Classful Network Addressing

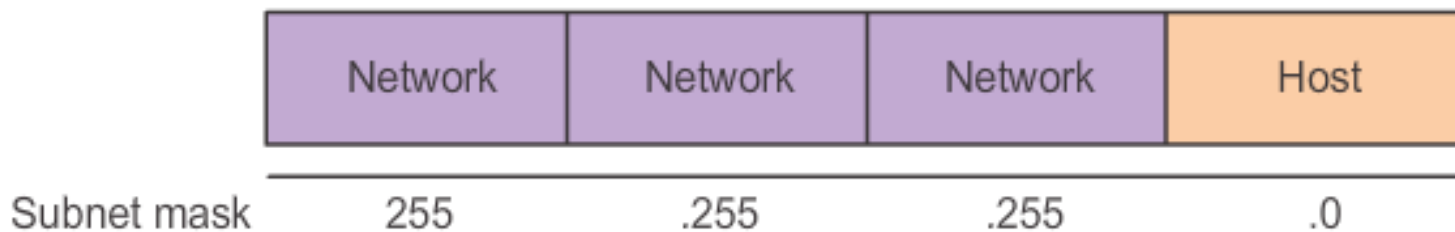| Class	High Order Bits	Start	End
Class A	0xxxxxxx	0.0.0.0	127.255.255.255
Class B	10xxxxxx	128.0.0.0	191.255.255.255
Class C	110xxxxx	192.0.0.0	223.255.255.255
Multicast	1110xxxx	224.0.0.0	239.255.255.255
Reserved	1111xxxx	240.0.0.0	255.255.255.255

Classful Subnet Masks

Class A

Network	Host	Host	Host

Subnet mask   255   .0   .0   .0

Class B

Network	Network	Host	Host

Subnet mask   255   .255   .0   .0

Class C

Network	Network	Network	Host

Subnet mask   255   .255   .255   .0
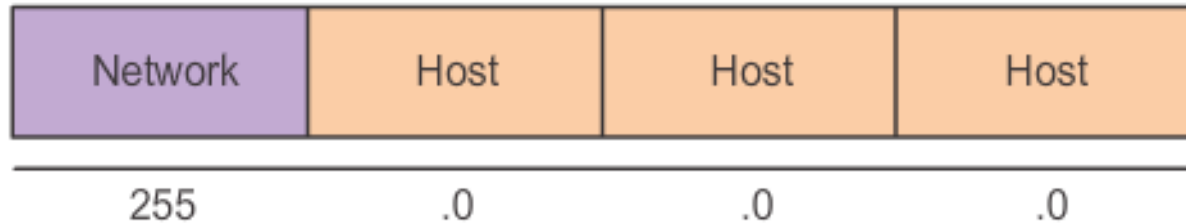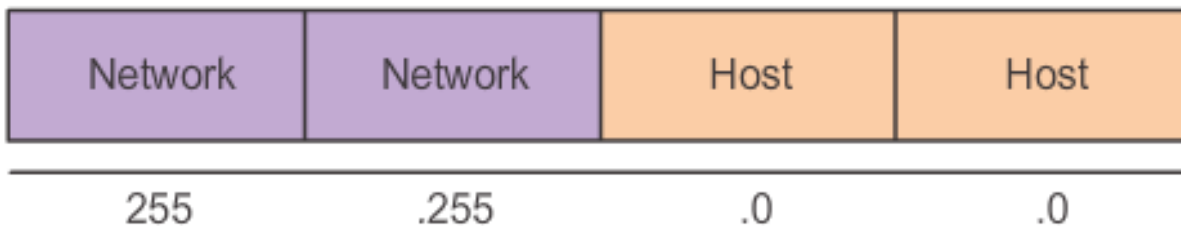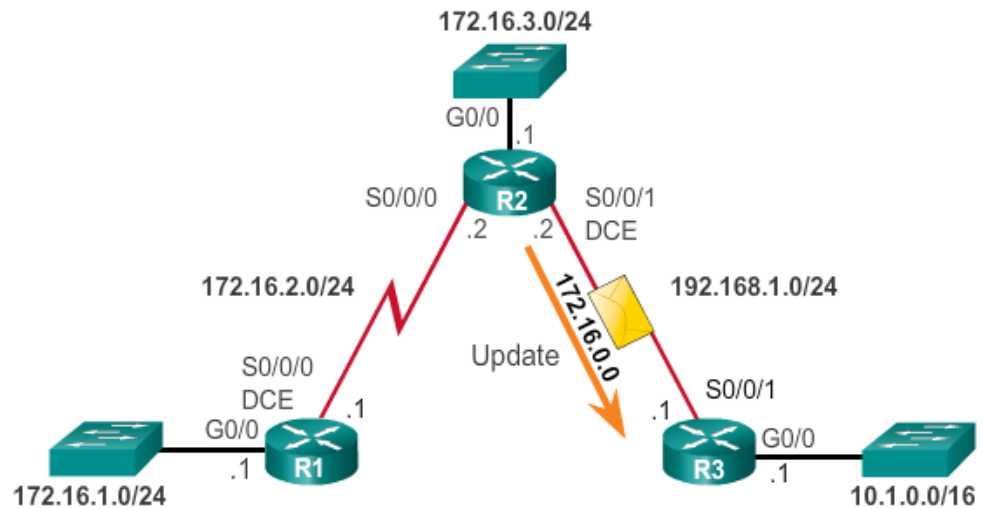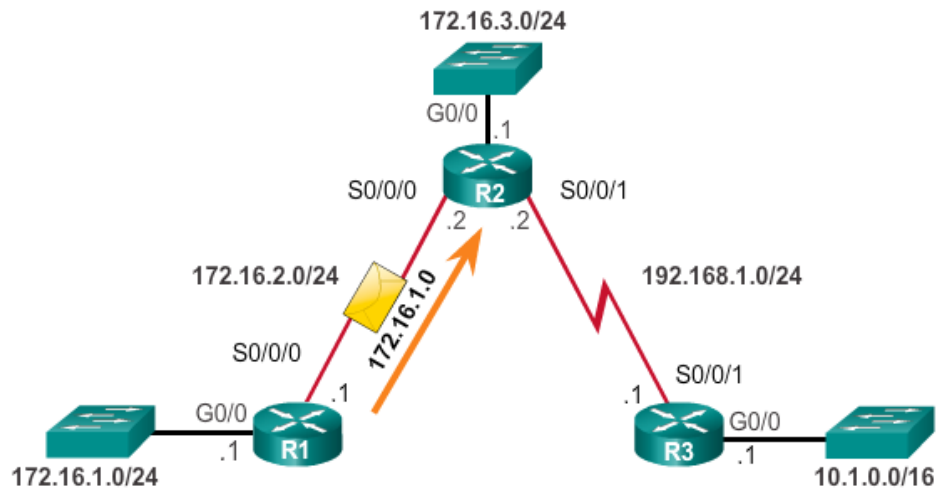
Classful Addressing
Classful Routing Protocol Example

Classful Addressing Waste

Classfull IP Address Allocation = Inefficient
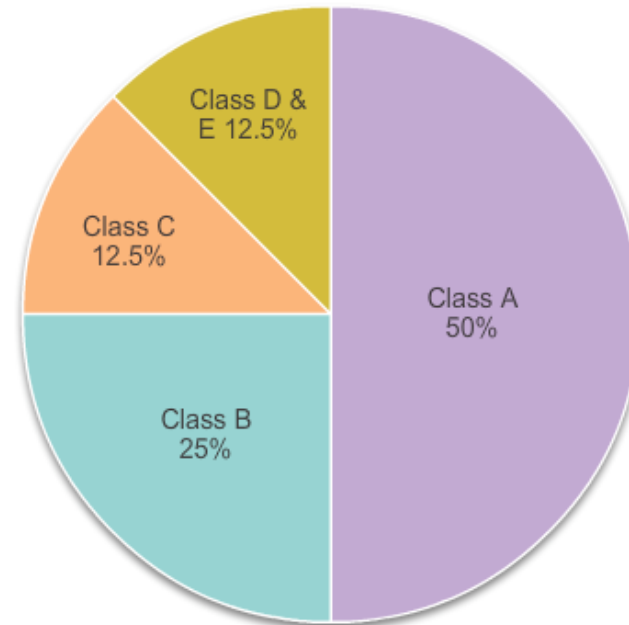
Class A (1 - 126)
# of possible networks: 126
# of Hosts/Net: 16,777,214
Max. # Hosts: 2,113,928,964

Class B (128 – 191)
# of possible networks: 16,384
# of Hosts/Net: 65,534
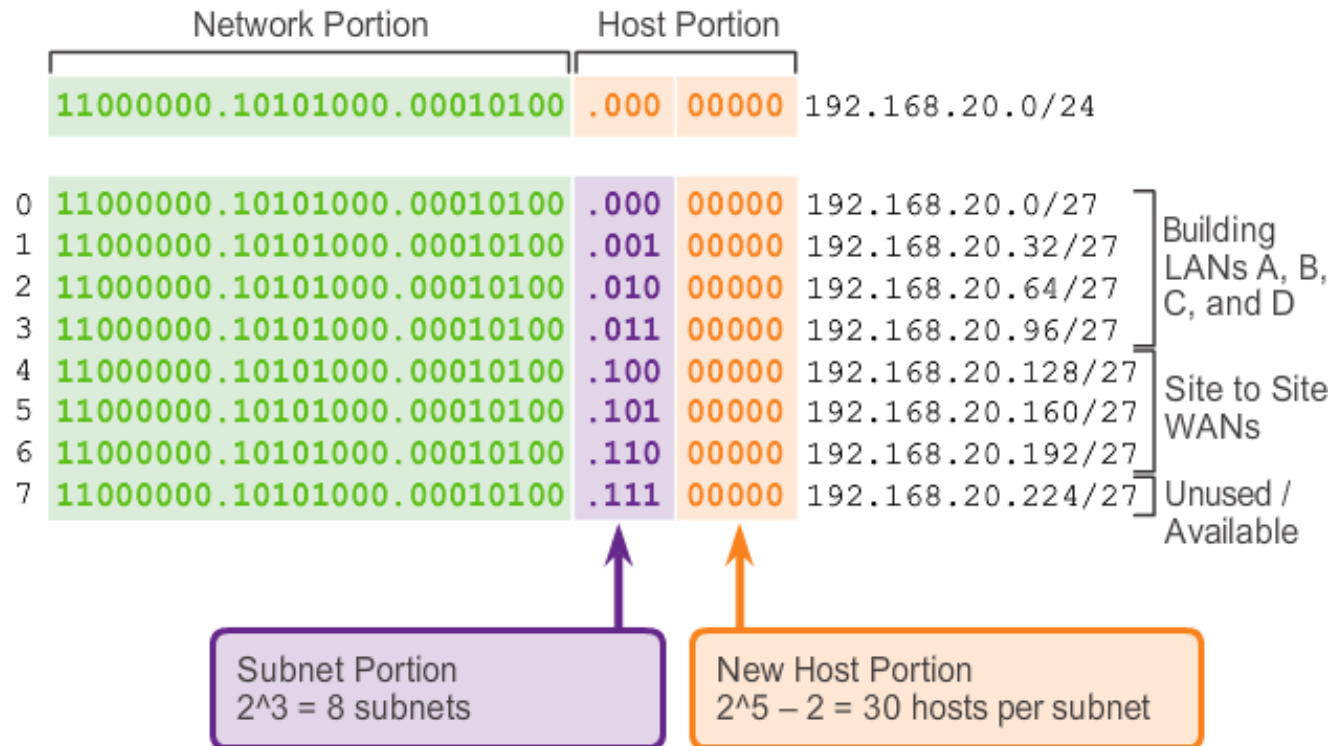Max. # Hosts: 1,073,709,056

Class C (192 – 223)
# of possible networks: 2,097,152
# of Hosts/Net: 254
Max. # Hosts: 532,676,608

Class D & E 12.5%

Class C 12.5%

Class A 50%

Class B 25%

VLSM
Fixed Length Subnet Masking

Basic Subnet Scheme

	Network Portion	Host Portion	
	11000000.10101000.00010100	.000 00000	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

Building LANs A, B, C, and D

Site to Site WANs

Unused / Available

Subnet Portion
$2^3 = 8$ subnets

New Host Portion
$2^5 - 2 = 30$ hosts per subnet

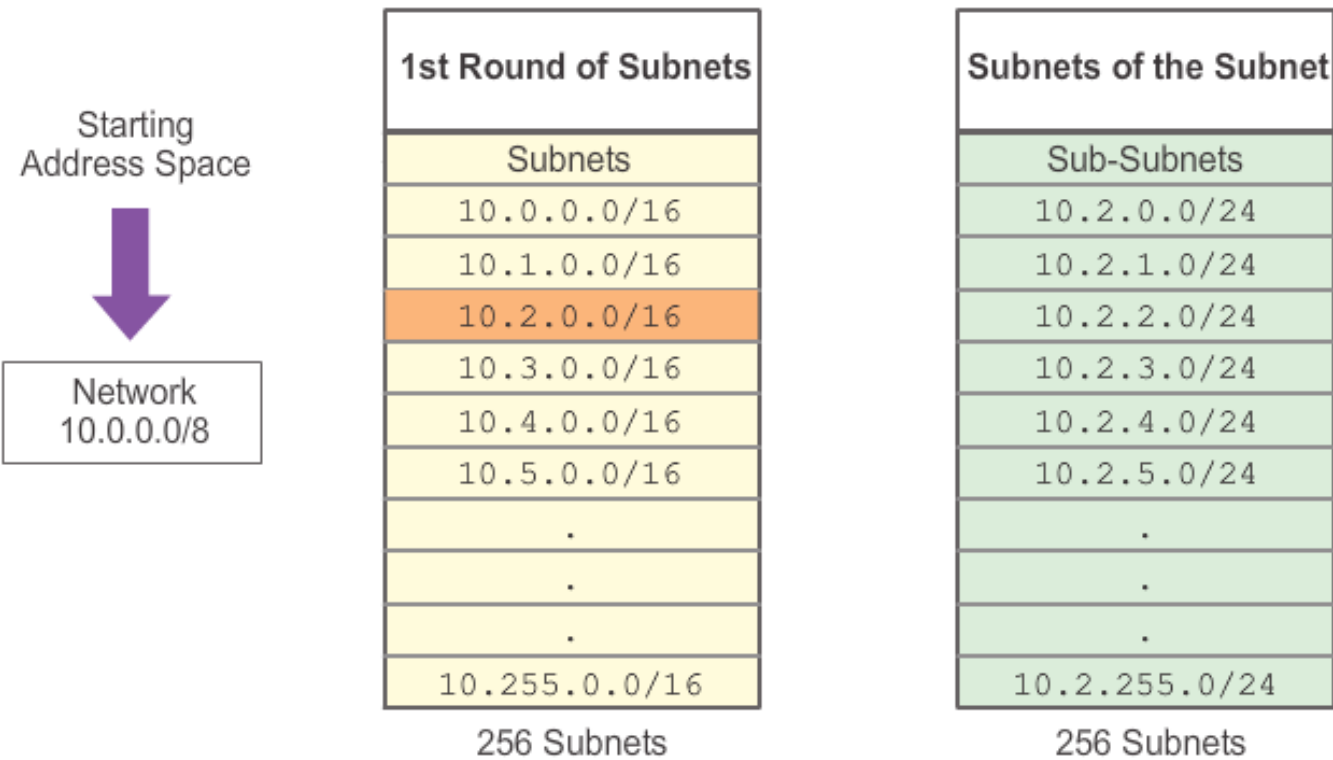# Variable Length Subnet Masking

Subnets of Varying Sizes
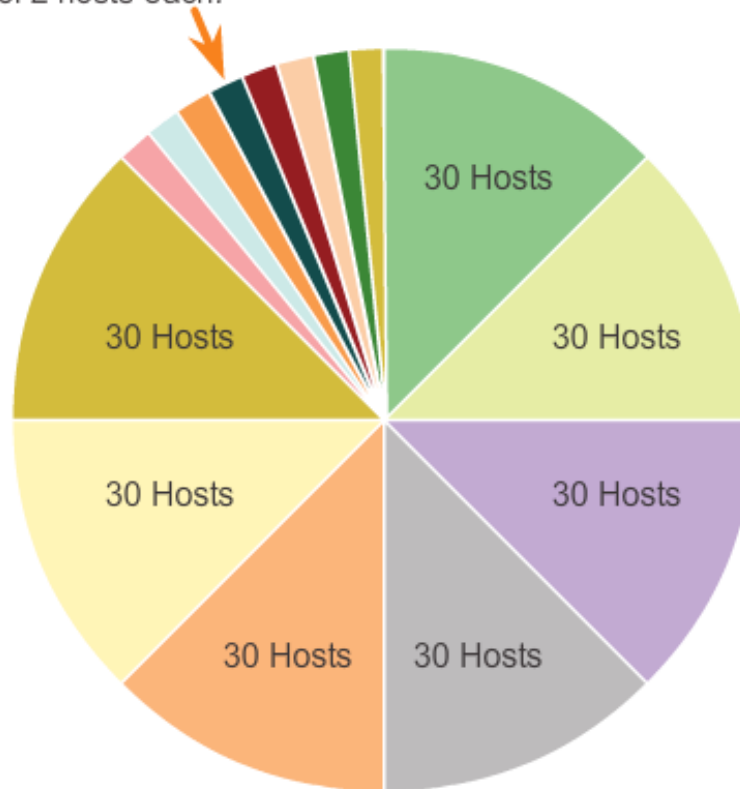
VLSM in Action

- VLSM allows the use of different masks for each subnet.

- After a network address is subnetted, those subnets can be further subnetted.

- VLSM is simply subnetting a subnet. VLSM can be thought of as sub-subnetting.

- Individual host addresses are assigned from the addresses of "sub-subnets".

VLSM
Subnetting Subnets
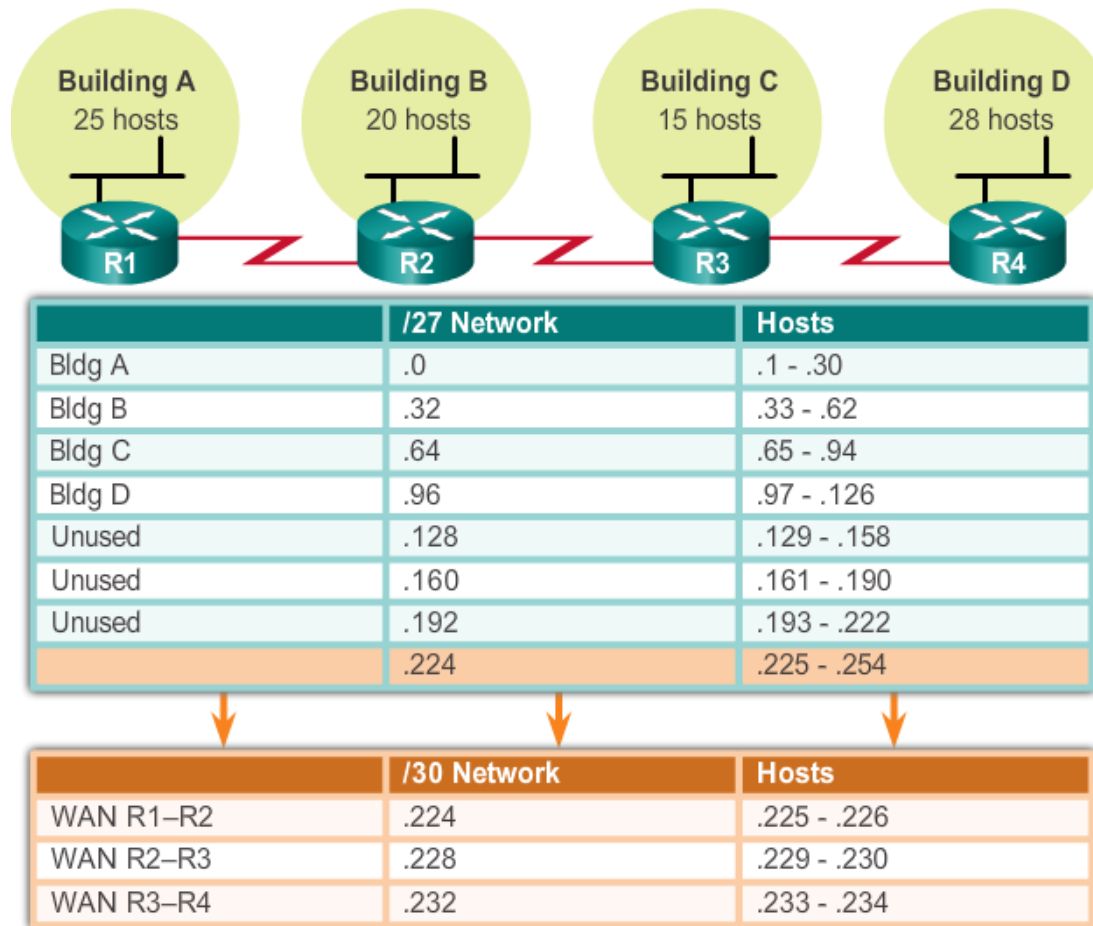

Subnetting the Subnet 10.2.0.0/16 to 10.2.0.0/24

1st Round of Subnets
Subnets
10.0.0.0/16
10.1.0.0/16
10.2.0.0/16
10.3.0.0/16
10.4.0.0/16
10.5.0.0/16
.
.
.
10.255.0.0/16

256 Subnets

Subnets of the Subnet
Sub-Subnets
10.2.0.0/24
10.2.1.0/24
10.2.2.0/24
10.2.3.0/24
10.2.4.0/24
10.2.5.0/24
.
.
.
10.2.255.0/24

256 Subnets

Starting
Address Space

Network
10.0.0.0/8

VLSM Example

Subnetting Subnet 192.168.20.224/27 to 192.168.20.224/30

Building A	Building B	Building C	Building D
25 hosts	20 hosts	15 hosts	28 hosts
R1	R2	R3	R4

	/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

CIDR
Classless Inter-Domain Routing

CIDR = Efficient

Class A (1 – 126)
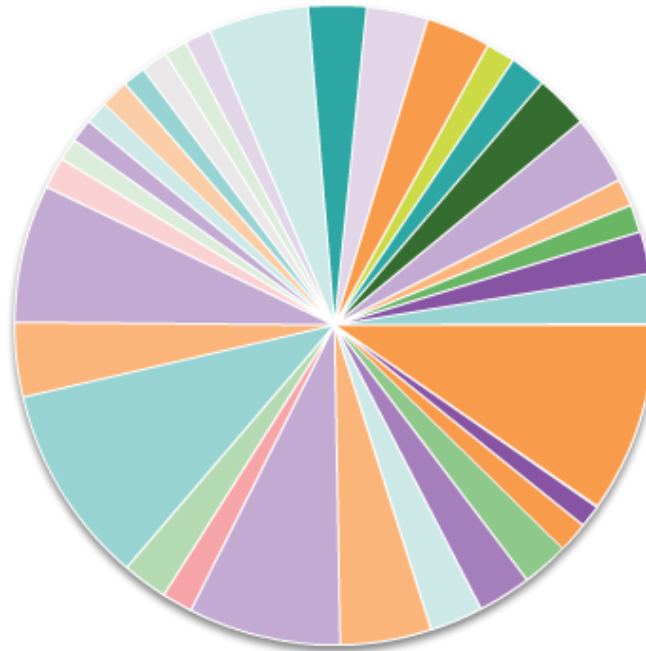# of possible networks: 126
# of Hosts/Net: 16,777,214
Max. # Hosts: 16,777,214

Class B (128 – 191)
# of possible networks: 16,384
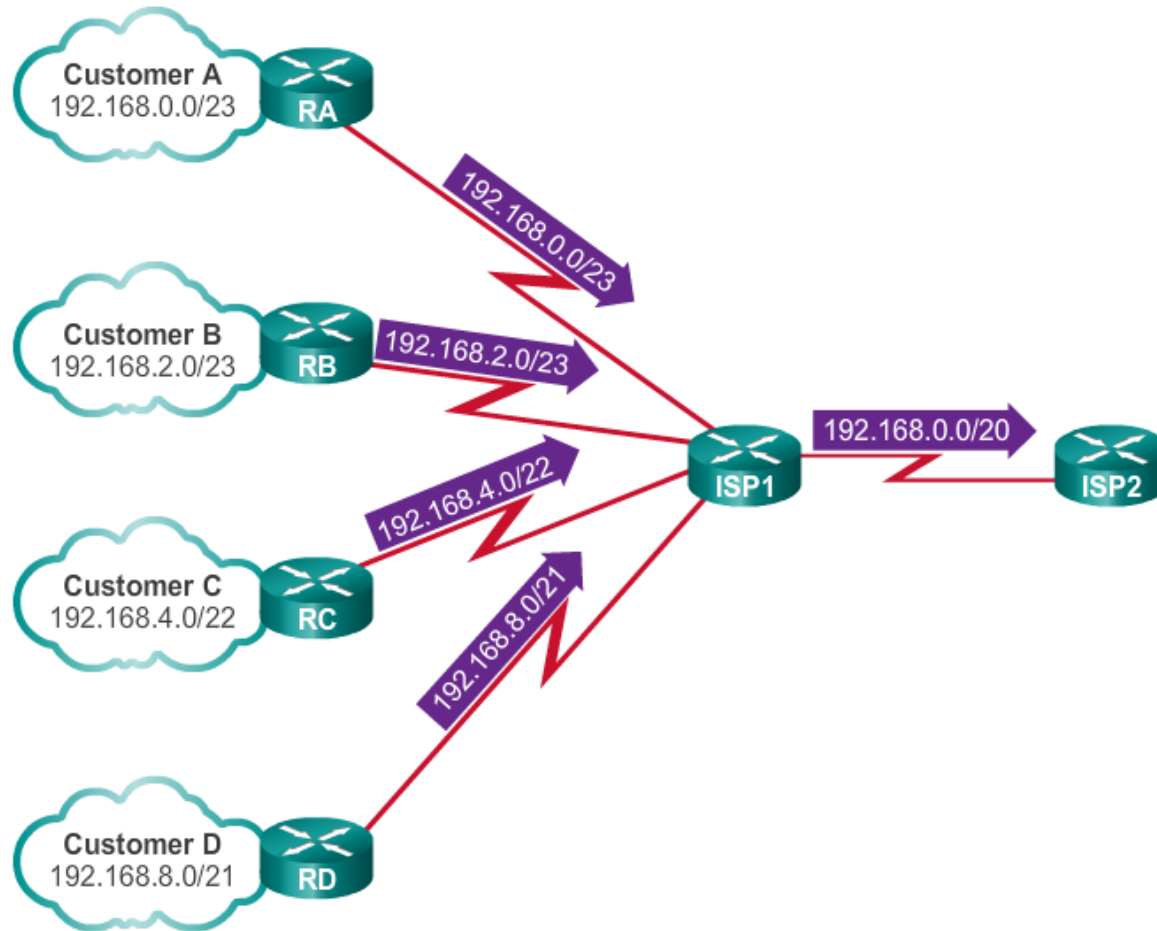# of Hosts/Net: 65,534
Max. # Hosts: 1,073,709,056

Class C (192 – 223)
# of possible networks: 2,097,152
# of Hosts/Net: 254
Max. # Hosts: 532,676,608

CIDR and Route Summarization

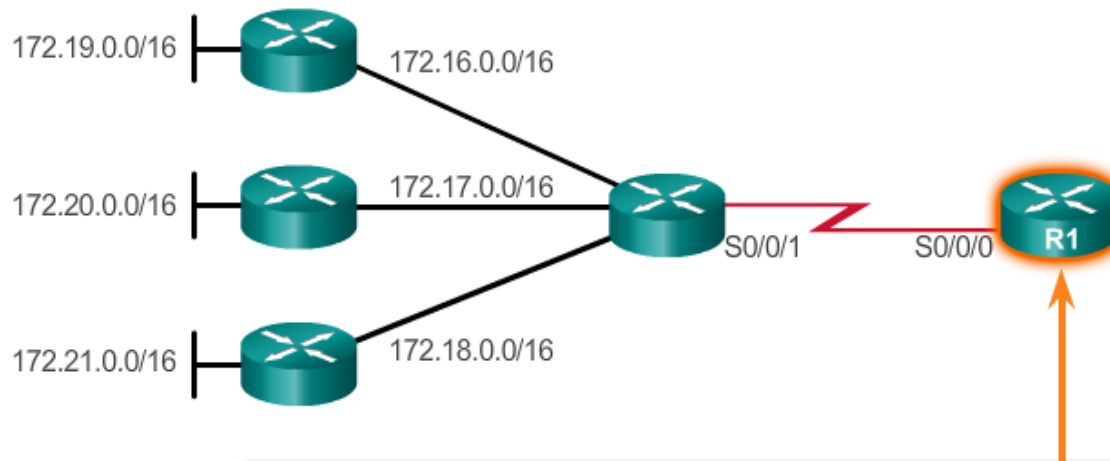Summarizing Supernet Routes

CIDR
Static Routing CIDR Example

One Summary Static Route

172.19.0.0/16

172.16.0.0/16

172.20.0.0/16

172.17.0.0/16

S0/0/1

S0/0/0

R1

172.21.0.0/16

172.18.0.0/16

```
R1(config)#no ip route 172.16.0.0 255.255.0.0 s0/0/0
R1(config)#no ip route 172.17.0.0 255.255.0.0 s0/0/0
R1(config)#no ip route 172.18.0.0 255.255.0.0 s0/0/0
R1(config)#no ip route 172.19.0.0 255.255.0.0 s0/0/0
R1(config)#no ip route 172.20.0.0 255.255.0.0 s0/0/0
R1(config)#no ip route 172.21.0.0 255.255.0.0 s0/0/0
R1(config)#
R1(config)#ip route 172.16.0.0 255.248.0.0 s0/0/0
R1(config)#
```

Classless Routing Protocol Example

Classless Routing Update
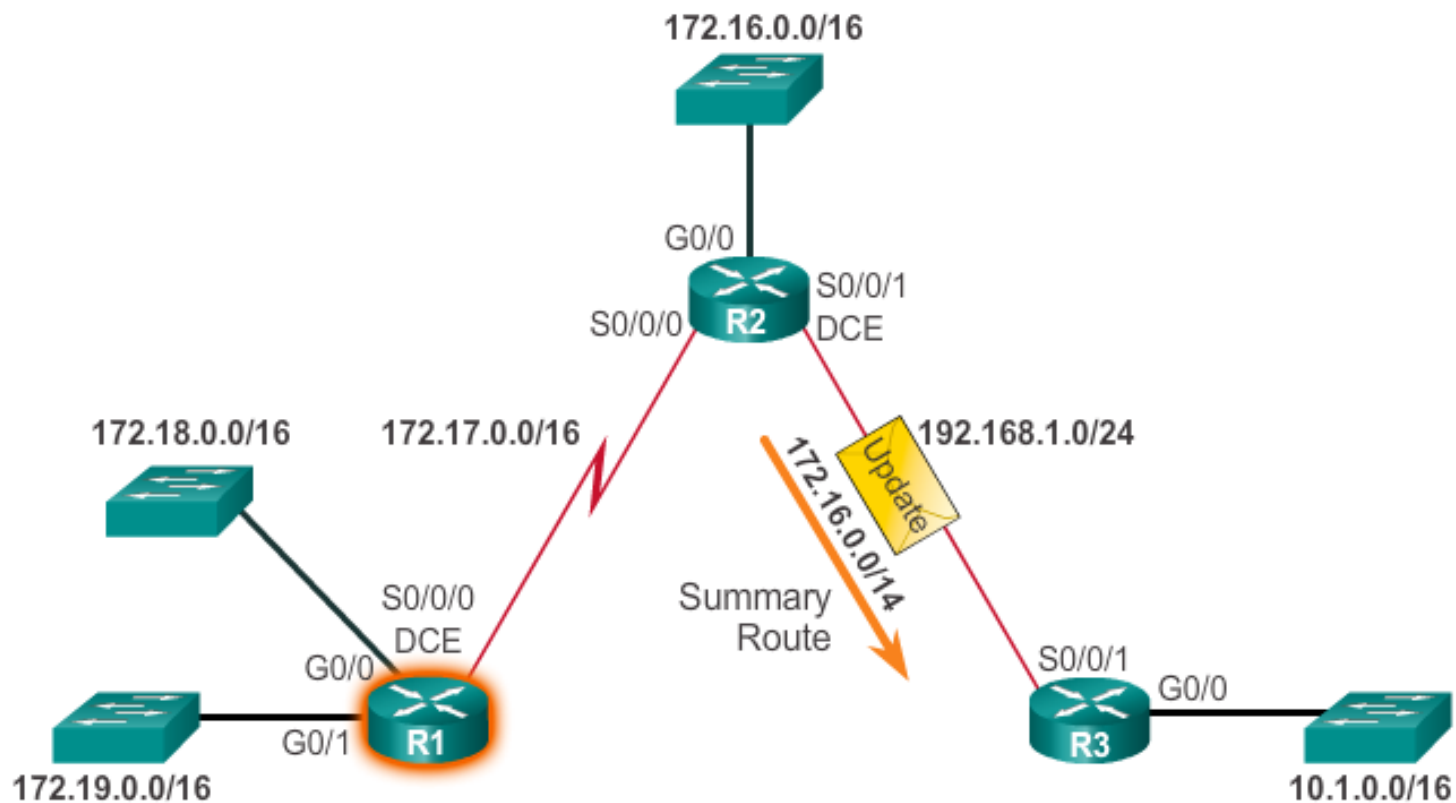
Route Summarization

- Route summarization, also known as route aggregation, is the process of advertising a contiguous set of addresses as a single address with a less-specific, shorter subnet mask.

- CIDR is a form of route summarization and is synonymous with the term supernetting.

- CIDR ignores the limitation of classful boundaries, and allows summarization with masks that are smaller than that of the default classful mask.

- This type of summarization helps reduce the number of entries in routing updates and lowers the number of entries in local routing tables.

Calculate a Summary Route

Calculating a Route Summary

Step 1: List networks in binary format.

172.20.0.0	**10101100 . 000101**00 . 00000000 . 00000000
172.21.0.0	**10101100 . 000101**01 . 00000000 . 00000000
172.22.0.0	**10101100 . 000101**10 . 00000000 . 00000000
172.23.0.0	**10101100 . 000101**11 . 00000000 . 00000000

Step 2: Count the number of far-left matching bits to determine the mask.

Answer: 14 matching bits = /14 or 255.252.0.0

Step 3: Copy the matching bits and add zero bits to determine the network address.

10101100 . 00010100 . 00000000 . 00000000

└——— Copy ———┘└——— Add zero bits ———┘

Answer: 172.20.0.0