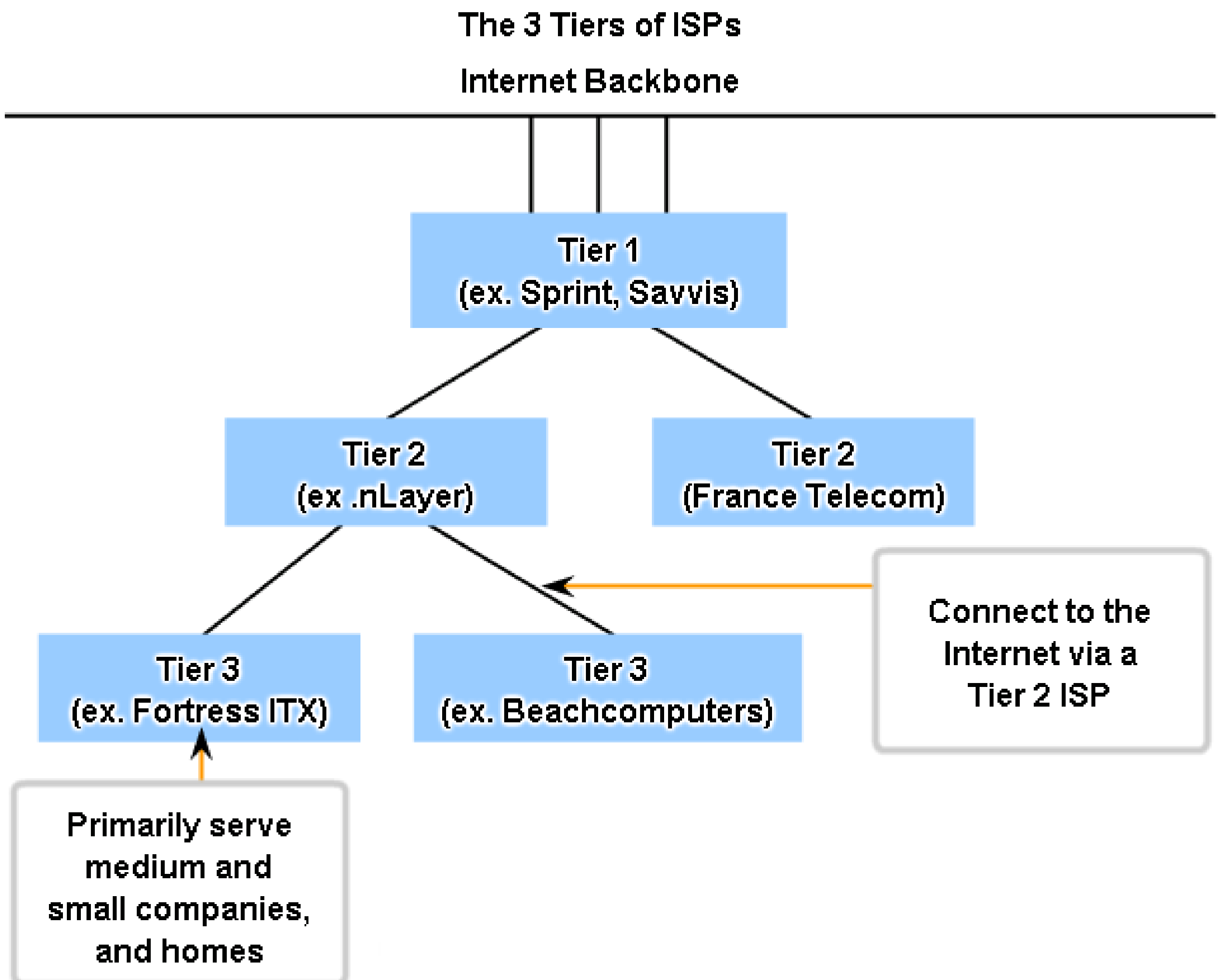
The 3 Tiers of ISPs
Internet Backbone
Primarily serve very large companies and Tier 2 ISPs
Tier 1 (ex. Sprint, Savvis)
Direct, multiple connections to the Internet backbone provide reliability
Tier 2 (ex .nLayer)
Tier 2 (France Telecom)
Tier 3 (ex. Fortress ITX)
Tier 3 (ex. Beachcomputers)

ISPs: Tier 2



The 3 Tiers of ISPs
Internet Backbone
Tier 1
(ex. Sprint, Savvis)
Connect to the Internet via a Tier 1 ISP
Primarily serve large companies and Tier 3 ISPs
Tier 2
(ex .nLayer)
Tier 2
(France Telecom)
Tier 3
(ex. Fortress ITX)
Tier 3
(ex. Beachcomputers)

ISPs: Tier 3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Tier 3
(ex. Beachcomputers)
Connect to the Internet via a Tier 2 ISP
Primarily serve medium and small companies, and homes

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Addressing the Network – IPv4



Calculating Addresses

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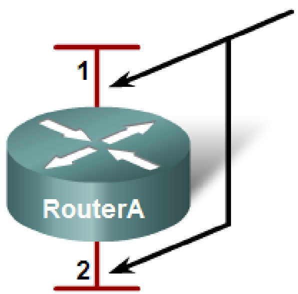
Basic subnetting

Borrowing Bits for Subnets



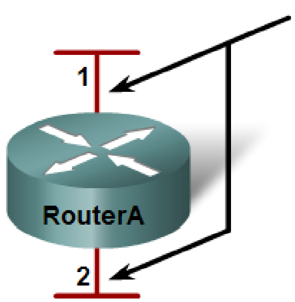
Only one network address is available.

1	192.168.1.0 (/24) 255.255.255.0	Address: Mask:	11000000.10101000.00010100.00000000 11111111.11111111.11111111.00000000

$\underbrace{11111111.11111111.11111111}_{\text{Network portion of the address}}$

Network portion of the address

Borrow a bit from the host portion.



With subnetting, two network addresses are available.

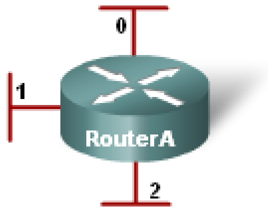
1	192.168.1.0 (/25) 255.255.255.128	Address: Mask:	11000000.10101000.00010100.00000000 11111111.11111111.11111111.10000000
2	192.168.1.128 (/25) 255.255.255.128	Address: Mask:	11000000.10101000.00010100.10000000 11111111.11111111.11111111.10000000

Increase the network portion of the address

Subnet	Network address	Host range	Broadcast address
0	192.168.1.0/25	192.168.1.1 - 192.168.1.126	192.168.1.127
1	192.168.1.128/25	192.168.1.129 - 192.168.1.254	192.168.1.255

Basic subnetting

Borrowing Bits for Subnets



-	192.168.1.0 (/24)	Address:	11000000.10101000.00010100.00000000
	255.255.255.0	Mask:	11111111.11111111.11111111.00000000
0	192.168.1.0 (/26)	Address:	11000000.10101000.00010100.00000000
	255.255.255.192	Mask:	11111111.11111111.11111111.11000000
1	192.168.1.64 (/26)	Address:	11000000.10101000.00010100.01000000
	255.255.255.192	Mask:	11111111.11111111.11111111.11000000
2	192.168.1.128 (/26)	Address:	11000000.10101000.00010100.10000000
	255.255.255.192	Mask:	11111111.11111111.11111111.11000000
3	192.168.1.192 (/26)	Address:	11000000.10101000.00010100.11000000
	255.255.255.192	Mask:	11111111.11111111.11111111.11000000

Two bits are borrowed to provide four subnets.

Unused address in this example.

A 1 in these positions in the mask means that these values are part of the network address.

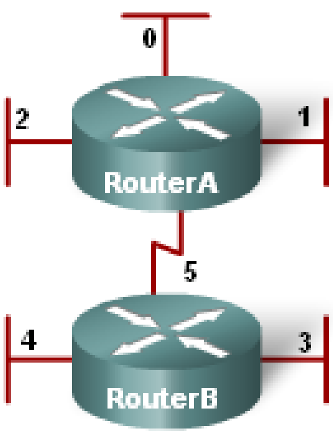
More subnets are available, but fewer addresses are available per subnet.

Subnet	Network address	Host range	Broadcast address
0	192.168.1.0/26	192.168.1.1 - 192.168.1.62	192.168.1.63
1	192.168.1.64/26	192.168.1.65 - 192.168.1.126	192.168.1.127
2	192.168.1.128/26	192.168.1.129 - 192.168.1.190	192.168.1.191
3	192.168.1.192/26	192.168.1.193 - 192.168.1.254	192.168.1.255

Basic subnetting

Borrowing Bits for Subnets

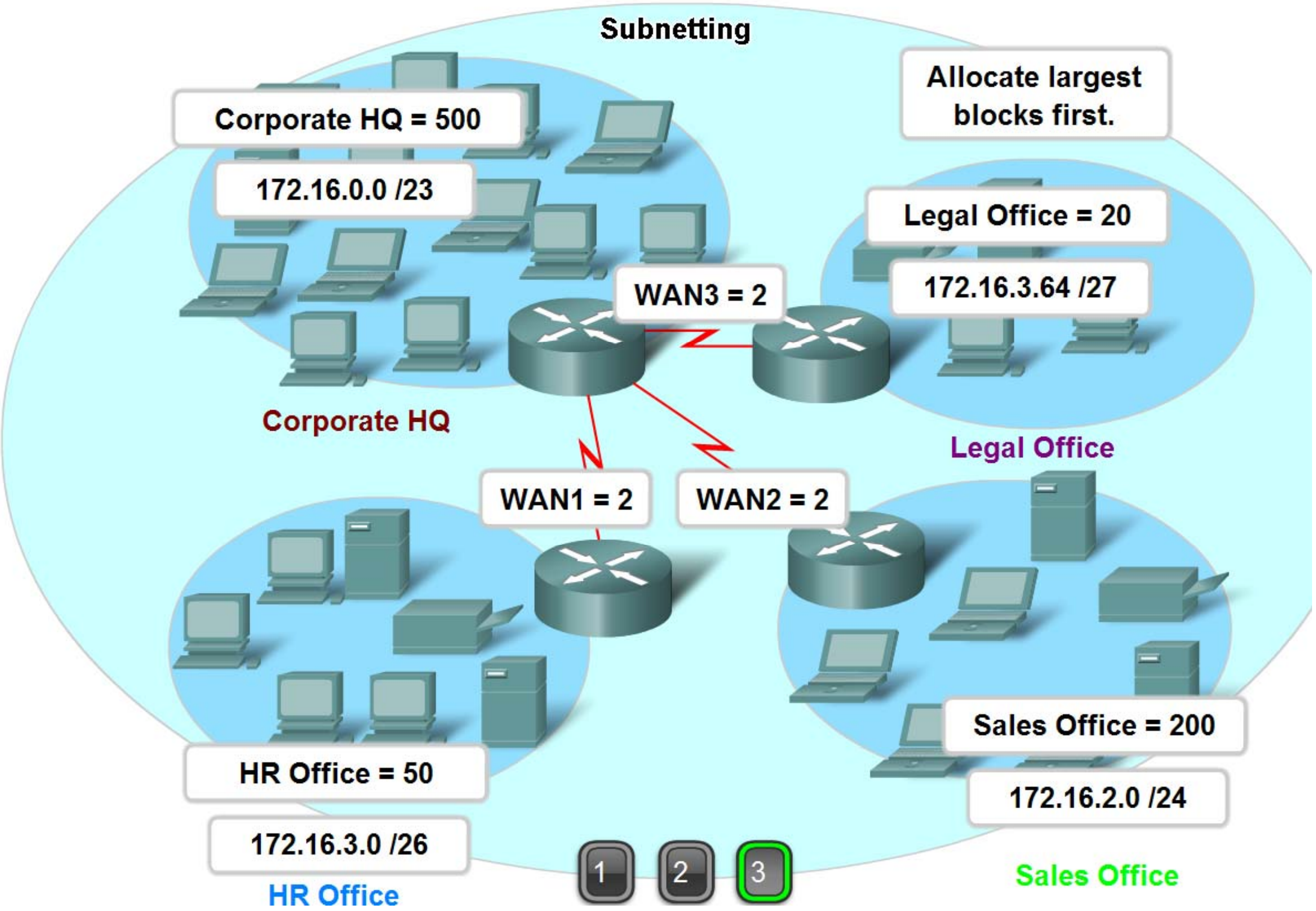
Start with this address	-	192.168.1.0 (/24)	Address:	11000000.10101000.00010100.00000000
		255.255.255.0	Mask:	11111111.11111111.11111111.00000000
Make 8 subnets	0	192.168.1.0 (/27)	Address:	11000000.10101000.00010100.00000000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	1	192.168.1.32 (/27)	Address:	11000000.10101000.00010100.00100000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	2	192.168.1.64 (/27)	Address:	11000000.10101000.00010100.01000000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	3	192.168.1.96 (/27)	Address:	11000000.10101000.00010100.01100000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	4	192.168.1.128 (/27)	Address:	11000000.10101000.00010100.10000000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	5	192.168.1.160 (/27)	Address:	11000000.10101000.00010100.10100000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	6	192.168.1.192 (/27)	Address:	11000000.10101000.00010100.11000000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	7	192.168.1.224 (/27)	Address:	11000000.10101000.00010100.11100000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000



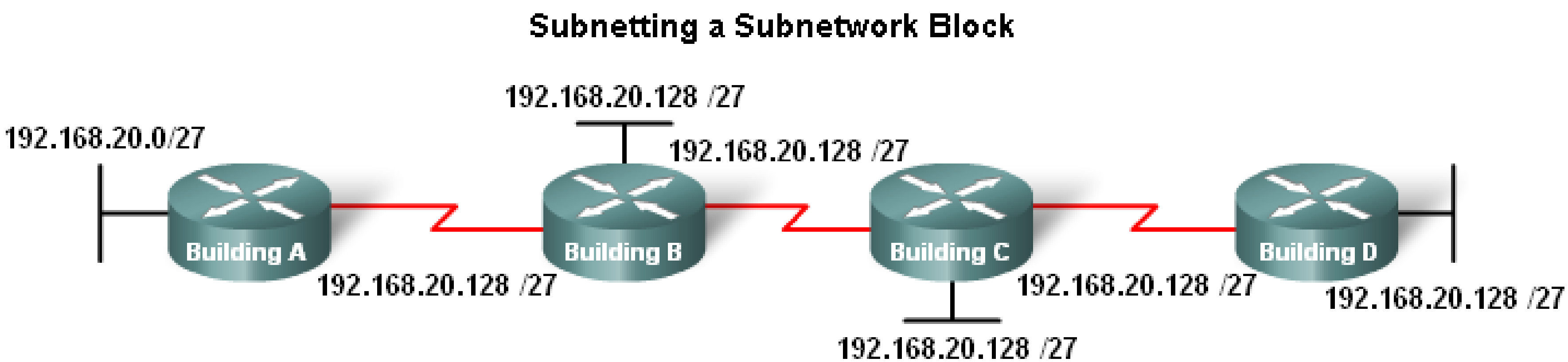
Three bits are borrowed to provide eight subnets.

Dividing Networks into Right Sizes

- Extract network addresses from host addresses using the subnet mask. Total host 800 -> choose block 172.16.0.0/22



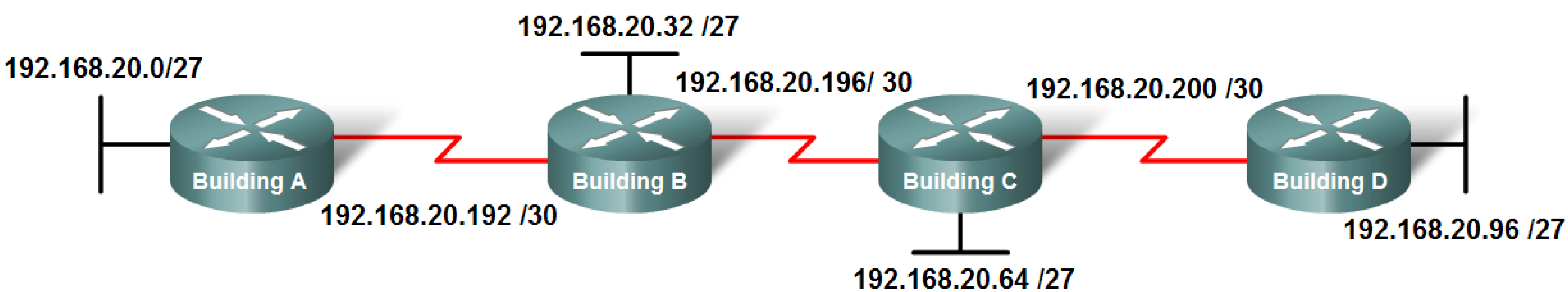
Subnetting a Subnet



Subnet Number	Subnet Address
Subnet 0	192.168.20.0/27
Subnet 1	192.168.20.32/27
Subnet 2	192.168.20.64/27
Subnet 3	192.168.20.96/27
Subnet 4	192.168.20.128/27
Subnet 5	192.168.20.160/27
Subnet 6	192.168.20.192/27
Subnet 7	192.168.20.224/27

Subnetting a Subnet

Subnetting a Subnetwork Block



Subnet Number	Subnet Address
Subnet 0	192.168.20.0/27
Subnet 1	192.168.20.32/27
Subnet 2	192.168.20.64/27
Subnet 3	192.168.20.96/27
Subnet 4	192.168.20.128/27
Subnet 5	192.168.20.160/27
Subnet 6	192.168.20.192/27
Subnet 7	192.168.20.224/27

Subnet Number	Subnet Address
Subnet 0	192.168.20.192/30
Subnet 1	192.168.20.196/30
Subnet 2	192.168.20.200/30
Subnet 3	192.168.20.204/30
Subnet 4	192.168.20.208/30
Subnet 5	192.168.20.212/30
Subnet 6	192.168.20.216/30
Subnet 7	192.168.20.20/30

Determining the Network Address

Activity

Given the host IP address and the subnet mask, enter the network address in binary and decimal.

Host Address	10	148	100	54
Subnet Mask	255	255	255	240
Host Address in binary	00001010	10010100	01100100	00110110
Subnet Mask in binary	11111111	11111111	11111111	11110000
Network Address in binary				
Network Address in decimal				

Calculating the Number of Hosts

Given the network address and the subnet mask, enter the number of possible hosts.

Network Address	10	0	0	0
Subnet Mask	255	255	0	0
Network address in binary	00001010	00000000	00000000	00000000
Subnet Mask in binary	11111111	11111111	00000000	00000000
Number of hosts				

Determining Valid Addresses for Hosts

Given the network address and the subnet mask, define the range of hosts, the broadcast address, and the next network address.

Network Address in decimal	10	187	0	0
Subnet Mask in decimal	255	255	224	0
Network address in binary	00001010	10111011	00000000	00000000
Subnet Mask in binary	11111111	11111111	11100000	00000000
First Usable Host IP Address in decimal	1st octet	2nd octet	3rd octet	4th octet
Last Usable Host IP Address in decimal	1st octet	2nd octet	3rd octet	4th octet
Broadcast Address in decimal	1st octet	2nd octet	3rd octet	4th octet
Next Network Address in decimal	1st octet	2nd octet	3rd octet	4th octet

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Addressing the Network – IPv4



Testing the Network Layer

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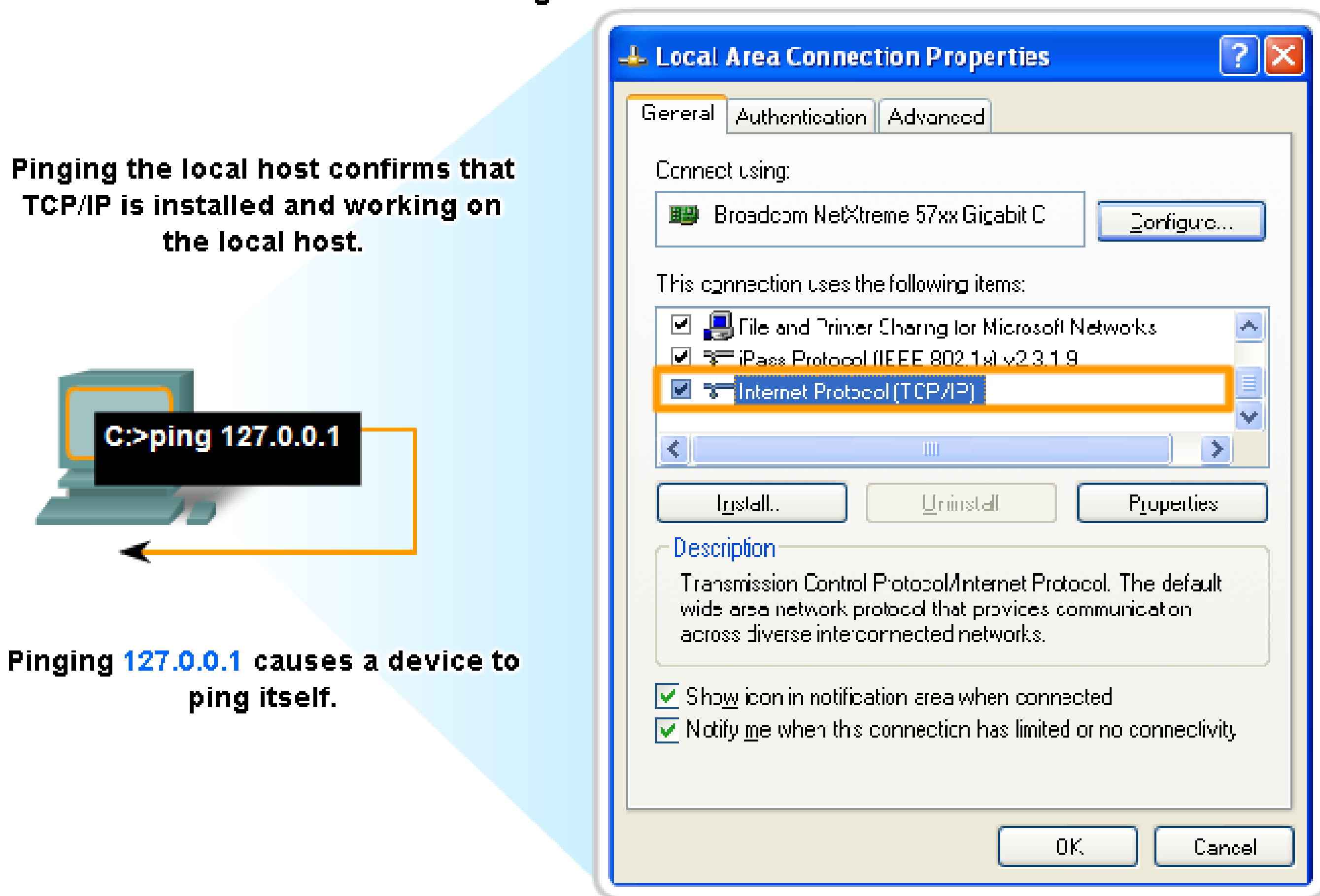
Testing the Local Stack

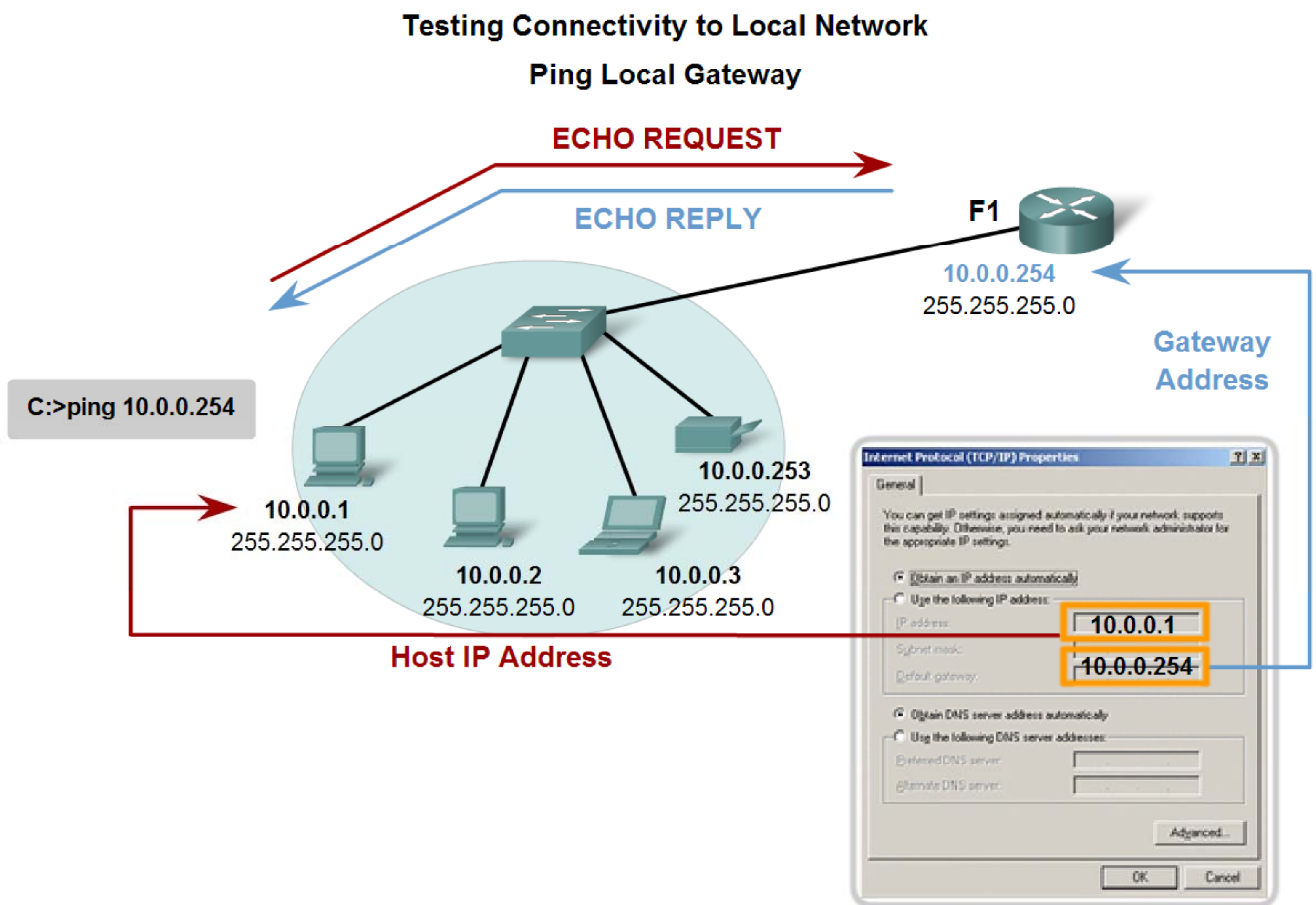
- Pinging the Local Loopback: 127.0.0.1

Testing Local TCP/IP Stack



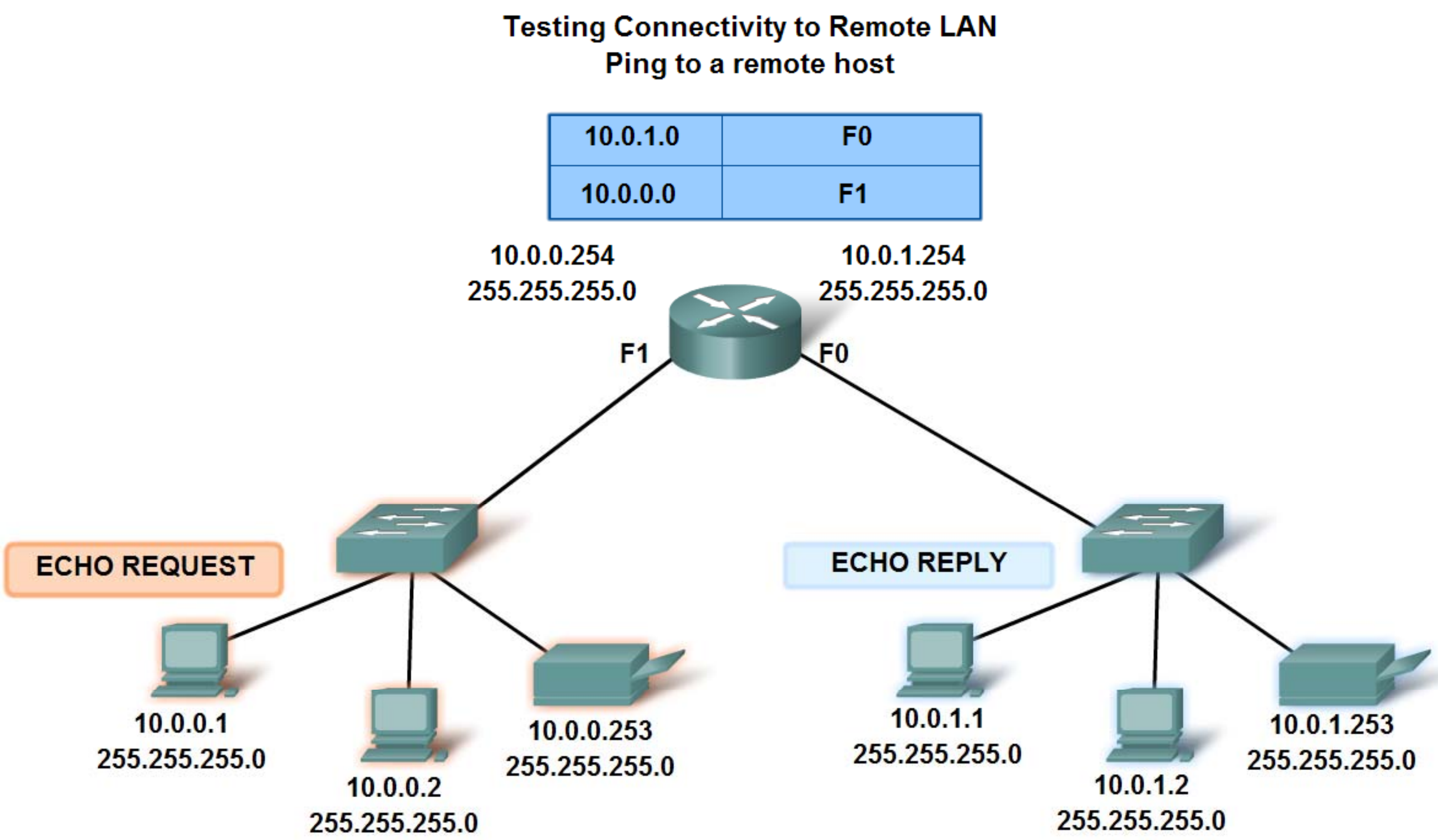
Testing Connectivity to the Local LAN

- Ping Gateway



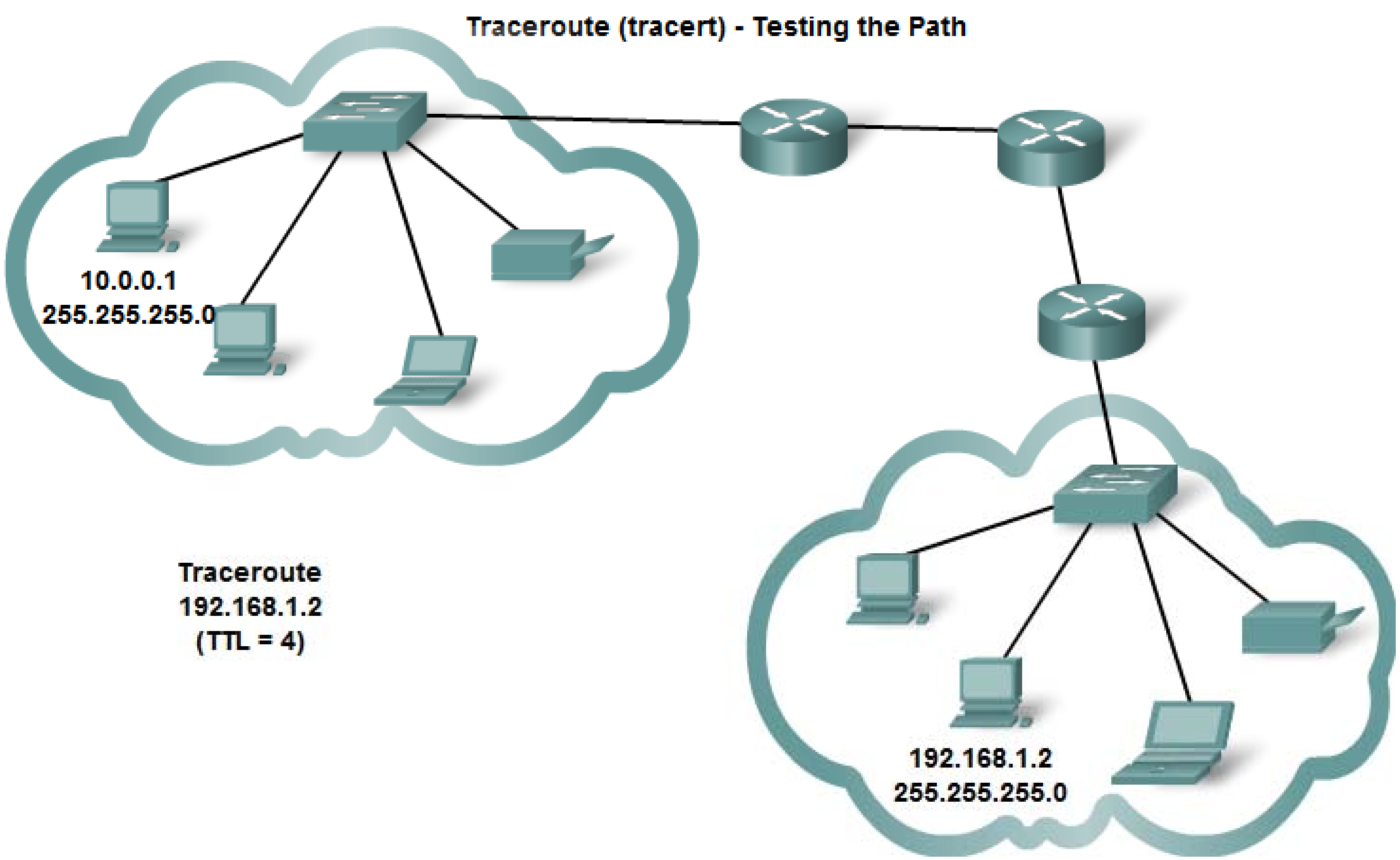
Testing Connectivity to Remote LAN

- Use ping to verify that a local host can communicate via a gateway to a device in remote network



Testing the Path

- Use tracert/traceroute to observe the path between two devices as they communicate and trace the steps of tracert/traceroute's operation

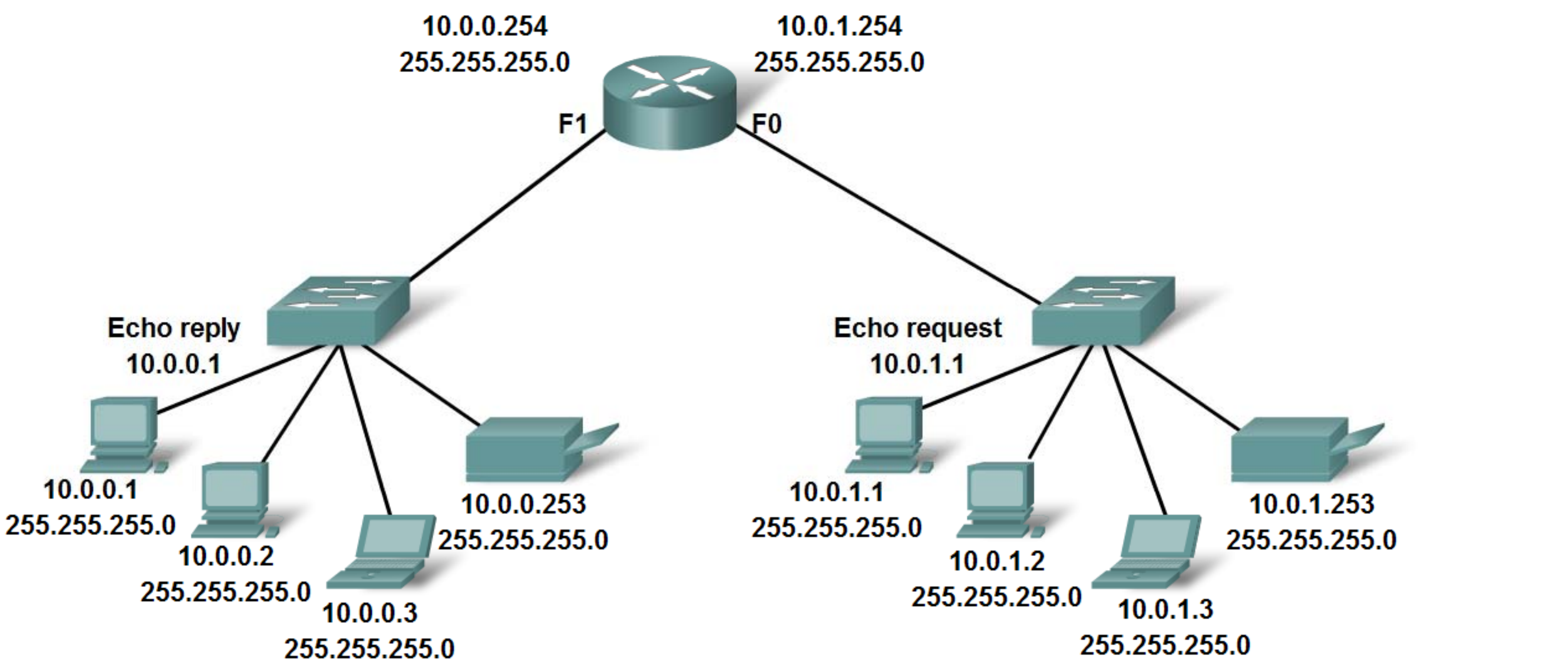


ICMPv4

- The purpose of these messages is to provide feedback about issues related to the processing of IP packets under certain conditions, not to make IP reliable. ICMP messages are not required and are often not allowed for security reasons.

ICM Ping to a remote host
Routing table

F1	10.0.0.0
F0	10.0.1.0



ICMP

- ICMP is the messaging protocol for the TCP/IP suite. ICMP provides control and error messages and is used by the ping and traceroute utilities. Although ICMP uses the basic support of IP as if it were a higher-level protocol ICMP, it is actually a separate Layer 3 of the TCP/IP suite.
- The types of ICMP messages - and the reasons why they are sent - are extensive. We will discuss some of the more common messages. ICMP messages that may be sent include:
  - Host confirmation
  - Unreachable Destination or Service
  - Time exceeded
  - Route redirection
  - Source quench