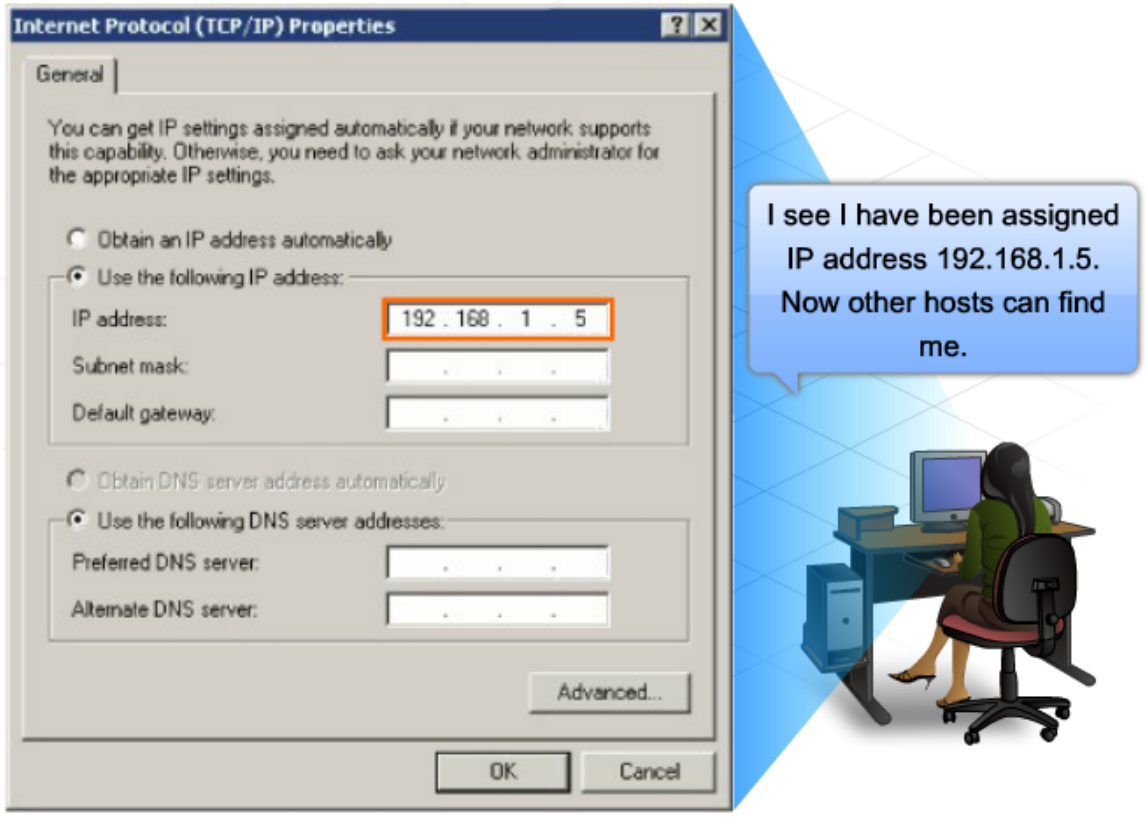
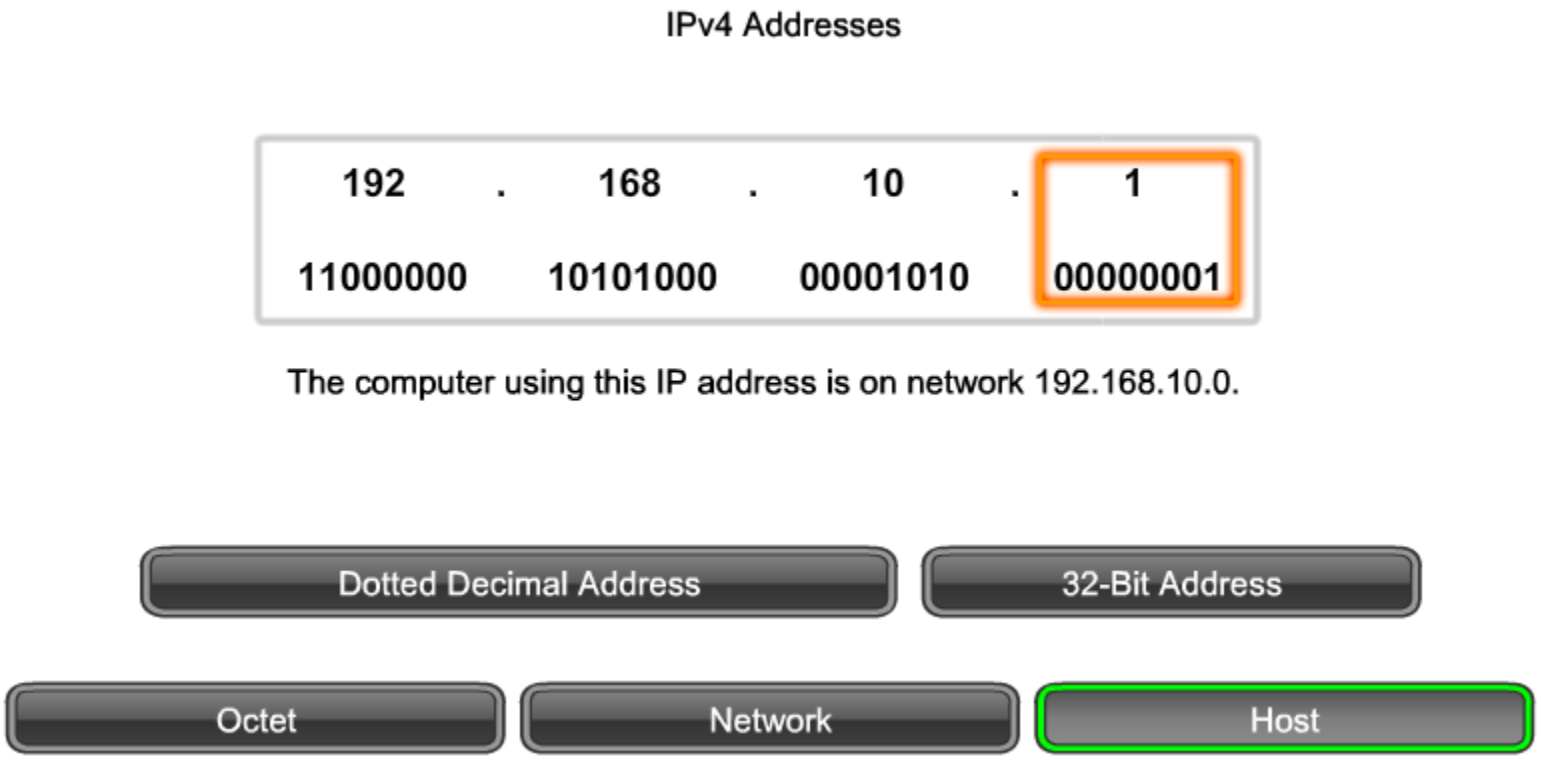
Addressing the Network-IPv4

Introduction

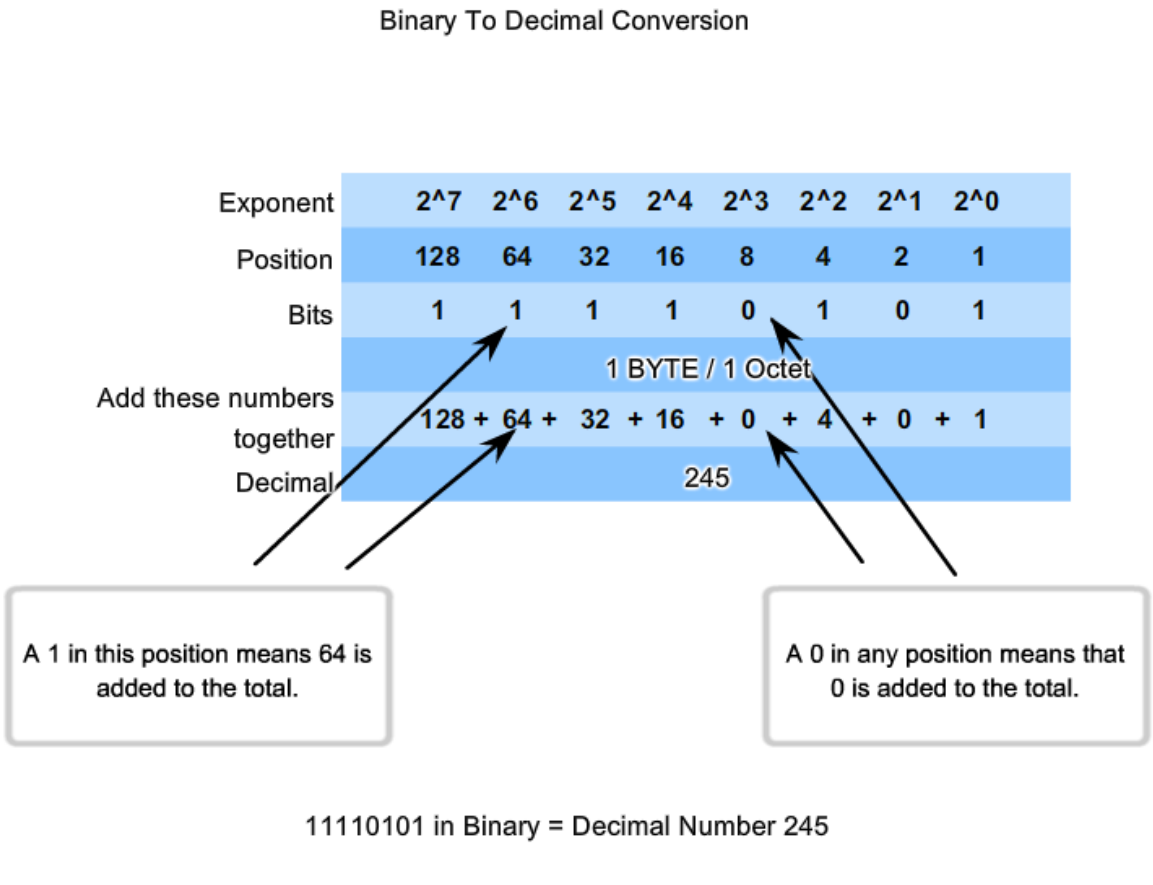


IP version 4 (IPv4) is the current form of addressing used on the Internet.

IPv4

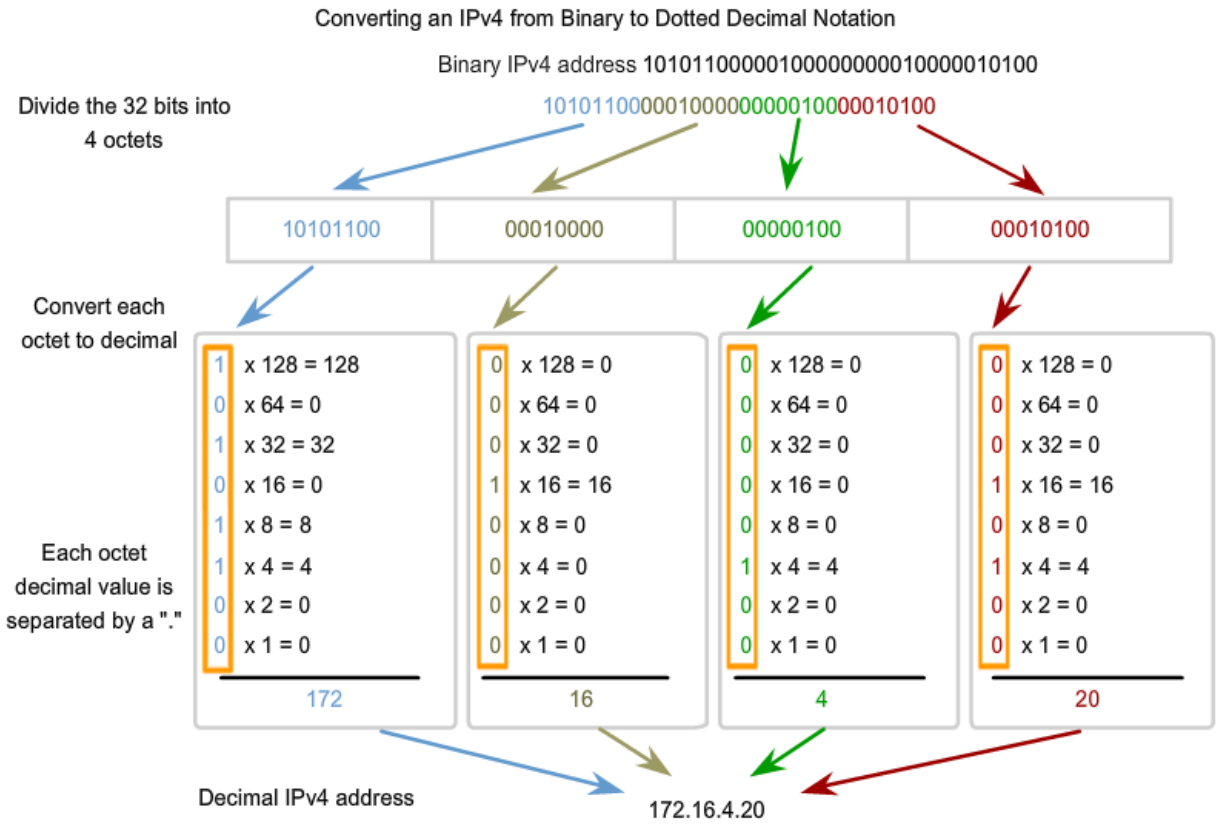

IPv4 Addresses
192 . 168 . 10 . 1
11000000 10101000 00001010 00000001
The computer using this IP address is on network 192.168.10.0.
Dotted Decimal Address
32-Bit Address
Octet
Network
Host

Binary to Decimal Cnversion

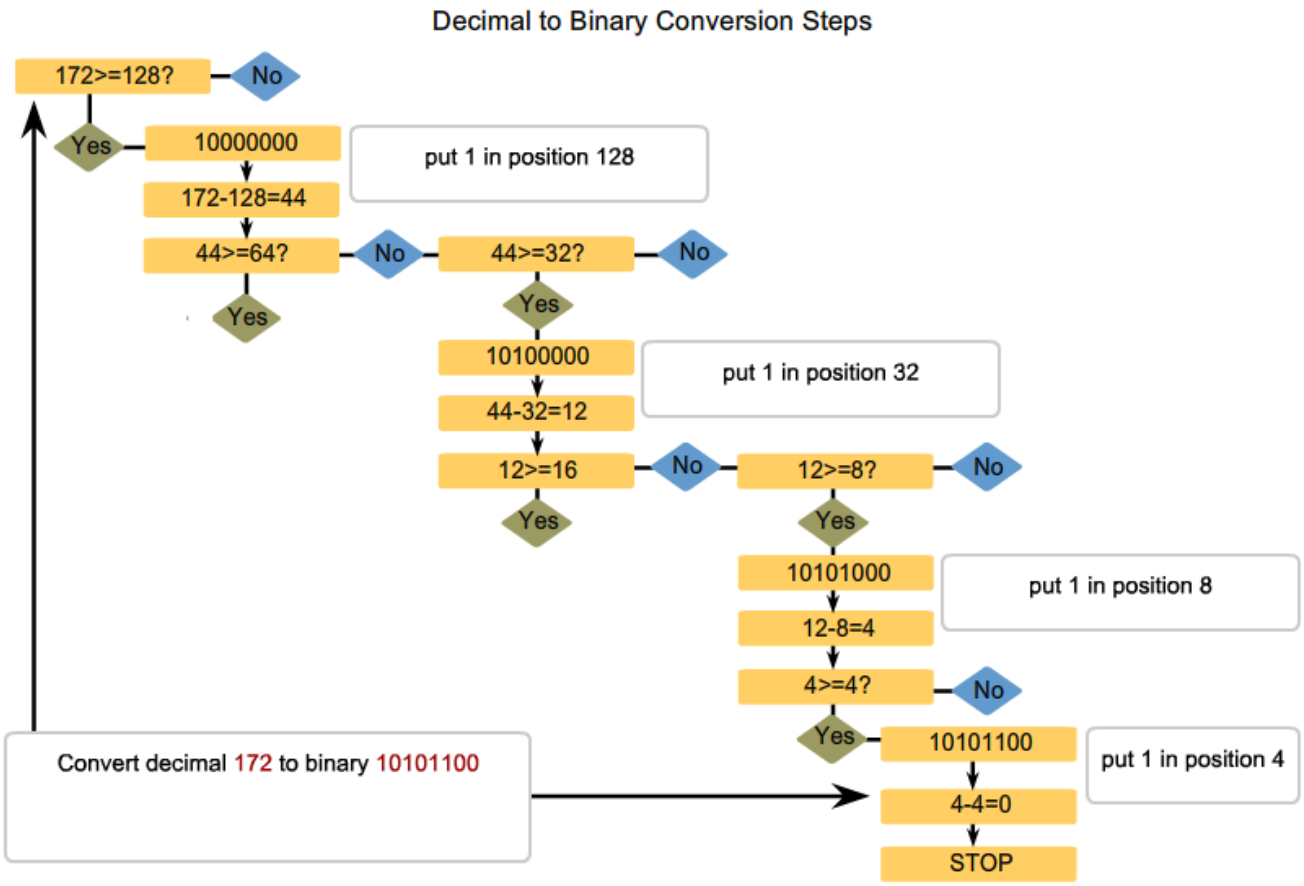


11110101 in Binary = Decimal Number 245

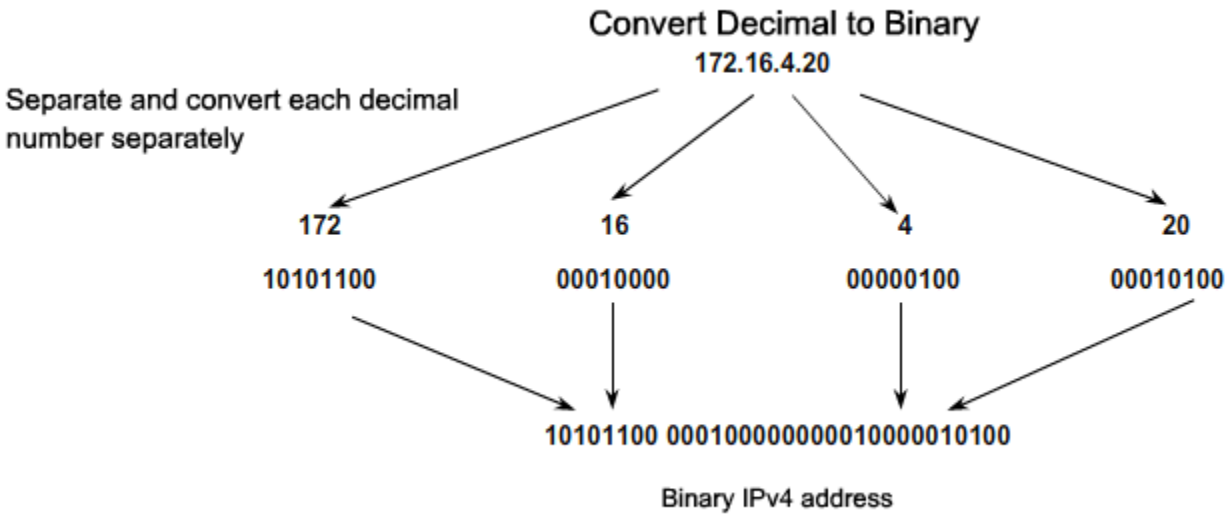
Binary to Decimal Cnversion….



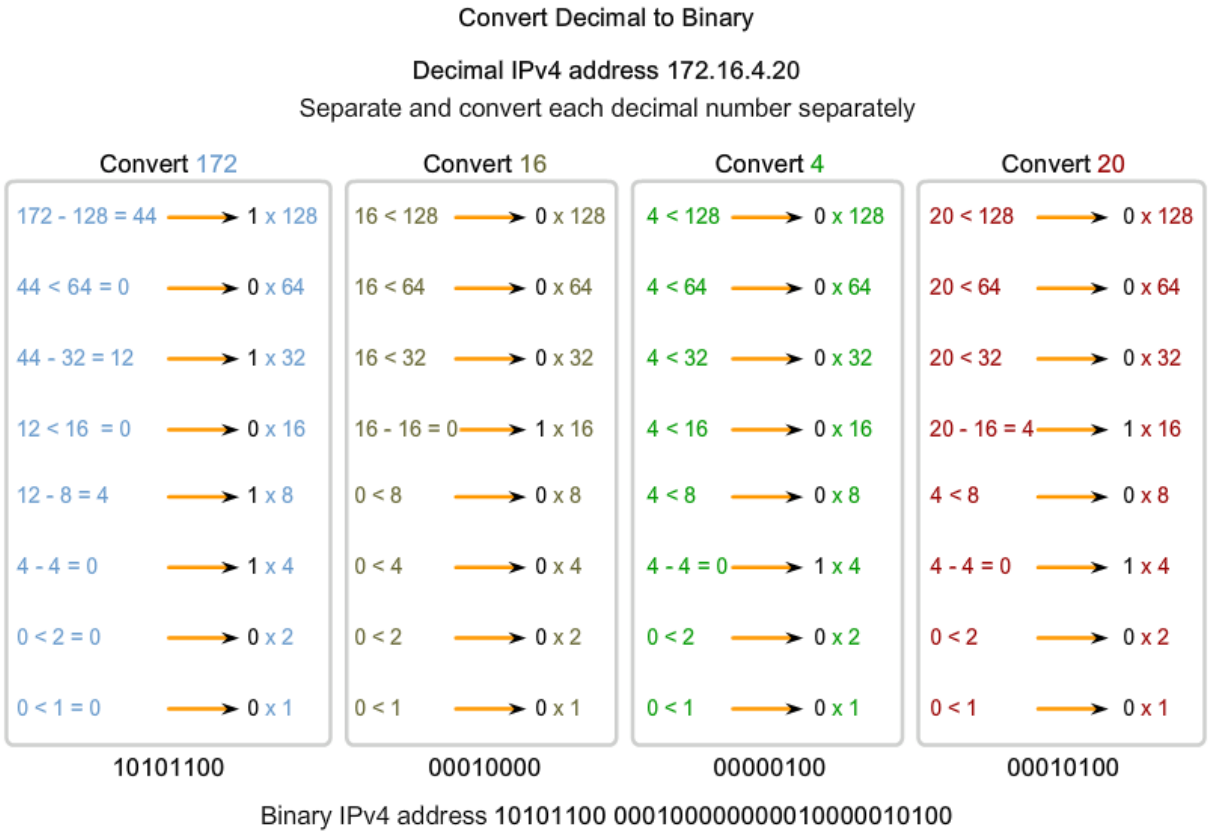
Decimal to Binary



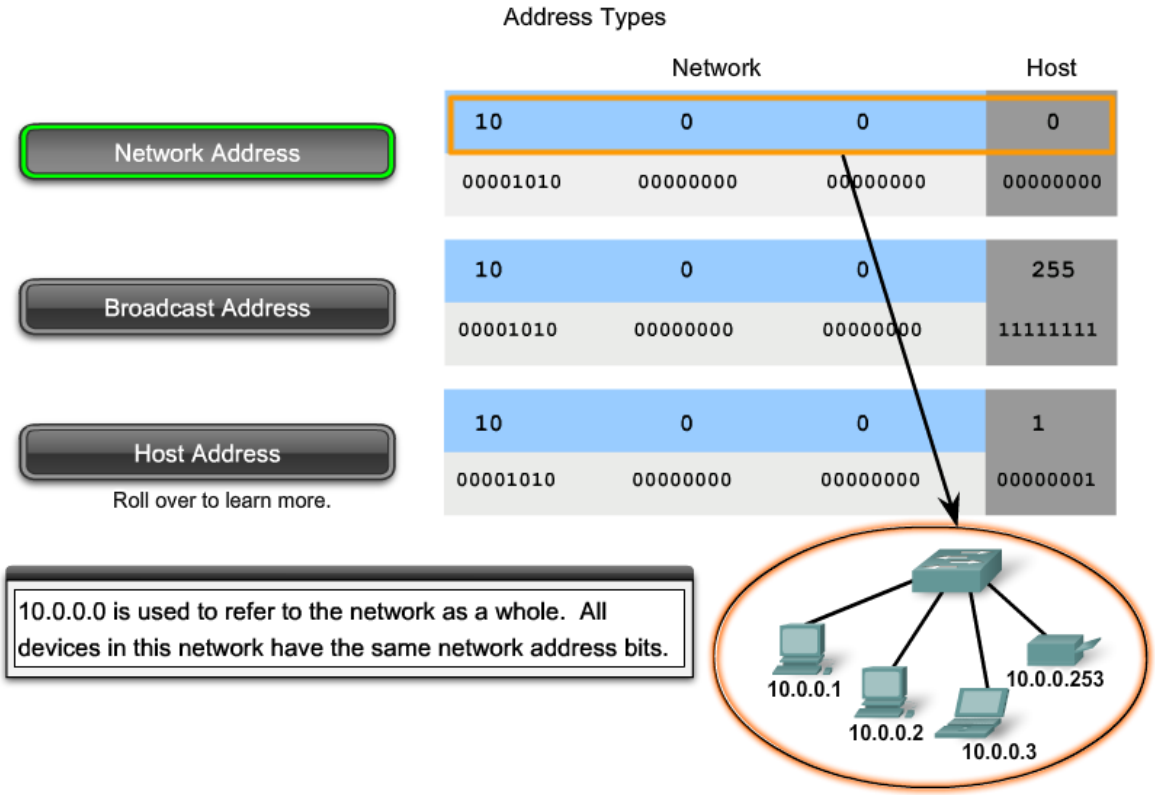
Decimal to Binary…



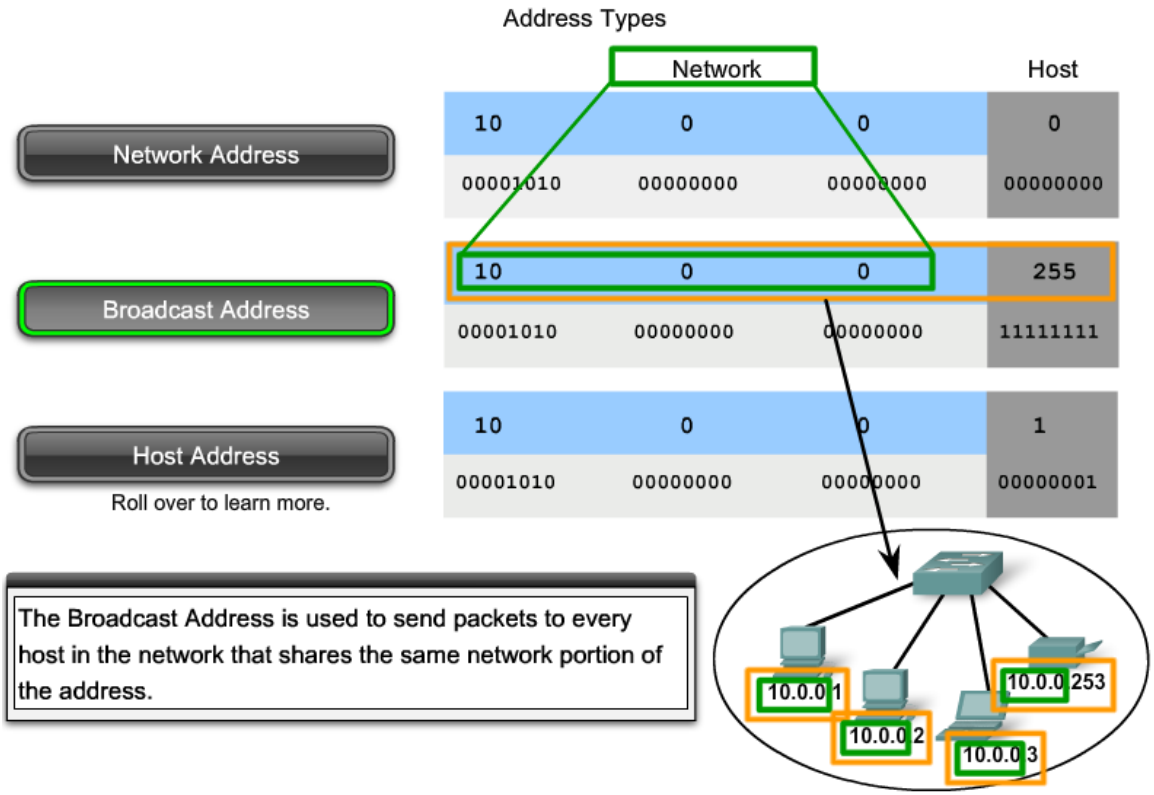
Decimal to Binary…



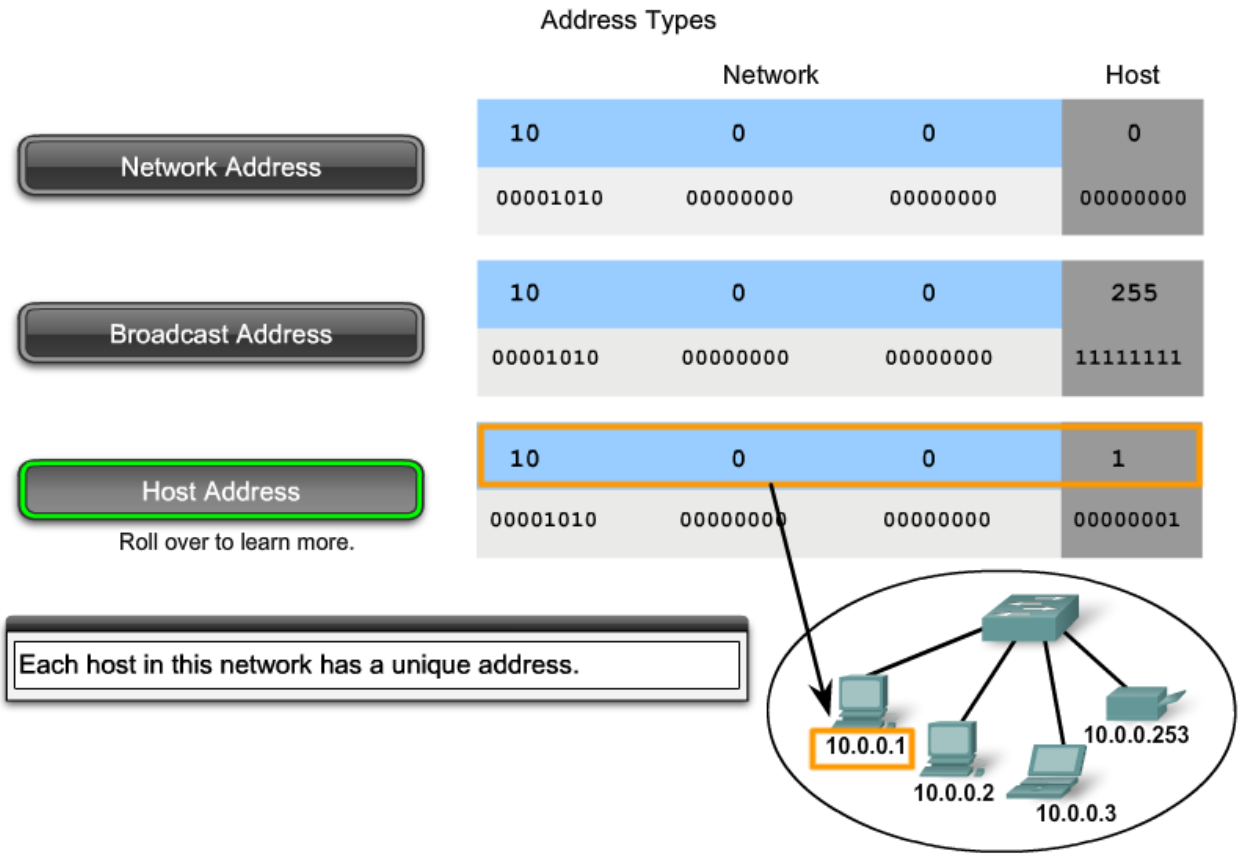
Types of addresses in an IPv4 Network



Types of addresses in an IPv4 Network…



Types of addresses in an IPv4 Network…



Types of addresses in an IPv4 Network…

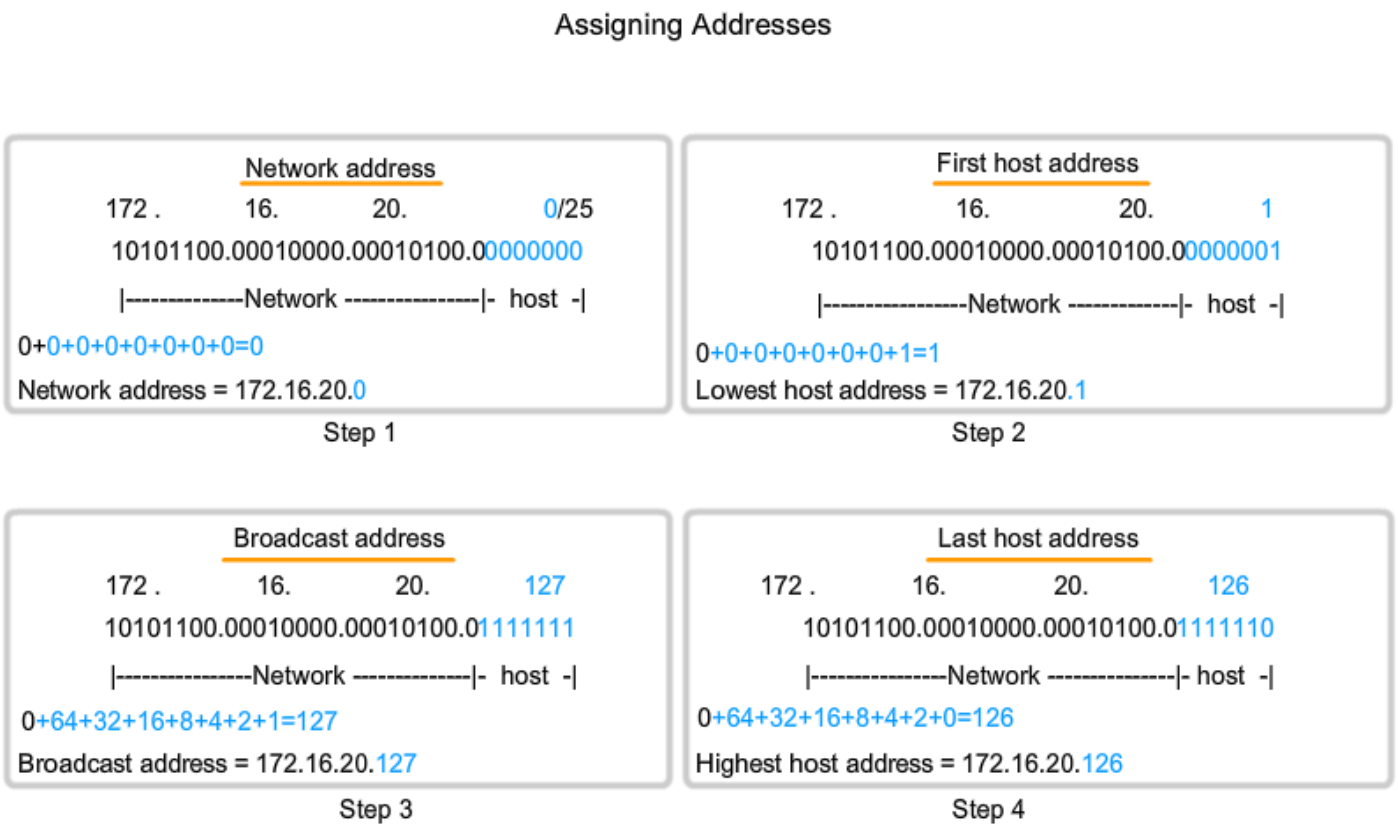
Using Different Prefixes for the 172.16.4.0 Network

Network	Network Address	Host Range	Broadcast Address
172.16.4.0 /24	172.16.4.0	172.16.4.1 - 172.16.4.254	172.16.4.255
172.16.4.0 /25	172.16.4.0	172.16.4.1 - 172.16.4.126	172.16.4.127
172.16.4.0 /26	172.16.4.0	172.16.4.1 - 172.16.4.62	172.16.4.63
172.16.4.0 /27	172.16.4.0	172.16.4.1 - 172.16.4.30	172.16.4.31

SAME NETWORK ADDRESS ALL PREFIXES

DIFFERENT BROADCAST ADDRESS EACH PREFIX

Calculating Network, Hosts and broadcast addresses



Examples

Given address/prefix of **148.6.123.128 /20**

For each row, enter the values for that type of address.

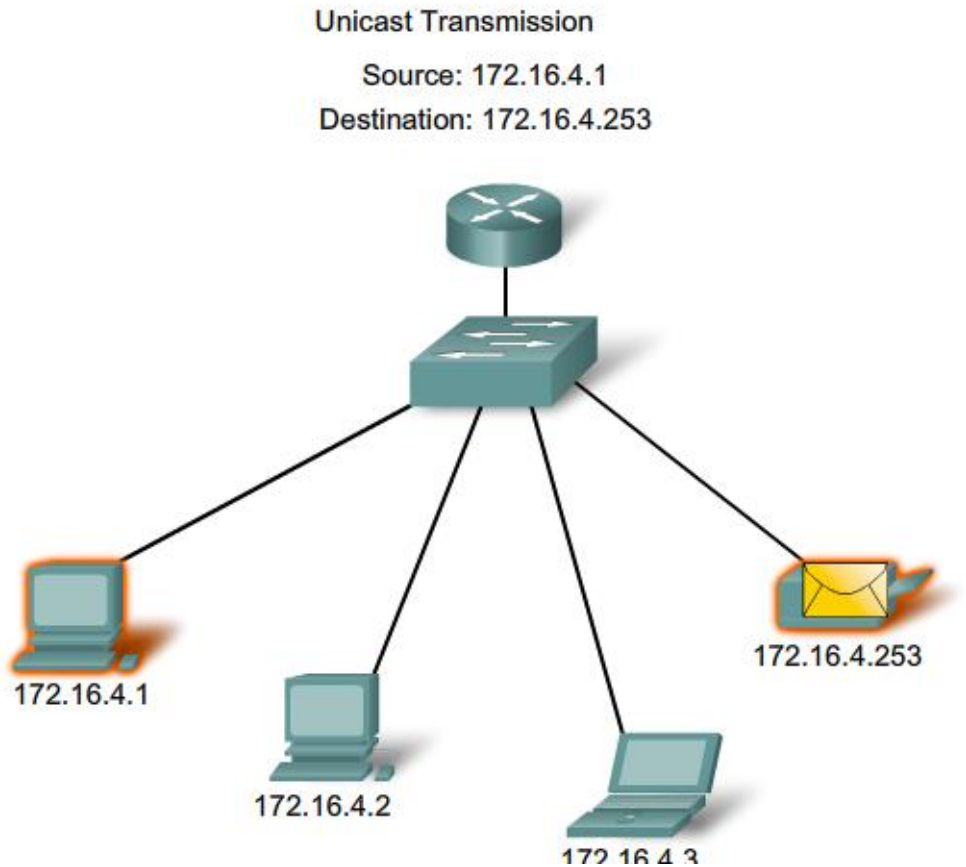
Type of Address	Enter LAST octet in binary	Enter LAST octet in decimal	Enter full address in decimal
Network	00000000	0	148.6.112.0
Broadcast	11111111	255	148.6.127.255
First Usable Host Address	00000001	1	148.6.112.1
Last Usable Host Address	11111110	254	148.6.127.254

Given address/prefix of **153.180.219.125 /22**

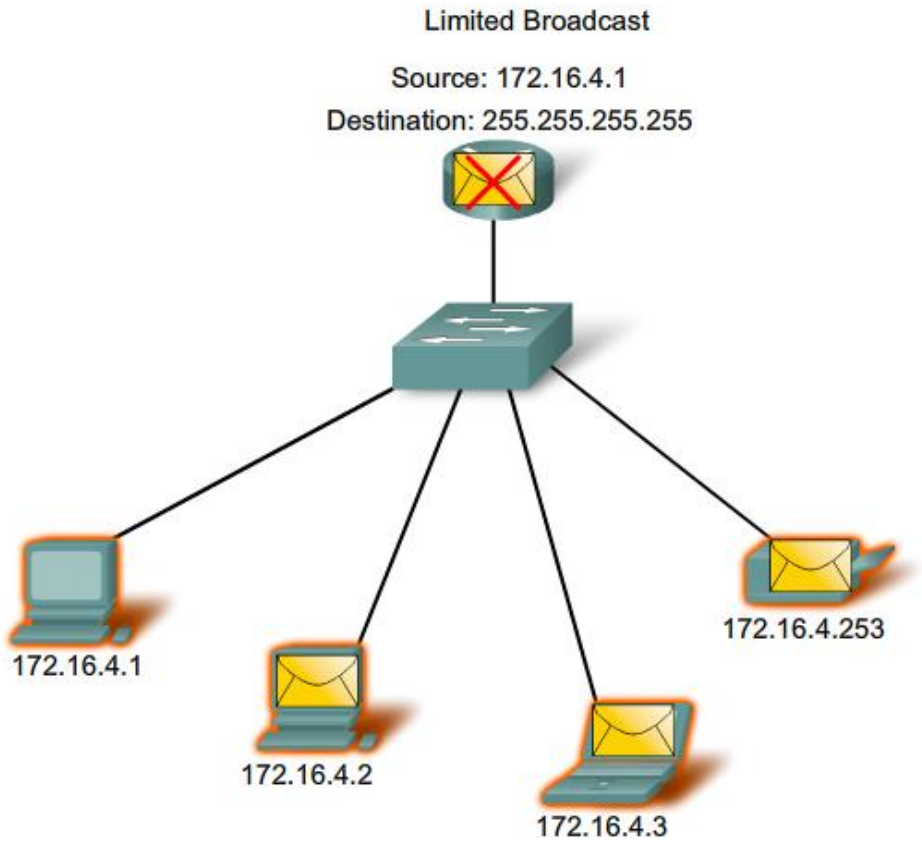
For each row, enter the values for that type of address.

Type of Address	Enter LAST octet in binary	Enter LAST octet in decimal	Enter full address in decimal
Network	00000000	0	153.180.216.0
Broadcast	11111111	255	153.180.219.255
First Usable Host Address	00000001	1	153.180.216.1
Last Usable Host Address	11111110	254	153.180.219.254

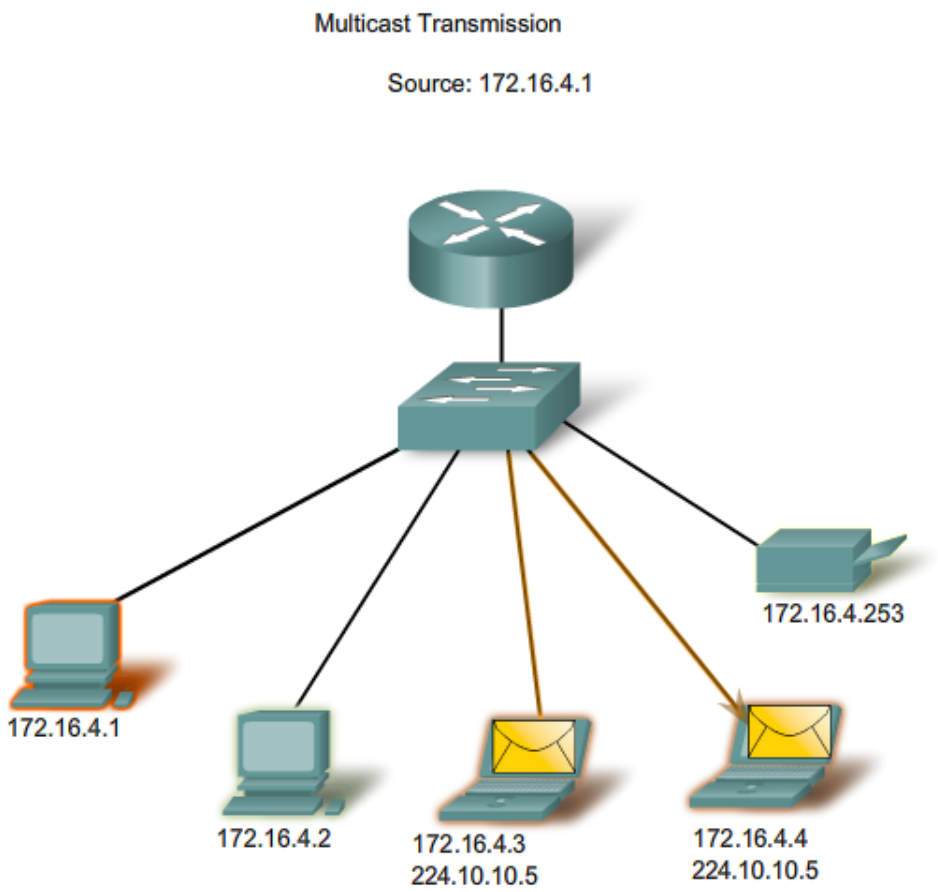
Unicast Transmission



Broadcast Transmission



Multicast Transmission

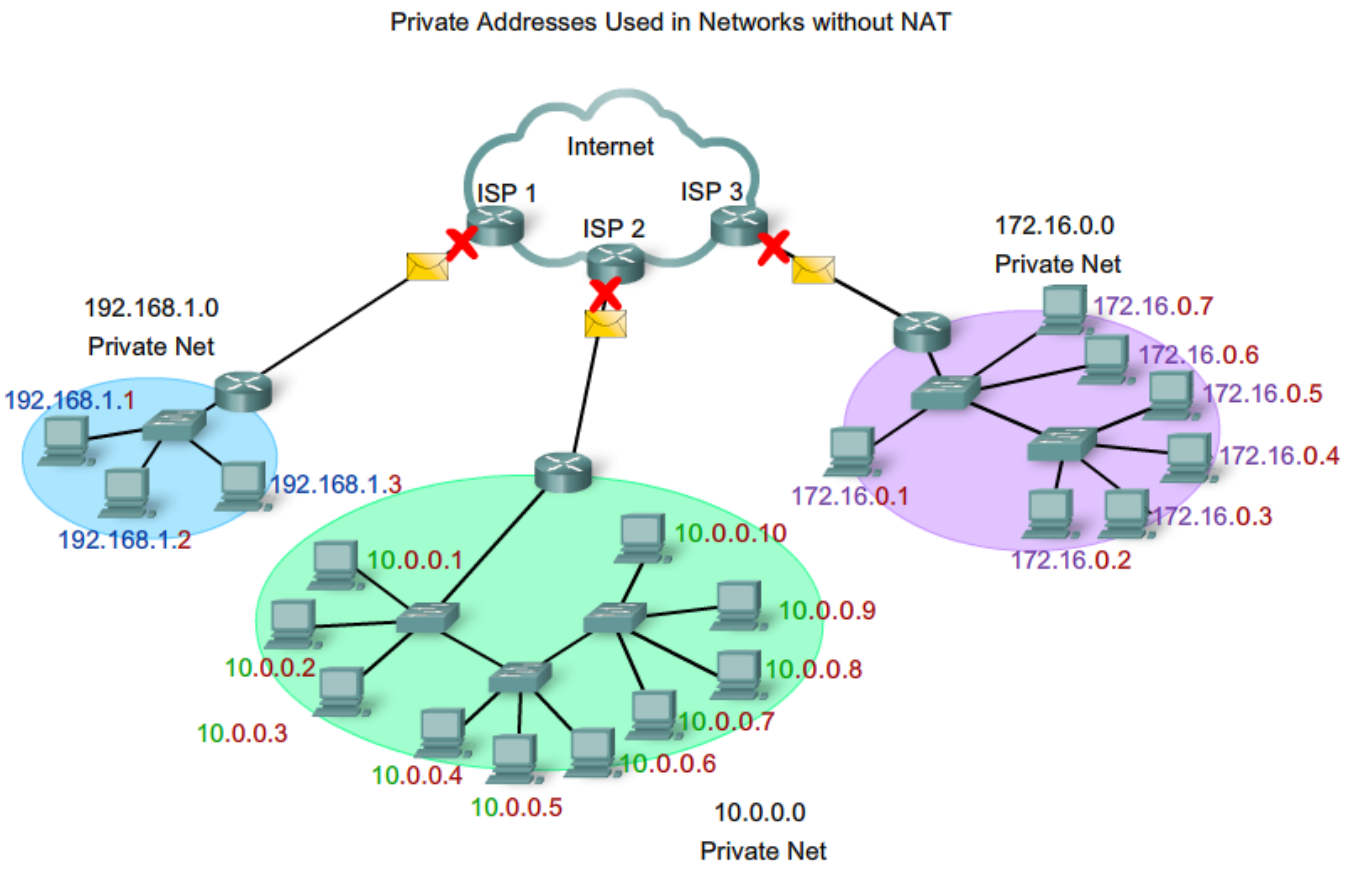


Reserved IPv4 Address Ranges

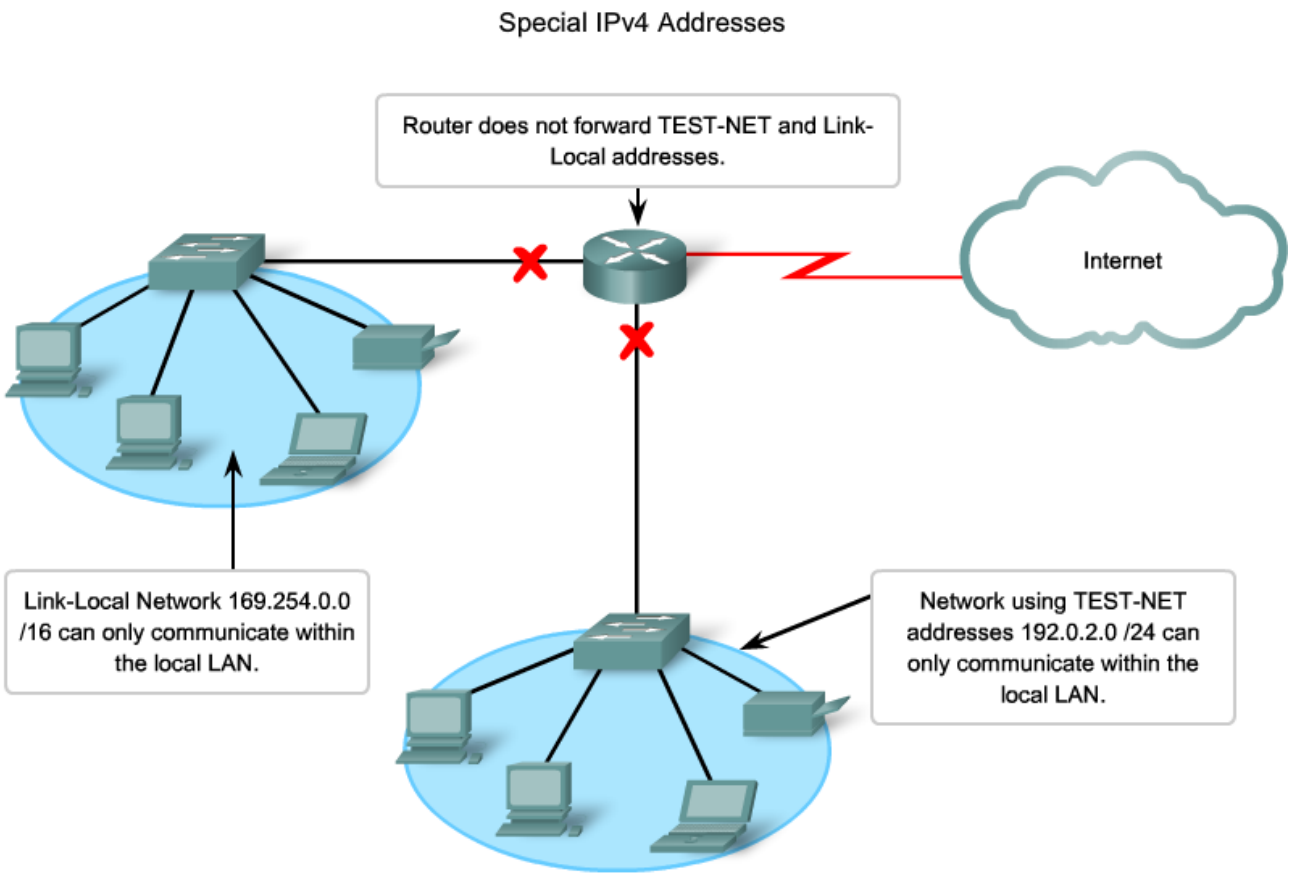
Reserved IPv4 Address Ranges

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



Special IPv4 Addresses

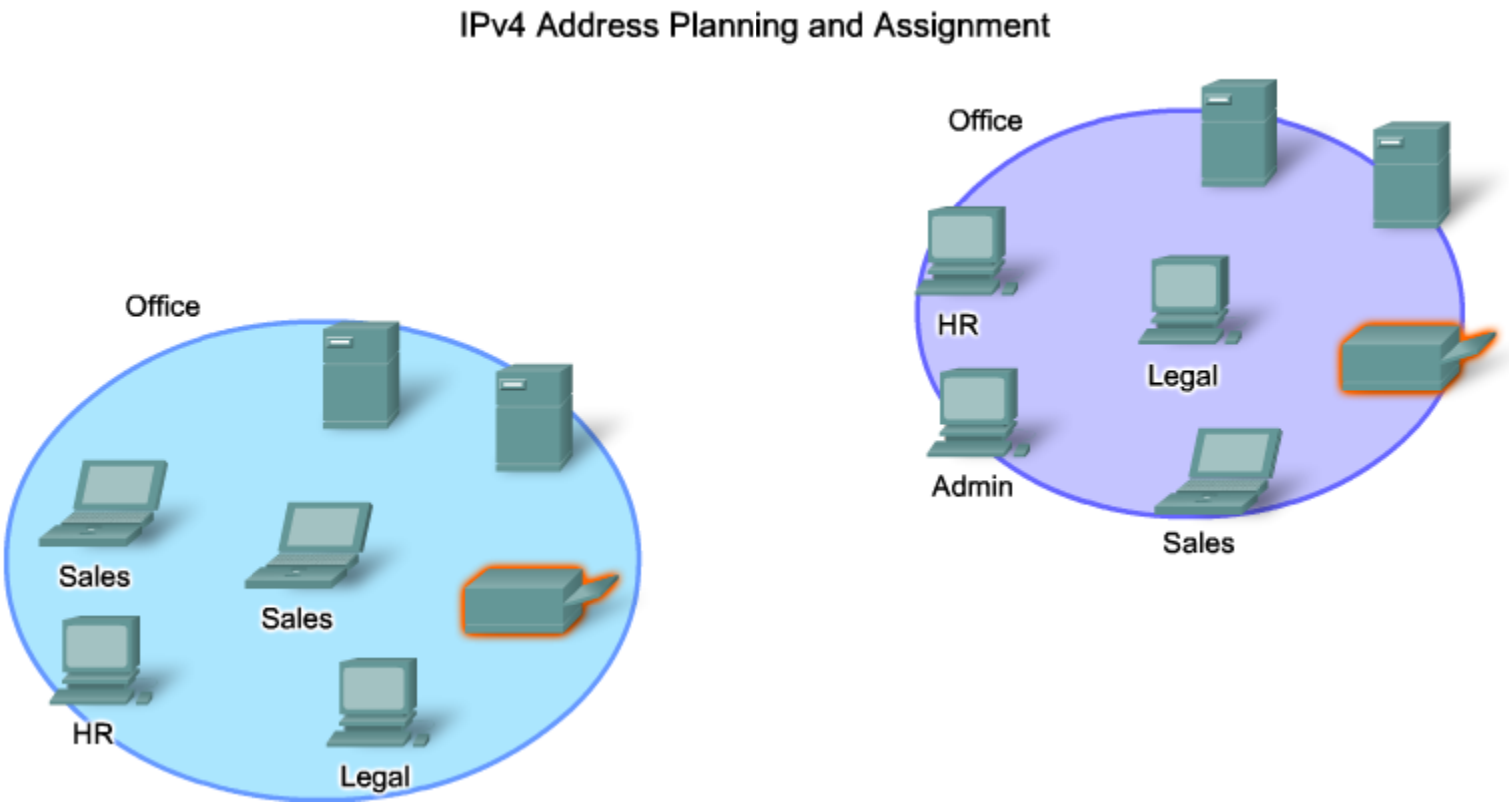


IP Addresses

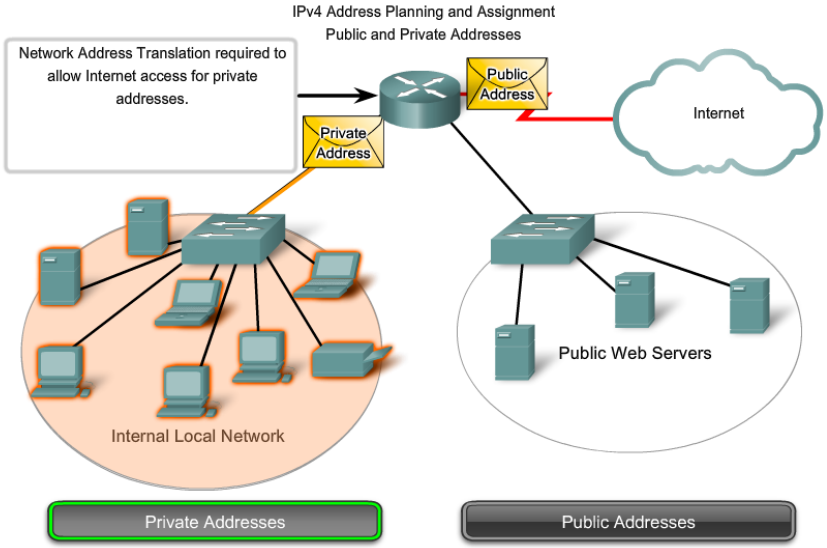
IP Address Classes

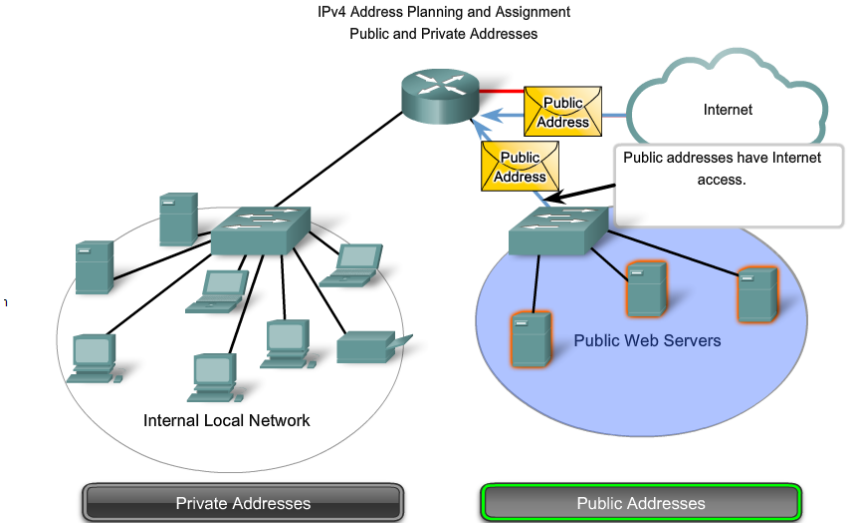
Address Class	1st octet range (decimal)	1st octet bits (green bits do not change)	Network(N) and Host(H) parts of address	Default subnet mask (decimal and binary)	Number of possible networks and hosts per network
A	1-127**	00000000-01111111	N.H.H.H	255.0.0.0	128 nets (2^7) 16,777,214 hosts per net (2^24-2)
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)		

Planning to Address the Network

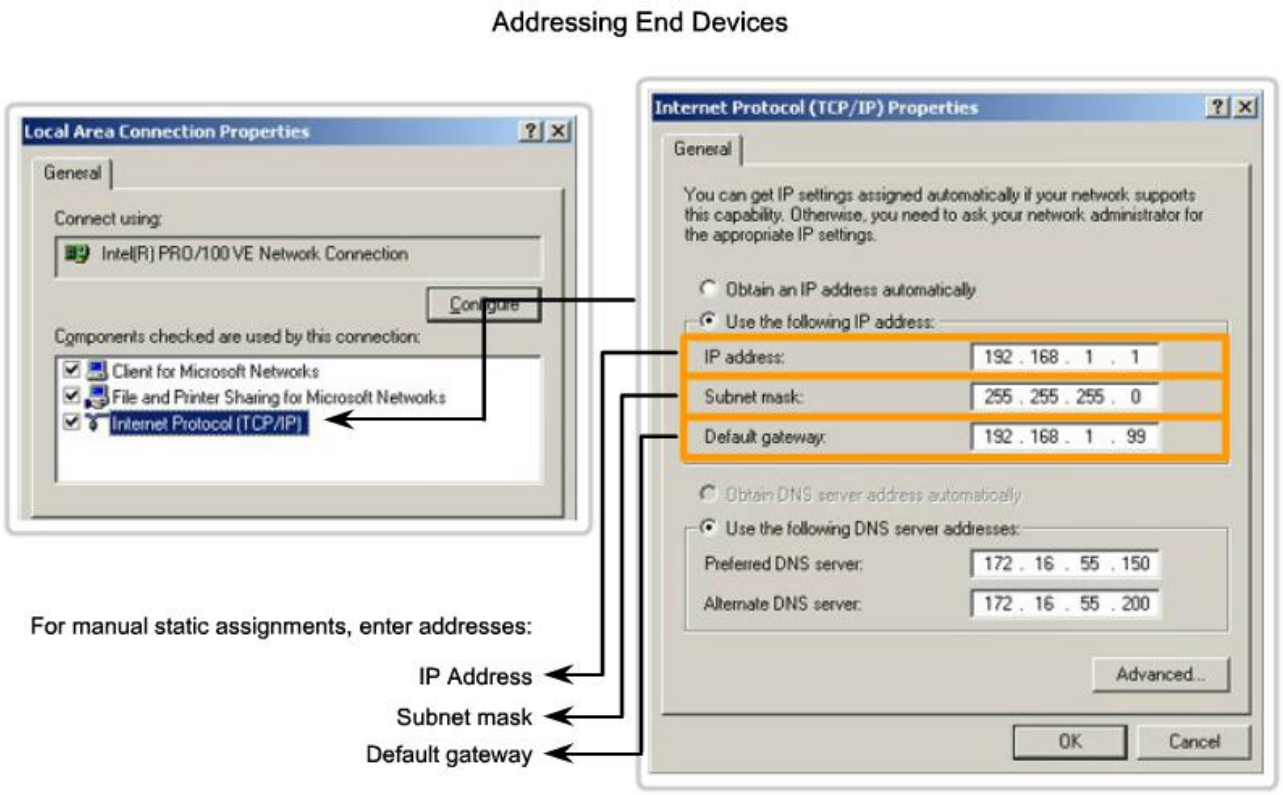


Planning to Address the Network….

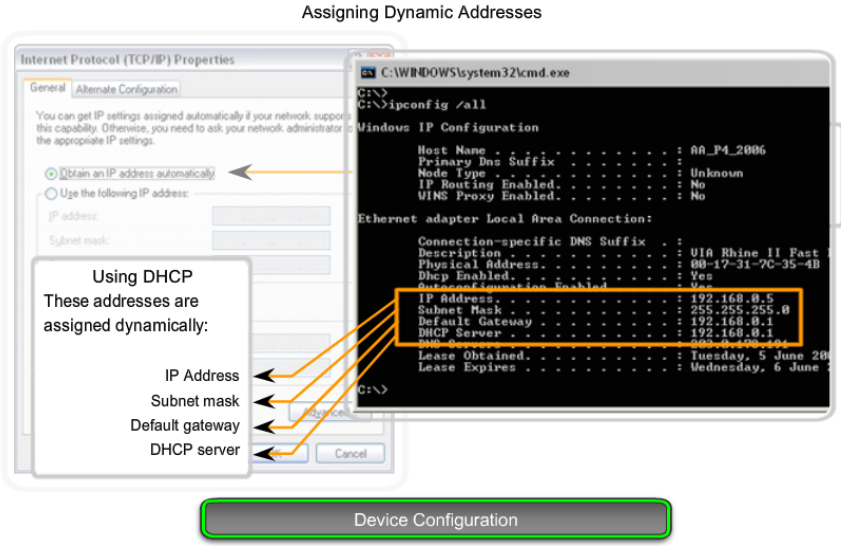




Static or Dynamic Addressing for End Devices



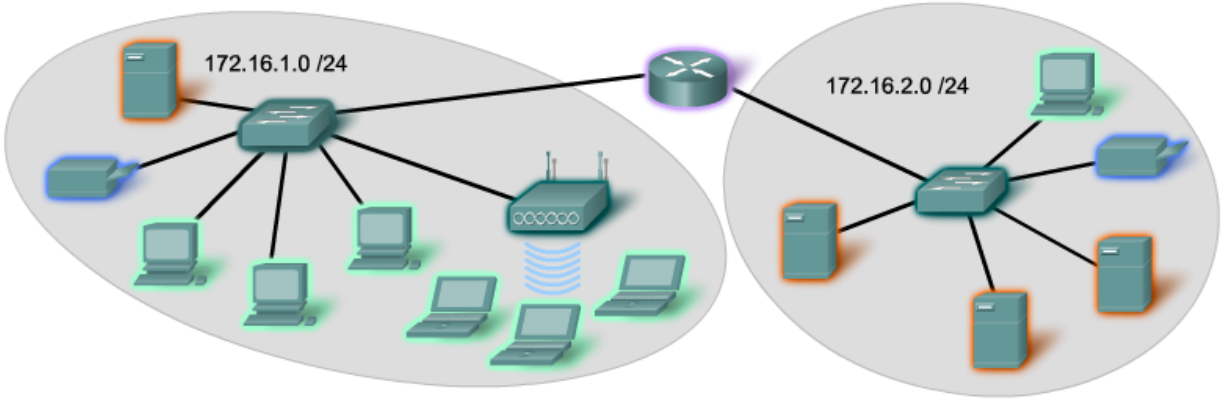
Static or Dynamic Addressing for End Devices …



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.128 /26
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	.....	

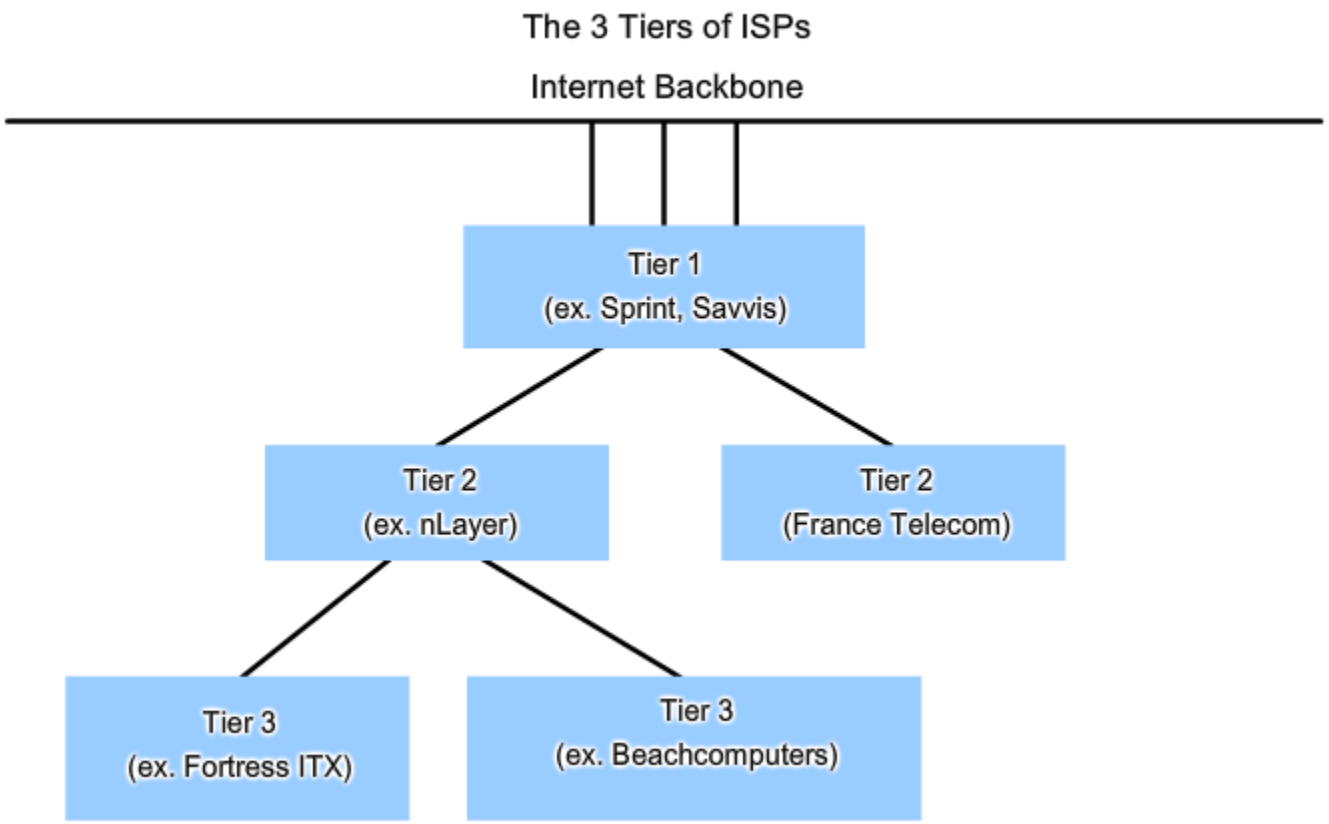


Who Assigns The Different Addresses?

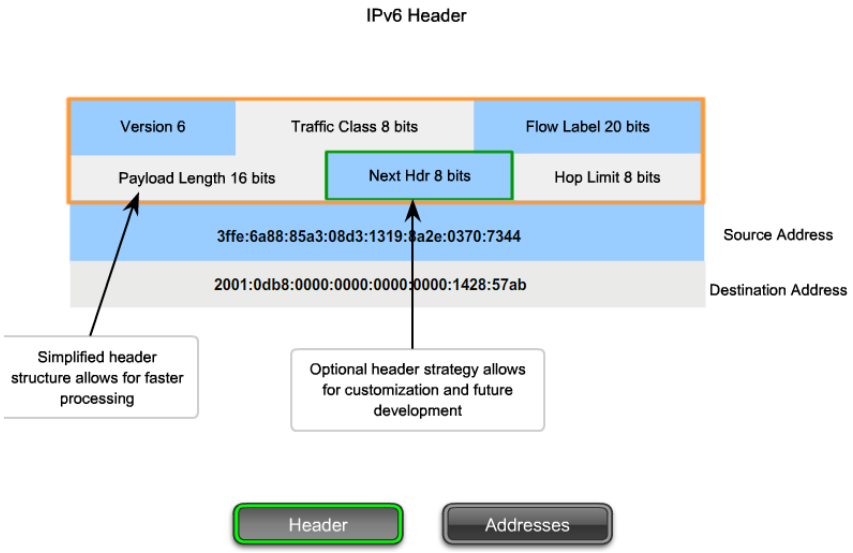
Entities that Oversee IP Address Allocation

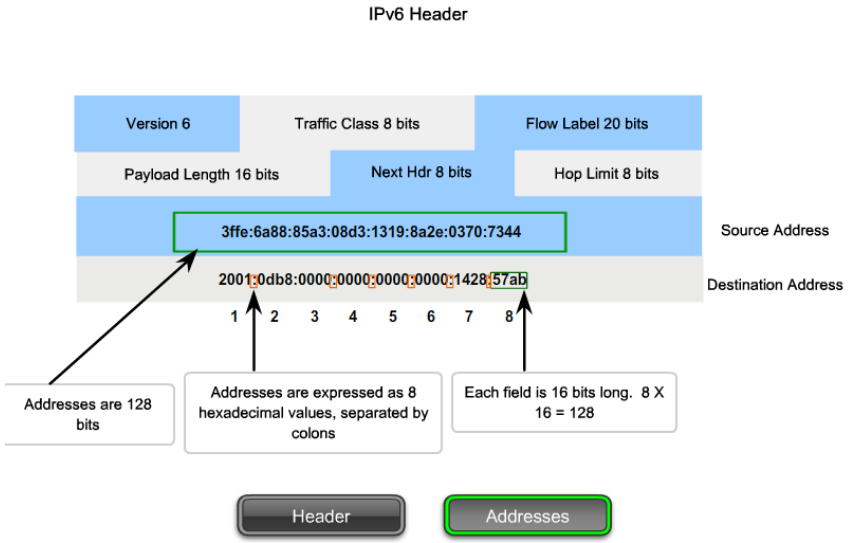
Global	IANA				
Regional Internet Registries	AfriNIC Africa Region	APNIC Asia/ Pacific Region	LACNIC Latin America And Caribbean Region	ARIN North America Region	RIPE NCC Europe, Middle East, Central Asia Region

ISPs

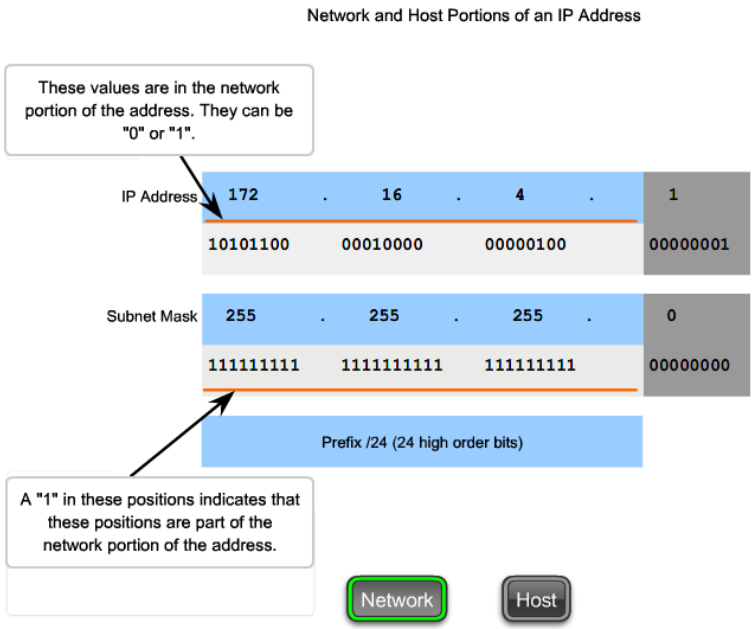

The 3 Tiers of ISPs
Internet Backbone
Tier 1
(ex. Sprint, Savvis)
Tier 2
(ex. nLayer)
Tier 2
(France Telecom)
Tier 3
(ex. Fortress ITX)
Tier 3
(ex. Beachcomputers)

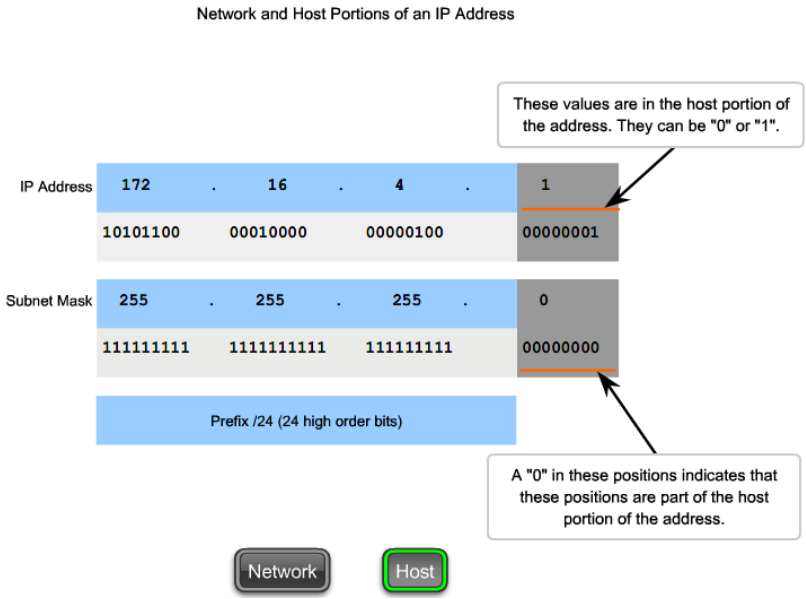
Overview of IPv6



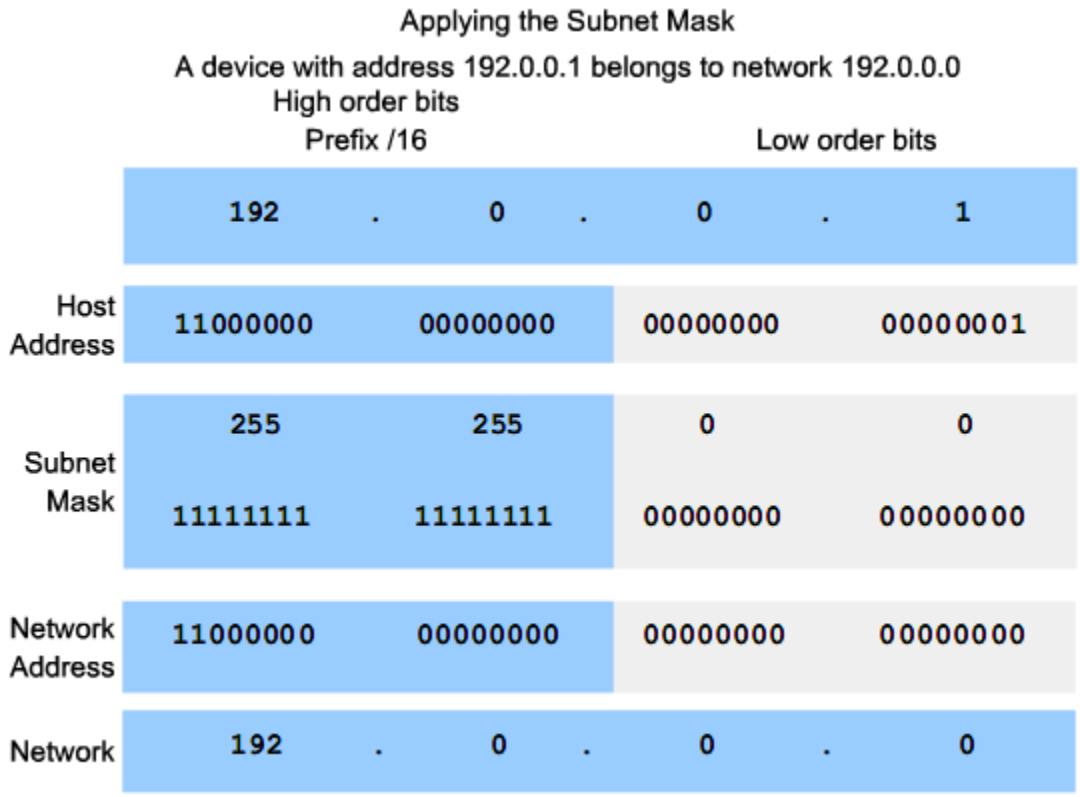


The subnet Mask- Defining the Network and Host Portions

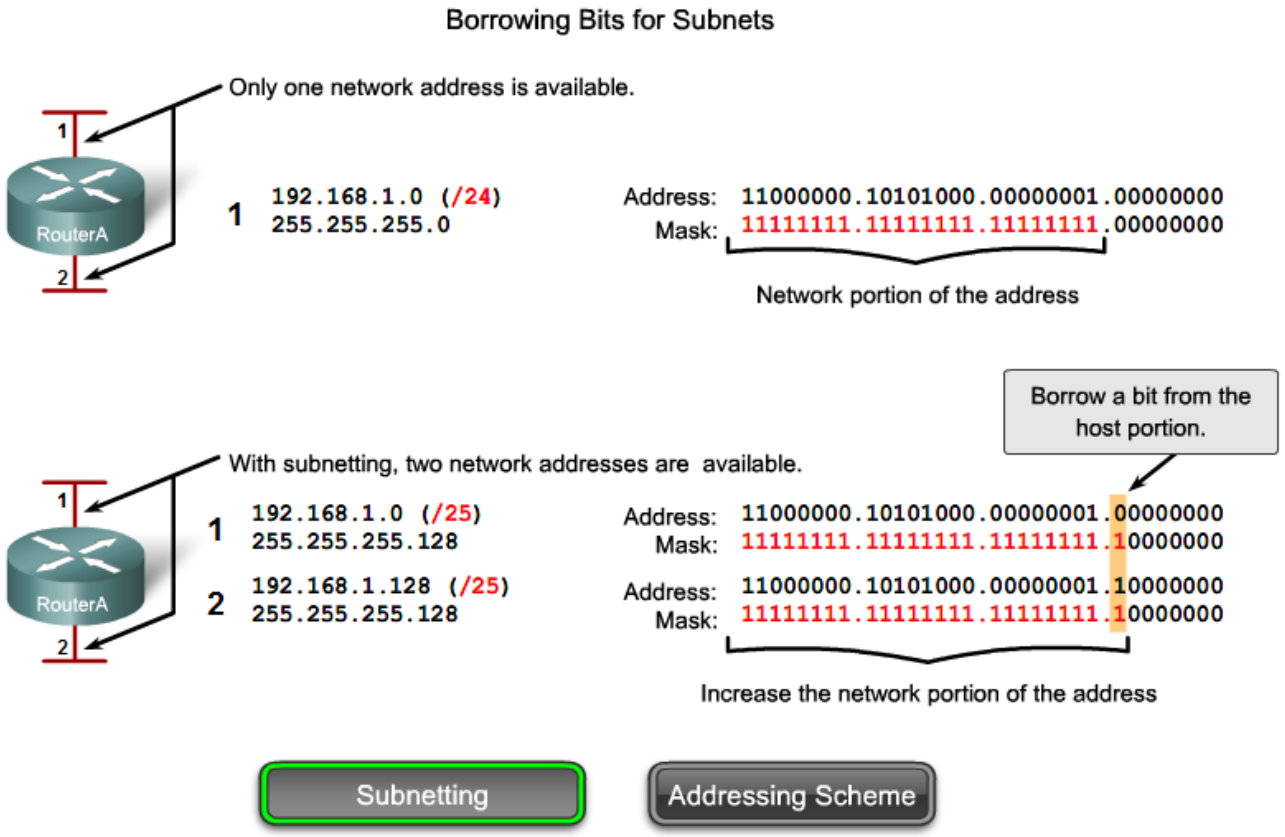




ANDing- What Is in our Network?



Basic Subnetting



Basic Subnetting…

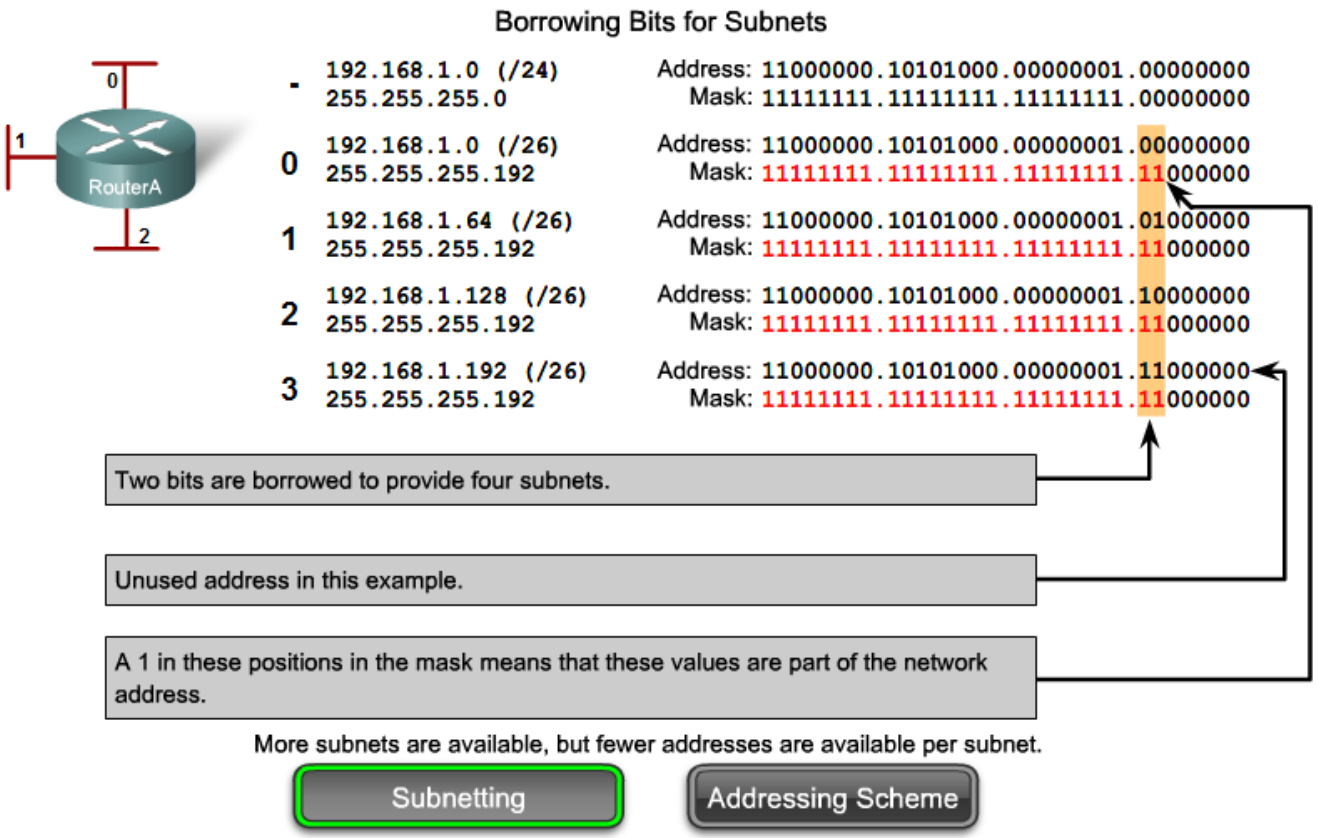
Borrowing Bits for Subnets

Addressing Scheme: Example of 2 networks

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

Subnetting | Addressing Scheme

Example with 3 subnets



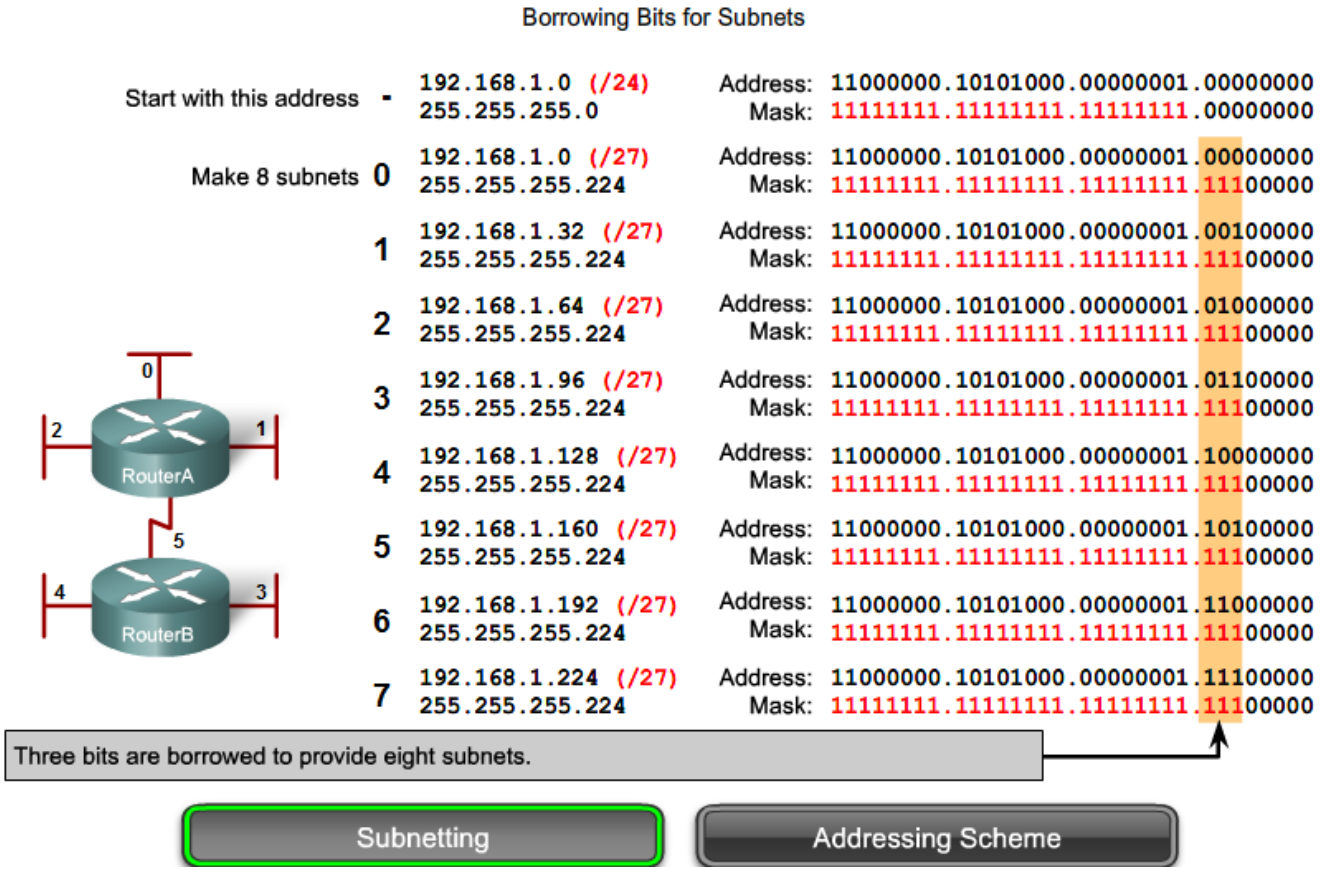
Example with 3 subnets…

Borrowing Bits for Subnets

Addressing Scheme: Example of 4 networks

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

Example with 6 subnets



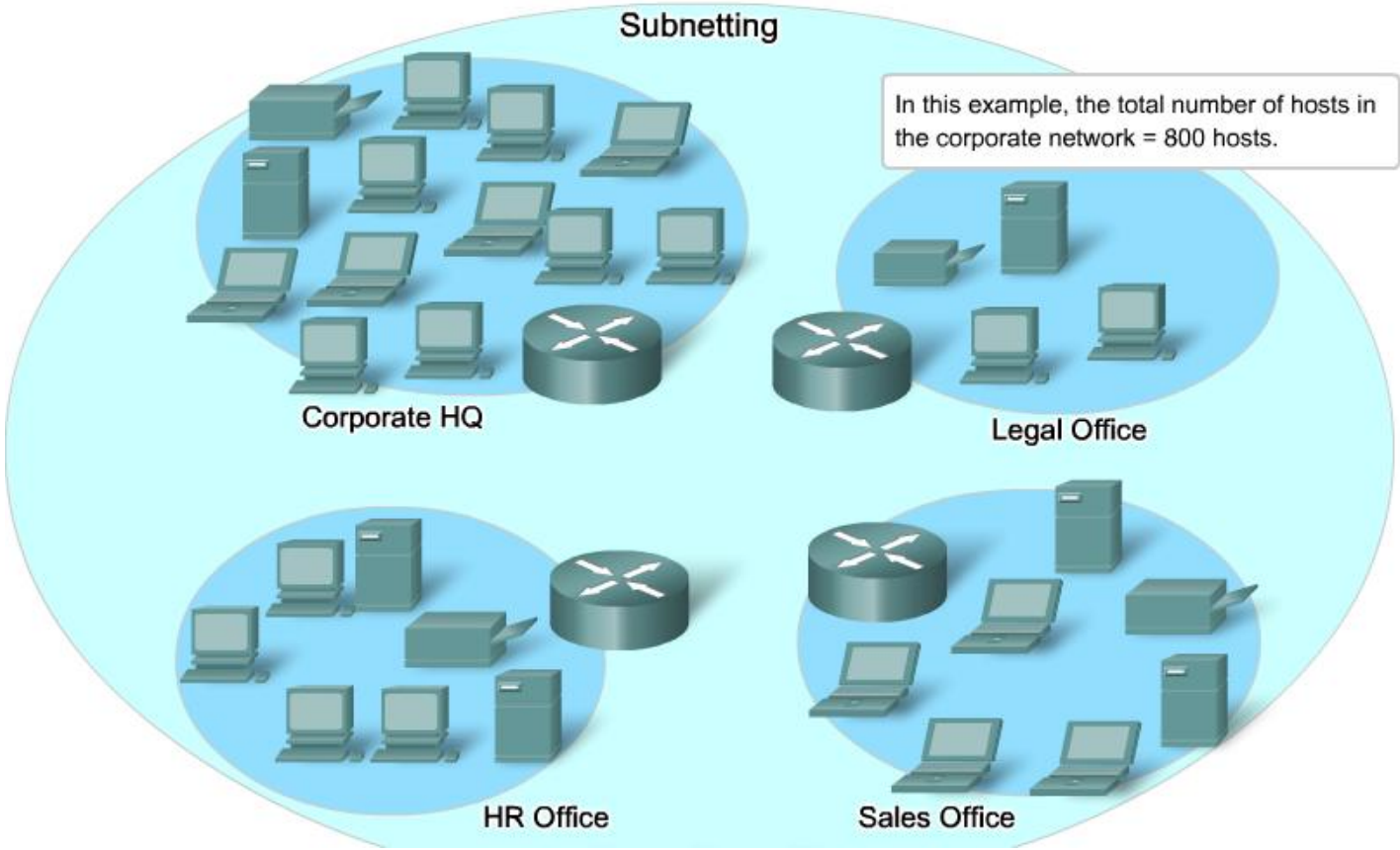
Example with 6 subnets…

Borrowing Bits for Subnets

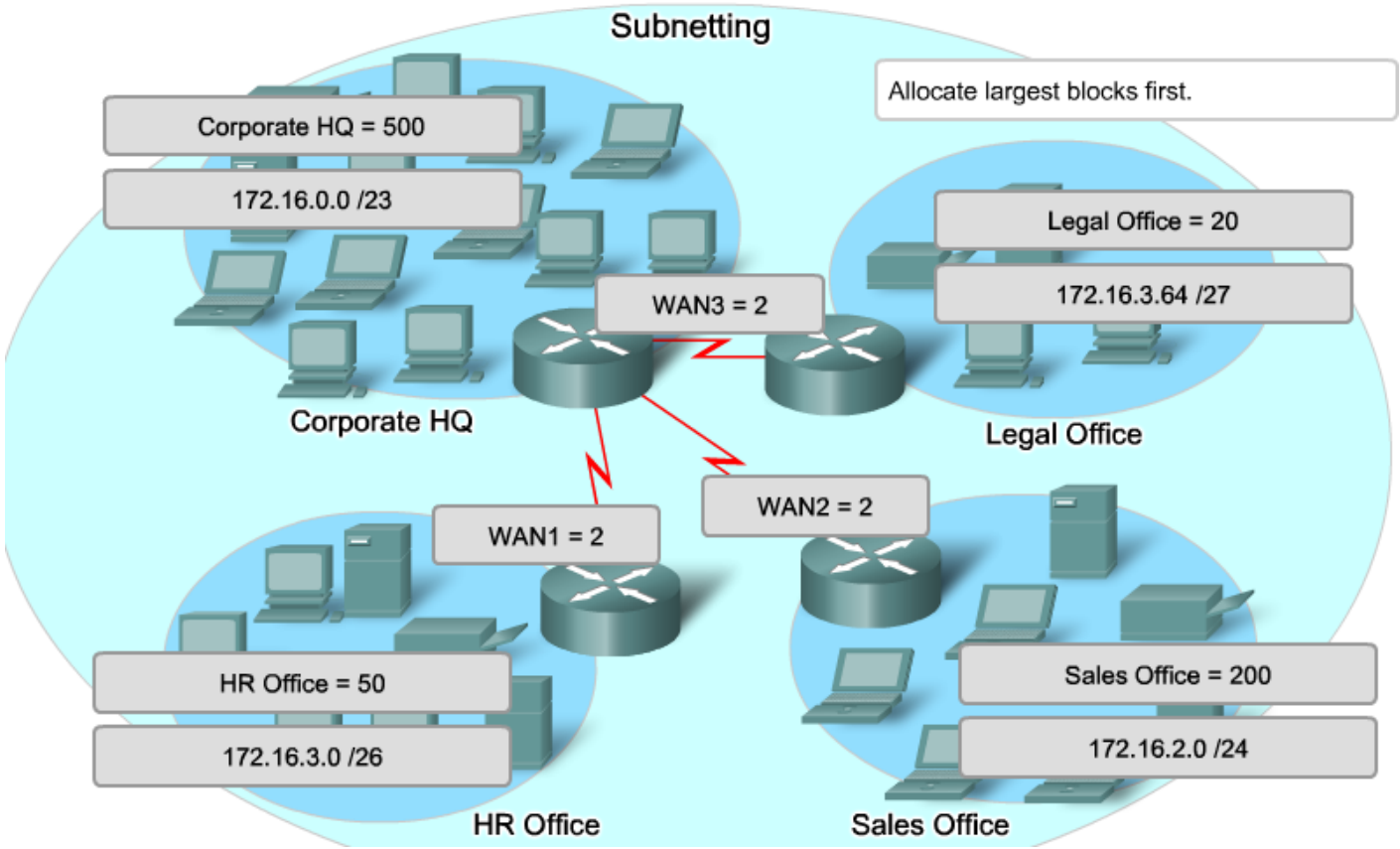
Addressing Scheme: Example of 6 networks

Subnet	Network address	Host range	Broadcast address
0	192.168.1.0/27	192.168.1.1 - 192.168.1.30	192.168.1.31
1	192.168.1.32/27	192.168.1.33 - 192.168.1.62	192.168.1.63
2	192.168.1.64/27	192.168.1.65 - 192.168.1.94	192.168.1.95
3	192.168.1.96/27	192.168.1.97 - 192.168.1.126	192.168.1.127
4	192.168.1.128/27	192.168.1.129 - 192.168.1.158	192.168.1.159
5	192.168.1.160/27	192.168.1.161 - 192.168.1.190	192.168.1.191
6	192.168.1.192/27	192.168.1.193 - 192.168.1.222	192.168.1.223
7	192.168.1.224/27	192.168.1.225 - 192.168.1.254	192.168.1.255

Subnetting- Dividing Networks Into Right Sizes



Subnetting- Dividing Networks Into Right Sizes…



Subnetting- Dividing Networks Into Right Sizes…

Corporate Net	HQ	Sales	HR	Legal
172.16.0.0/22	172.16.0.0/23	172.16.2.0/24	172.16.3.0/26	172.16.3.64/27
172.16.0.1	172.16.0.1			
	172.16.1.255			
		172.16.2.0		
		172.16.2.255		
			172.16.3.0	
			172.16.3.63	
				172.16.3.64
				172.16.3.95

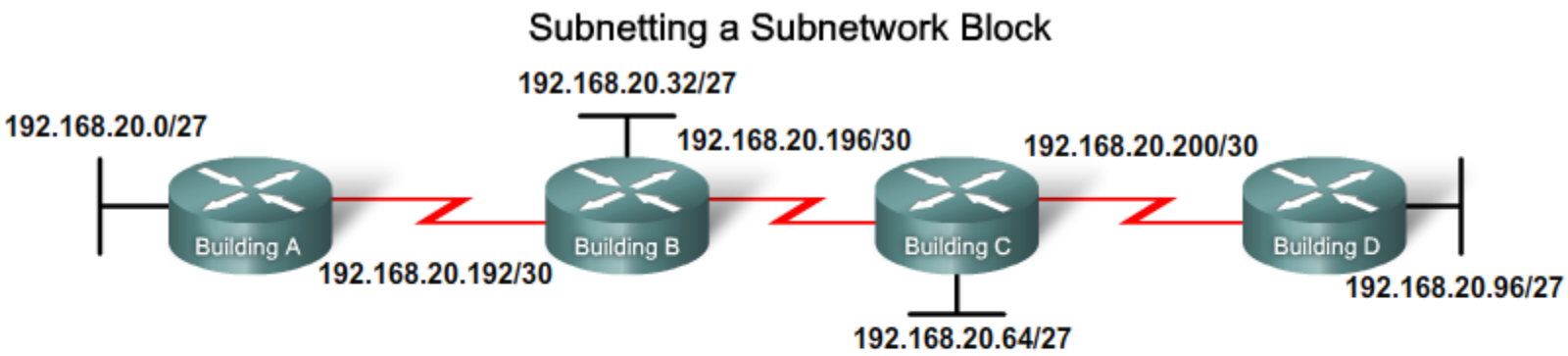
Subnetting- Dividing Networks Into Right Sizes…

HQ	HQ1	HQ2
172.16.0.0/23		
172.16.0.1	172.16.0.1	
	172.16.0.255	
		172.16.1.0
172.16.1.255		172.16.1.255

Step 1

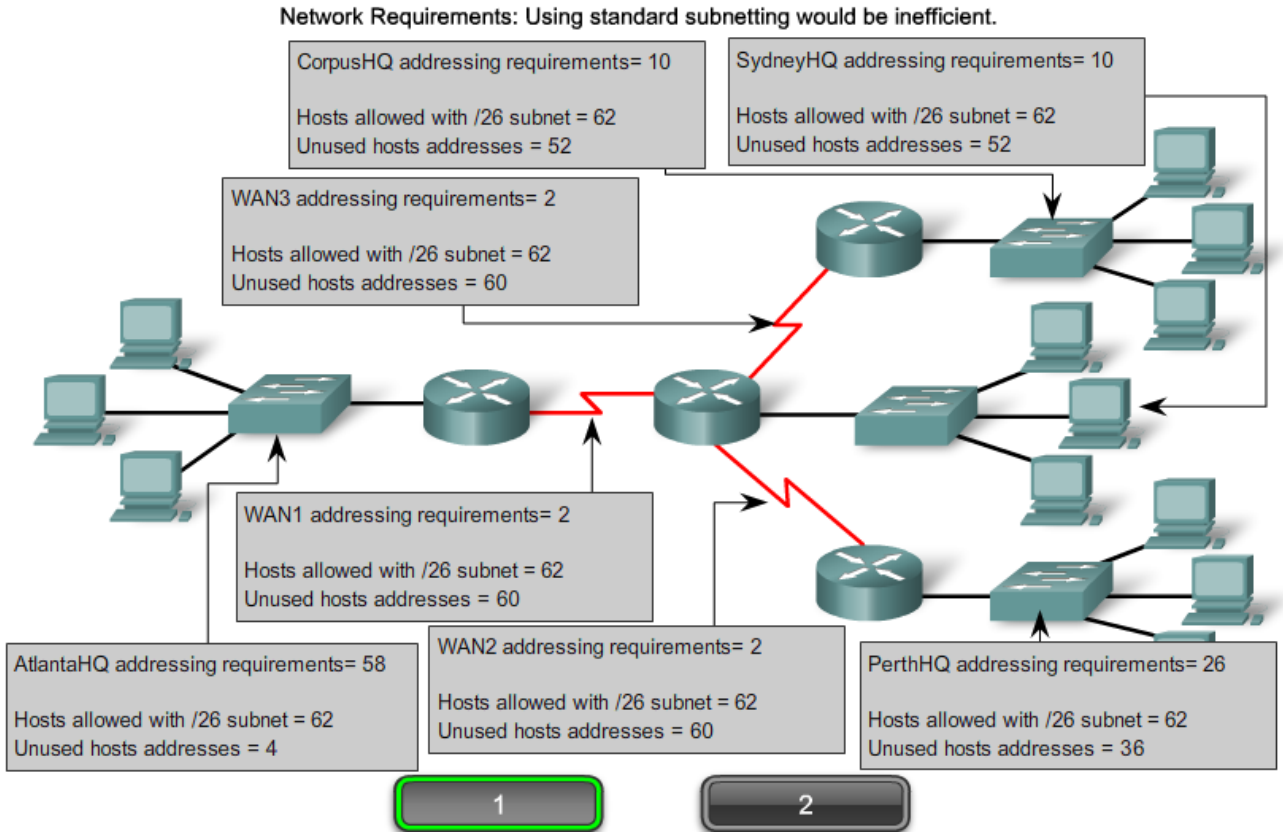
Step 2

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

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	192.168.20.220/30


Network Requirements: Using standard subnetting would be inefficient.
CorpusHQ addressing requirements= 10
Hosts allowed with /26 subnet = 62
Unused hosts addresses = 52
SydneyHQ addressing requirements= 10
Hosts allowed with /26 subnet = 62
Unused hosts addresses = 52
WAN3 addressing requirements= 2
Hosts allowed with /26 subnet = 62
Unused hosts addresses = 60
WAN1 addressing requirements= 2
Hosts allowed with /26 subnet = 62
Unused hosts addresses = 60
AtlantaHQ addressing requirements= 58
Hosts allowed with /26 subnet = 62
Unused hosts addresses = 4
WAN2 addressing requirements= 2
Hosts allowed with /26 subnet = 62
Unused hosts addresses = 60
PerthHQ addressing requirements= 26
Hosts allowed with /26 subnet = 62
Unused hosts addresses = 36
1
2

Network Requirements: Using standard subnetting would be inefficient.

	Actual Requirements	Total Wasted Addresses
AtlantaHQ	58 host addresses	4 addresses
PerthHQ	26 host addresses	36 addresses
SydneyHQ	10 host addresses	52 addresses
CorpusHQ	10 host addresses	52 addresses
WAN links	2 host addresses (each)	60 addresses

1

2

Example

Name - required addresses	Subnet address	Address range	Broadcast Address	Network/prefix
AtlantaHQ - 58				
PerthHQ - 26				
SydneyHQ - 10				
CorpusHQ - 10				
WAN1 - 2				
WAN2 - 2				
WAN3 - 2				

On your documentation, list your requirements in descending order.

Example…

Name - required addresses	Subnet address	Address range	Broadcast Address	Network/prefix
AtlantaHQ - 58	**192.168.15.0**	**.1 - .62**	**.63**	**192.168.15.0 /26**
PerthHQ - 26				
SydneyHQ - 10				
CorpusHQ - 10				
WAN1 - 2				
WAN2 - 2				
WAN3 - 2				

Calculate the subnet mask to meet largest requirement - AtlantaHQ.

1 2 3 4 5 6 7 8

Example…

Name - required addresses	Subnet address	Address range	Broadcast Address	Network/prefix
AtlantaHQ - 58	192.168.15.0	.1 - .62	.63	192.168.15.0 /26
PerthHQ - 26	192.168.15.64	.65 - .94	.95	192.168.15.64 /27
SydneyHQ - 10				
CorpusHQ - 10				
WAN1 - 2				
WAN2 - 2				
WAN3 - 2				

Use the next available Address .64 to calculate a subnet mask for the next largest requirement - PerthHQ.

1 2 3 4 5 6 7 8

Example…

Name - required addresses	Subnet address	Address range	Broadcast Address	Network/prefix
AtlantaHQ - 58	192.168.15.0	.1 - .62	.63	192.168.15.0 /26
PerthHQ - 26	192.168.15.64	.65 - .94	.95	192.168.15.64 /27
SydneyHQ - 10	192.168.15.96	.97 - .110	.111	192.168.15.96 /28
CorpusHQ - 10				
WAN1 - 2				
WAN2 - 2				
WAN3 - 2				

Use the next available .96 to calculate a subnet for SydneyHQ requirement of 10 hosts.

Example…

Name - required addresses	Subnet address	Address range	Broadcast Address	Network/prefix
AtlantaHQ - 58	192.168.15.0	.1 - .62	.63	192.168.15.0 /26
PerthHQ - 26	192.168.15.64	.65 - .94	.95	192.168.15.64 /27
SydneyHQ - 10	192.168.15.96	.97 - .110	.111	192.168.15.96 /28
CorpusHQ - 10	192.168.15.112	.113 - .126	.127	192.168.15.112 /28
WAN1 - 2				
WAN2 - 2				
WAN3 - 2				

Use the next available address .112 to calculate a subnet for CorpusHQ which also requires 10 hosts.

Example…

Name - required addresses	Subnet address	Address range	Broadcast Address	Network/prefix
AtlantaHQ - 58	192.168.15.0	.1 - .62	.63	192.168.15.0 /26
PerthHQ - 26	192.168.15.64	.65 - .94	.95	192.168.15.64 /27
SydneyHQ - 10	192.168.15.96	.97 - .110	.111	192.168.15.96 /28
CorpusHQ - 10	192.168.15.112	.113 - .126	.127	192.168.15.112 /28
WAN1 - 2	192.168.15.128	.129 - .130	.131	192.168.15.128 /30
WAN2 - 2				
WAN3 - 2				

WAN links require 2 addresses each.

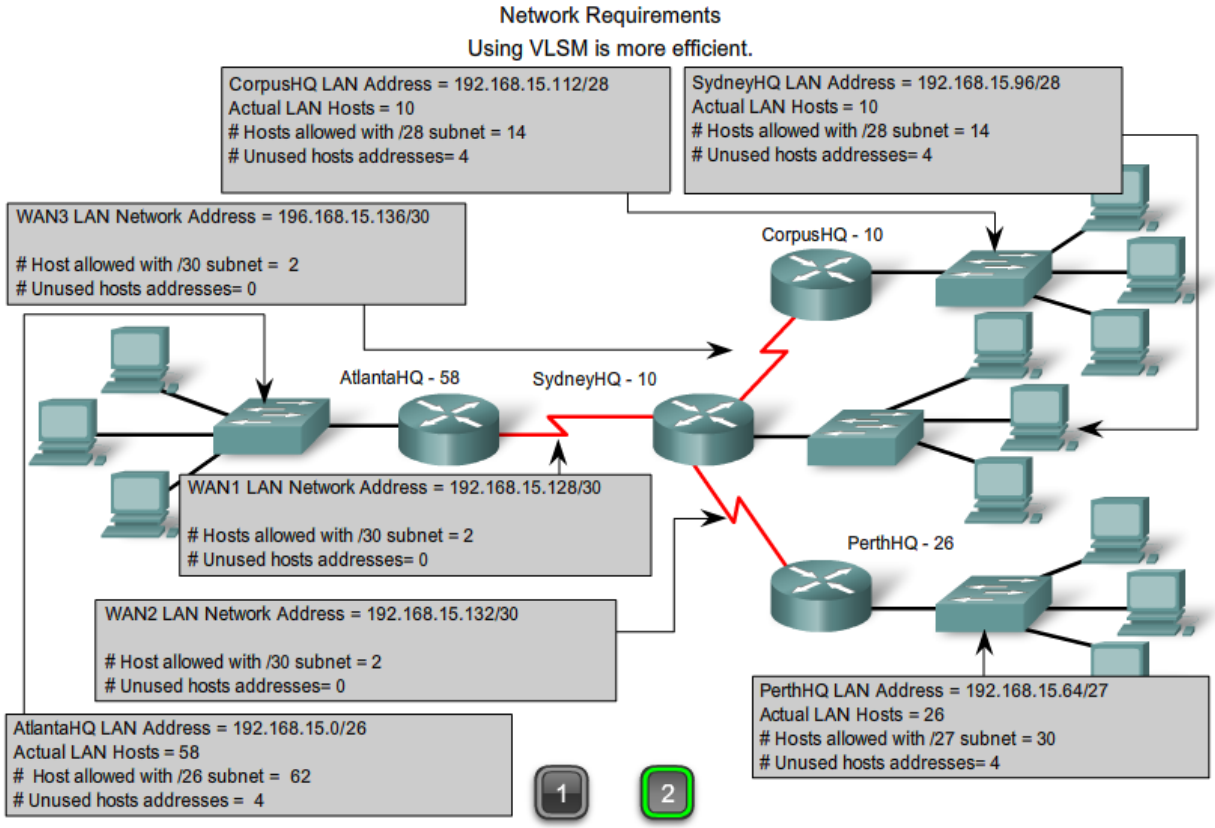
Example…

Name - required addresses	Subnet address	Address range	Broadcast Address	Network/prefix
AtlantaHQ - 58	192.168.15.0	.1 - .62	.63	192.168.15.0 /26
PerthHQ - 26	192.168.15.64	.65 - .94	.95	192.168.15.64 /27
SydneyHQ - 10	192.168.15.96	.97 - .110	.111	192.168.15.96 /28
CorpusHQ - 10	192.168.15.112	.113 - .126	.127	192.168.15.112 /28
WAN1 - 2	192.168.15.128	.129 - .130	.131	192.168.15.128 /30
WAN2 - 2	192.168.15.132	.133 - 134	.135	192.168.15.132 /30
WAN3 - 2	192.168.15.136	.137 - .138	.139	192.168.15.136 /30

The networking problem is solved.

Network Requirements
Using VLSM is more efficient.

Name - required addresses	Subnet address	Address range	Broadcast Address	Network /prefix
AtlantaHQ - 58	192.168.15.0	.1-.62	.63	192.168.15.0/26
PerthHQ - 26	192.168.15.64	.65-.94	.95	192.168.15.64/27
SydneyHQ - 10	192.168.15.96	.97-.110	.111	192.168.15.96/28
CorpusHQ - 10	192.168.15.112	.113-.126	.127	192.168.15.112/28
WAN1 - 2	192.168.15.128	.129-.130	.131	192.168.15.128/30
WAN2 - 2	192.168.15.132	.133-.134	.135	192.168.15.132/30
WAN3 - 2	192.168.15.136	.137-.138	.139	192.168.15.136/30

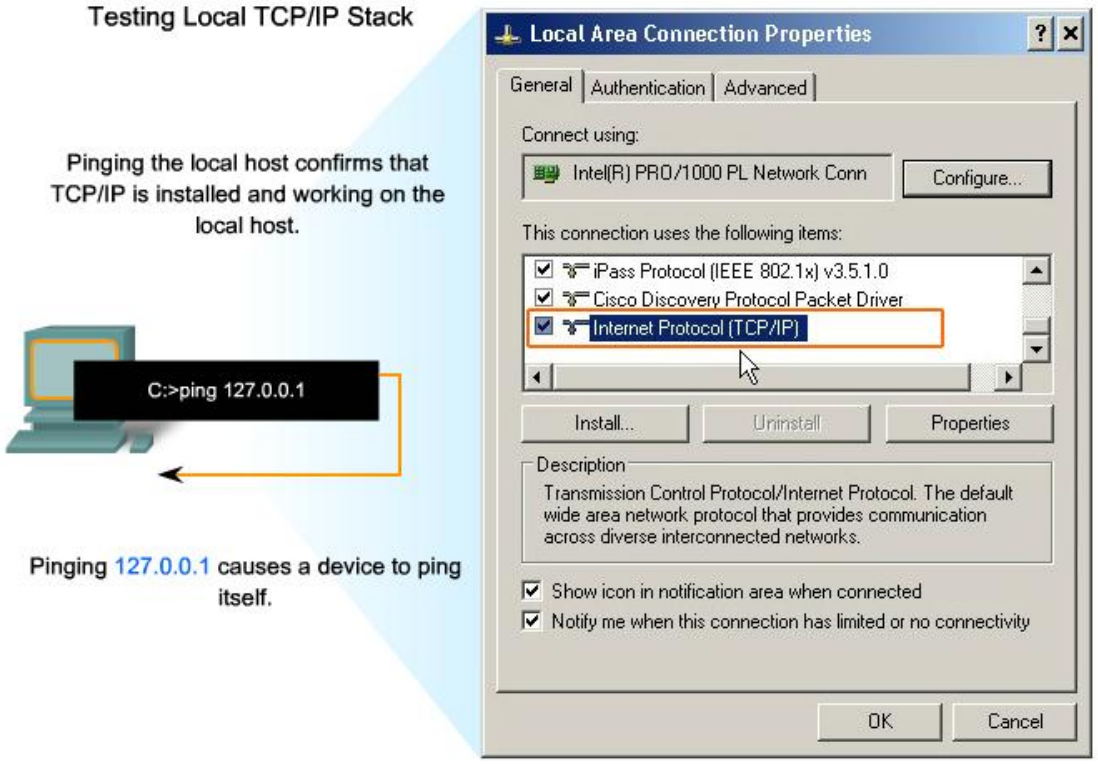

Network Requirements
Using VLSM is more efficient.
CorpusHQ LAN Address = 192.168.15.112/28
Actual LAN Hosts = 10
Hosts allowed with /28 subnet = 14
Unused hosts addresses= 4
SydneyHQ LAN Address = 192.168.15.96/28
Actual LAN Hosts = 10
Hosts allowed with /28 subnet = 14
Unused hosts addresses= 4
WAN3 LAN Network Address = 196.168.15.136/30
Host allowed with /30 subnet = 2
Unused hosts addresses= 0
CorpusHQ - 10
AtlantaHQ - 58
SydneyHQ - 10
WAN1 LAN Network Address = 192.168.15.128/30
Hosts allowed with /30 subnet = 2
Unused hosts addresses= 0
PerthHQ - 26
WAN2 LAN Network Address = 192.168.15.132/30
Host allowed with /30 subnet = 2
Unused hosts addresses= 0
PerthHQ LAN Address = 192.168.15.64/27
Actual LAN Hosts = 26
Hosts allowed with /27 subnet = 30
Unused hosts addresses= 4
AtlantaHQ LAN Address = 192.168.15.0/26
Actual LAN Hosts = 58
Host allowed with /26 subnet = 62
Unused hosts addresses = 4
1
2

VLSM Chart

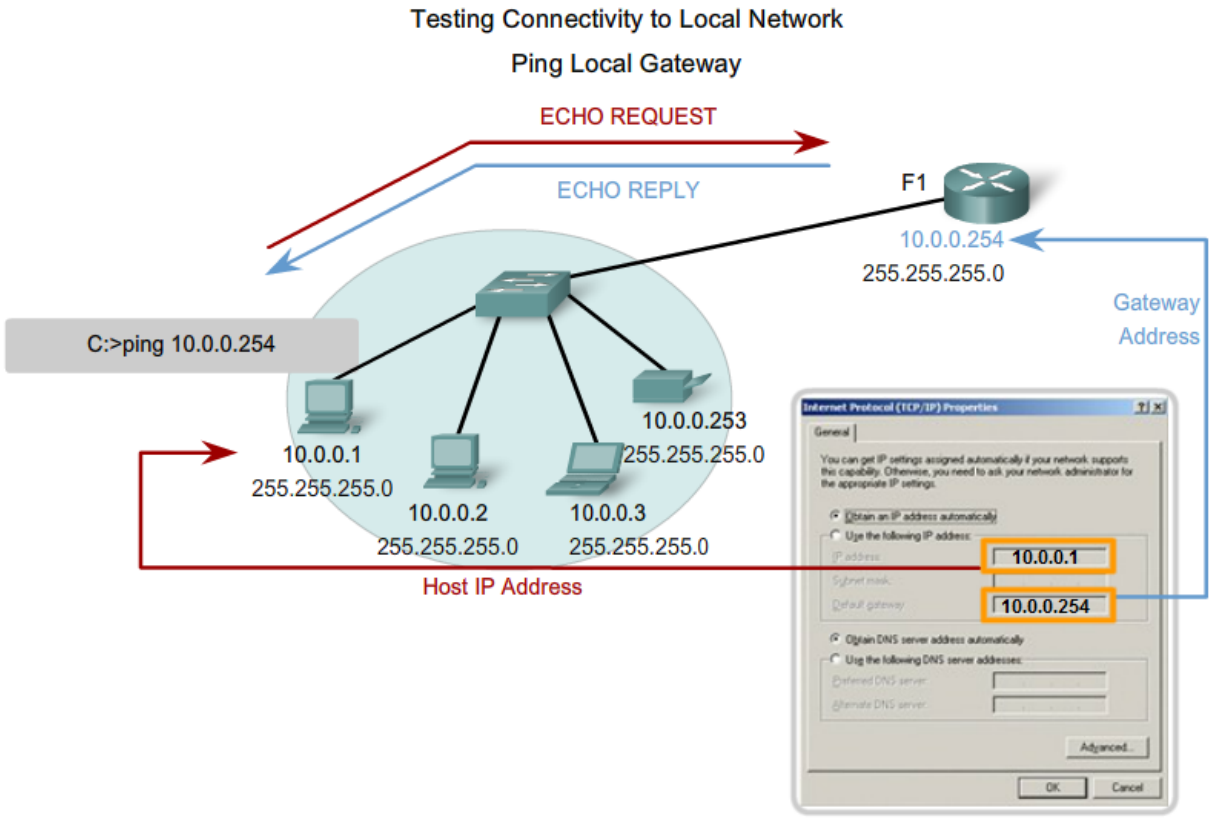
/25 (1 subnet bit) 2 subnets 126 hosts	/26 (2 subnet bits) 4 subnets 62 hosts	/27 (3 subnet bits) 8 subnets 30 hosts	/28 (4 subnet bits) 16 subnets 14 hosts	/29 (5 subnet bits) 32 subnets 6 hosts	/30 (6 subnet bits) 64 subnets 2 hosts
.0	.0 (.1-.62)	.0 (.1-.30)	.0 (.1-.14)	.0 (.1-.6)	.0 (.1-.2)
.4					.4 (.5-.6)
.8				.8 (.9 - .14)	.8 (.9 - .10)
.12					.12 (.13-.14)
.16			.16 (.17-.30)	.16 (.17-.22)	.16 (.17-.18)
.20					.20 (.21-.22)
.24				.24 (.25-.30)	.24 (.25-.26)
.28					.28 (.29-.30)
.32		.32 (.33-.62)	.32 (.33-.46)	.32 (.33-.38)	.32 (.33-.34)
.36					.36 (.37-.38)
.40				.40 (.41-.46)	.40 (.41-.42)
.44					.44 (.45-.46)
.48			.48 (.49-.62)	.48 (.49-.54)	.48 (.49-.50)
.52					.52 (.53-.54)
.56				.56 (.57-.62)	.56 (.57-.58)
.60					.60 (.61-.62)
.64	.64 (.65-.126)	.64 (.65-.94)	.64 (.65-.78)	.64 (.65-.70)	.64 (.65-.66)
.68					.68 (.69-.70)
.72				.72 (.73-.78)	.72 (.73-.74)
.76					.76 (.77-.78)
.80			.80 (.81-.94)	.80 (.81-.86)	.80 (.81-.82)
.84					.84 (.85-.86)
.88				.88 (.89-.94)	.88 (.89-.90)
.92					.92 (.93-.94)
.96		.96 (.97-.126)	.96 (.97-.110)	.96 (.97-.102)	.96 (.97-.98)
.100					.100 (.101-.102)
.104				.104 (.105-.110)	.104 (.105-.106)
.108					.108 (.109-.110)
.112			.112 (.113-.126)	.112 (.113-.118)	.112 (.113-.114)
.116					.116 (.117-.118)
.120				.120 (.121-.126)	.120 (.121-.122)
.124					.124 (.125-.126)

.0

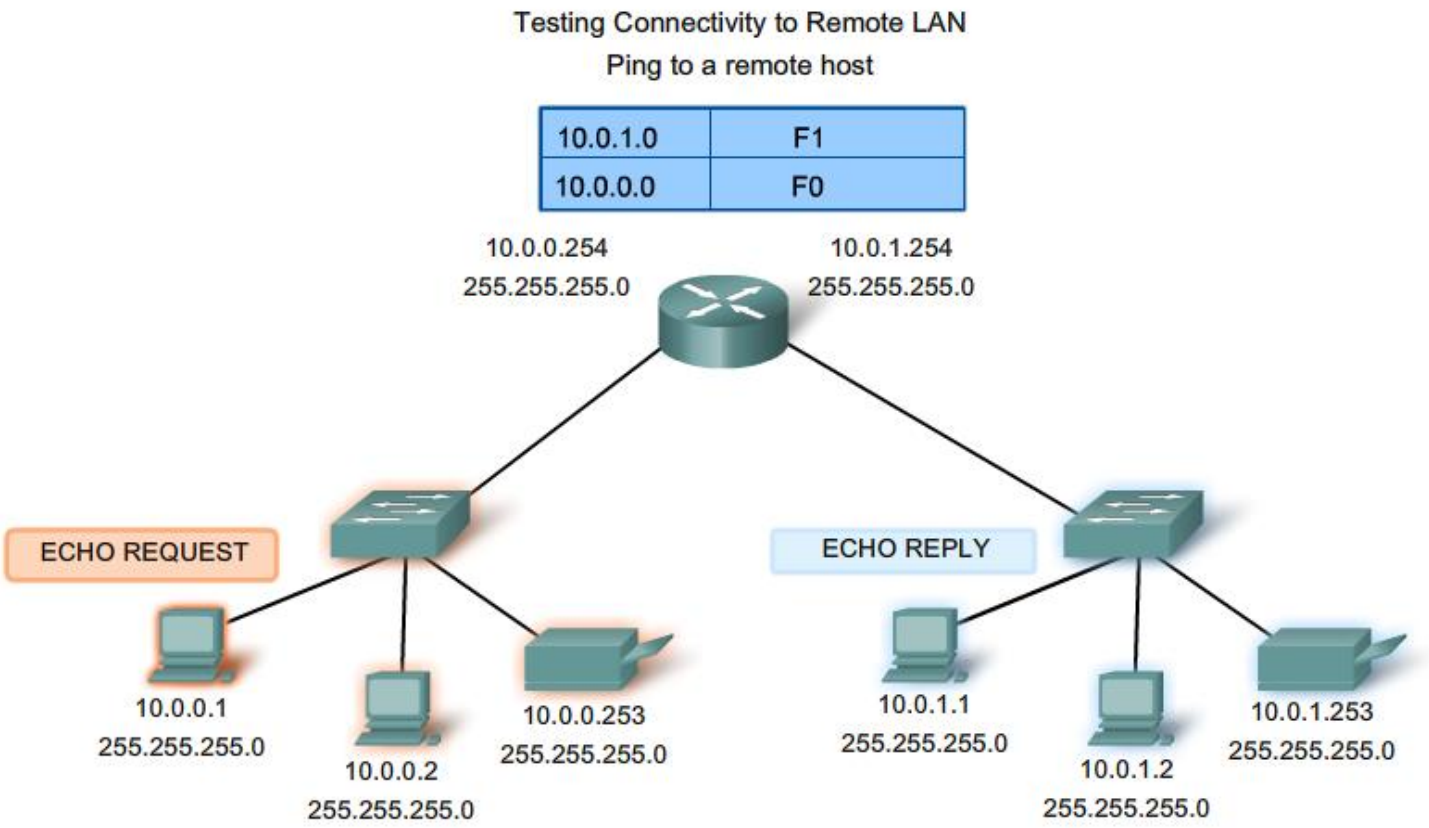
Testing the network Layer- testing the local stack ping 127.0.0.1



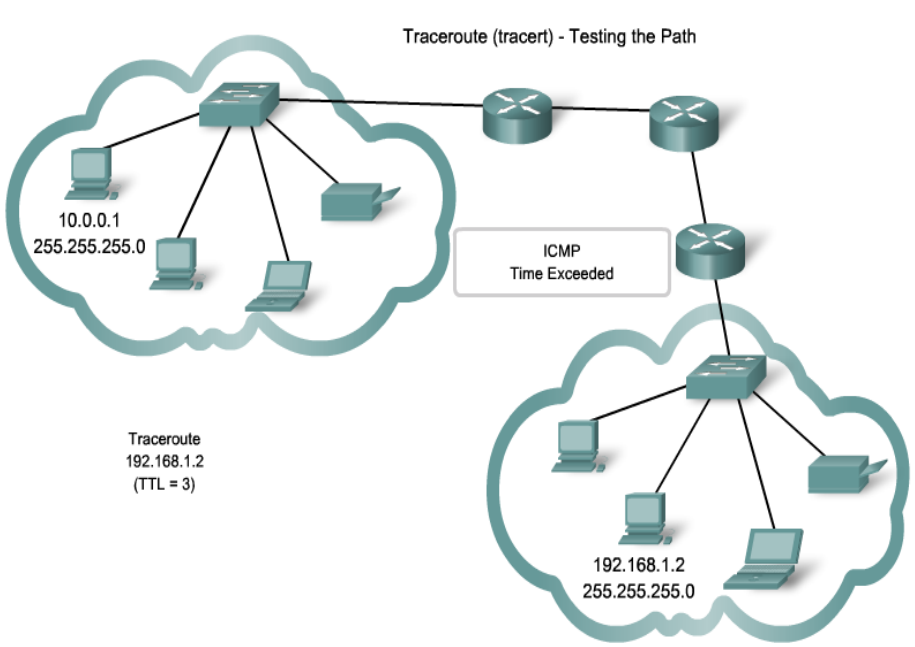
Ping Gateway-Testing the connectivity to the local LAN

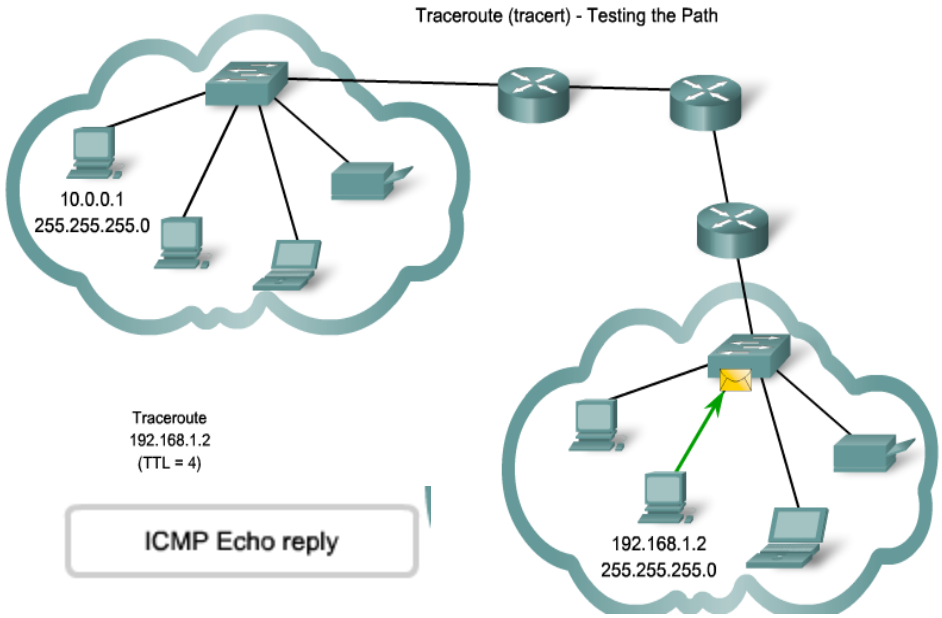


Ping Remote Host- testing connectivety to remote LAN

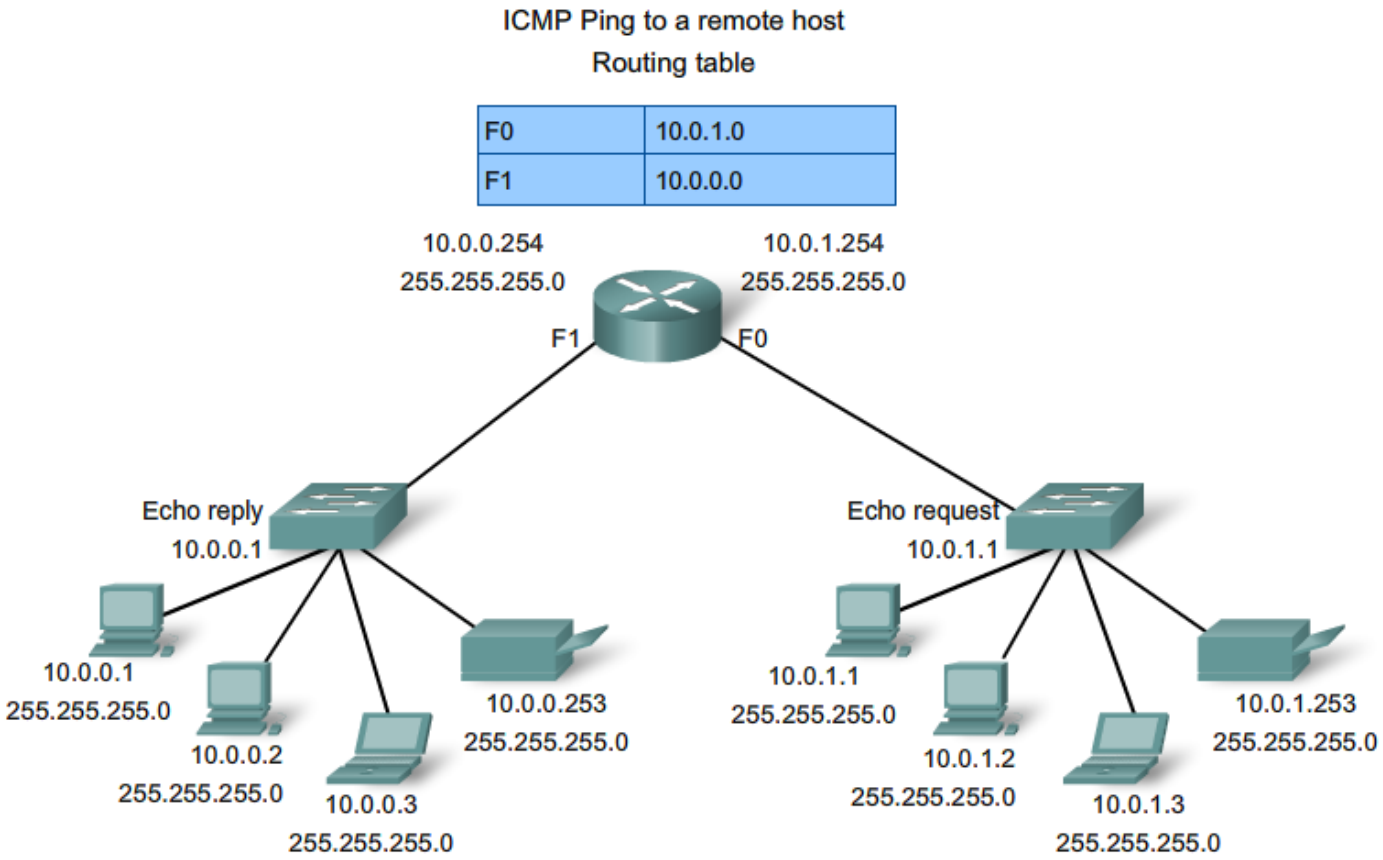


Traceroute (tracert)





The protocol supporting testing and Messaging-ICMPv4



Summary

- IPv4 addresses are hierarchical with network, subnetwork, and host portions. An IPv4 address can represent a complete network, a specific host, or the broadcast address of the network.
- Different addresses are used for unicast, multicast, and broadcast data communications.
- Addressing authorities and ISPs allocate address ranges to users, who in turn can assign these addresses to their network devices statically or dynamically. The allocated address range can be divided into subnetworks by calculating and applying subnet masks.
- Careful addressing planning is required to make best use of the available address space. Size, location, use, and access requirements are all considerations in the address planning process.
- Once implemented, an IP network needs to be tested to verify its connectivity and operational performance.

The End