Creating 4 Subnets

/26 Subnetting Topology

192.168.1.2/26

192.168.1.0/26

PC1

G0/0

.1

192.168.1.128/26

.130

R1

.129

S0/0/0

R2

S0/0/0

.65

G0/1

PC2

192.168.1.66/26

192.168.1.64/26
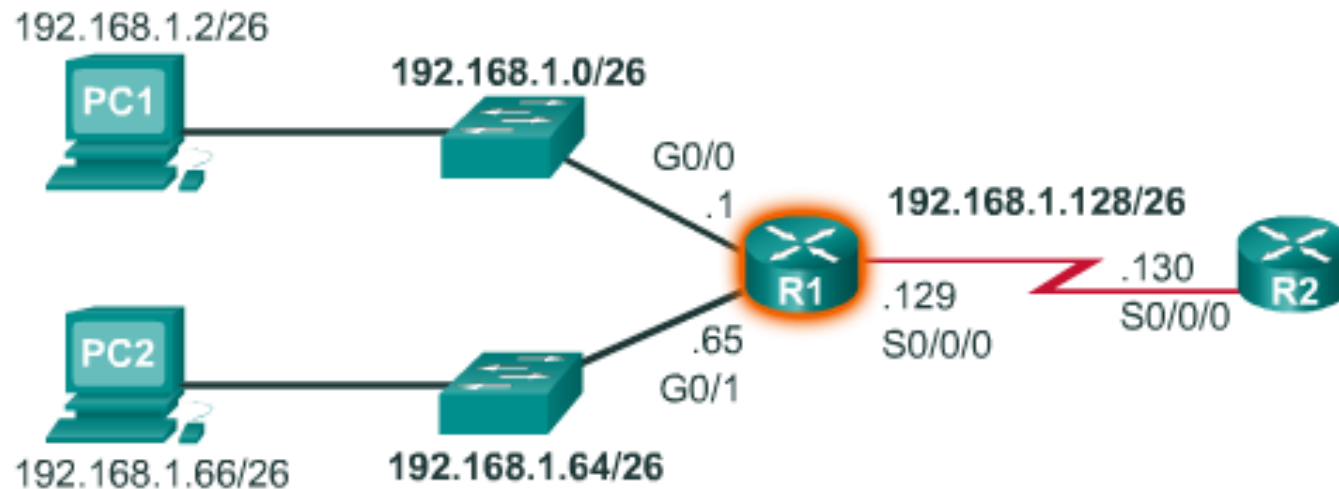
Creating 4 Subnets (cont.)

Borrowing 2 Bits
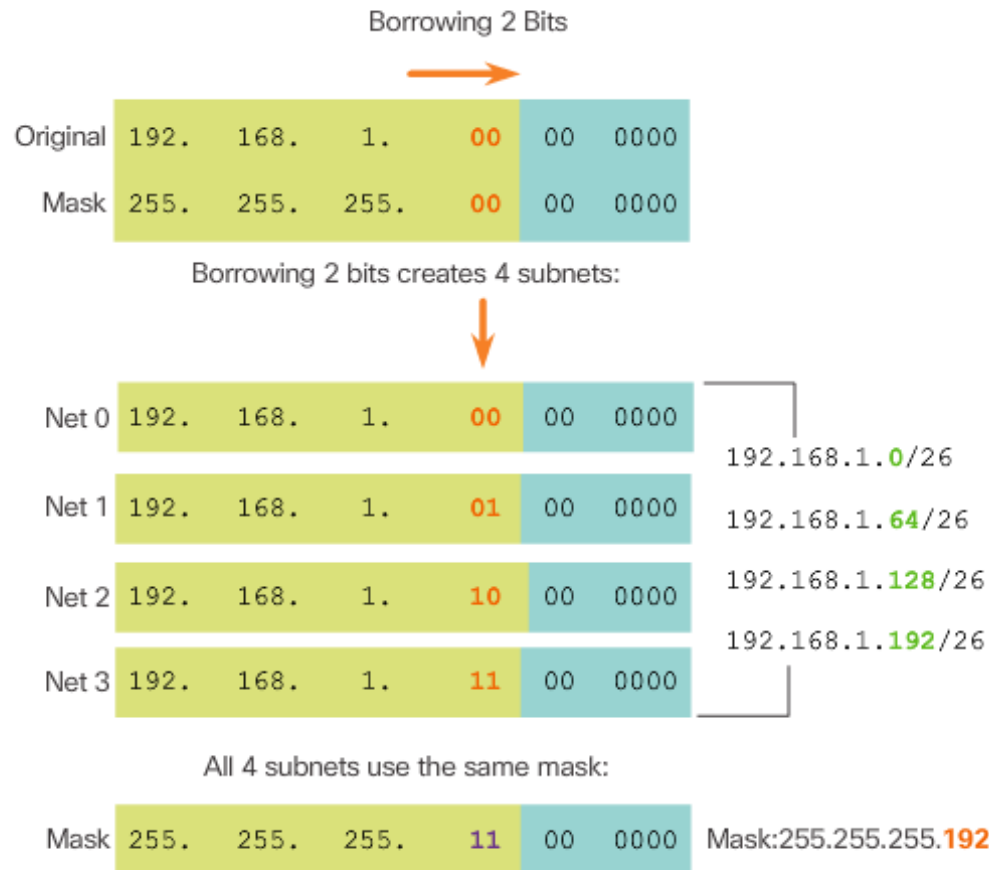
Creating 4 Subnets (cont.)

Calculate Number of Hosts

Address Range for 192.168.1.0/26 Subnet

| 192. | 168. | 1. | 00 | 00 | 0000 |

6 bits remain in host field

2^6 = 64 hosts per subnet
$2^6 - 2$ = 62 valid hosts per subnet

Network Address

| 192. | 168. | 1. | 00 | 00 | 0000 | = 192.168.1.0

First Host Address

| 192. | 168. | 1. | 00 | 00 | 0001 | = 192.168.1.1

Last Host Address

| 192. | 168. | 1. | 00 | 11 | 1110 | = 192.168.1.62

Broadcast Address

| 192. | 168. | 1. | 00 | 11 | 1111 | = 192.168.1.63

Creating 4 Subnets (cont.)

Address Ranges Nets 0 – 2

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

Creating 4 Subnets (cont.)

Configuring the Interfaces with /26 Addresses
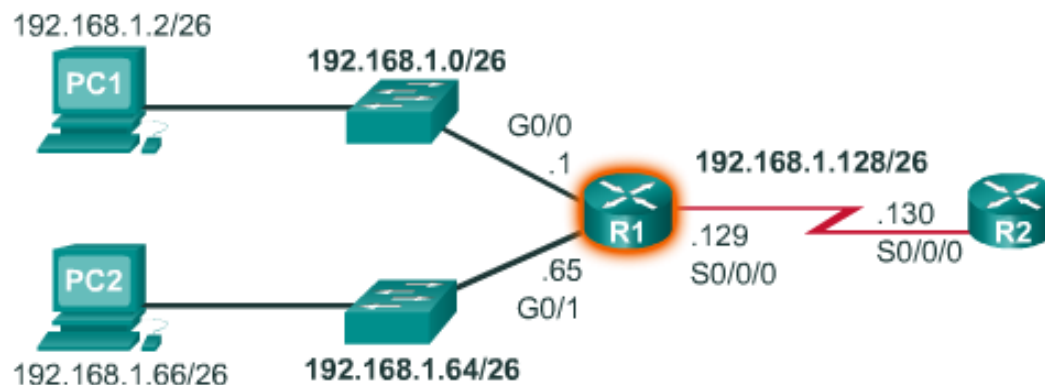

```
R1(config)#interface gigabitethernet 0/0
R1(config-if)#ip address 192.168.1.1 255.255.255.192
R1(config-if)#exit
R1(config)#interface gigabitethernet 0/1
R1(config-if)#ip address 192.168.1.65 255.255.255.192
R1(config-if)#exit
R1(config)#interface serial 0/0/0
R1(config-if)#ip address 192.168.1.129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

Creating Subnets with a /16 prefix

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	32564
/18	255.255.192.0	nnnnnnnn.nnnnnnnn.nnhhhhhh.hhhhhhhh 11111111.11111111.11000000.00000000	4	16282
/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
/23	255.255.254.0	nnnnnnnn.nnnnnnnn.nnnnnnnh.hhhhhhhh 11111111.11111111.11111110.00000000	128	510
/24	255.255.255.0	nnnnnnnn.nnnnnnnn.nnnnnnnn.hhhhhhhh 11111111.11111111.11111111.00000000	256	254
/25	255.255.255.128	nnnnnnnn.nnnnnnnn.nnnnnnnn.nhhhhhhh 11111111.11111111.11111111.10000000	512	126
/26	255.255.255.192	nnnnnnnn.nnnnnnnn.nnnnnnnn.nnhhhhhh 11111111.11111111.11111111.11000000	1024	62
/27	255.255.255.224	nnnnnnnn.nnnnnnnn.nnnnnnnn.nnnhhhhh 11111111.11111111.11111111.11100000	2048	30

Creating 100 Subnets with a /16 Network

172 . 16 . 0 . 0

nnnnnnnn.nnnnnnnn.hhhhhhhh.hhhhhhhh

Borrowing **1** bit: $2^1 = 2$

Borrowing **2** bits: $2^2 = 4$

Borrowing **3** bits: $2^3 = 8$

Borrowing **4** bits: $2^4 = 16$

Borrowing **5** bits: $2^5 = 32$

Borrowing **6** bits: $2^6 = 64$

Borrowing **7** bits: $2^7 = 128$

Borrowing **8** bits: $2^8 = 256$

Borrowing **9** bits: $2^9 = 512$

Borrowing **10** bits: $2^{10} = 1024$

Borrowing **11** bits: $2^{11} = 2048$

Borrowing **12** bits: $2^{12} = 4096$

Borrowing **13** bits: $2^{13} = 8192$

Borrowing **14** bits: $2^{14} = 16384$

Creating 100 Subnets with a /16 Network (cont.)

Resulting /23 Subnets

Borrowing 7 bits creates 128 subnets

172.	16.	0000 0000.	0000 0000	172.16.0.0/23
172.	16.	0000 0010.	0000 0000	172.16.2.0/23
172.	16.	0000 0100.	0000 0000	172.16.4.0/23

. . to . .

| 172. | 16. | 1111 1110. | 0000 0000 | 172.16.254.0/23 |

Calculating the Hosts

Hosts = 2^n
(where n = host bits remaining)

172.	16.	00 00 00 00. 0000 0000

9 bits remain in host field
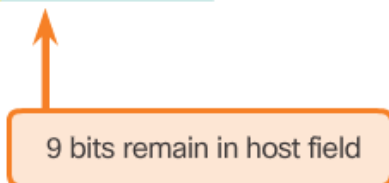
2^9 = 512 hosts per subnet
2^9 – 2 = 510 valid hosts per subnet

Address Range for 172.16.0.0/23 Subnet

Network Address

| 172. | 16. | 00 00 00 00. 0000 0000 | = 172.16.0.0/23 |

First Host Address
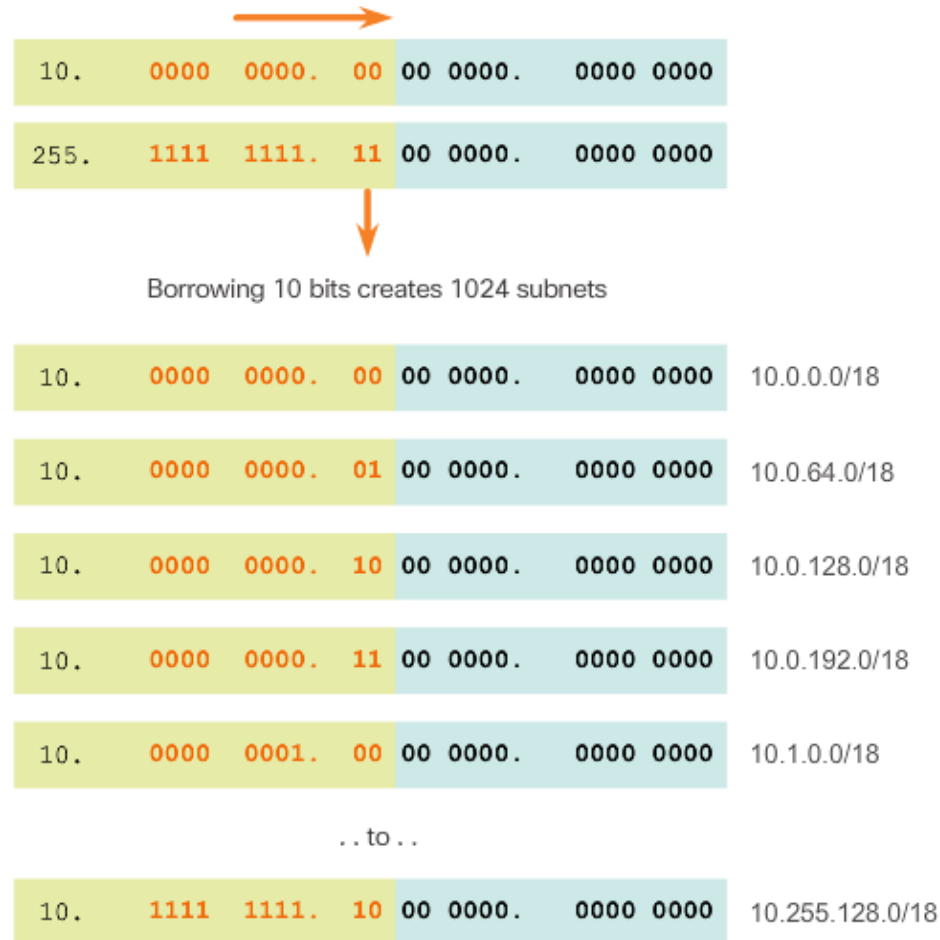
| 172. | 16. | 00 00 00 00. 0000 0001 | = 172.16.0.1/23 |

Last Host Address

| 172. | 16. | 00 00 00 01. 1111 1110 | = 172.16.1.254/23 |

Broadcast Address

| 172. | 16. | 00 00 00 01. 1111 1111 | = 172.16.1.255/23 |

Creating 1000 Subnets with a /8 Network

Borrowing 10 bits creates 1024 subnets

10.	0000	0000.	00	00 0000.	0000 0000	10.0.0.0/18
10.	0000	0000.	01	00 0000.	0000 0000	10.0.64.0/18
10.	0000	0000.	10	00 0000.	0000 0000	10.0.128.0/18
10.	0000	0000.	11	00 0000.	0000 0000	10.0.192.0/18
10.	0000	0001.	00	00 0000.	0000 0000	10.1.0.0/18

. . to . .

| 10. | 1111 | 1111. | 10 | 00 0000. | 0000 0000 | 10.255.128.0/18 |

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

Calculating Hosts

| 10. | 00 00 00 00. | 0000 0000. | 0000 0000 |

↑
14 bits remain in host field

2^{14} = 16384 hosts per subnet
2^{14} – 2 = 16382 valid hosts per subnet

Address Range for 10.0.0.0/18 Subnet

Network Address

| 10. | 00 00 00 00. | 0000 0000. | 0000 0000 | = 10.0.0.0/18 |

First Host Address

| 10. | 00 00 00 00. | 0000 0000. | 0000 0001 | = 10.0.0.1/18 |

Last Host Address

| 10. | 00 00 00 00. | 0011 1111. | 1111 1110 | = 10.0.63.254/18 |

Broadcast Address

| 10. | 00 00 00 00. | 0011 1111. | 1111 1111 | = 10.0.63.255/18 |

Subnetting Based on Host Requirements

Two considerations when planning subnets:

- The number of host addresses required for each network.

- The number of individual subnets needed.

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

The more bits borrowed to create subnets, the fewer host bits available.

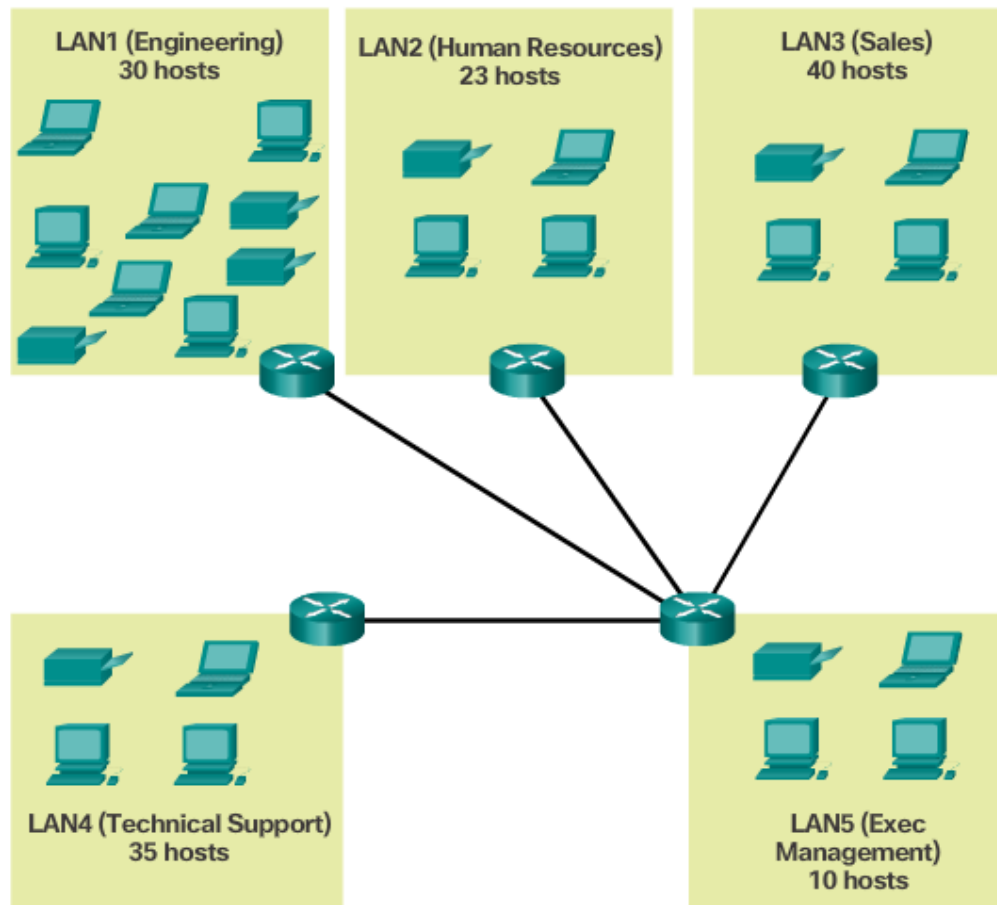# Subnetting Based on Network Requirements

Subnets Based on Organizational Structure

Research and Development

Executive Management

Sales

Technical Support

Human Resources

Engineers

Corporate Network

Network Requirement Example

Corporate Network

LAN1 (Engineering)
30 hosts

LAN2 (Human Resources)
23 hosts

LAN3 (Sales)
40 hosts

LAN4 (Technical Support)
35 hosts

LAN5 (Exec Management)
10 hosts

Network Requirement Example (cont.)

	Network Portion	Host Portion	Dotted Decimal
	10101100.00010000.000000	00.00 000000	172.16.0.0/22
0	10101100.00010000.000000	00.00 000000	172.16.0.0/26
1	10101100.00010000.000000	00.01 000000	172.16.0.64/26
2	10101100.00010000.000000	00.10 000000	172.16.0.128/26
3	10101100.00010000.000000	00.11 000000	172.16.0.192/26
4	10101100.00010000.000000	01.00 000000	172.16.1.0/26
5	10101100.00010000.000000	01.01 000000	172.16.1.64/26
6	10101100.00010000.000000	01.10 000000	172.16.1.128/26

Nets 7 – 13 not shown

14	10101100.00010000.000000	11.10 000000	172.16.3.128/26
15	10101100.00010000.000000	11.11 000000	172.16.3.192/26

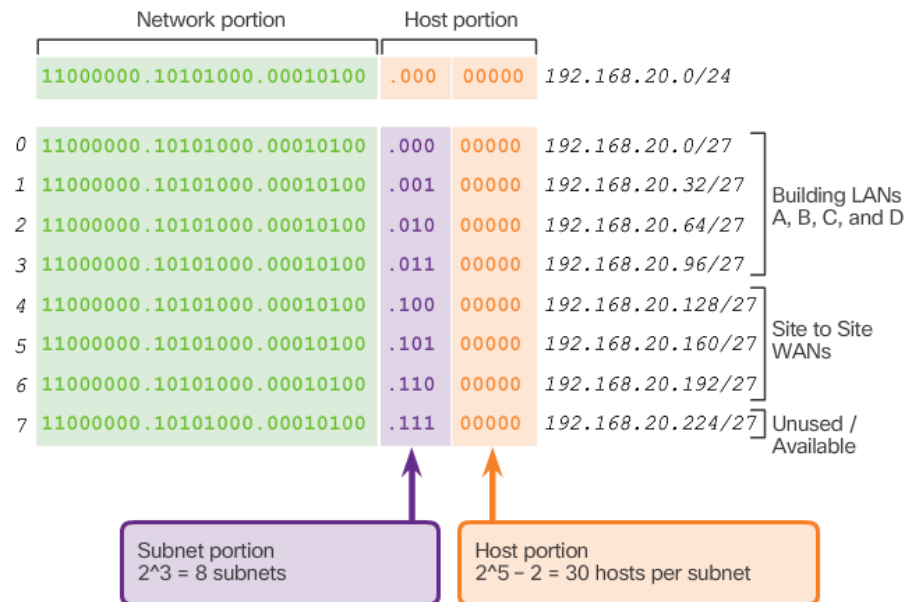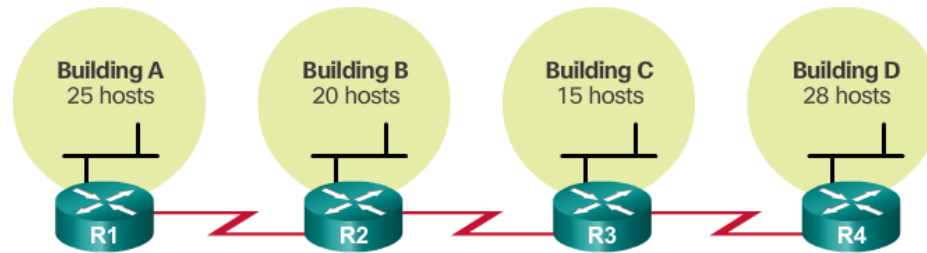4 bits borrowed from host portion to create subnets

Network Requirement Example (cont.)

172.16.0.0/22

LAN 1
172.16.0.0/26

LAN 2
172.16.0.64/26

LAN 3
172.16.1.0/26

172.16.2.64/26

172.16.2.128/26

172.16.2.192/26

172.16.2.0/26

LAN 4
172.16.0.128/26

LAN 5
172.16.0.192/26
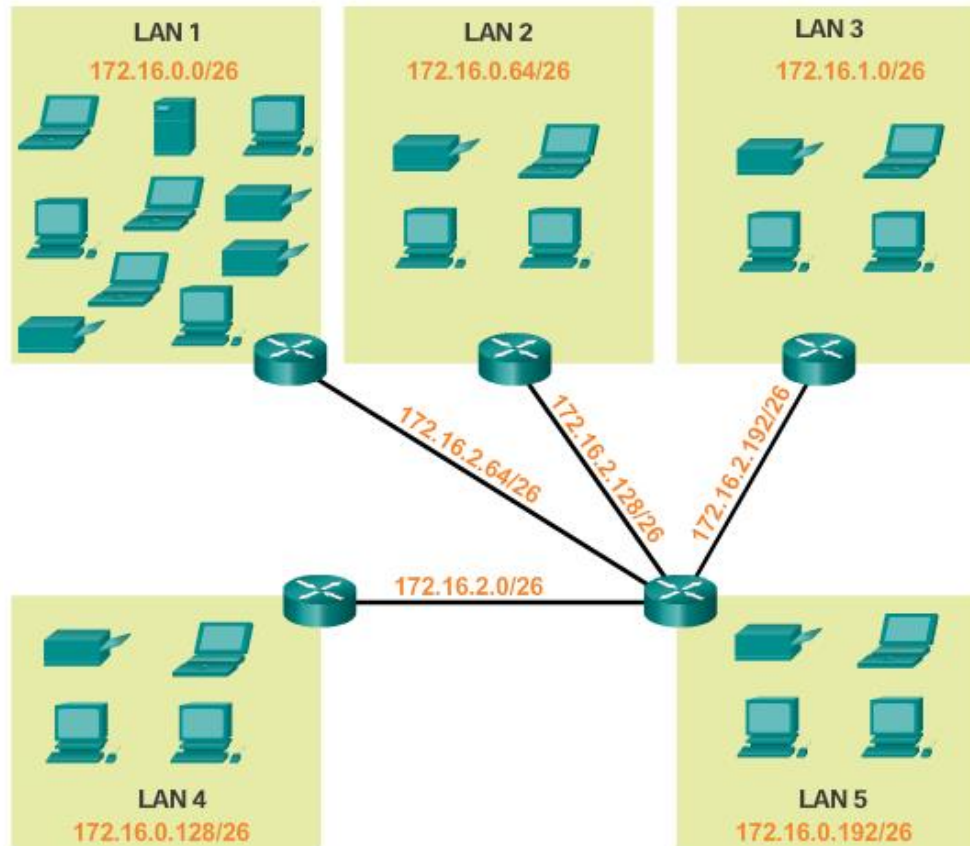
Traditional Subnetting Wastes Addresses

Traditional Subnetting Wastes Addresses (Cont.)

Unused Addresses on WAN Subnets

	Network portion	Host portion		Dotted Decimal
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

Host portion
$2^5 - 2 = 30$ hosts per subnet

$30 - 2 = 28$
Each WAN subnet wastes 28 addresses

$28 \times 3 = 84$
84 addresses are unused