Cisco Networking Academy
Mind Wide Open

Chapter 8:
Subnetting IP networks

Introduction to Networks v5.1

Section 8.1: Subnetting an IPv4 Network

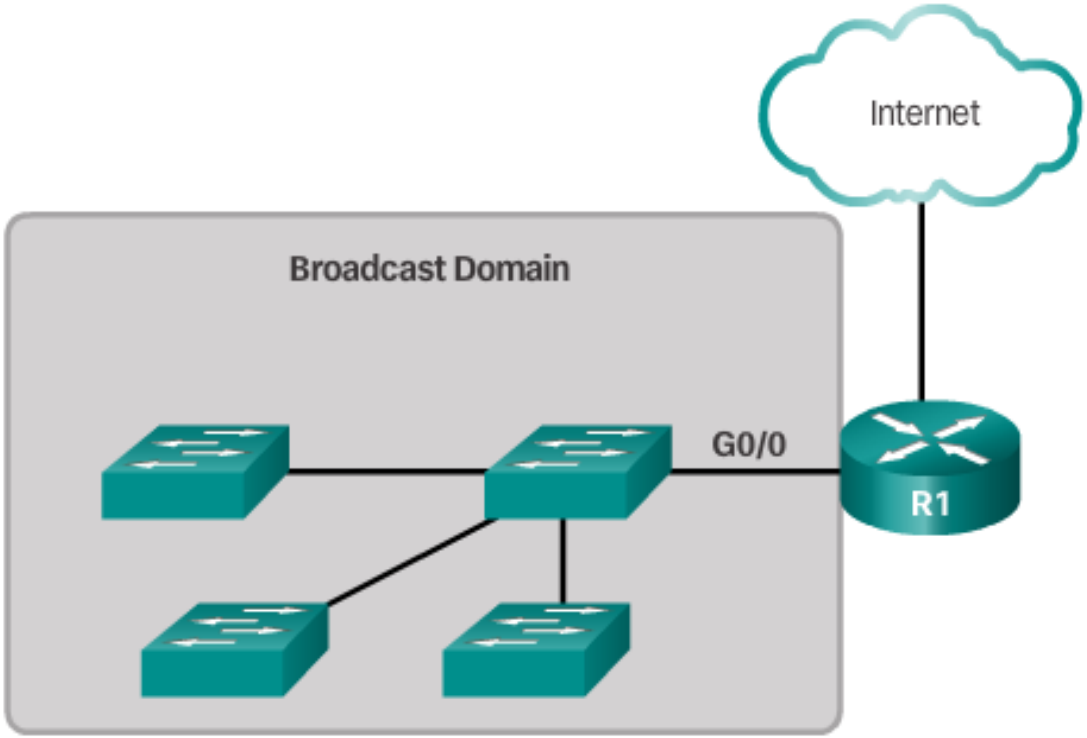
Upon completion of this section, you should be able to:

- Explain how subnetting segments a network to enable better communication.
- Explain how to calculate IPv4 subnets for a /24 prefix.
- Explain how to calculate IPv4 subnets for a /16 and /8 prefix.
- Given a set of requirements for subnetting, implement an IPv4 addressing scheme.
- Explain how to create a flexible addressing scheme using variable length subnet masking (VLSM).

Topic 8.1.1:
Network Segmentation

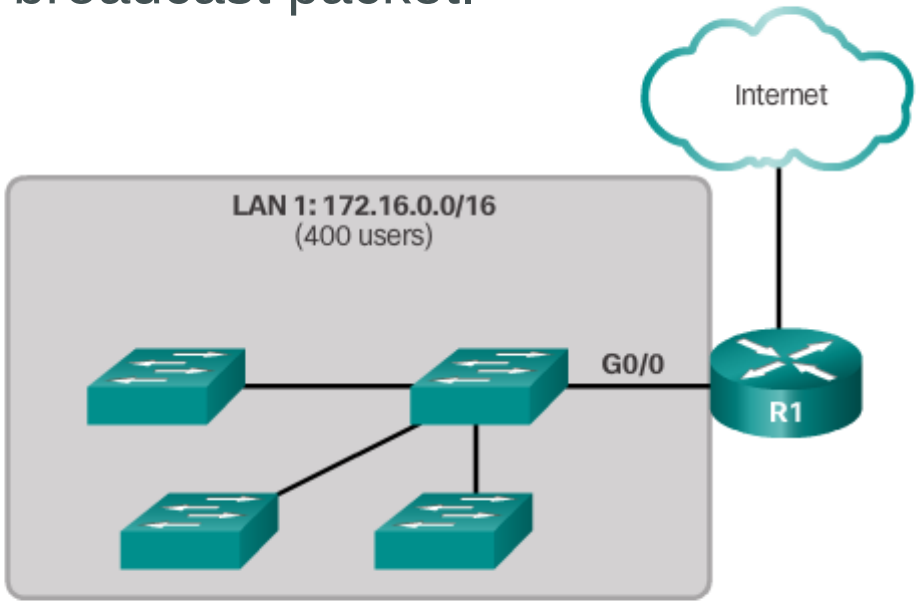
Broadcast Domains

Each router interface connects a *broadcast domain* and broadcasts are only propagated within its specific broadcast domain.



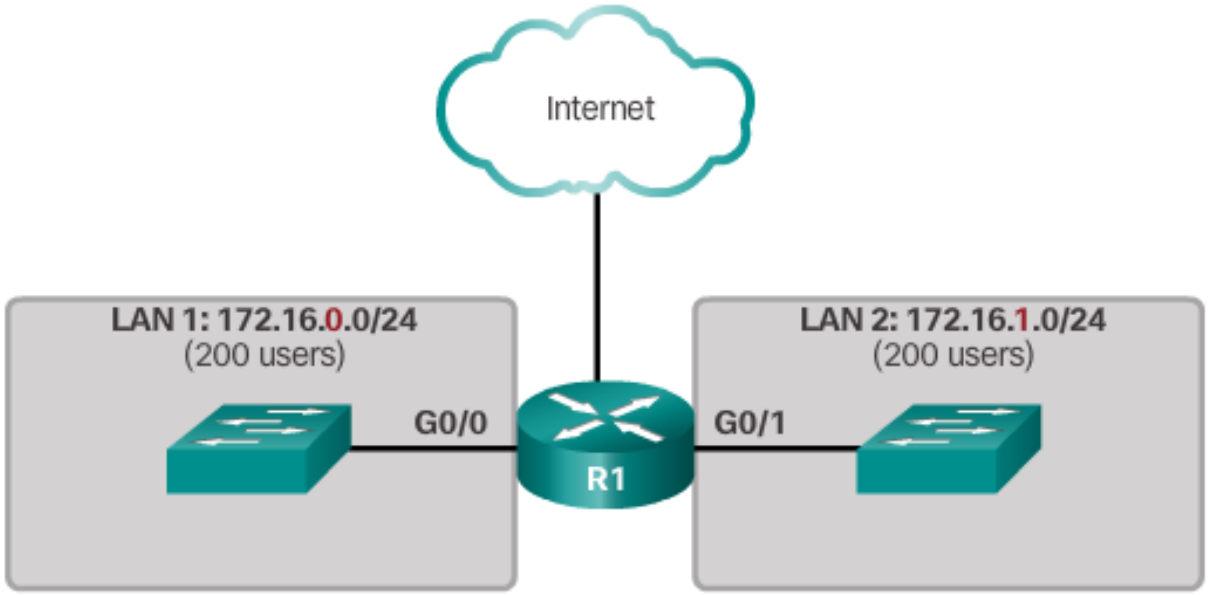
Problems with Large Broadcast Domains

- Slow network operations due to the significant amount of broadcast traffic.
- Slow device operations because a device must accept and process each broadcast packet.



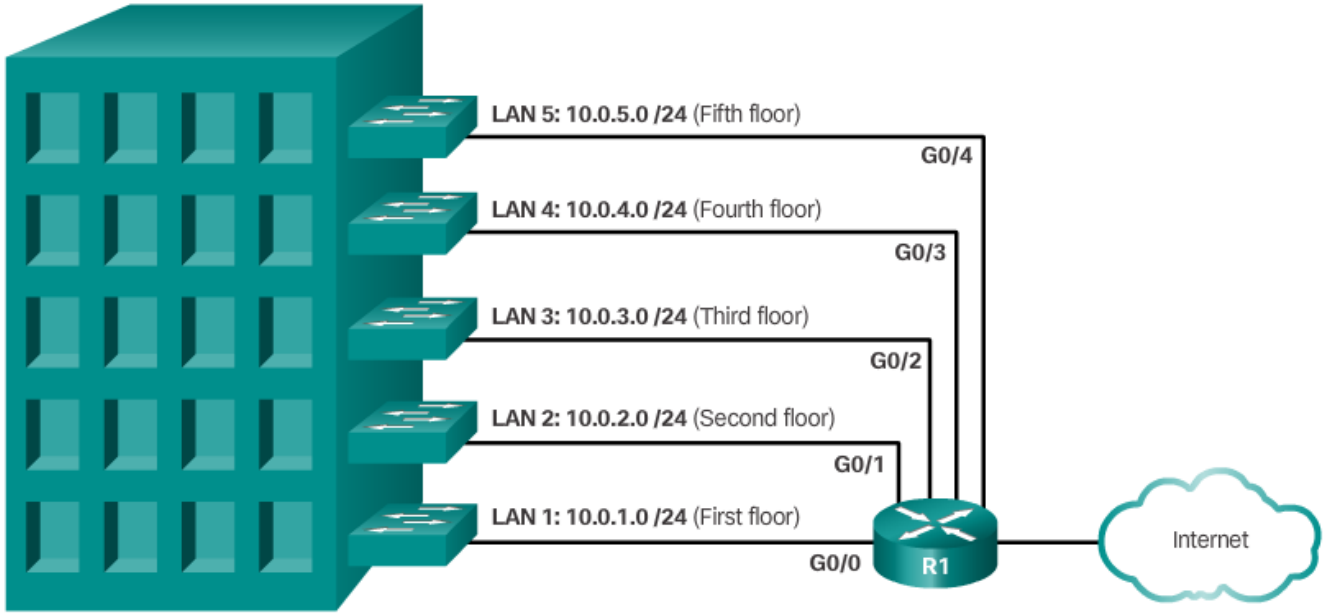
Problems with Large Broadcast Domains (cont.)

- Solution -reduce the size of the network to create smaller broadcast domains in a process called *subnetting*.
- These smaller network spaces are called *subnets*.



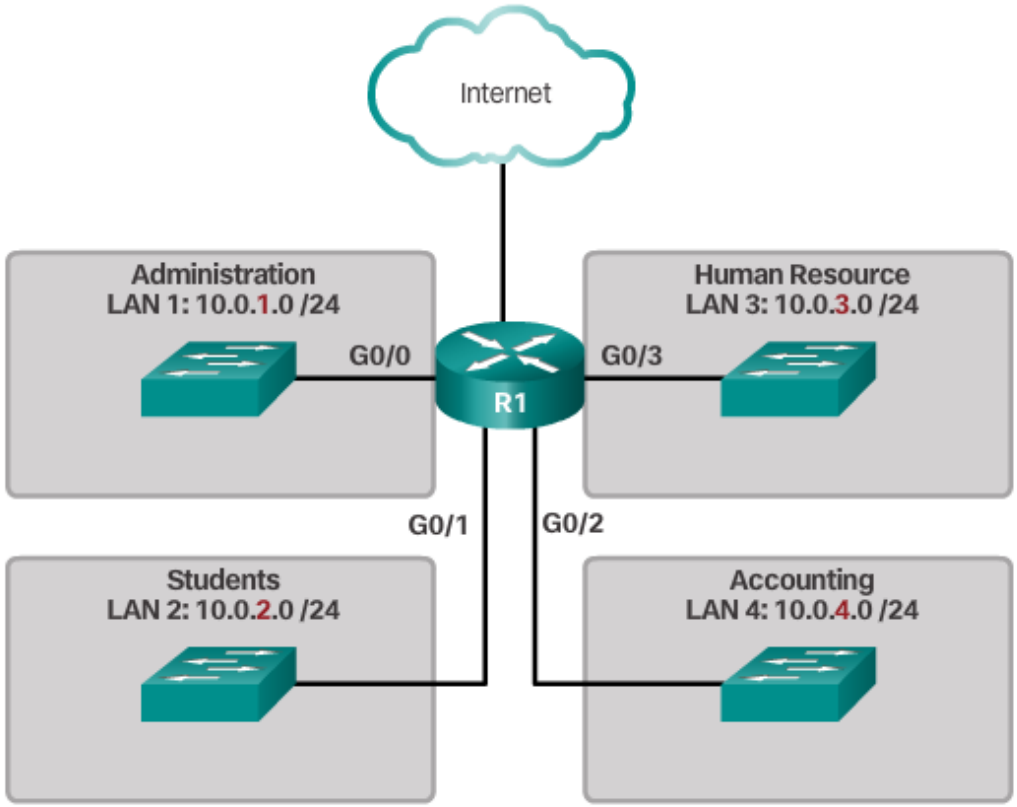
Reasons for Subnetting

Network administrators can group devices and services into subnets that are determined by: Location



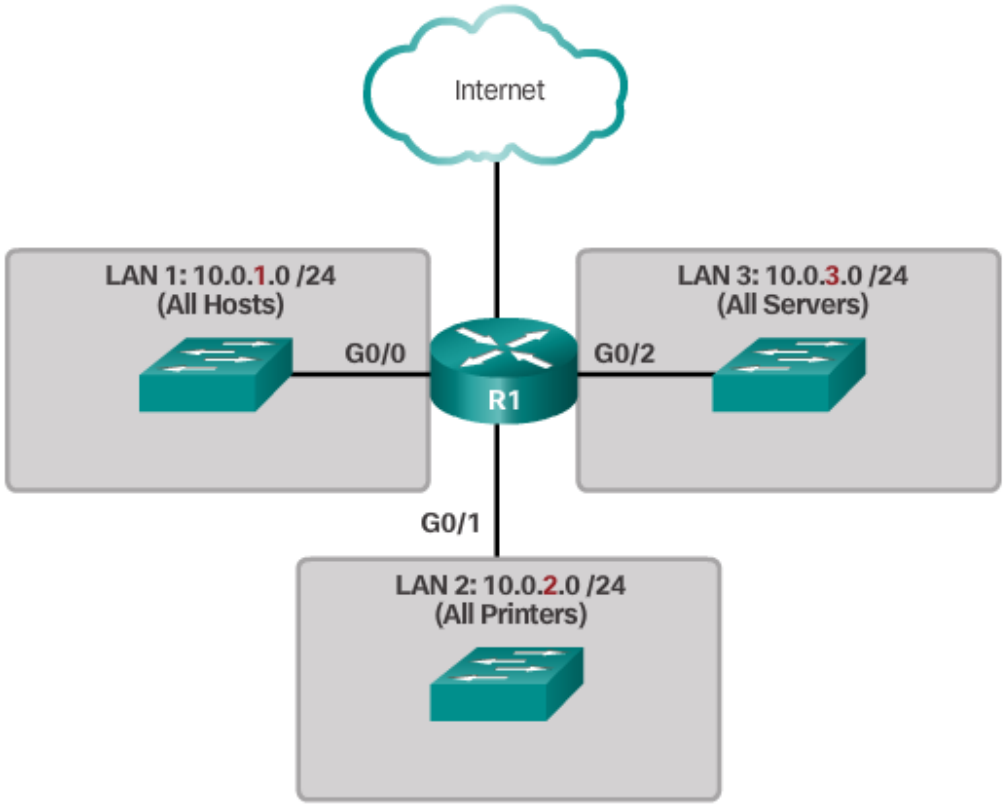
Reasons for Subnetting (cont.)

Network administrators can group devices and services into subnets that are determined by: Organizational unit.



Reasons for Subnetting (cont.)

Network administrators can group devices and services into subnets that are determined by: Device type.



Octet Boundaries

Subnetting Networks on the Octet Boundary

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 on the Octet Boundary

Subnetting 10.x.0.0/16

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
10.2.0.0/16	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 10.x.x.0/24

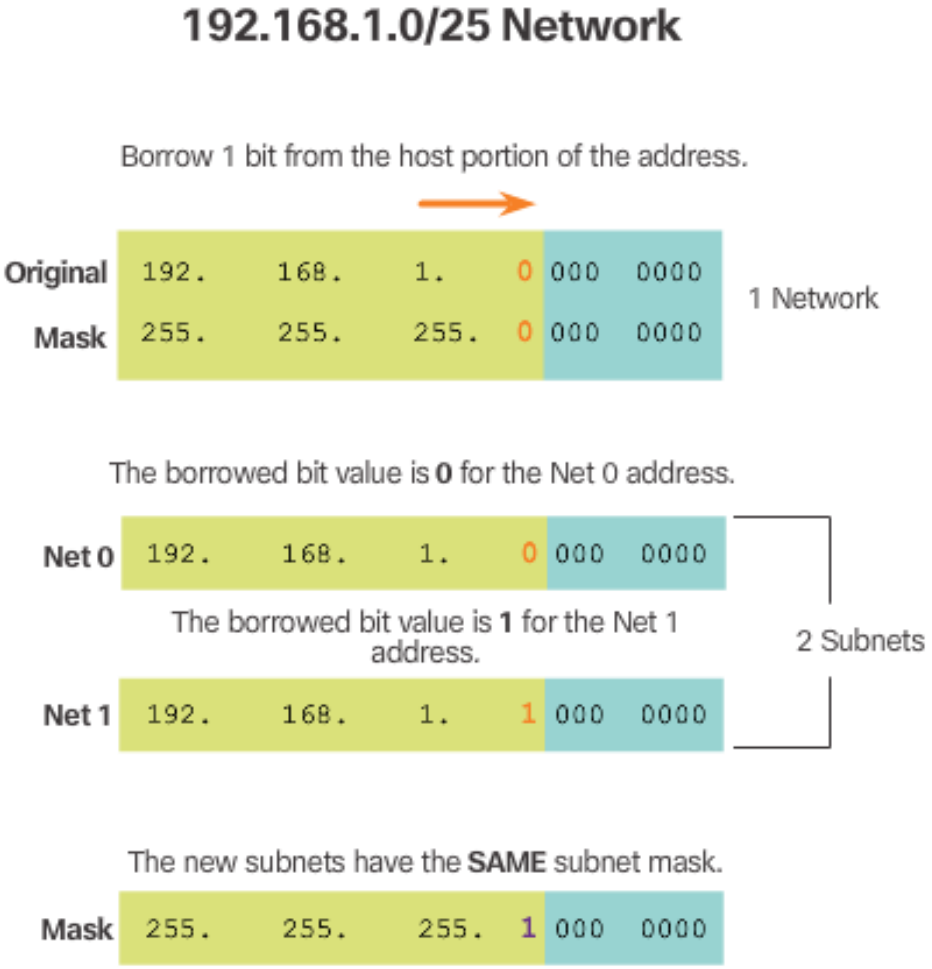
Subnet Address (65,536 Possible Subnets)	Host Range (254 possible hosts per subnet)	Broadcast
10.0.0.0/24	10.0.0.1 – 10.0.0.254	10.0.0.255
10.0.1.0/24	10.0.1.1 – 10.0.1.254	10.0.1.255
10.0.2.0/24	10.0.2.1 – 10.0.2.254	10.0.1.255
…	…	…
10.0.255.0/24	10.0.255.1 – 10.0.255.254	10.0.255.255
10.1.0.0/24	10.1.0.1 – 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

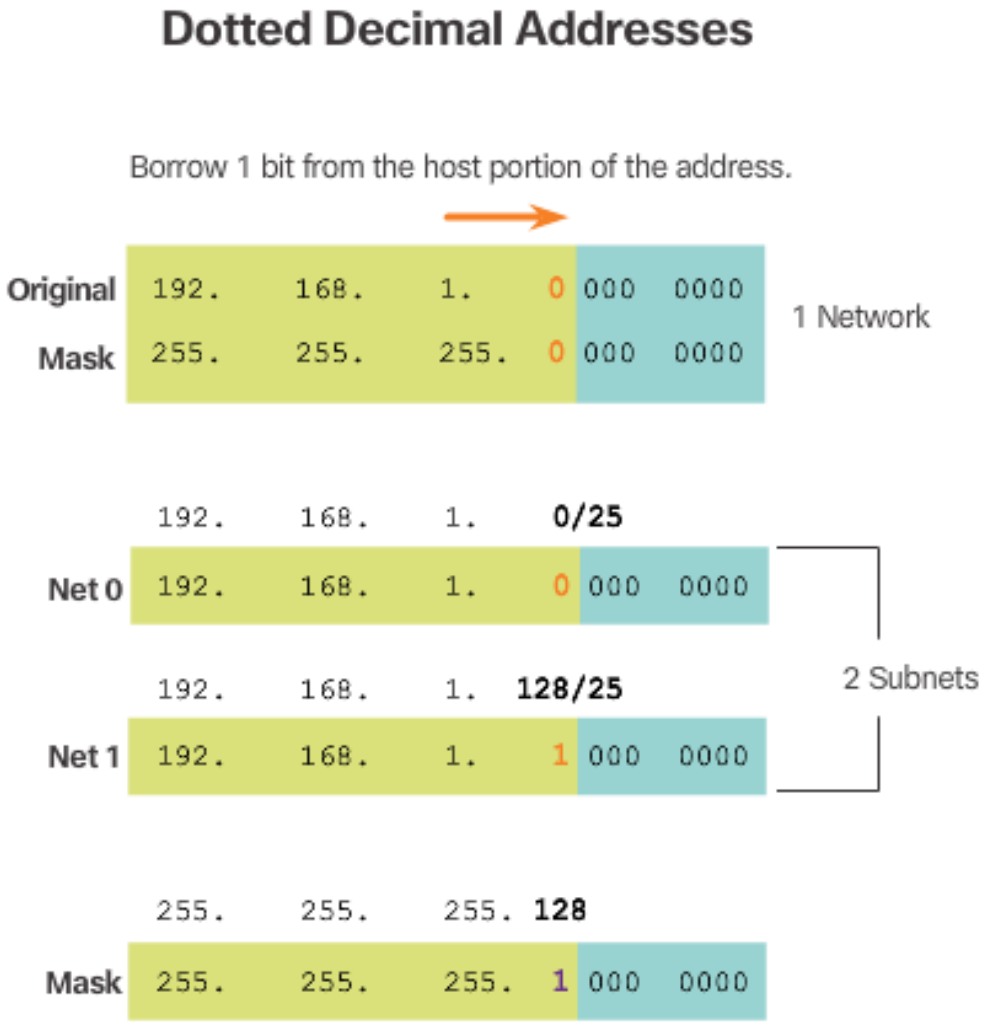
- /25 – Borrowing 1 bit from the fourth octet creates 2 subnets supporting 126 hosts each.
- /26 – Borrowing 2 bits creates 4 subnets supporting 62 hosts each.
- /27– Borrowing 3 bits creates 8 subnets supporting 30 hosts each.
- /28 – Borrowing 4 bits creates 16 subnets supporting 14 hosts each.
- /29 – Borrowing 5 bits creates 32 subnets supporting 6 hosts each.
- /30– Borrowing 6 bits creates 64 subnets supporting 2 hosts each.

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

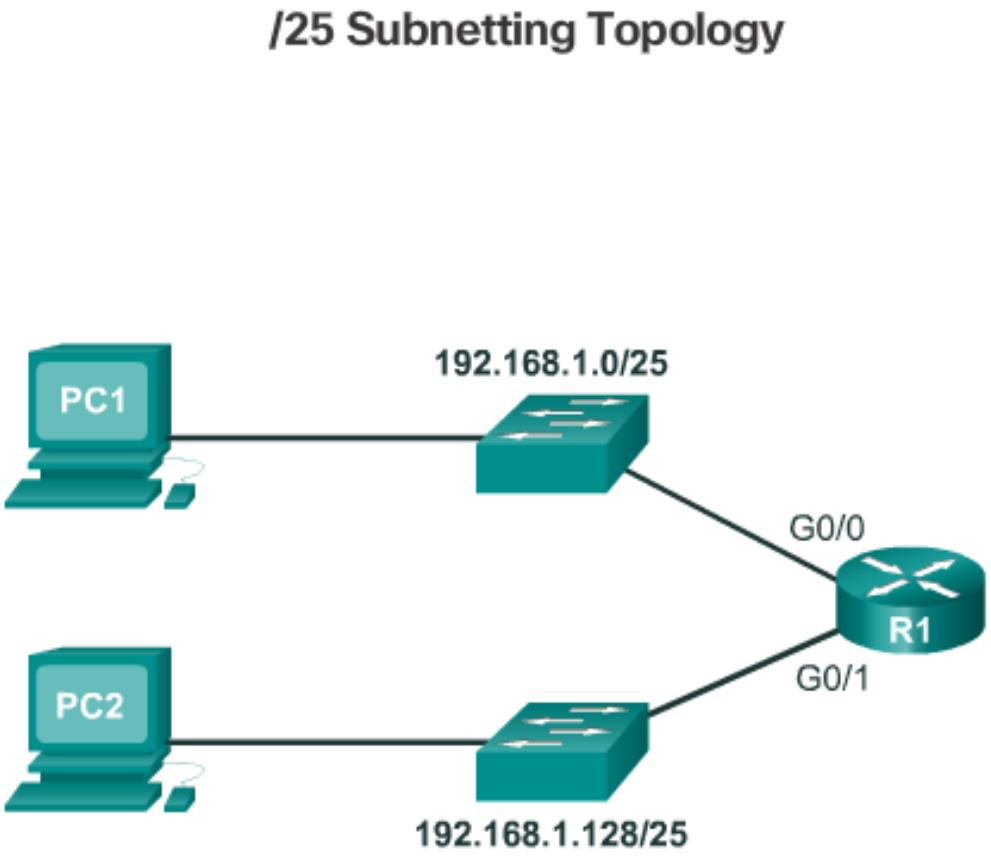
Classless Subnetting Example



Classless Subnetting Example (cont.)



Creating 2 Subnets



Creating 2 Subnets (cont.)

Address Range for 192.168.1.0/25 Subnet

Network Address

192. 168. 1. 0 000 0000 = 192.168.1.0

First Host Address

192. 168. 1. 0 000 0001 = 192.168.1.1

Last Host Address

192. 168. 1. 0 111 1110 = 192.168.1.126

Broadcast Address

192. 168. 1. 0 111 1111 = 192.168.1.127

Address Range for 192.168.1.128/25 Subnet

Network Address

192. 168. 1. 1 000 0000 = 192.168.1.128

First Host Address

192. 168. 1. 1 000 0001 = 192.168.1.129

Last Host Address

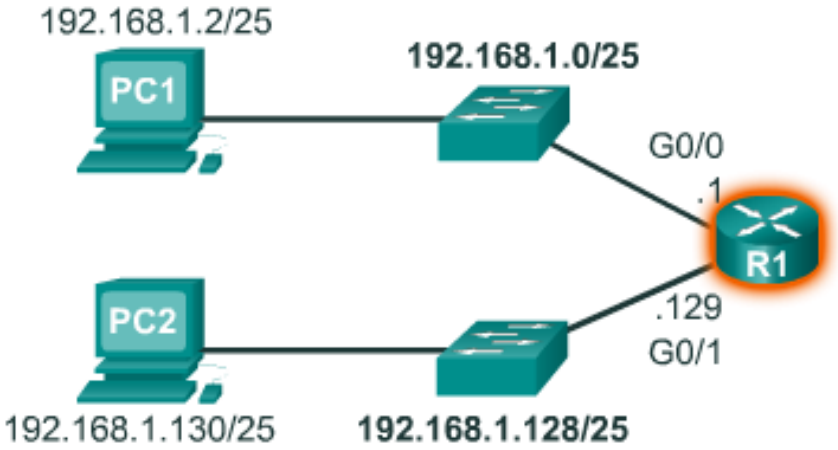
192. 168. 1. 1 111 1110 = 192.168.1.254

Broadcast Address

192. 168. 1. 1 111 1111 = 192.168.1.255

Creating 2 Subnets (cont.)

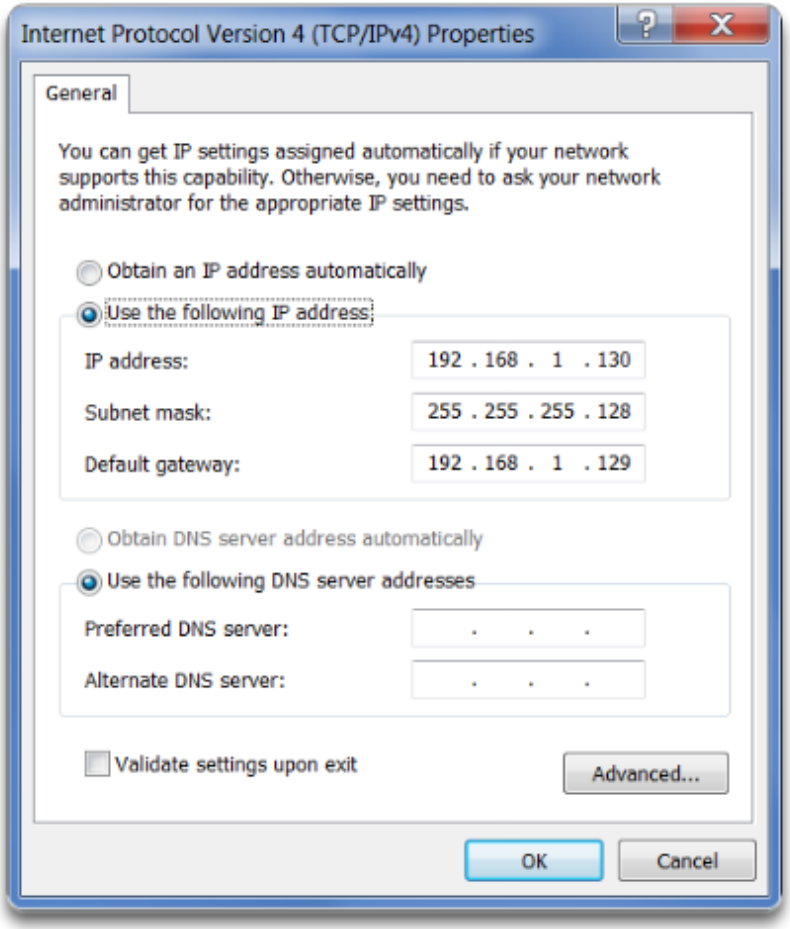
Configure R1 Gigabit Interfaces




```
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
```

Creating 2 Subnets (cont.)

Assign a Valid Host IP Address



Subnetting Formulas

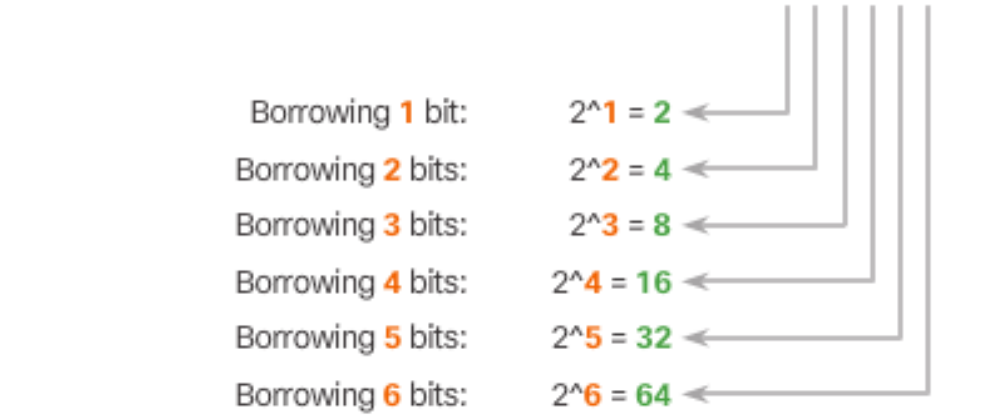
To calculate the number of subnets.

$$2^n$$

n= bits borrowed

192 . 168 . 1 . 0

nnnnnnnn.nnnnnnnn.nnnnnnnn.hhhhhhhh



Subnetting Formulas (cont.)

To calculate the number of hosts.

$$2^n-2$$

n= the number of bits remaining in the host field