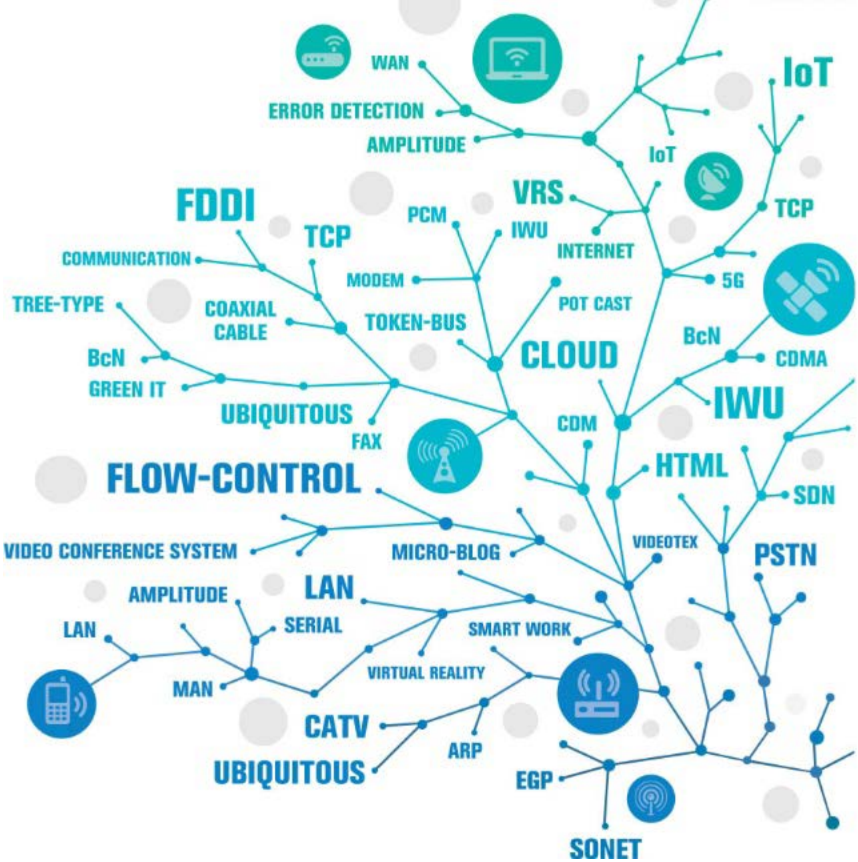

WAN
IoT
ERROR DETECTION
AMPLITUDE
IoT
FDDI
PCM
VRS
TCP
TCP
IWU
INTERNET
COMMUNICATION
MODEM
5G
TREE-TYPE
COAXIAL
CABLE
POT CAST
TOKEN-BUS
BcN
BcN
CLOUD
CDMA
GREEN IT
UBIQUITOUS
IWU
CDM
FAX
FLOW-CONTROL
HTML
SDN
VIDEO CONFERENCE SYSTEM
MICRO-BLOG
VIDEOTEX
PSTN
AMPLITUDE
LAN
LAN
SERIAL
SMART WORK
VIRTUAL REALITY
MAN
CATV
ARP
UBIQUITOUS
EGP
SONET

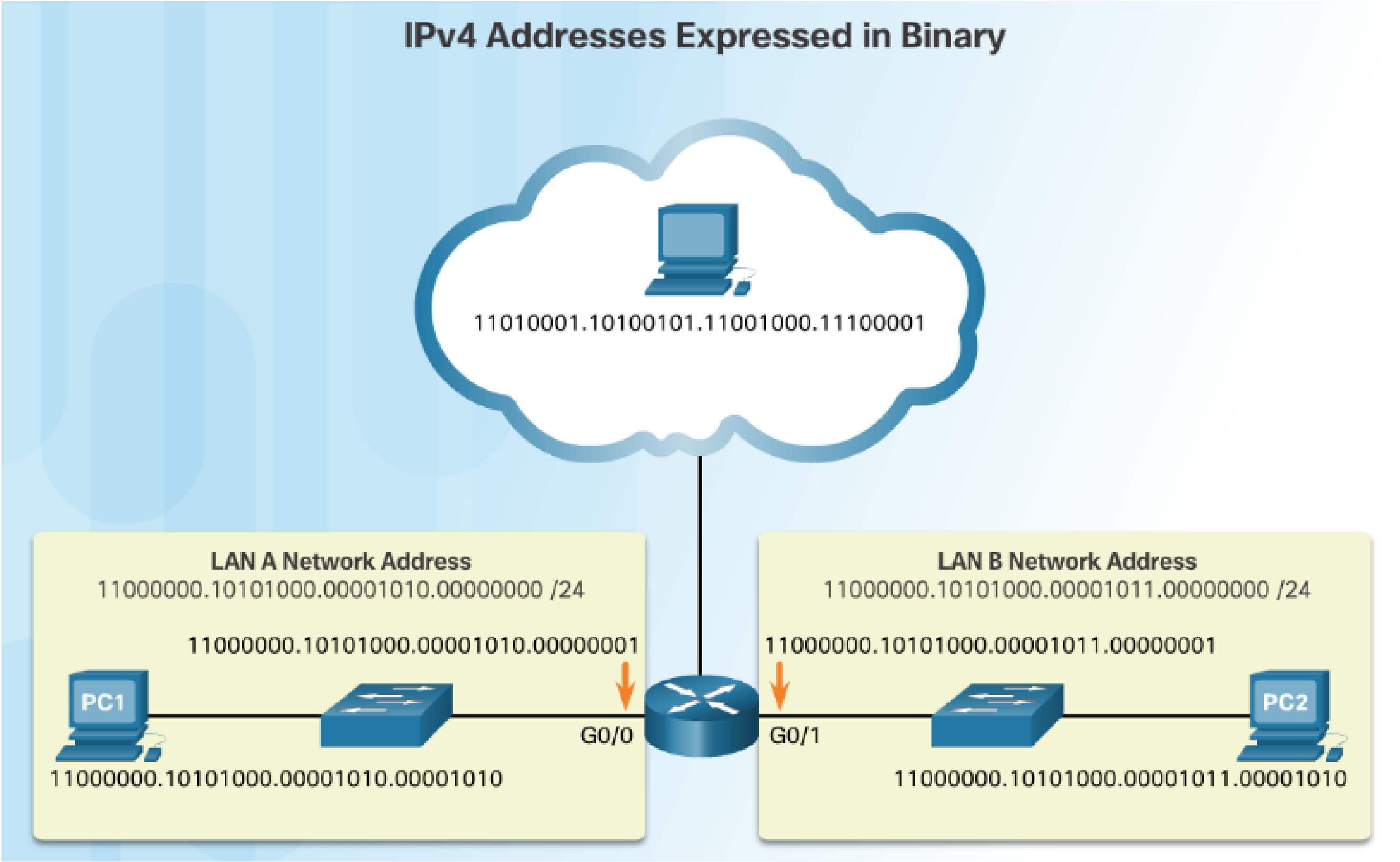
라우팅&스위칭

IP 주소

목차

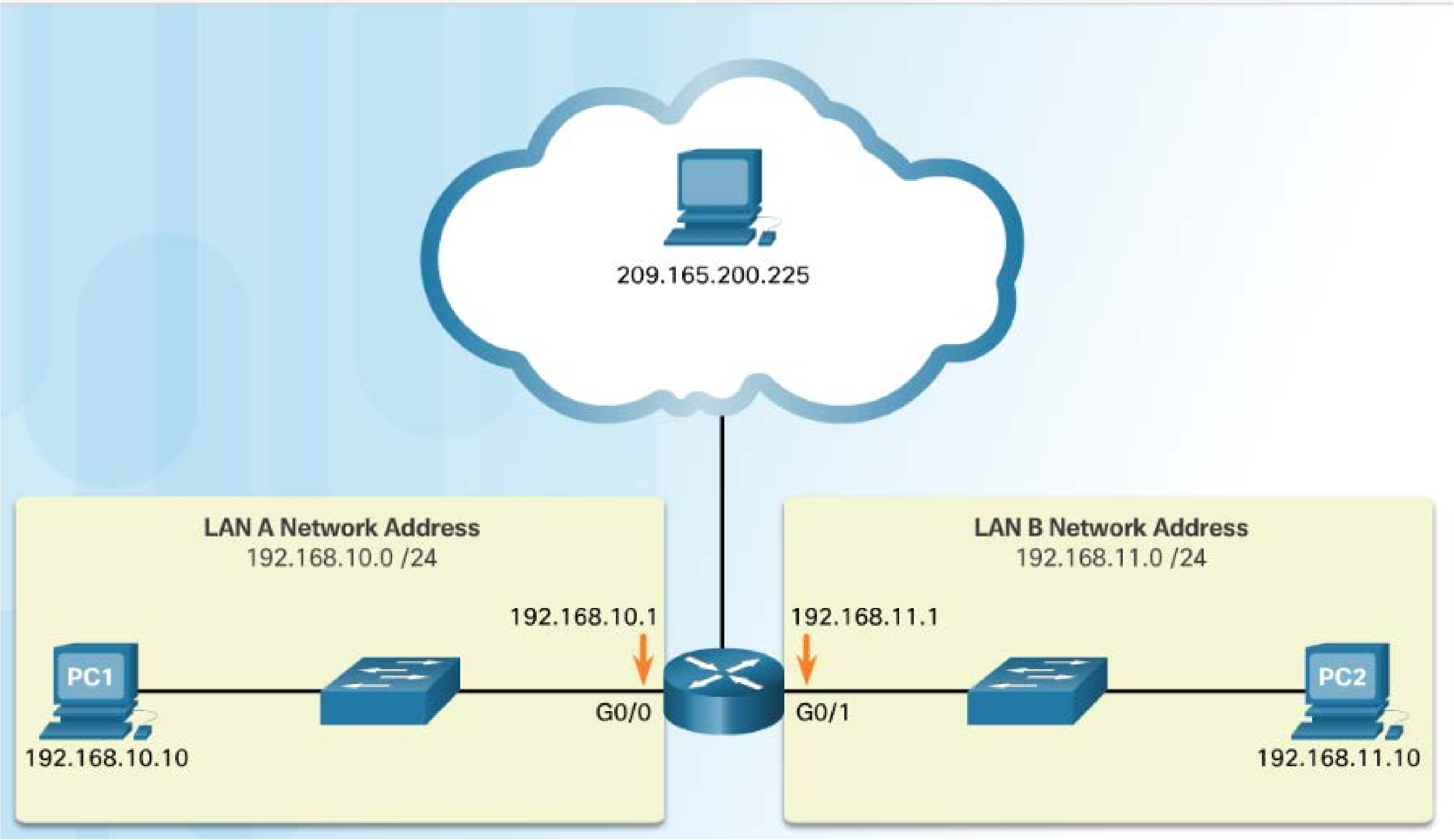
IPv4 Addresses

- **Binary numbering system consists of the numbers 0 and 1 called bits**
  - IPv4 addresses are expressed in 32 binary bits divided into 4 8-bit octets



IPv4 Addresses (Cont.)

- **IPv4 addresses are commonly expressed in dotted decimal notation**



Positional Notation

10진수 자리 표현

Decimal Positional Notation

Radix	10	10	10	10
Position in Number	3	2	1	0
Calculate	(10^3)	(10^2)	(10^1)	(10^0)
Positional Value	1000	100	10	1

10진수 1234에 적용

	Thousands	Hundreds	Tens	Ones
Positional Value	1000	100	10	1
Decimal Number (1234)	1	2	3	4
Calculate	1 x 1000	2 x 100	3 x 10	4 x 1
Add them up ...	1000	+ 200	+ 30	+ 4
Result	1,234			

Binary and Decimal Conversion

Positional Notation

■ 2진수 자리 표현

Binary Positional Notation

Radix	2	2	2	2	2	2	2	2
Position in Number	7	6	5	4	3	2	1	0
Calculate	(2^7)	(2^6)	(2^5)	(2^4)	(2^3)	(2^2)	(2^1)	(2^0)
Positional Value	128	64	32	16	8	4	2	1

■ 2진수 11000000에 적용

Positional Value	128	64	32	16	8	4	2	1
Binary Number (11000000)	1	1	0	0	0	0	0	0
Calculate	1 x 128	1 x 64	0 x 32	0 x 16	0 x 8	0 x 4	0 x 2	0 x 1
Add Them Up ...	128	+ 64	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0
Result	192							

Binary and Decimal Conversion
Binary to Decimal Conversion

- **To convert a binary IPv4 address to decimal enter the 8-bit binary number of each octet under the positional value of row 1 and then calculate to produce the decimal.**

11000000.10101000.00001011.00001010

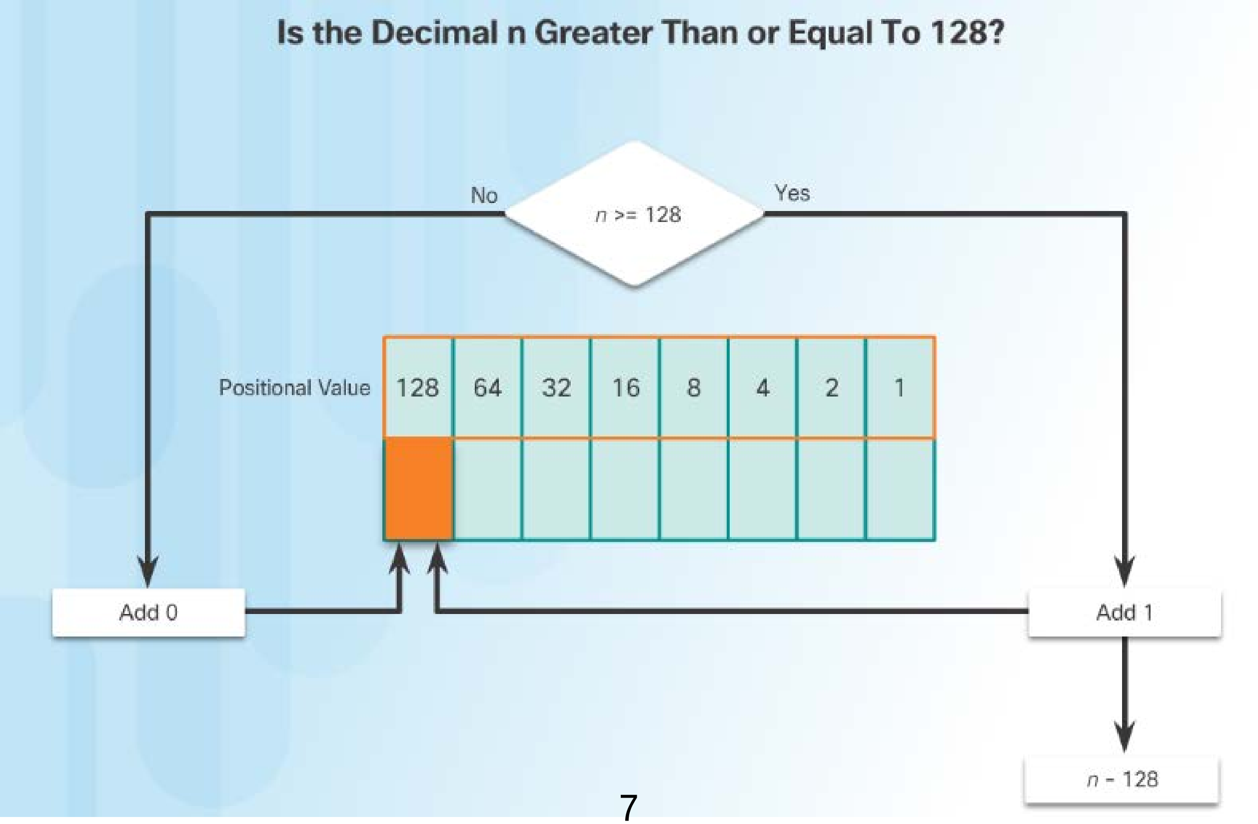
Positional Value	128	64	32	16	8	4	2	1
Binary number	1	1	0	0	0	0	0	0
Calculate	128	64	32	16	8	4	2	1
Add Them Up...	128	+ 64	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0
Result	192							

192.___.___.___

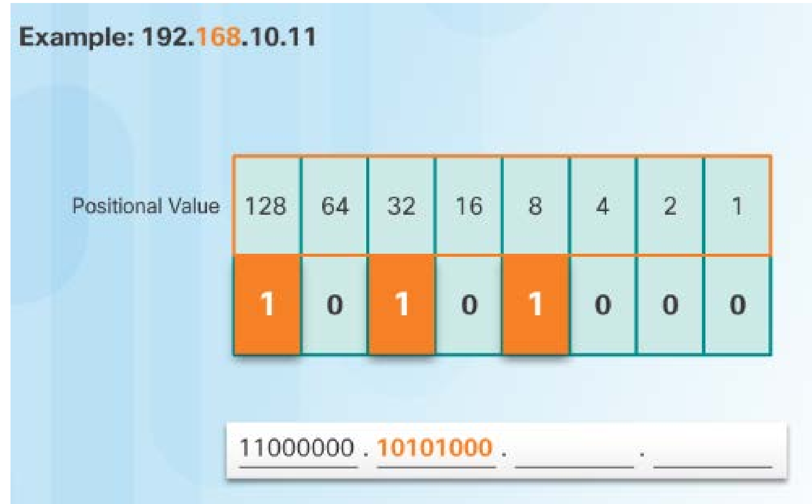
Dotted Decimal Notation

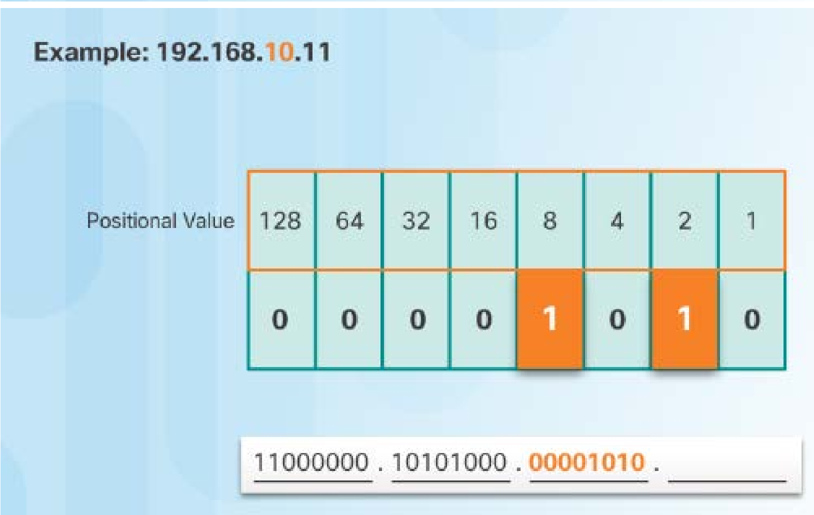
Decimal to Binary Conversion

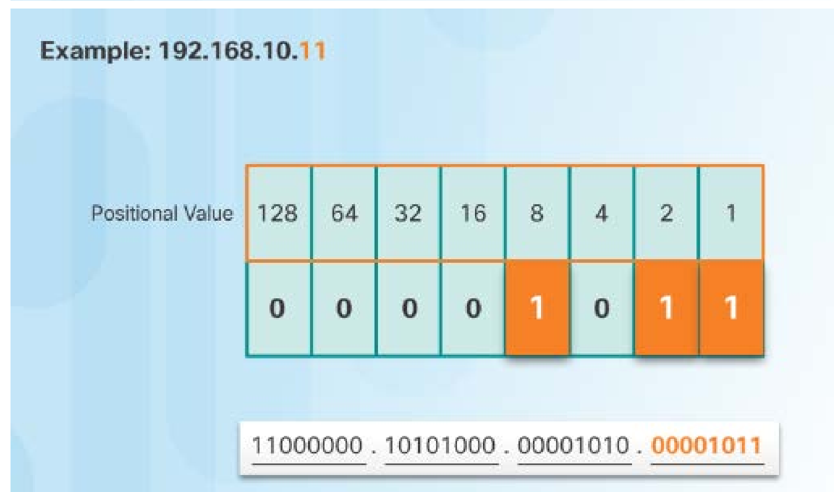
- To convert a decimal IPv4address to binary use the positional chart and check first if the number is greater than the 128 bit. If no a 0 is placed in this position. If yes then a 1 is placed in this position.
- 128 is subtracted from the original number and the remainder is then checked against the next position (64) If it is less than 64 a 0 is placed in this position. If it is greater, a 1 is placed in this position and 64 is subtracted.
- The process repeats until all positional values have been entered.



Decimal to Binary Conversion Examples

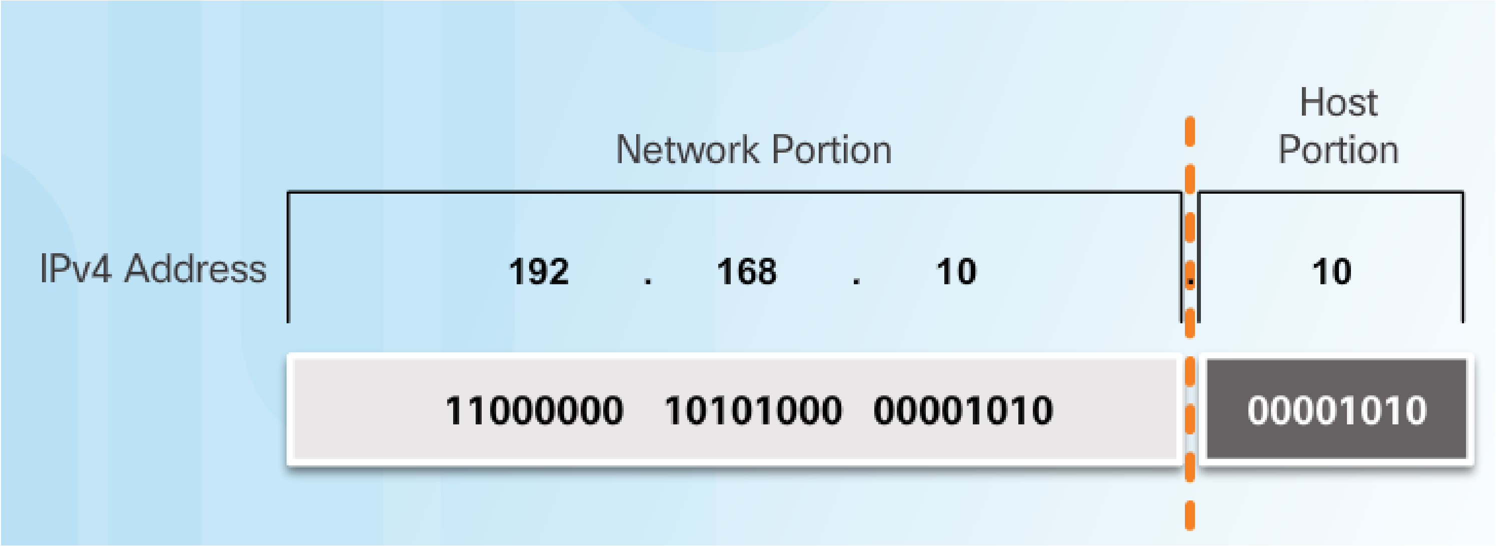






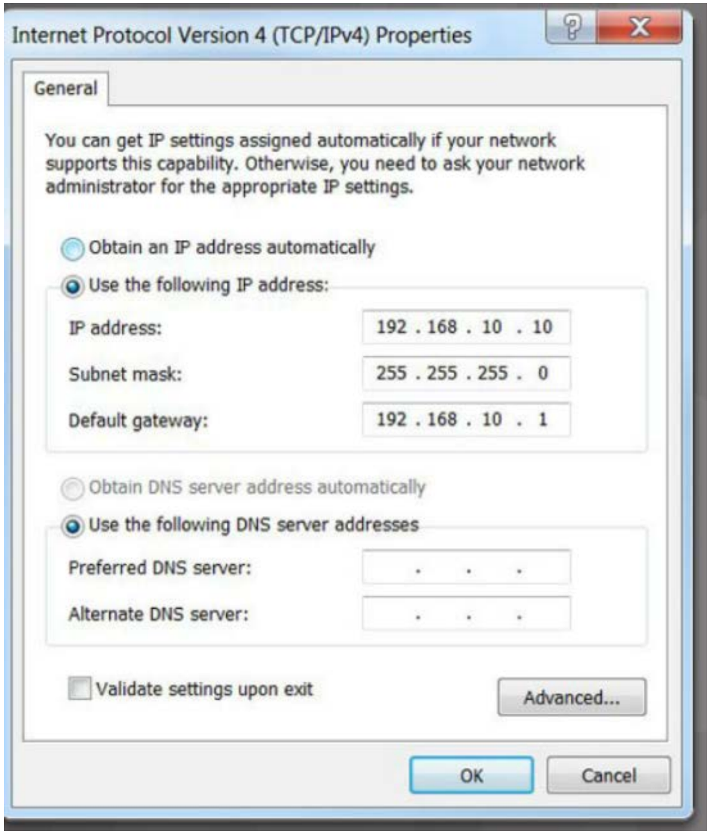
Network and Host Portions

- **An IPv4 address is hierarchical.**
  - Composed of a Network portion and Host portion.
- **All devices on the same network must have the identical network portion.**
- **The Subnet Mask helps devices identify the network portion and host portion.**



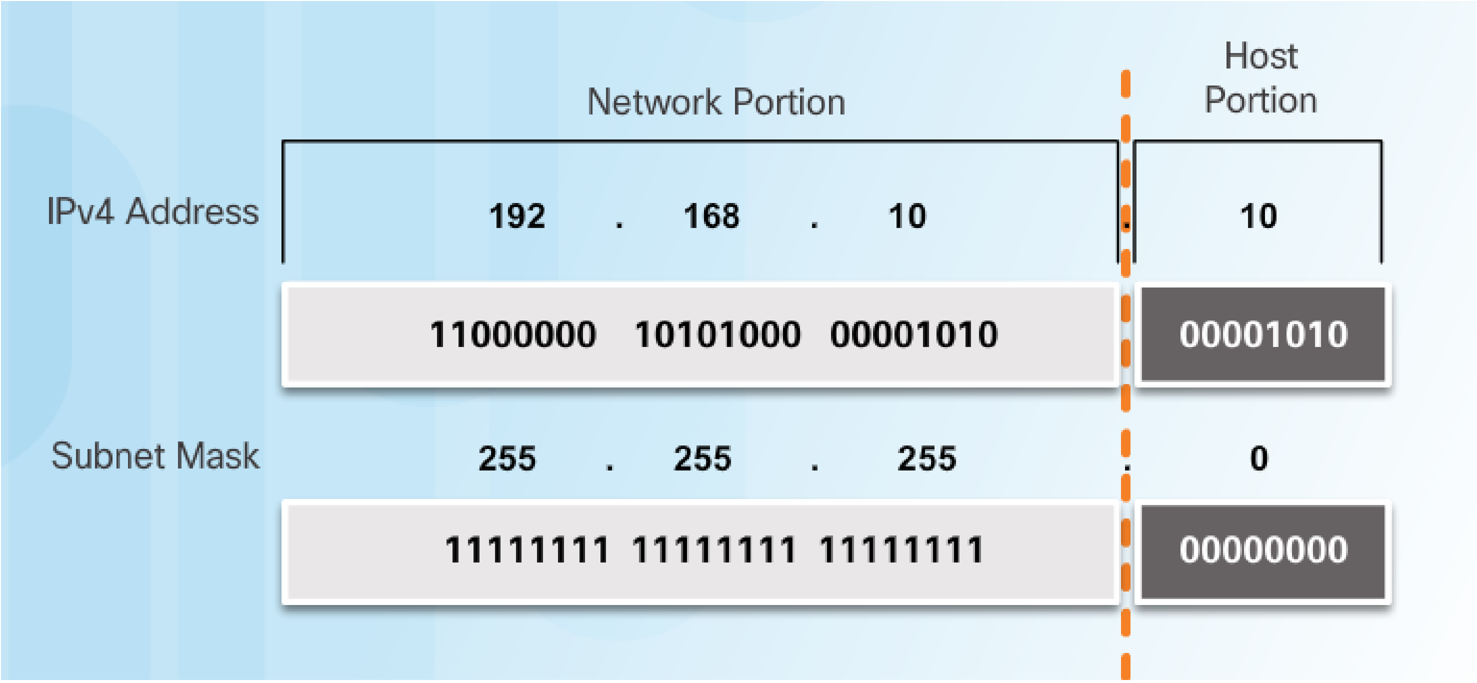
The Subnet Mask

- **Three IPv4 addresses must be configured on a host:**
  - Unique IPv4 address of the host.
  - Subnet mask - identifies the network/host portion of the IPv4 address.
  - Default gateway -IP address of the local router interface.



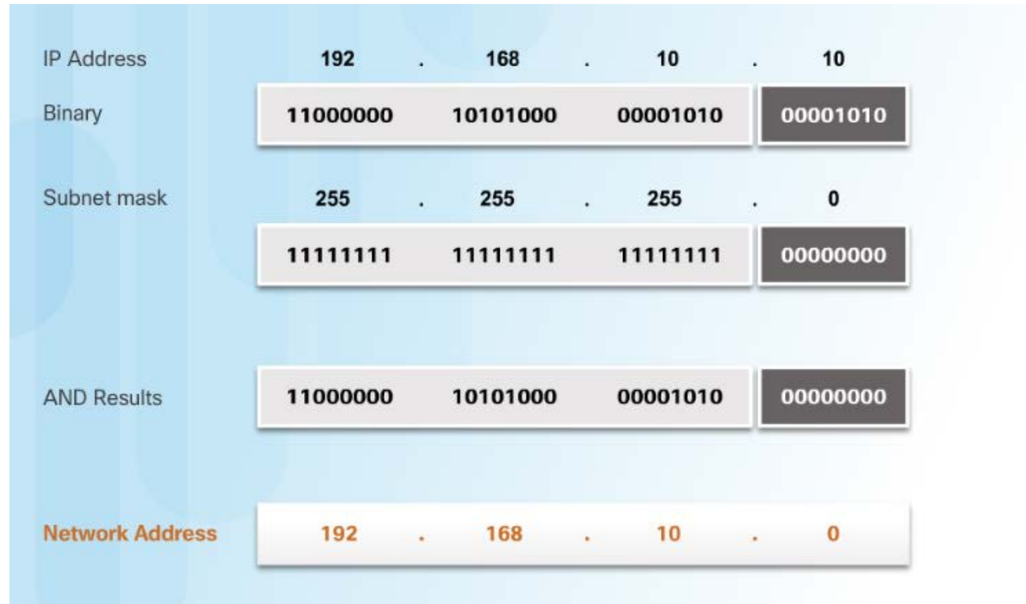
The Subnet Mask (Cont.)

- The IPv4 address is compared to the subnet mask bit by bit, from left to right.
- A 1 in the subnet mask indicates that the corresponding bit in the IPv4 address is a network bit.



Logical AND

- A logical AND is one of three basic binary operations used in digital logic.
- Used to determine the Network Address
- The Logical AND of two bits yields the following results:



1 AND 1 = 1
0 AND 1 = 0
0 AND 0 = 0
1 AND 0 = 0

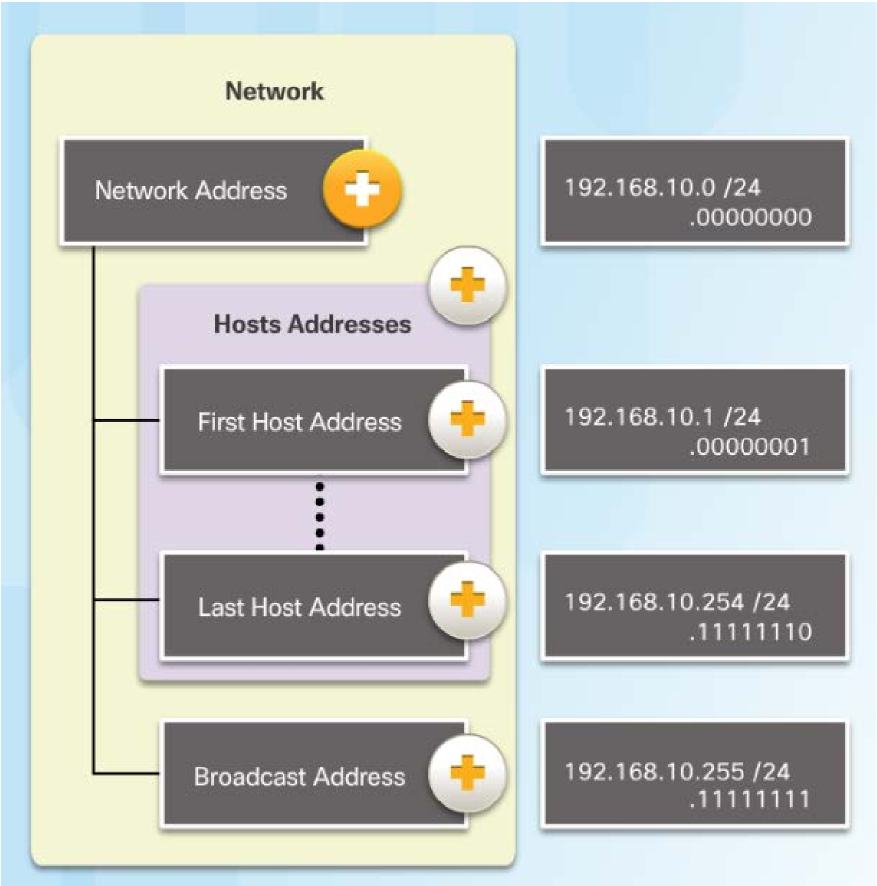
The Prefix Length

Comparing the Subnet Mask and Prefix Length

Subnet Mask	32-bit Address	Prefix Length
255.0.0.0	11111111.00000000.00000000.00000000	/8
255.255.0.0	11111111.11111111.00000000.00000000	/16
255.255.255.0	11111111.11111111.11111111.00000000	/24
255.255.255.128	11111111.11111111.11111111.10000000	/25
255.255.255.192	11111111.11111111.11111111.11000000	/26
255.255.255.224	11111111.11111111.11111111.11100000	/27
255.255.255.240	11111111.11111111.11111111.11110000	/28
255.255.255.248	11111111.11111111.11111111.11111000	/29
255.255.255.252	11111111.11111111.11111111.11111100	/30

- The Prefix Length:
  - Shorthand method of expressing the subnet mask.
  - Equals the number of bits in the subnet mask set to 1.
  - Written in slash notation, / followed by the number of network bits.

Network, Host, and Broadcast Addresses



- Types of Addresses in Network 192.168.10.0/24
  - Network Address - host portion is all 0s (.00000000)
  - First Host address - host portion is all 0s and ends with a 1 (.00000001)
  - Last Host address - host portion is all 1s and ends with a 0 (.11111110)
  - Broadcast Address - host portion is all 1s (.11111111)

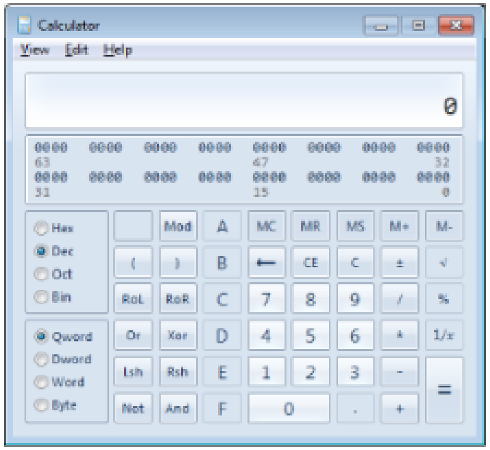
Lab – Using the Windows Calculator with Network Addresses

7.1.2.8 Lab - Using the Windows Calculator with Network Addresses

Cisco Networking Academy®

Mind Wide Open™

Lab – Using the Windows Calculator with Network Addresses



Objectives

Part 1: Access the Windows Calculator

Part 2: Convert between Numbering Systems

Part 3: Convert Host IPv4 Addresses and Subnet Masks into Binary

Part 4: Determine the Number of Hosts in a Network Using Powers of 2

Part 5: Convert MAC Addresses and IPv6 Addresses to Binary

Background / Scenario

Network technicians use binary, decimal, and hexadecimal numbers when working with computers and networking devices. Microsoft provides a built-in Calculator application as part of the operating system. The Windows 7 version of Calculator includes a Standard view that can be used to perform basic arithmetic tasks such as addition, subtract, multiplication, and division. The Calculator application also has advanced programming, scientific, and statistical capabilities.

In this lab, you will use the Windows 7 Calculator application Programmer view to convert between the binary, decimal, and hexadecimal number systems. You will also use the Scientific view powers function to determine the number of hosts that can be addressed based on the number of host bits available.

Required Resources

- 1 PC (Windows 7 or 8)

Lab – Converting IPv4 Addresses to Binary

7.1.2.9 Lab - Converting IPv4 Addresses to Binary

Cisco Networking Academy® Mind Wide Open™

Lab – Converting IPv4 Addresses to Binary

Objectives

Part 1: Convert IPv4 Addresses from Dotted Decimal to Binary

Part 2: Use Bitwise ANDing Operation to Determine Network Addresses

Part 3: Apply Network Address Calculations

Background / Scenario

Every IPv4 address is comprised of two parts: a network portion and a host portion. The network portion of an address is the same for all devices that reside in the same network. The host portion identifies a specific host within a given network. The subnet mask is used to determine the network portion of an IP address. Devices on the same network can communicate directly; devices on different networks require an intermediary Layer 3 device, such as a router, to communicate.

To understand the operation of devices on a network, we need to look at addresses the way devices do—in binary notation. To do this, we must convert the dotted decimal form of an IP address and its subnet mask to binary notation. After this has been done, we can use the bitwise ANDing operation to determine the network address.

This lab provides instructions on how to determine the network and host portion of IP addresses by converting addresses and subnet masks from dotted decimal to binary, and then using the bitwise ANDing operation. You will then apply this information to identify addresses in the network.

Part 1: Convert IPv4 Addresses from Dotted Decimal to Binary

In Part 1, you will convert decimal numbers to their binary equivalent. After you have mastered this activity, you will convert IPv4 addresses and subnet masks from dotted decimal to their binary form.

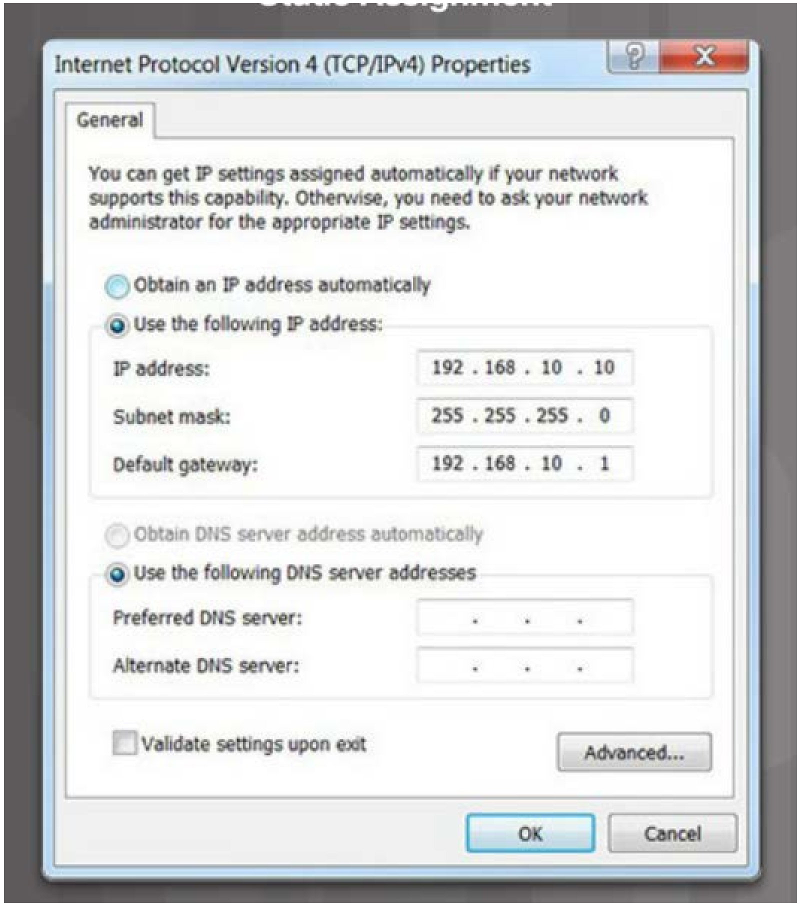
Step 1: Convert decimal numbers to their binary equivalent.

Fill in the following table by converting the decimal number to an 8-bit binary number. The first number has been completed for your reference. Recall that the eight binary bit values in an octet are based on the powers of 2, and from left to right are 128, 64, 32, 16, 8, 4, 2, and 1.

Decimal	Binary
192	11000000
168	

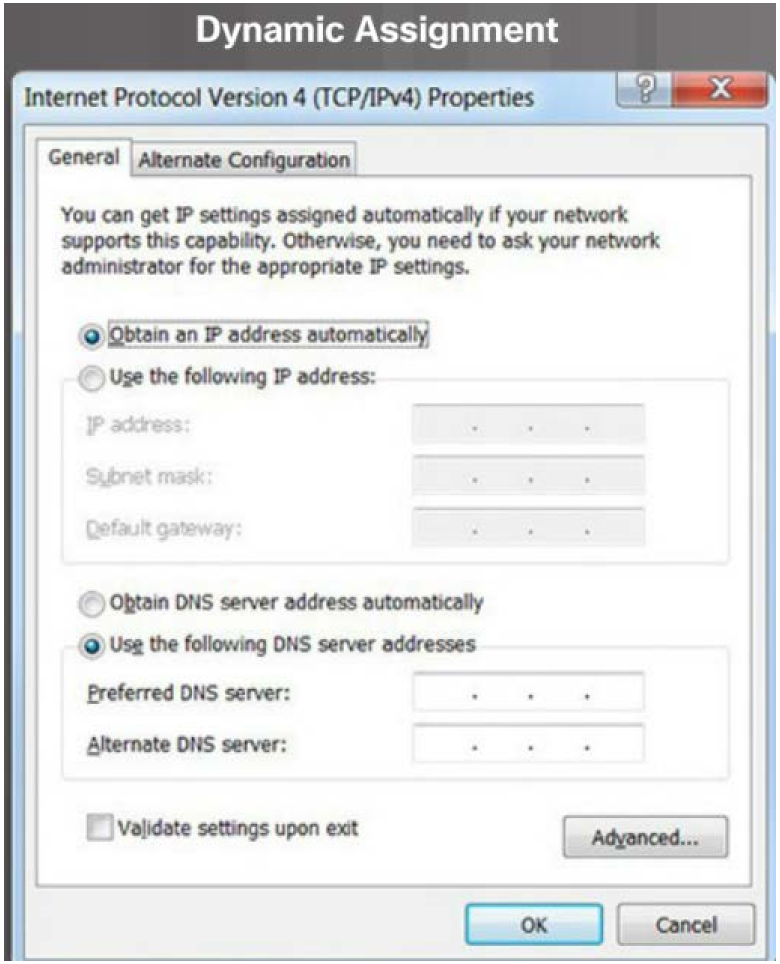
Static IPv4 Address Assignment to a Host

- 프린터, 서버 및 네트워크 장치와 같은 일부 장치에는 고정 IP 주소가 필요합니다.
- 소규모 네트워크의 호스트는 static addresses로 구성할 수도 있습니다.

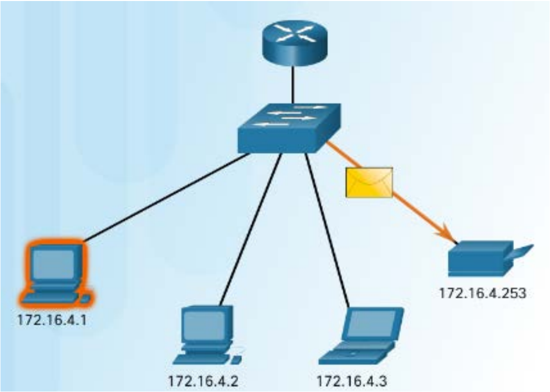


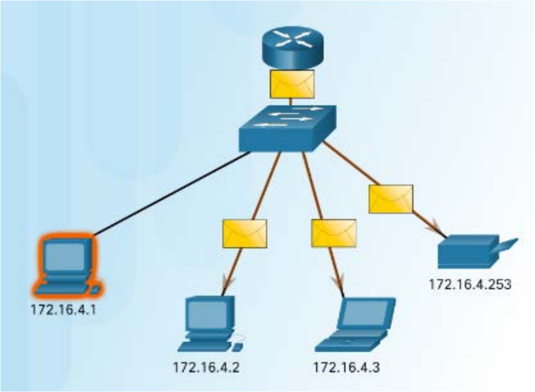
Dynamic IPv4 Address Assignment to a Host

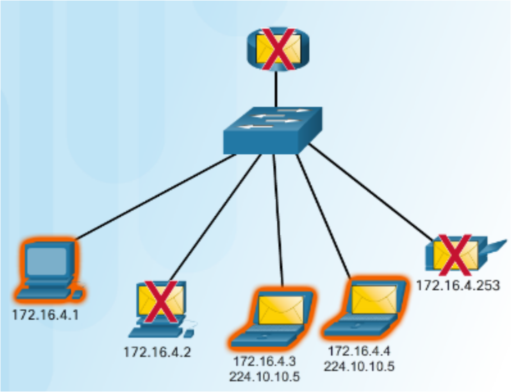
- 대부분의 네트워크는 DHCP (Dynamic Host Configuration Protocol)를 사용하여 IPv4 주소를 동적으로 할당합니다.
- DHCP 서버는 IPv4 주소, 서브넷 마스크, 기본 게이트웨이 및 기타 구성 정보를 제공합니다.
- DHCP는 특정 시간 동안 주소를 호스트에 임대합니다.
- 호스트의 전원이 꺼지거나 네트워크에서 분리된 경우 주소는 다시 사용할 수 있도록 풀로 반환됩니다.



IPv4 Communication



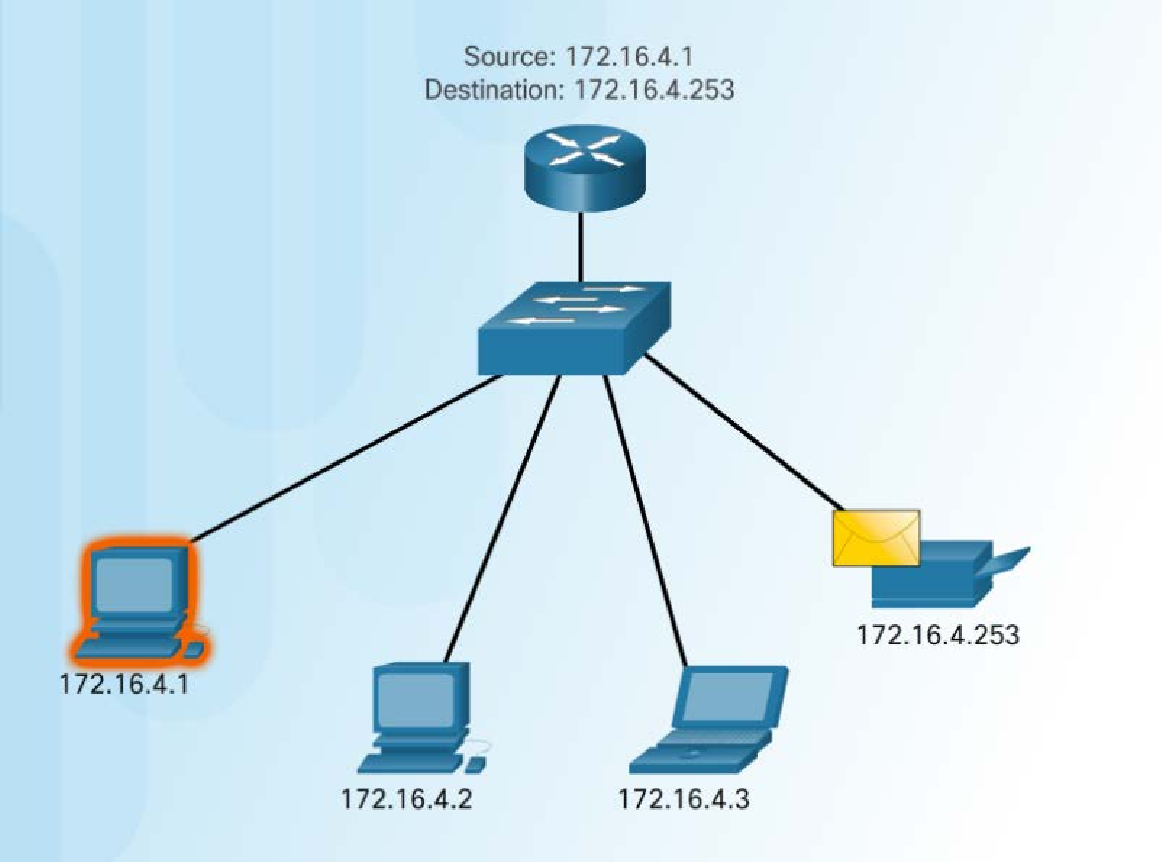




- Unicast – one to one communication.
- Broadcast– one to all.
- Multicast – one to a select group.

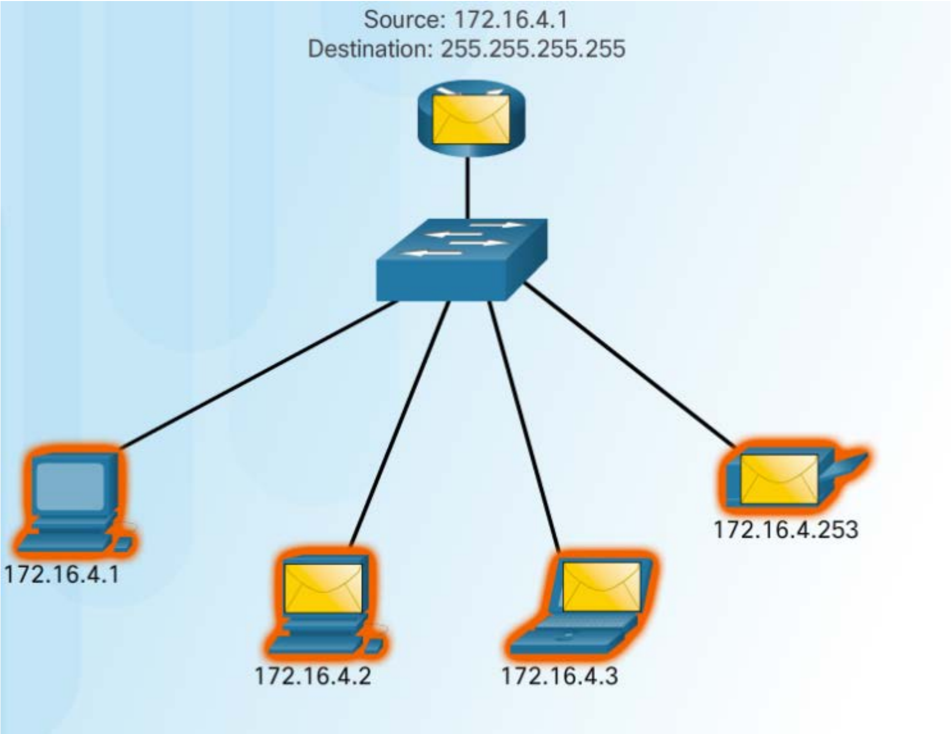
Unicast Transmission

- Unicast – one to one communication.
  - Use the address of the destination device as the destination address.



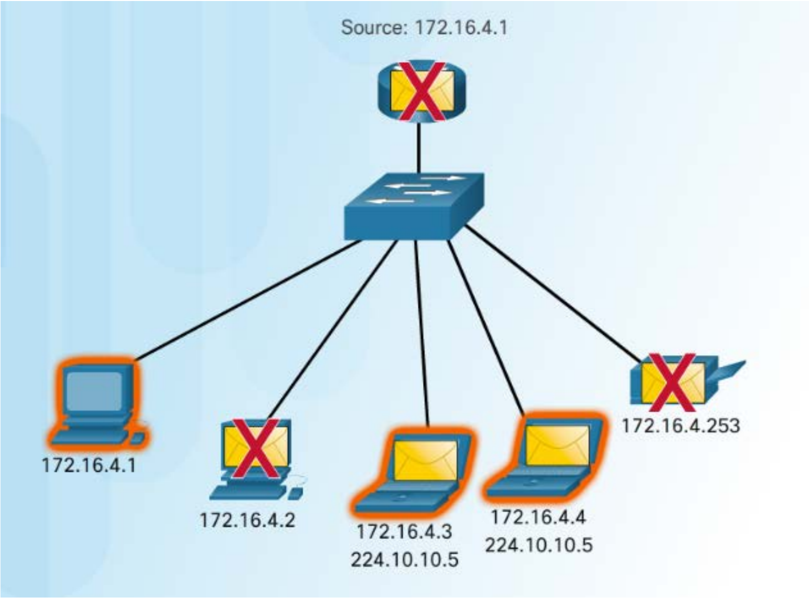
Broadcast Transmission

- Broadcast– one to all
  - Message sent to everyone in the LAN (broadcast domain.)
  - destination IPv4 address has all ones (1s) in the host portion.



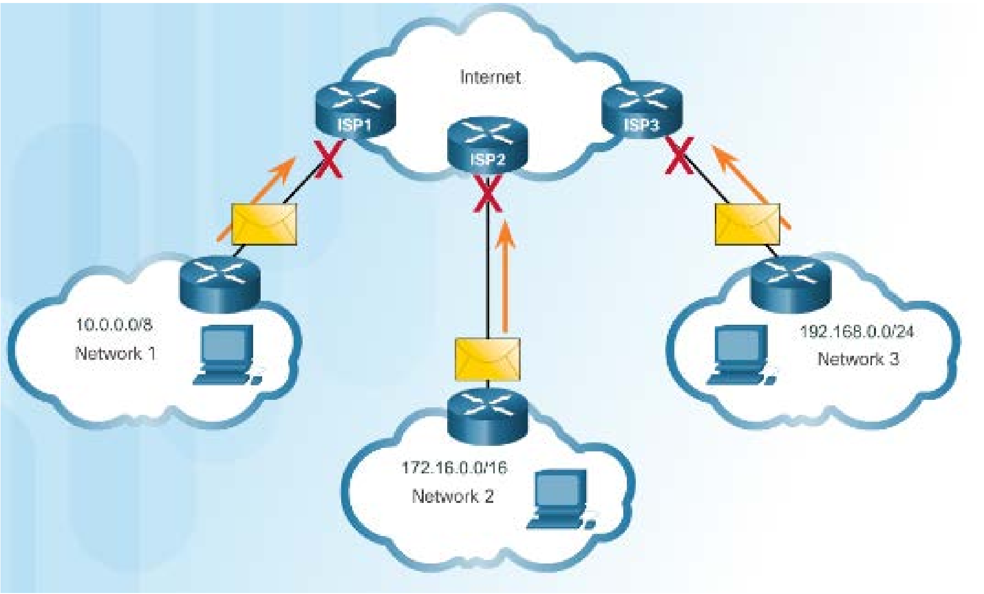
Multicast Transmission

- Multicast– one to a select group.
  - 224.0.0.0 ~ 239.255.255.255 멀티 캐스트용으로 예약된 주소
  - 라우팅 프로토콜은 라우팅 정보를 교환하기 위해 멀티 캐스트 전송을 사용합니다.



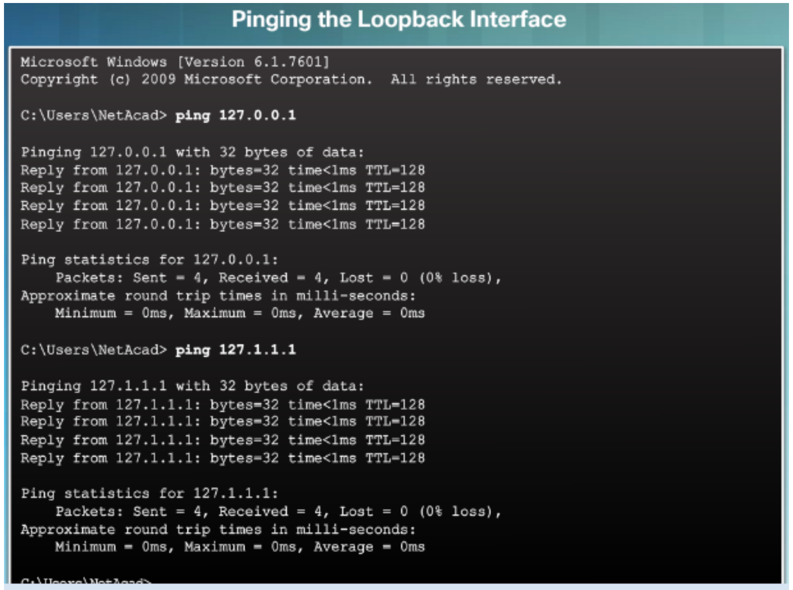
Public and Private IPv4 Addresses

- **Private Addresses**
  - 라우팅 불가
  - IPv4 주소의 고갈으로 인해 1990 년대 중반에 도입
  - 내부 네트워크에만 사용됨
  - 라우팅이 가능하려면 공용 IPv4로 변환되어야 함
  - RFC 1918에 의해 정의 됨
- **Private Address Blocks**
  - 10.0.0.0 /8 or
    10.0.0.0 to 10.255.255.255
  - 172.16.0.0 /12 or
    172.16.0.0 to 172.31.255.255
  - 192.168.0.0 /16 or
    192.168.0.0 to 192.168.255.255



Special User IPv4 Addresses

- **Loopback addresses (127.0.0.0 /8 or 127.0.0.1)**
  - TCP / IP 구성이 작동하는지 테스트하기 위해 호스트에서 사용됨
- **Link-Local addresses (169.254.0.0 /16 or 169.254.0.1)**
  - 일반적으로 APIPA (Automatic Private IP Addressing) 주소라고 함
  - 사용 가능한 DHCP 서버가 없는 경우 Windows 클라이언트에서 자체 구성을 위해 사용
- **TEST-NET addresses (192.0.2.0/24 or 192.0.2.0 to 192.0.2.255)**
  - 교육 및 학습에 사용



Legacy Classful Addressing

- **In 1981, Internet IPv4 addresses were assigned using classful addressing (RFC 790)**
- **Network addresses were based on 3 classes:**
  - **Class A** (0.0.0.0/8 to 127.0.0.0/8) – Designed to support extremely large networks with more than 16 million host addresses.
  - **Class B** (128.0.0.0 /16 – 191.255.0.0 /16) – Designed to support the needs of moderate to large size networks up to approximately 65,000 host addresses.
  - **Class C** (192.0.0.0 /24 – 223.255.255.0 /24) – Designed to support small networks with a maximum of 254 hosts.

Class A Specifics	
Address Block	0.0.0.0 - 127.0.0.0
Default Subnet Mask	/8 (255.0.0.0)
Maximum Number of Networks	128
Number of Host per Network	16,777,214
High order bit	0xxxxxxx.___.___.___

* 0.0.0.0 and 127.0.0.0 are reserved and cannot be assigned

Class B Specifics	
Address Block	128.0.0.0 - 191.255.0.0
Default Subnet Mask	/16 (255.255.0.0)
Maximum Number of Networks	16,384
Number of Host per Network	65,534
High order bit	10xxxxxx.___.___.___

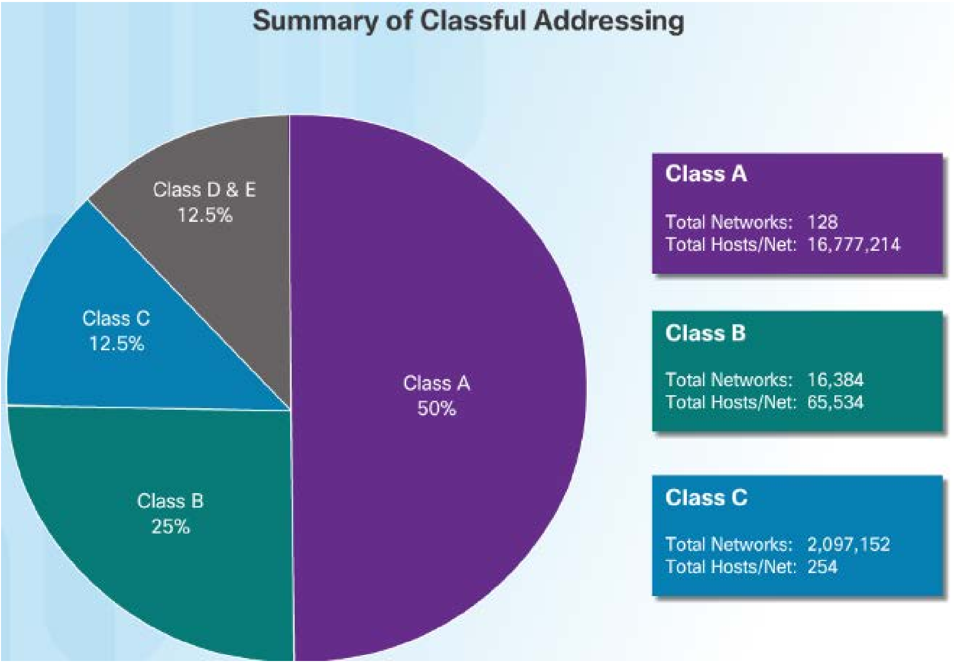
Class C Specifics	
Address Block	192.0.0.0 - 223.255.255.0
Default Subnet Mask	/24 (255.255.255.0)
Maximum Number of Networks	2,097,152
Number of Host per Network	254
High order bit	110xxxxx.___.___.___

IP 주소


32 bits
0 으로 시작
네트워크 ID (8 bits)
호스트 ID (24 bits)
클래스 A
32bit
1 0 으로 시작
네트워크 ID (16 bits)
호스트 ID (16 bits)
클래스 B
32bit
1 1 0 으로 시작
네트워크 ID (24 bits)
호스트 ID (8 bits)
클래스 C

Classless Addressing

- **Classful Addressing 은 IPv4 addresses를 낭비하고 가용성을 고갈시킴**
- **1990년대 도입된 Classless Addressing**
  - Classless Inter-Domain Routing (CIDR, pronounced "cider")
  - Allowed service providers to allocate IPv4 addresses on any address bit boundary (prefix length) instead of only by a class A, B, or C.



Assignment of IP Addresses

- **The following organizations manage and maintain IPv4 and IPv6 addresses for the various regions.**
  - American Registry for Internet Numbers (ARIN)- North America.
  - Réseaux IP Europeans (RIPE) - Europe, the Middle East, and Central Asia
  - Asia Pacific Network Information Centre (APNIC) - Asia and Pacific regions
  - African Network Information Centre (AfriNIC) – Africa
  - Regional Latin-American and Caribbean IP Address Registry (LACNIC) - Latin America and some Caribbean islands

Lab – Identifying IPv4 Addresses

- Use this if there is text information you wish to highlight.

7.1.4.9 Lab - Identifying IPv4 Addresses

Cisco Networking Academy® Mind Wide Open™

Lab– Identifying IPv4 Addresses

Objectives

Part 1: Identify IPv4 Addresses

Part 2: Classify IPv4 Addresses

Background / Scenario

In this lab, you will examine the structure of Internet Protocol version 4 (IPv4) addresses. You will identify the various types of IPv4 addresses and the components that help comprise the address, such as network portion, host portion, and subnet mask. Types of addresses covered include public, private, unicast, and multicast.

Required Resources

- Device with Internet access
- Optional: IPv4 address calculator

Part 1: Identify IPv4 Addresses

In Part 1, you will be given several examples of IPv4 addresses and will complete tables with appropriate information.

Step 1: Analyze the table shown below and identify the network portion and host portion of the given IPv4 addresses.

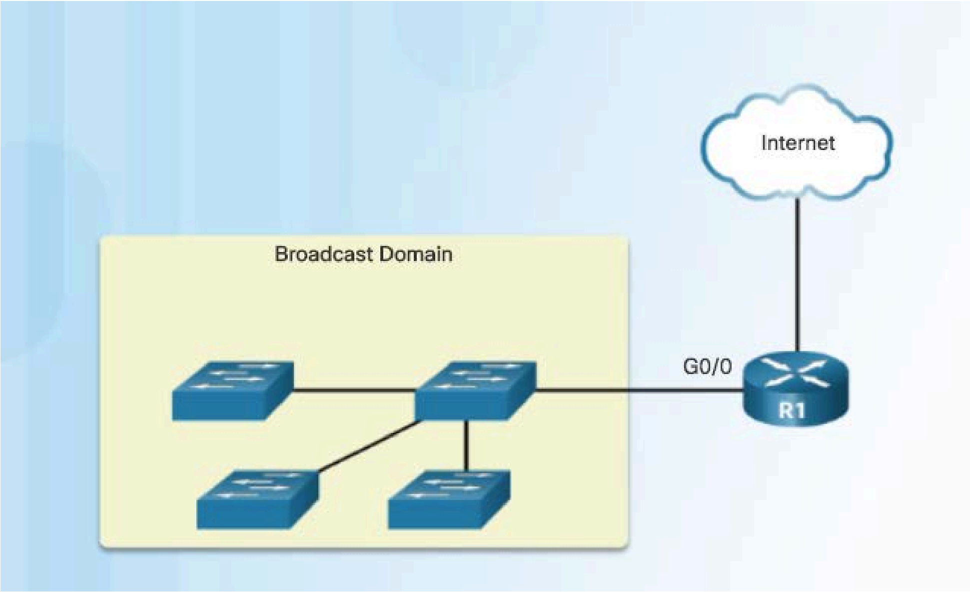
The first two rows show examples of how the table should be completed.

Key for table:
N = all 8 bits for an octet are in the network portion of the address
n = a bit in the network portion of the address
H = all 8 bits for an octet are in the host portion of the address
h = a bit in the host portion of the address

IP Address/Prefix	Network/Host N,n = Network, H,h = Host	Subnet Mask	Network Address
192.168.10.10/24	N.N.N.H	255.255.255.0	192.168.10.0
10.101.99.17/23	N.N.nnnnnnnh.H	255.255.254.0	10.101.98.0
209.165.200.227/27			
172.31.45.252/24			
10.1.8.200/26			
172.16.117.77/20			
10.1.1.101/25			
209.165.202.140/27			
[illegible]			

Broadcast Domains

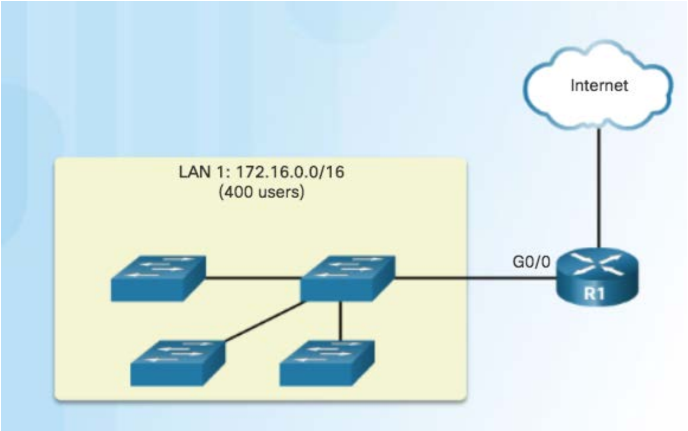
- **Ethernet LAN에서 장치들은 다음의 위치를 알기 위해 브로트캐스트를 사용함**
  - **Other devices** - 로컬 네트워크의 알려진 IPv4 주소로 Layer 2 브로드캐스트를 전송하여 연결된 MAC 주소를 검색하는 ARP (Address Resolution Protocol)
  - **Services –** 로컬 네트워크에서 브로드캐스트를 보내 DHCP 서버를 찾는 DHCP (Dynamic Host Configuration Protocol)
- **Switches 브로드캐스트를 수신한 인터페이스를 제외한 모든 인터페이스에서 브로드캐스트를 전파함**



Problems with Large Broadcast Domains

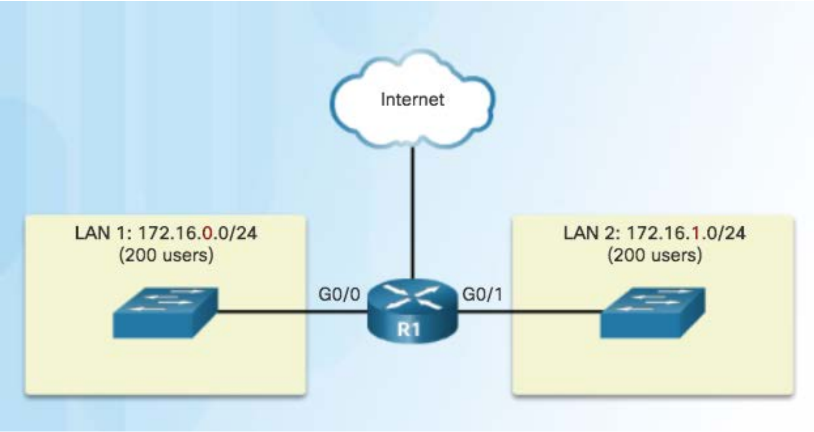
- **호스트들은 과도한 브로드캐스트를 생성하여 네트워크에 부정적인 영향을 줄 수 있음**
  - 상당한 양의 트래픽으로 인해 느린 네트워크 작업이 발생 가능
  - 장치가 각 브로드캐스트 패킷을 받아들이고 처리해야하기 때문에 장치 작업이 느려짐
- **Solution: 네트워크의 크기를 줄여 보다 작은 브로드캐스트 도메인을 만드십시오. 이러한 작은 네트워크 공간을 subnet이라고 합니다.**

One Broadcast Domain



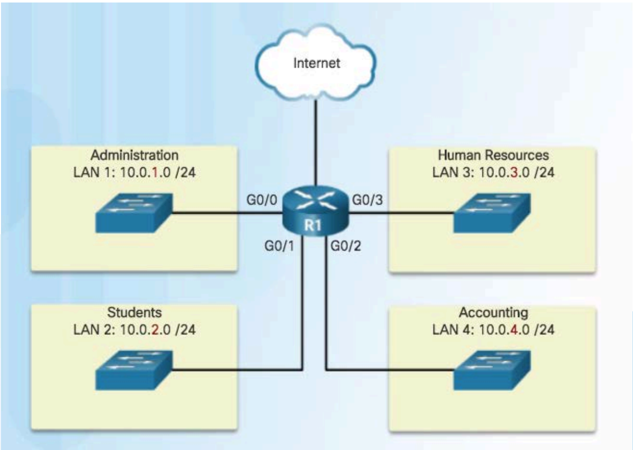
Broadcast in LAN 1 contained in 1 subnet

Broadcast in LAN 2 contained in 1 subnet



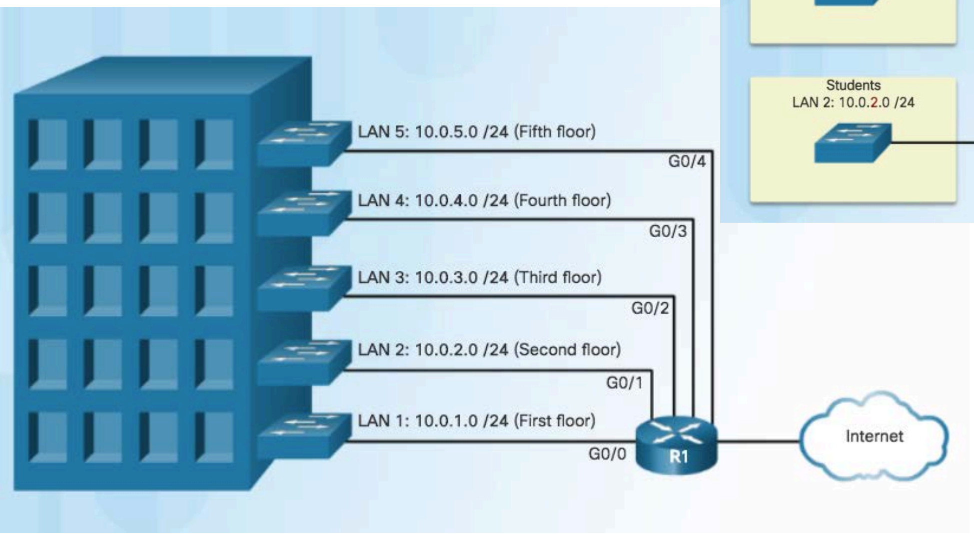
Reasons for Subnetting

- 전체 네트워크 트래픽을 줄이고 네트워크 성능을 향상시킵니다.
- 관리자가 서브넷 사이에 서로 통신하게 하거나 통신할 수 없게 하는 것과 같은 보안 정책을 구현할 수 있습니다.

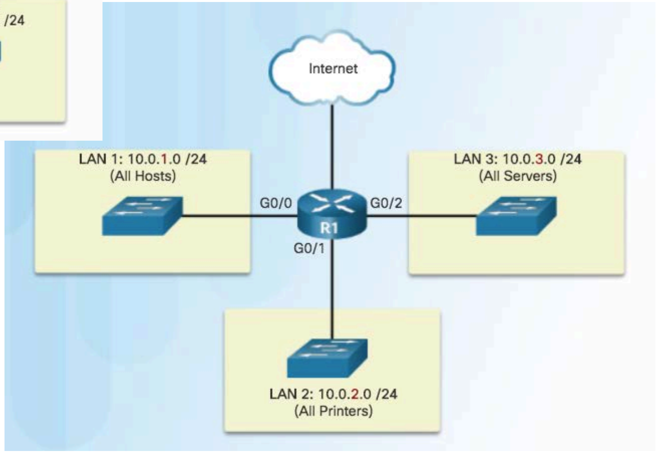


Communicating between Networks

Subnetting by Location



Subnetting by Device Type



Octet Boundaries

- Prefix length and the subnet mask 주소의 네트워크 부분을 식별하는 방법
- Subnets은 network bits에 host bits를 빌려와서 만들짐
- host bits 를 많이 빌릴수록 더 많은 subnets 이 정의될 수 있음.

Networks are most easily subnetted at the octet boundary of /8, /16, and /24

Prefix Length	Subnet Mask	Subnet Mask in Binary (n = network, h = host)	# of hosts
/8	255.0.0.0	nnnnnnnn.hhhhhhhh.hhhhhhhh.hhhhhhhh 11111111.00000000.00000000.00000000	16,777,214
/16	255.255.0.0	nnnnnnnn.nnnnnnnn.hhhhhhhh.hhhhhhhh 11111111.11111111.00000000.00000000	65,534
/24	255.255.255.0	nnnnnnnn.nnnnnnnn.nnnnnnnn.hhhhhhhh 11111111.11111111.11111111.00000000	254

Subnetting an IPv4 Network

Subnetting on the Octet Boundary

- **Subnetting Network 10.x.0.0/16**
- **Define up to 256 subnets with each subnet capable of connecting 65,534 hosts.**
- **First two octets identify the network portion while the last two octets are for host IP addresses.**

Subnet Address (256 Possible Subnets)	Host Range (65,534 possible hosts per subnet)	Broadcast
10.0.0.0/16	10.0.0.1 – 10.0.255.254	10.0.255.255
10.1.0.0/16	10.1.0.1 – 10.1.255.254	10.1.255.255
10.2.0.0/16	10.2.0.1 – 10.2.255.254	10.2.255.255
10.3.0.0/16	10.3.0.1 – 10.3.255.254	10.3.255.255
10.4.0.0/16	10.4.0.1 – 10.4.255.254	10.4.255.255
10.5.0.0/16	10.5.0.1 – 10.5.255.254	10.5.255.255
10.6.0.0/16	10.6.0.1 – 10.6.255.254	10.6.255.255
10.7.0.0/16	10.7.0.1 – 10.7.255.254	10.7.255.255
...	...	...
10.255.0.0/16	10.255.0.1 – 10.255.255.254	10.255.255.255

Subnetting on the Octet Boundary (Cont.)

- **Subnetting Network 10.x.x.0/24**
- **Define 65,536 subnets each capable of connecting 254 hosts.**
- **/24 boundary is very popular in subnetting because of number of hosts.**

Subnet Address (65,536 Possible Subnets)	Host Range (254 possible hosts per subnet)	Broadcast
10.0.0.0/24	10.0.0.1 - 10.0.0.254	10.0.0.255
10.0.1.0/24	10.0.1.1 - 10.0.1.254	10.0.1.255
10.0.2.0/24	10.0.2.1 - 10.0.2.254	10.0.1.255
...	...	...
10.0.255.0/24	10.0.255.1 - 10.0.255.254	10.0.255.255
10.1.0.0/24	10.1.0.1 - 10.1.0.254	10.1.0.255
10.1.1.0/24	10.1.1.1 - 10.1.1.254	1.1.1.0.255
10.1.2.0/24	10.1.2.1 - 10.1.2.254	10.1.2.0.255
...	...	...
10.100.0.0/24	10.100.0.1 - 10.100.0.254	10.100.0.255
...	...	...
10.255.255.0/24	10.255.255.1 - 10.255.255.254	10.255.255.255

Classless Subnetting

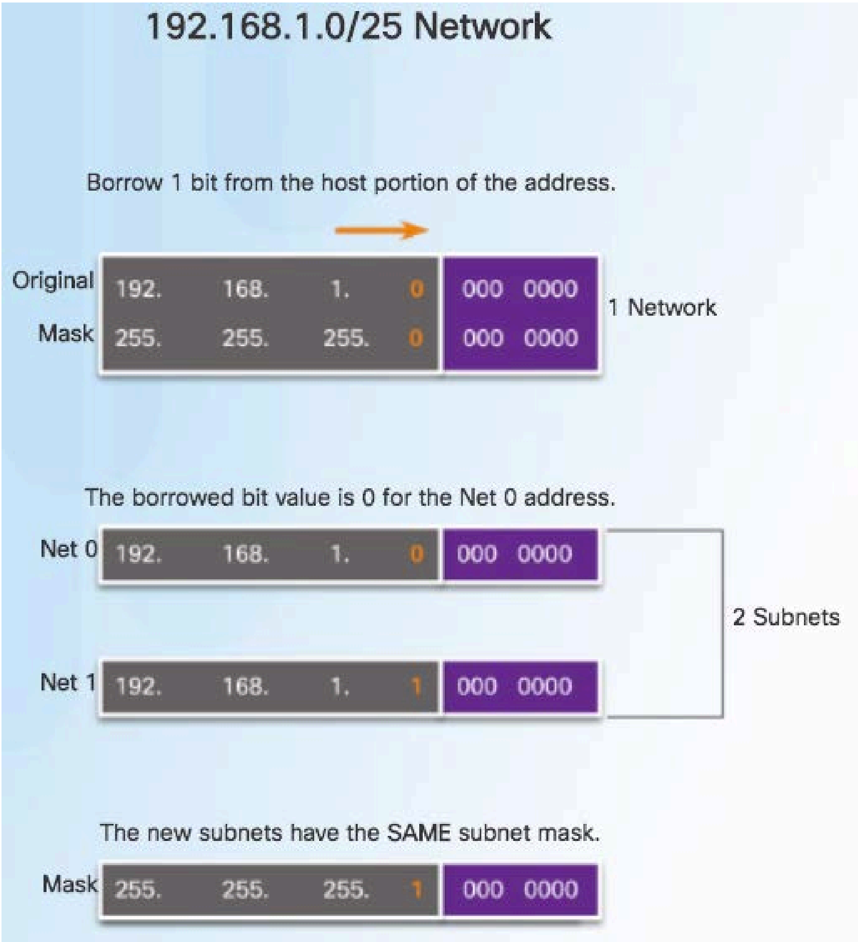
Subnets can borrow bits from *any* host bit position to create other masks.

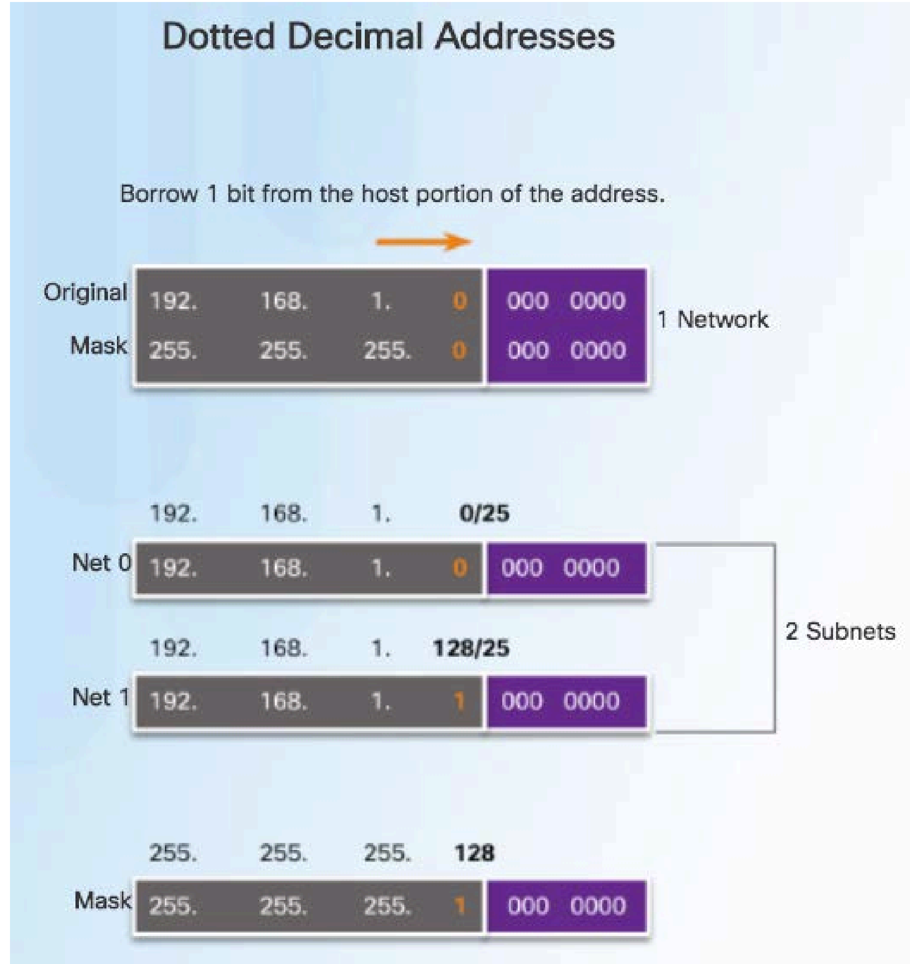
Subnetting a /24 Network

Prefix Length	Subnet Mask	Subnet Mask in Binary (n = network, h = host)	# of subnets	# of hosts
/25	255.255.255.128	nnnnnnnn.nnnnnnnn.nnnnnnnn.nhhhhhhh 11111111.11111111.11111111.10000000	2	126
/26	255.255.255.192	nnnnnnnn.nnnnnnnn.nnnnnnnn.nnhhhhhh 11111111.11111111.11111111.11000000	4	62
/27	255.255.255.224	nnnnnnnn.nnnnnnnn.nnnnnnnn.nnnhhhhh 11111111.11111111.11111111.11100000	8	30
/28	255.255.255.240	nnnnnnnn.nnnnnnnn.nnnnnnnn.nnnnhhhh 11111111.11111111.11111111.11110000	16	14
/29	255.255.255.248	nnnnnnnn.nnnnnnnn.nnnnnnnn.nnnnnhhh 11111111.11111111.11111111.11111000	32	6
/30	255.255.255.252	nnnnnnnn.nnnnnnnn.nnnnnnnn.nnnnnnhh 11111111.11111111.11111111.11111100	64	2

Subnetting an IPv4 Network

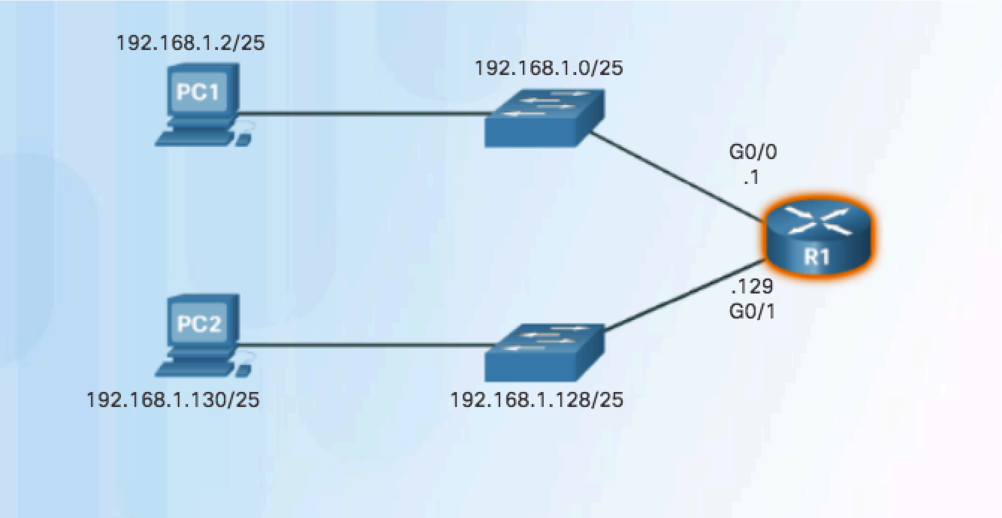
Classless Subnetting Example



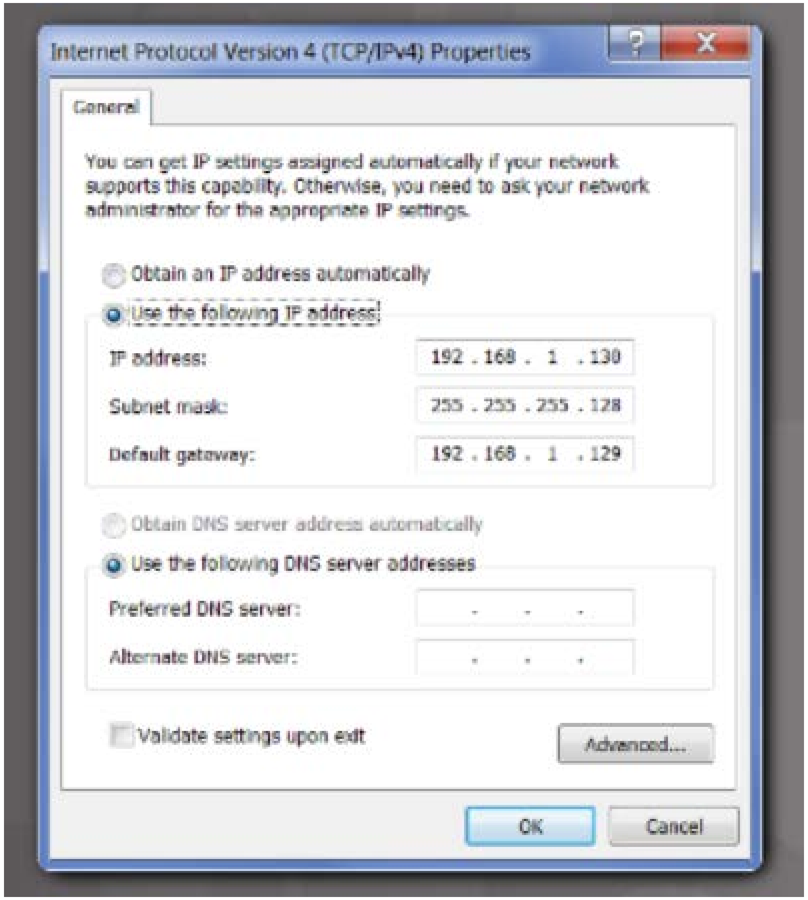


Creating 2 Subnets

/25 Subnetting Topology

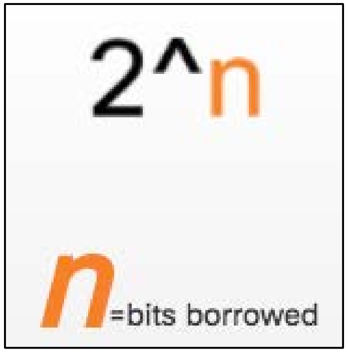



```
R1(config)# interface gigabitethernet 0/0
R1(config-if)# ip address 192.168.1.1 255.255.255.128
R1(config-if)# exit
R1(config)# interface gigabitethernet 0/1
R1(config-if)# ip address 192.168.1.129 255.255.255.128
```

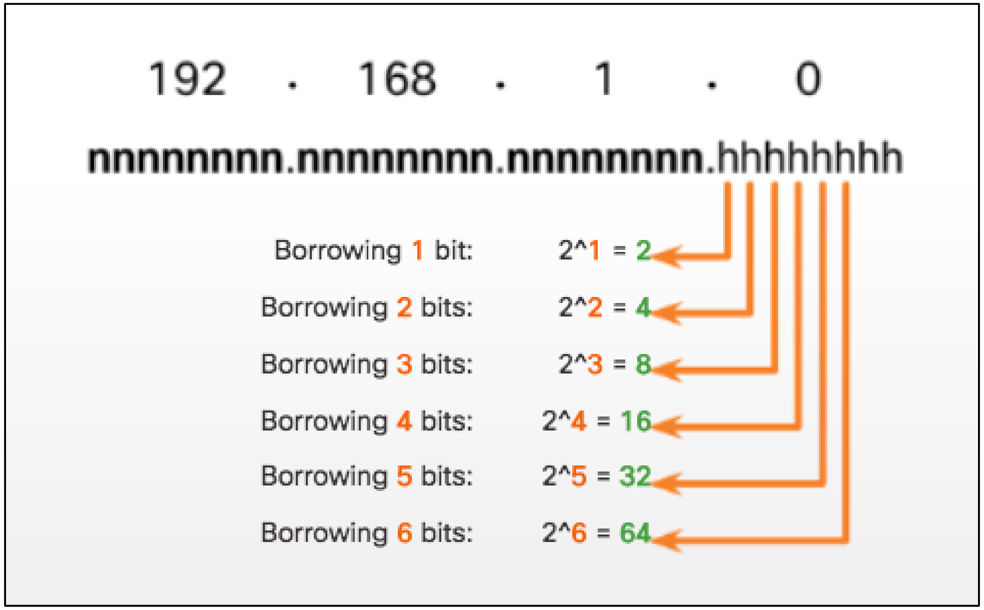


Subnetting Formulas

Calculate Number of Subnets Formula



Subnetting a /24 Network



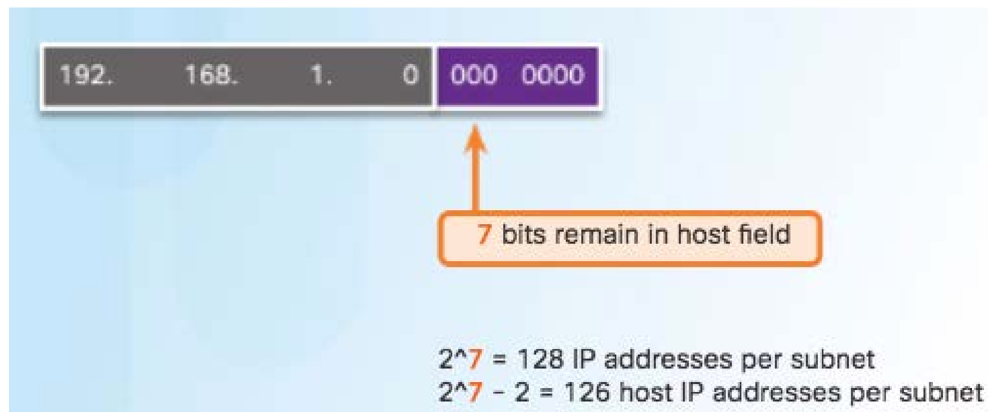
Subnetting Formulas (Cont.)

Calculate Number of Hosts Formula

$$2^n-2$$

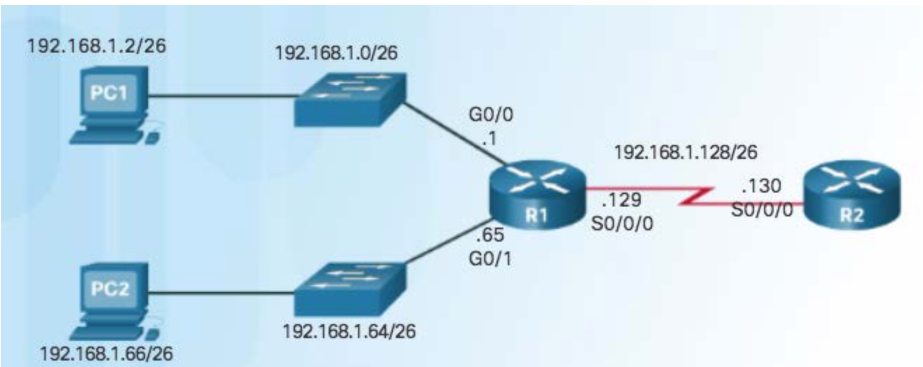
n = the number of bits remaining in the host field

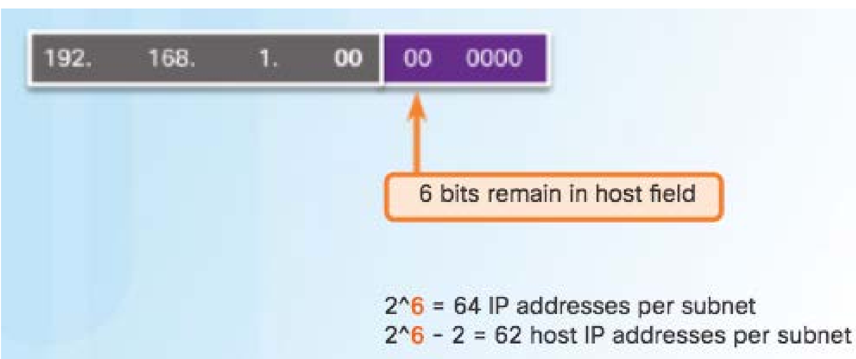
Calculating the Number of Hosts

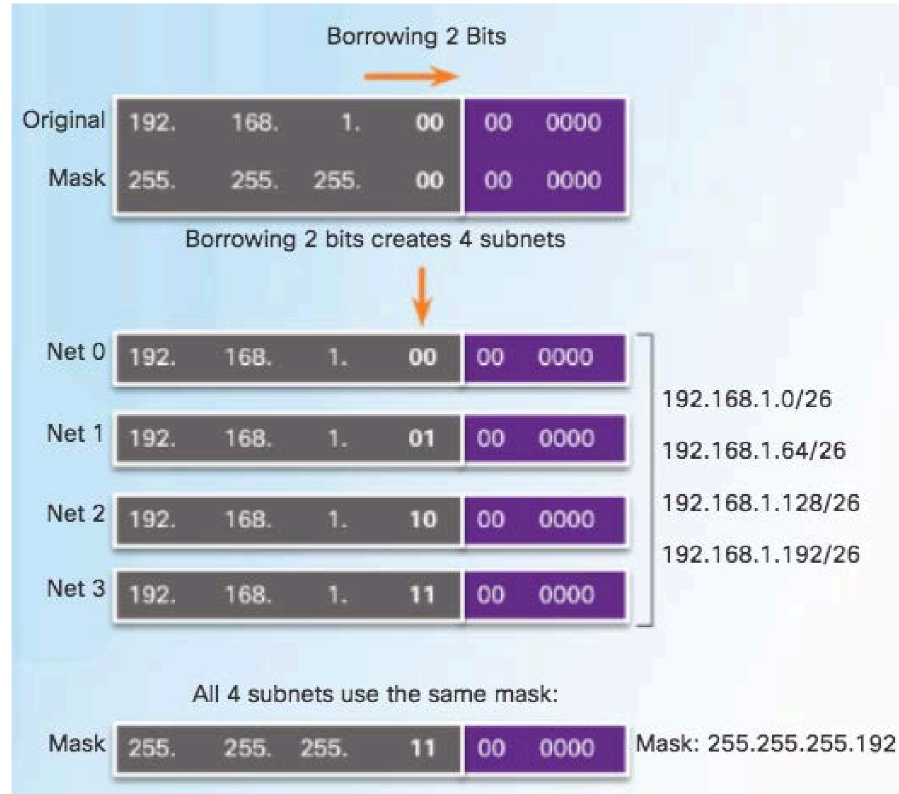


Subnetting an IPv4 Network
Creating 4 Subnets

- **/26 Subnetting Topology**







Subnetting an IPv4 Network

Creating 4 Subnets (Cont.)

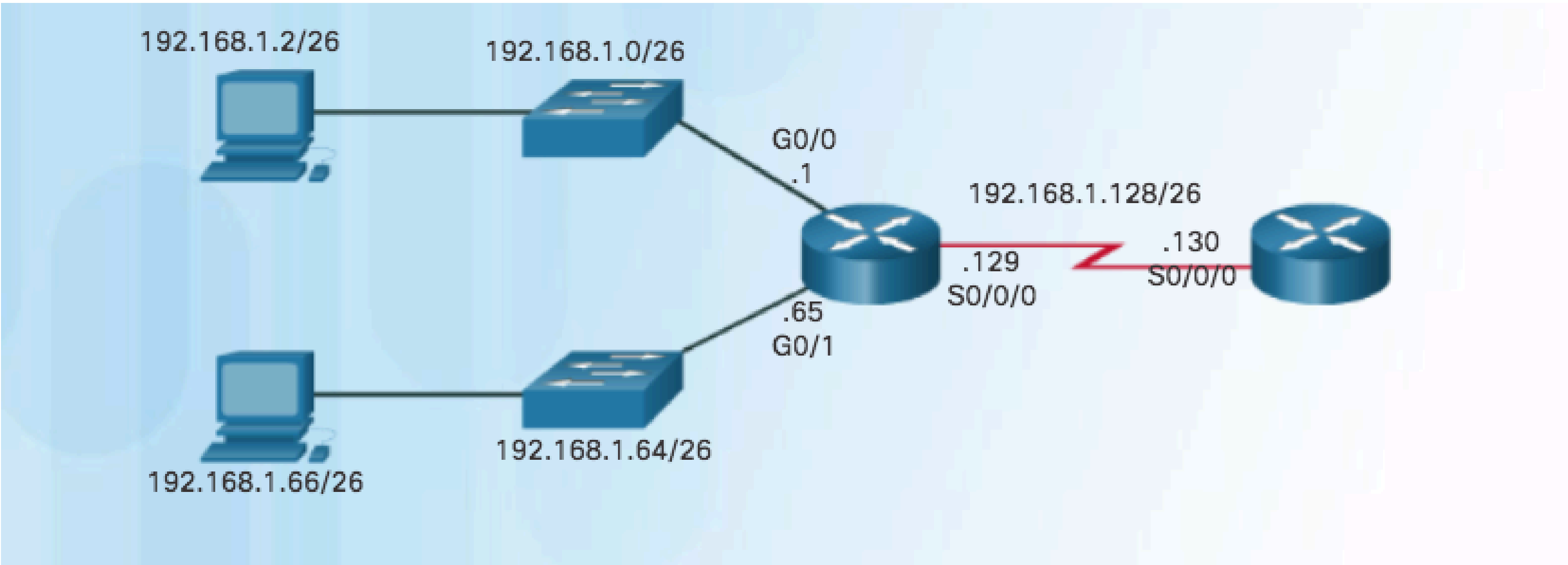
/26 Subnetting Topology

Net 0	Network	192.	168.	1.	00	00	0000	192.168.1.0
	First	192.	168.	1.	00	00	0001	192.168.1.1
	Last	192.	168.	1.	00	11	1110	192.168.1.62
	Broadcast	192.	168.	1.	00	11	1111	192.168.1.63
Net 1	Network	192.	168.	1.	01	00	0000	192.168.1.64
	First	192.	168.	1.	01	00	0001	192.168.1.65
	Last	192.	168.	1.	01	11	1110	192.168.1.126
	Broadcast	192.	168.	1.	01	11	1111	192.168.1.127
Net 2	Network	192.	168.	1.	10	00	0000	192.168.1.128
	First	192.	168.	1.	10	00	0001	192.168.1.129
	Last	192.	168.	1.	10	11	1110	192.168.1.190
	Broadcast	192.	168.	1.	10	11	1111	192.168.1.191

Subnetting an IPv4 Network

Creating 4 Subnets (Cont.)

- **/26 Subnetting Topology**




```
R1(config)#interface gigabitethernet 0/0
R1(config-if)#ip address 192.168.1.1 255.255.255.192
R1(config-if)#exit
R1(config)#interface gigabitethernet 0/1
R1(config-if)#ip address 192.168.1.65 255.255.255.192
R1(config-if)#exit
R1(config)#interface serial 0/0/0
R1(config-if)#ip address 192.168.1.129 255.255.255.192
```

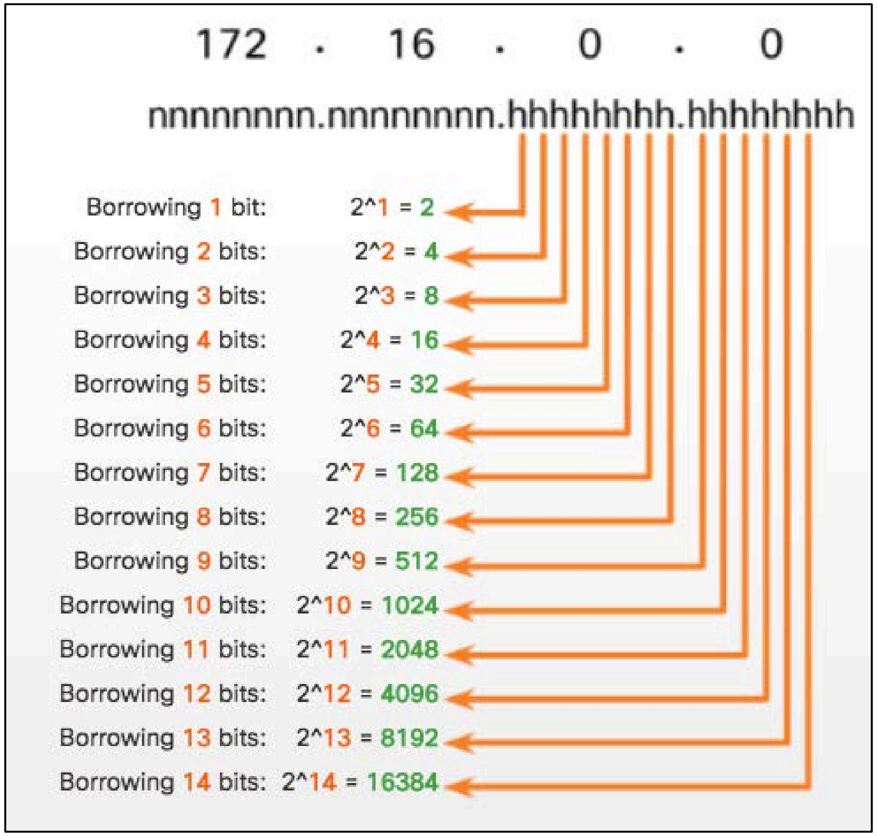
Creating Subnets with a /16 prefix

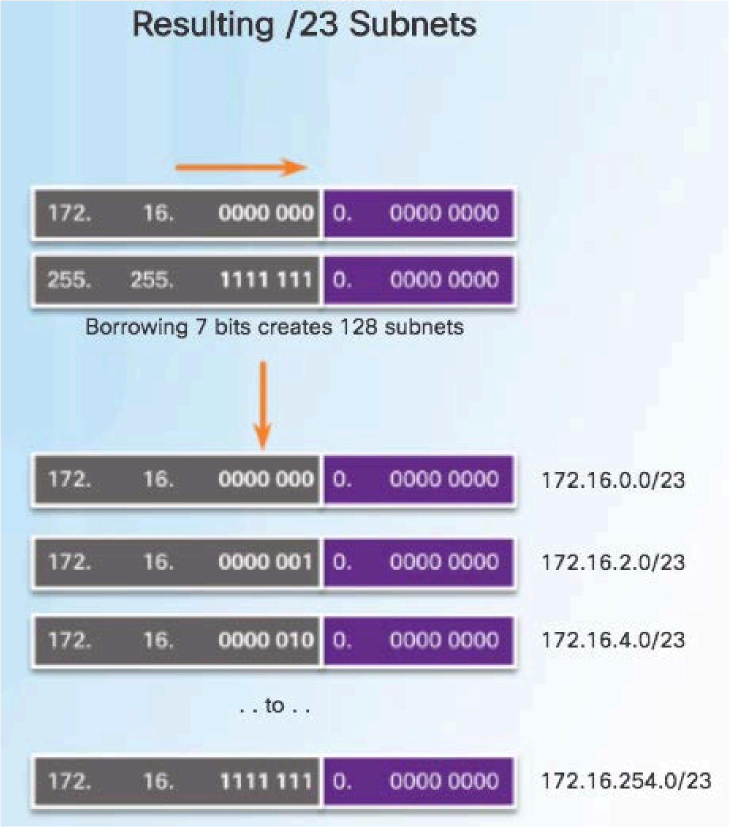
Subnetting a /16 Network

Prefix Length	Subnet Mask	Network Address (n = network, h = host)	# of subnets	# of hosts
/17	255.255.128.0	nnnnnnnn.nnnnnnnn.nhhhhhhh.hhhhhhhh 11111111.11111111.10000000.00000000	2	32766
/18	255.255.192.0	nnnnnnnn.nnnnnnnn.nnhhhhhh.hhhhhhhh 11111111.11111111.11000000.00000000	4	16382
/19	255.255.224.0	nnnnnnnn.nnnnnnnn.nnnhhhhh.hhhhhhhh 11111111.11111111.11100000.00000000	8	8190
/20	255.255.240.0	nnnnnnnn.nnnnnnnn.nnnnhhhh.hhhhhhhh 11111111.11111111.11110000.00000000	16	4094
/21	255.255.248.0	nnnnnnnn.nnnnnnnn.nnnnnhhh.hhhhhhhh 11111111.11111111.11111000.00000000	32	2046
/22	255.255.252.0	nnnnnnnn.nnnnnnnn.nnnnnnhh.hhhhhhhh 11111111.11111111.11111100.00000000	64	1022

Subnetting a /16 and /8 Prefix

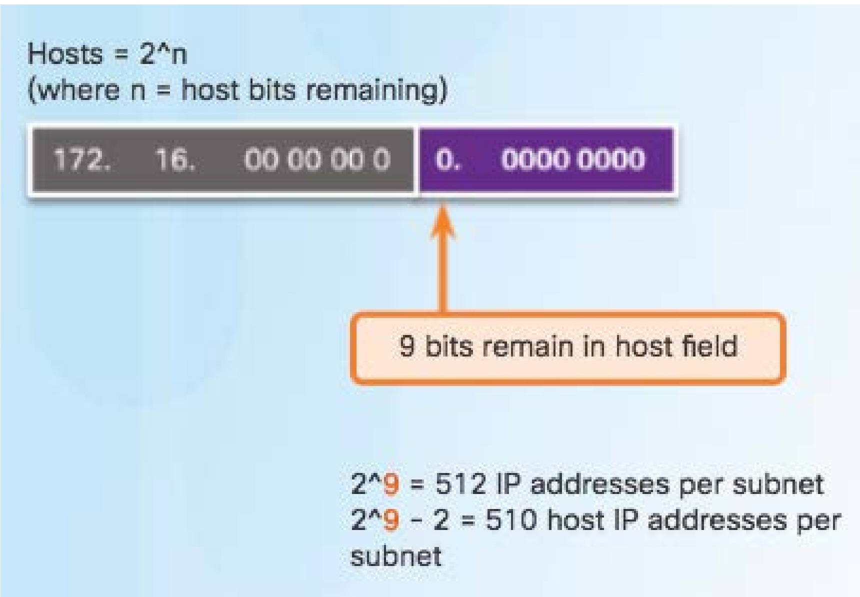
Creating 100 Subnets with a /16 prefix

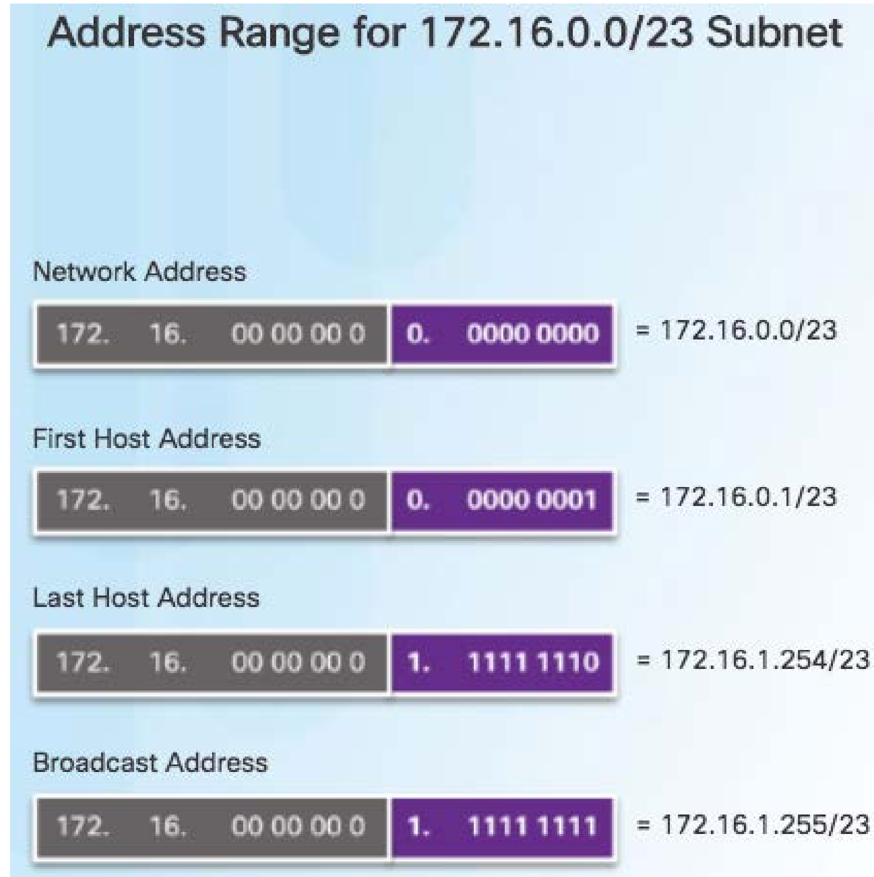




Subnetting a /16 and /8 Prefix

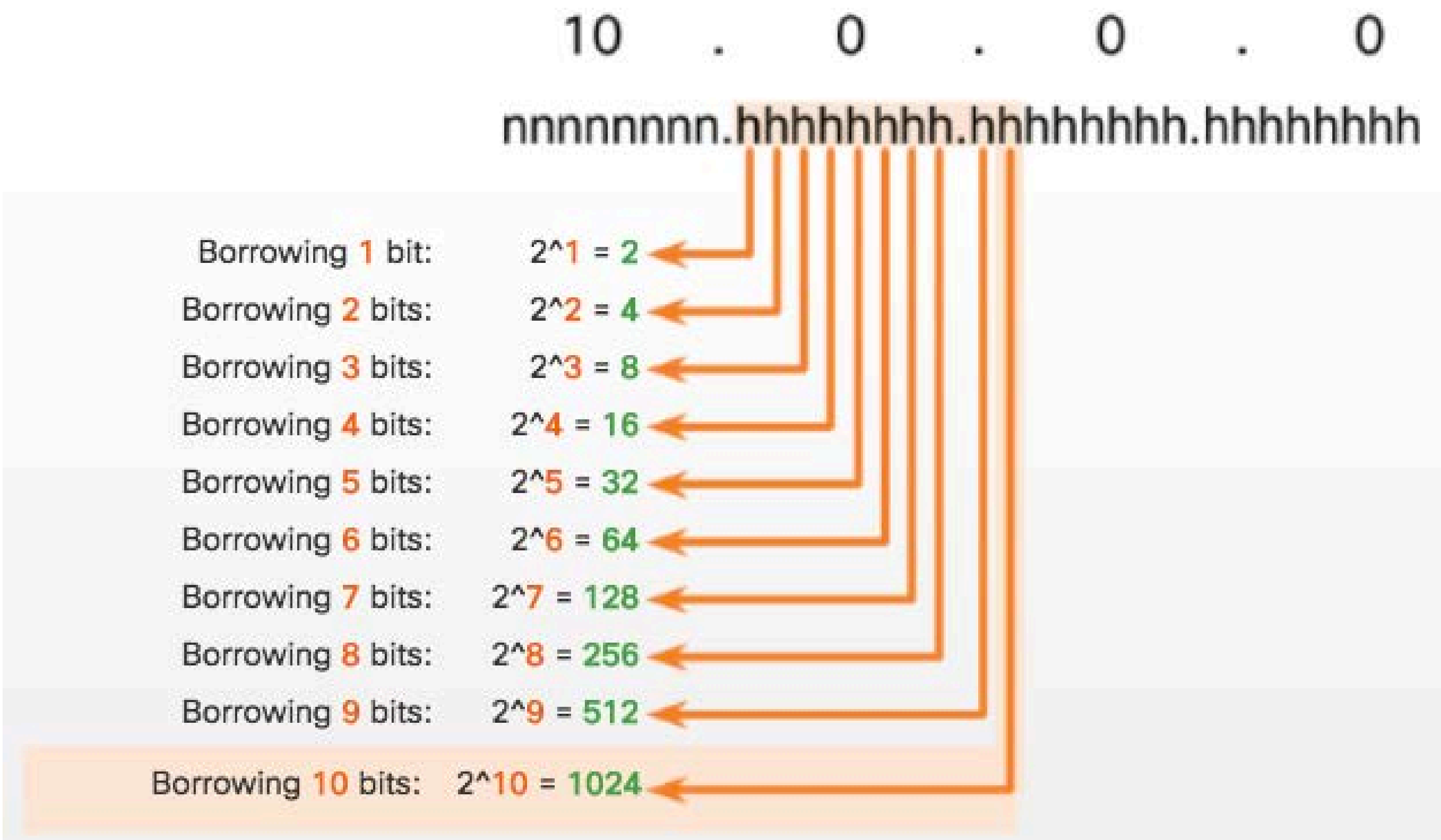
Calculating the Hosts





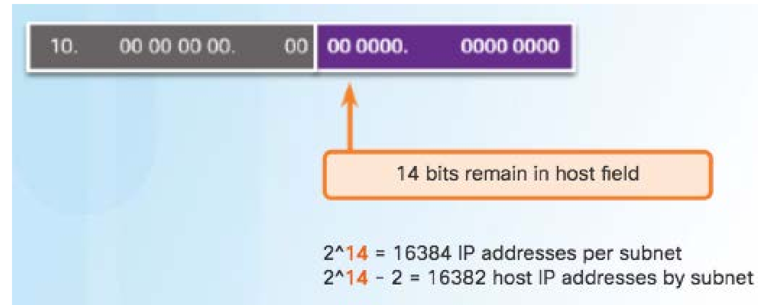
Subnetting a /16 and /8 Prefix

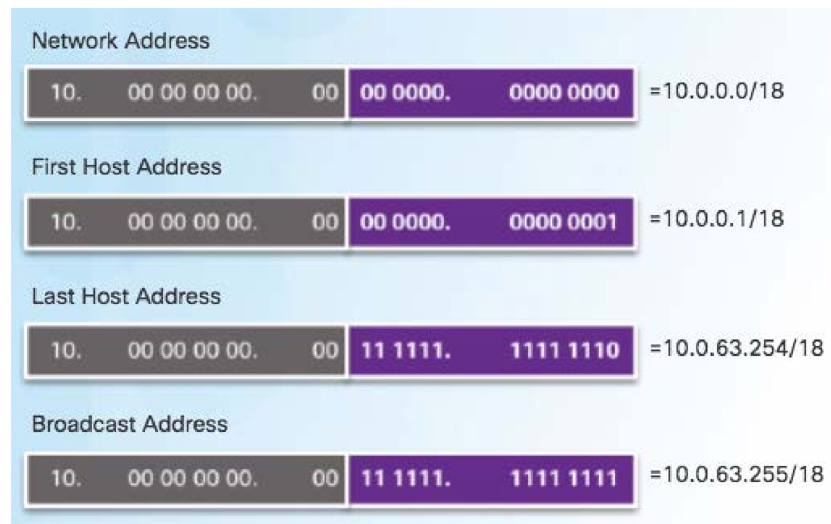
Creating 1000 Subnets with a /8 Network



Subnetting a /16 and /8 Prefix

Creating 1000 Subnets with a /8 Network (Cont.)





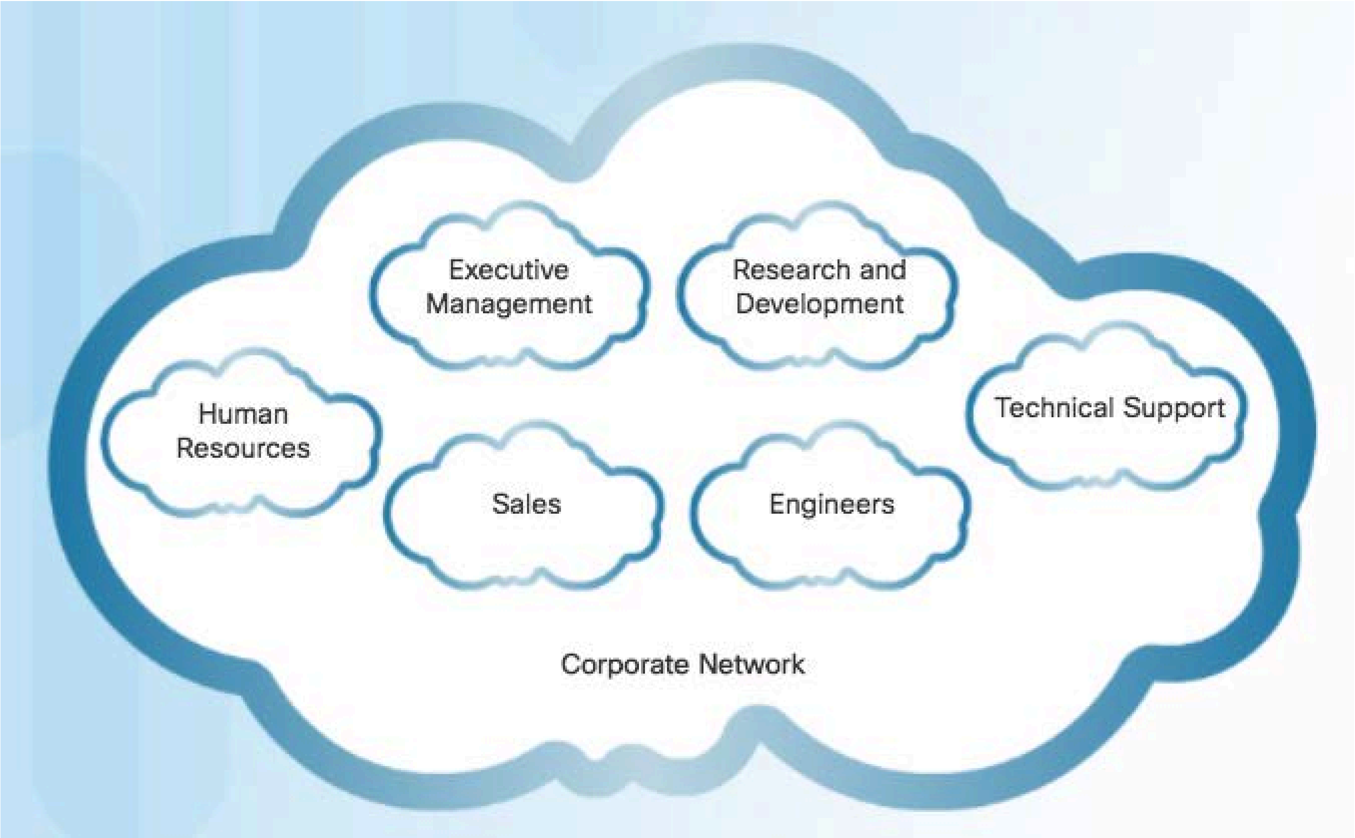
Subnetting to Meet Requirements

Subnetting Based on Host Requirements

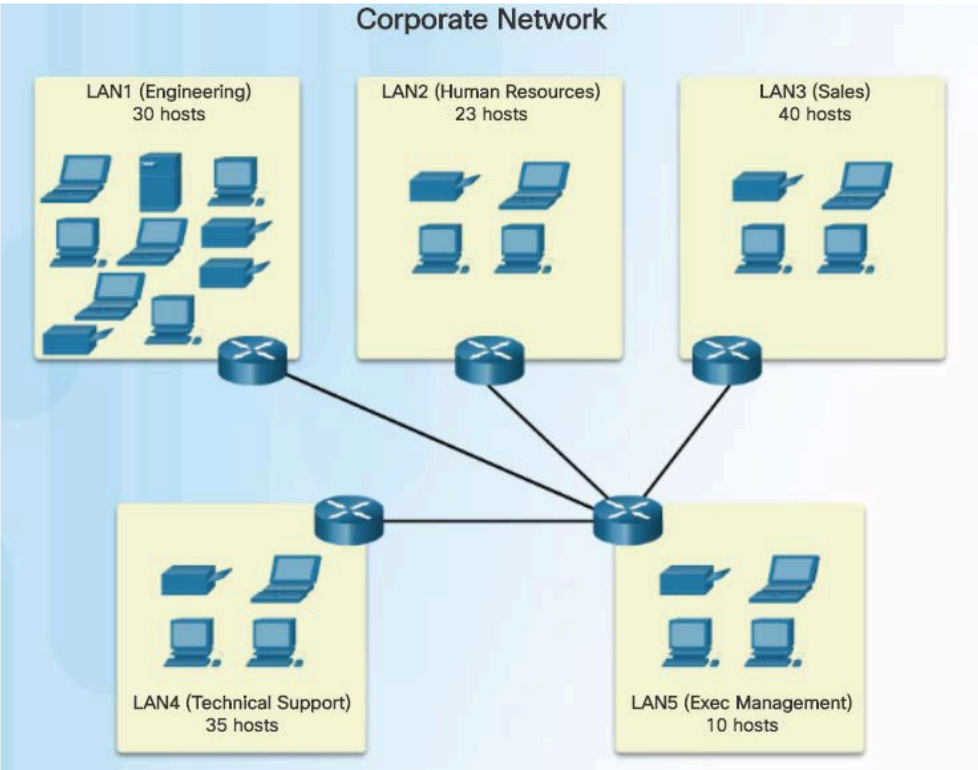
Prefix Length	Subnet Mask	Subnet Mask in Binary (n = network, h = host)	# of subnets	# of hosts
/25	255.255.255.128	nnnnnnnn.nnnnnnnn.nnnnnnnn.nhhhhhhh 11111111.11111111.11111111.10000000	2	126
/26	255.255.255.192	nnnnnnnn.nnnnnnnn.nnnnnnnn.nnhhhhhh 11111111.11111111.11111111.11000000	4	62
/27	255.255.255.224	nnnnnnnn.nnnnnnnn.nnnnnnnn.nnnhhhhh 11111111.11111111.11111111.11100000	8	30
/28	255.255.255.240	nnnnnnnn.nnnnnnnn.nnnnnnnn.nnnnhhhh 11111111.11111111.11111111.11110000	16	14

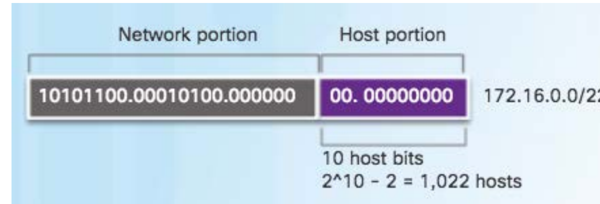
Subnetting to Meet Requirements
Subnetting Based On Network Requirements

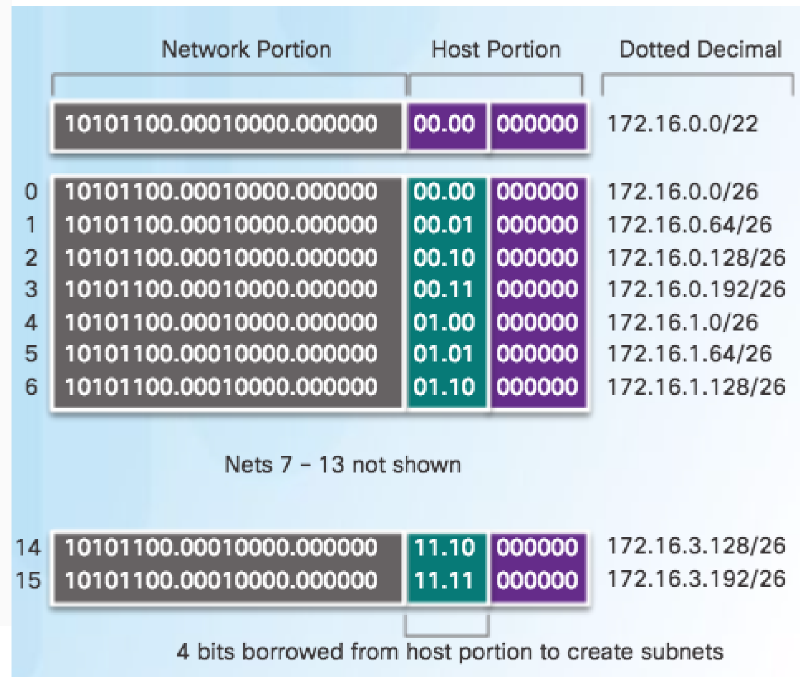
Host devices used by employees in the Engineering department in one network and Management in a separate network.



Subnetting to Meet Requirements
Network Requirement Example

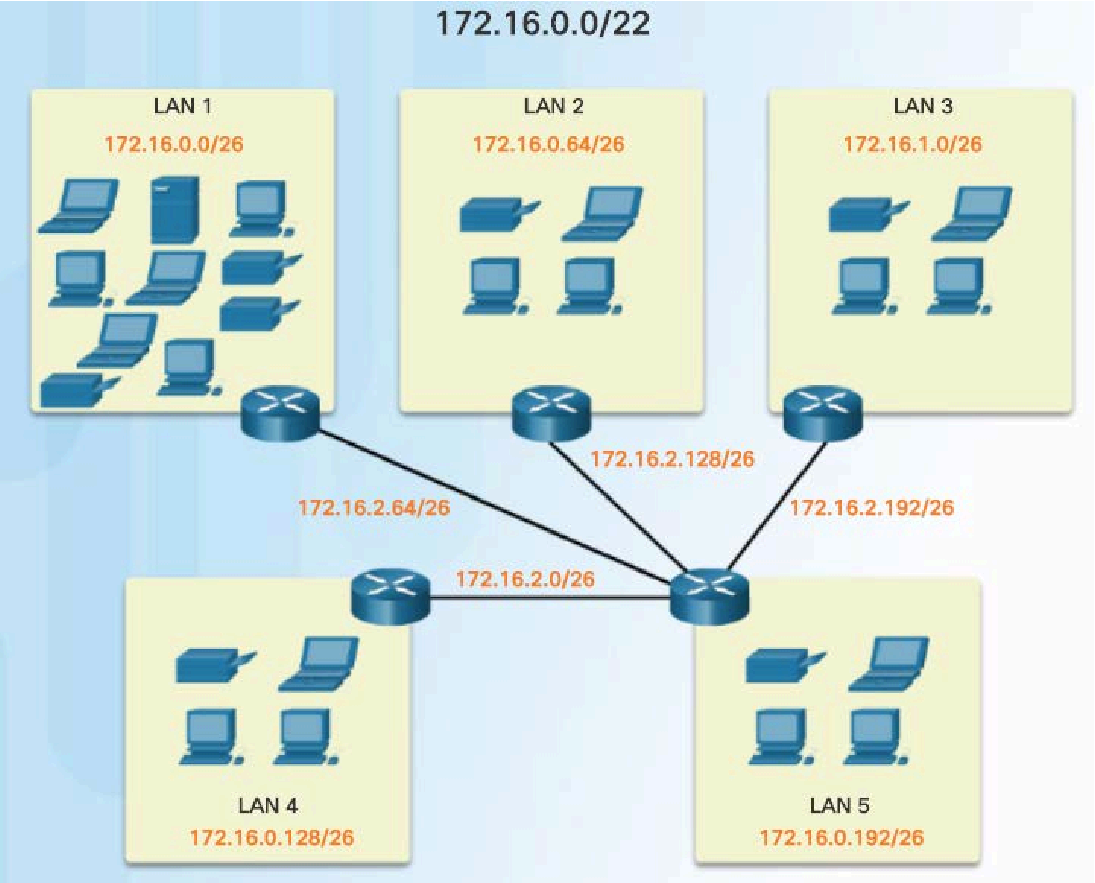






Subnetting to Meet Requirements

Network Requirement Example (Cont.)



Lab – Calculating IPv4 Subnets

8.1.4.6 Lab - Calculating IPv4 Subnets

Cisco Networking Academy® Mind Wide Open™

Lab – Calculating IPv4 Subnets

Objectives

Part 1: Determine IPv4 Address Subnetting

Part 2: Calculate IPv4 Address Subnetting

Background / Scenario

The ability to work with IPv4 subnets and determine network and host information based on a given IP address and subnet mask is critical to understanding how IPv4 networks operate. The first part is designed to reinforce how to compute network IP address information from a given IP address and subnet mask. When given an IP address and subnet mask, you will be able to determine other information about the subnet.

Required Resources

- 1 PC (Windows 7 or 8 with Internet access)
- Optional: IPv4 address calculator

Part 1: Determine IPv4 Address Subnetting

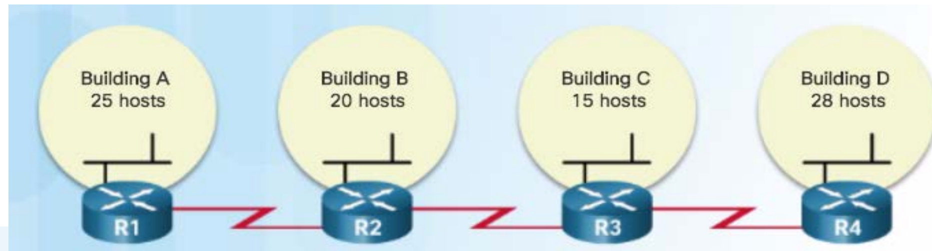
In Part 1, you will determine the network and broadcast addresses, as well as the number of hosts, given an IPv4 address and subnet mask.

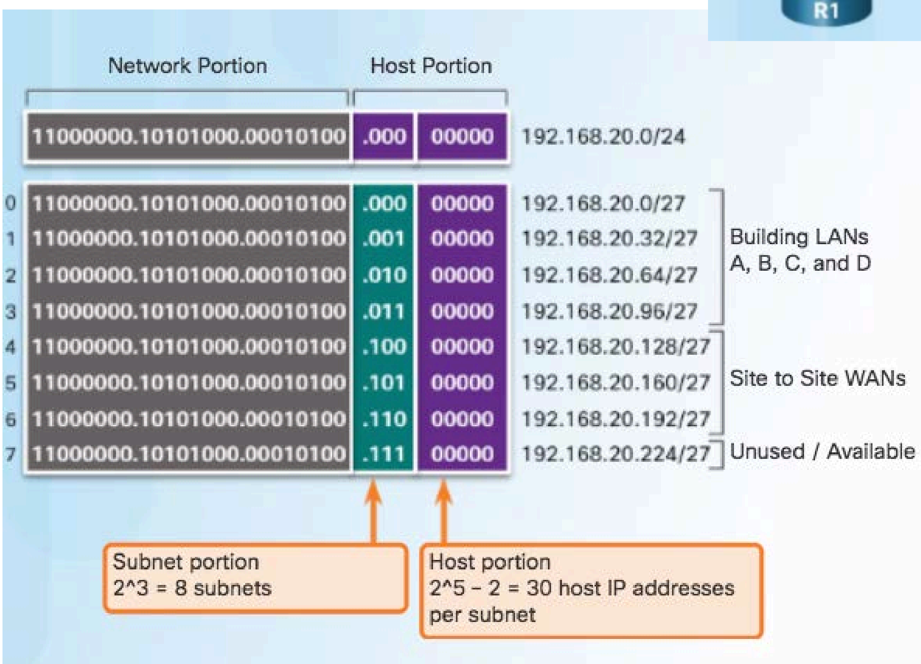
REVIEW: To determine the network address, perform binary ANDing on the IPv4 address using the subnet mask provided. The result will be the network address. Hint: If the subnet mask has decimal value 255 in an octet, the result will ALWAYS be the original value of that octet. If the subnet mask has decimal value 0 in an octet, the result will ALWAYS be 0 for that octet.

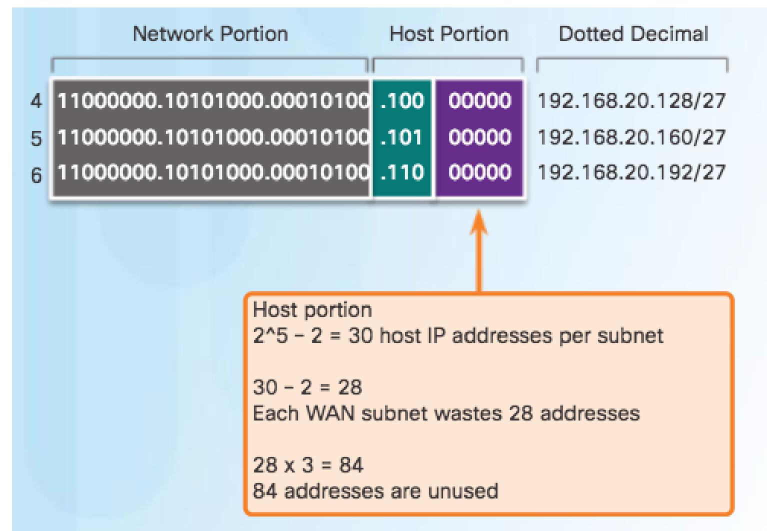
Example:

IP Address	192.168.10.10
Subnet Mask	255.255.255.0
	==========
Result (Network)	192.168.10.0

Traditional Subnetting Wastes Addresses



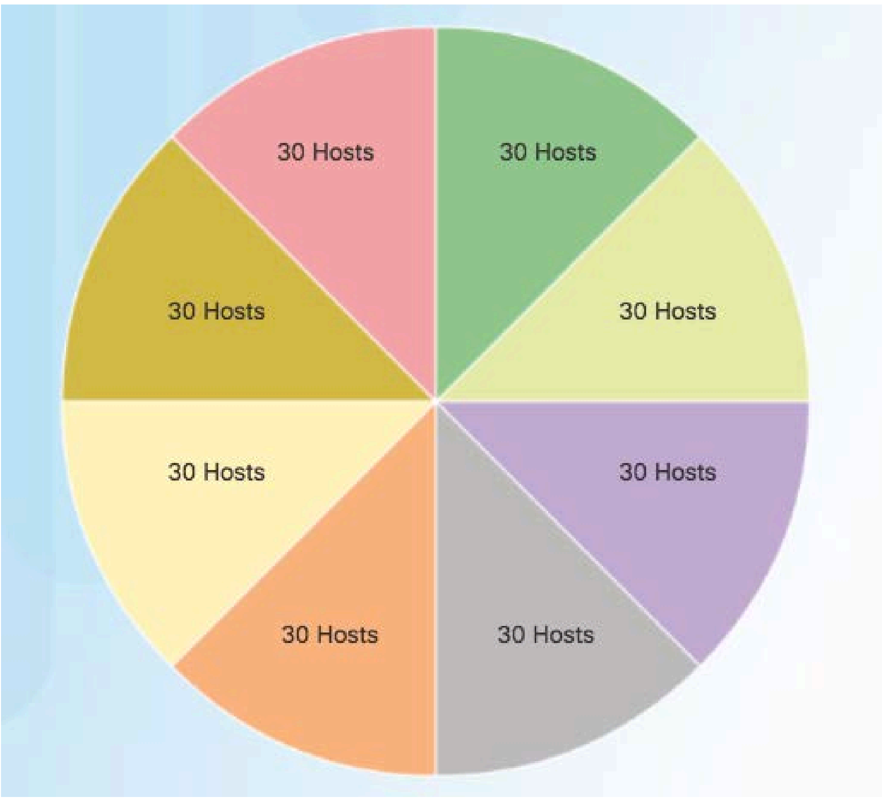




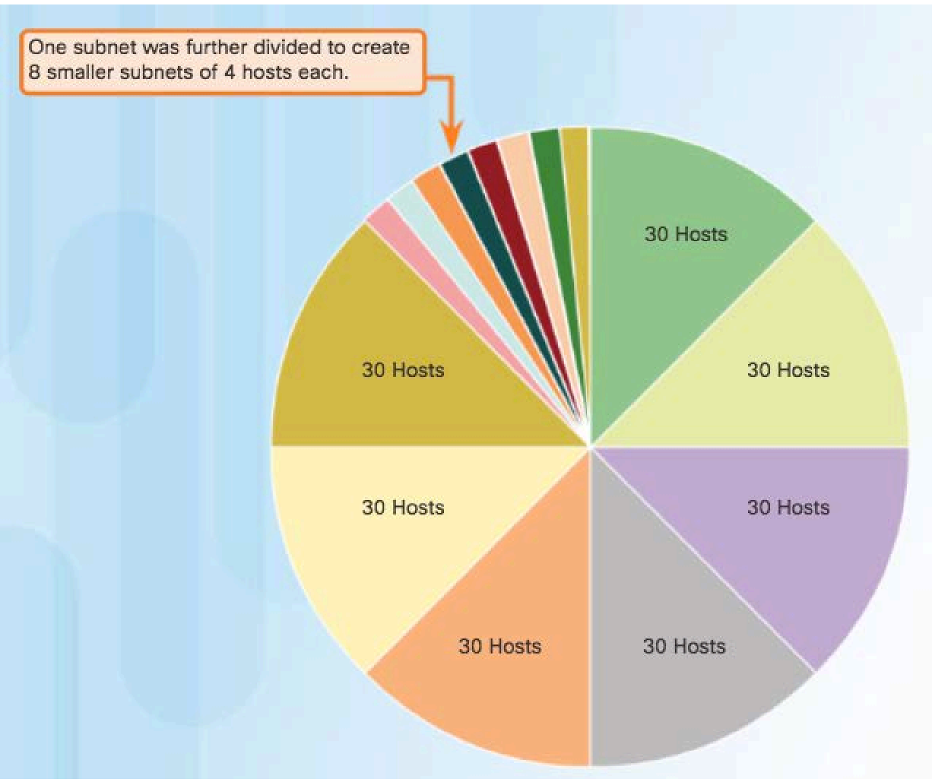
Benefits of Variable Length Subnet Masking

Variable Length Subnet Masks (VLSM)

Traditional



Subnets of Varying Sizes



Benefits of Variable Length Subnet Masking

Basic VLSM

Basic Subnetting

	Network portion	Host portion		Dotted Decimal
	11000000.10101000.00010100	.00000000		192.168.20.0/24
0	11000000.10101000.00010100	.000	00000	192.168.20.0/27
1	11000000.10101000.00010100	.001	00000	192.168.20.32/27
2	11000000.10101000.00010100	.010	00000	192.168.20.64/27
3	11000000.10101000.00010100	.011	00000	192.168.20.96/27
4	11000000.10101000.00010100	.100	00000	192.168.20.128/27
5	11000000.10101000.00010100	.101	00000	192.168.20.160/27
6	11000000.10101000.00010100	.110	00000	192.168.20.192/27
7	11000000.10101000.00010100	.111	00000	192.168.20.224/27

Subnets 0–3: LANs A, B, C, D

Subnets 4–6: Unused / Available

Subnet 7 will be subnetted further.

	Network portion	Host portion		Dotted Decimal
7	11000000.10101000.00010100	.111	00000	192.168.20.224/27

3 more bits borrowed from subnet 7

	Network portion	Host portion		Dotted Decimal
7:0	11000000.10101000.00010100	.111000	00	192.168.20.224/30
7:1	11000000.10101000.00010100	.111001	00	192.168.20.228/30
7:2	11000000.10101000.00010100	.111010	00	192.168.20.232/30
7:3	11000000.10101000.00010100	.111011	00	192.168.20.236/30
7:4	11000000.10101000.00010100	.111100	00	192.168.20.240/30
7:5	11000000.10101000.00010100	.111101	00	192.168.20.244/30
7:6	11000000.10101000.00010100	.111110	00	192.168.20.248/30
7:7	11000000.10101000.00010100	.111111	00	192.168.20.252/30

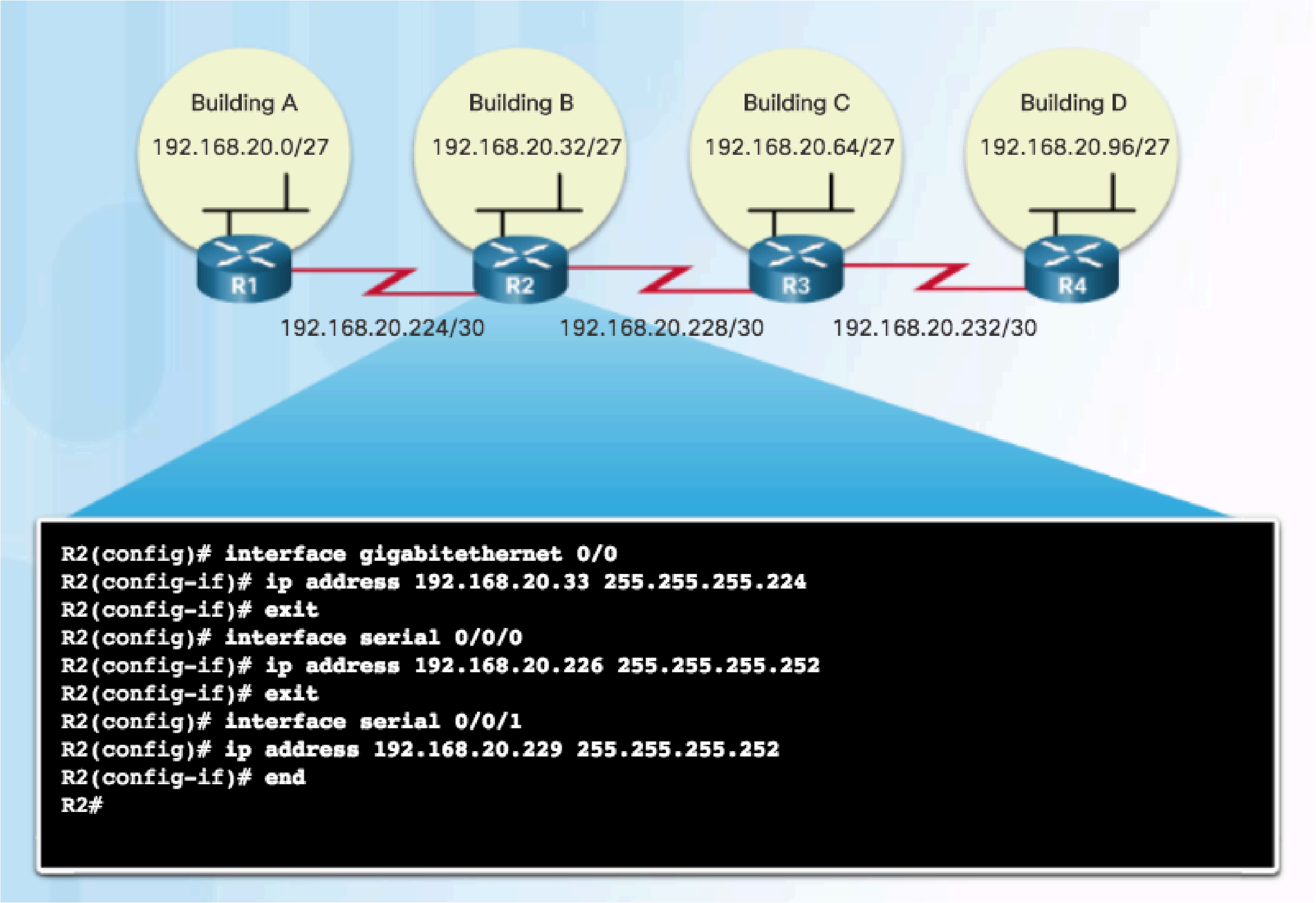
Subnets 7:0–7:2: WANs

Subnets 7:3–7:7: Unused / Available

Subnetting a subnet

Benefits of Variable Length Subnet Masking

VLSM in Practice



VLSM Chart

VLSM Subnetting of 192.168.20.0/24

	/27 Network	Hosts
Bldg A	.0	.1 - .30
Bldg B	.32	.33 - .62
Bldg C	.64	.65 - .94
Bldg D	.96	.97 - .126
Unused	.128	.129 - .158
Unused	.160	.161 - .190
Unused	.192	.193 - .222
	.224	.225 - .254

	/30 Network	Hosts
WAN R1-R2	.224	.225 - .226
WAN R2-R3	.228	.229 - .230
WAN R3-R4	.232	.233 - .234
Unused	.236	.237 - .238
Unused	.240	.241 - .242
Unused	.244	.245 - .246
Unused	.248	.249 - .250
Unused	.252	.253 - .254

Thank You