



subnetting

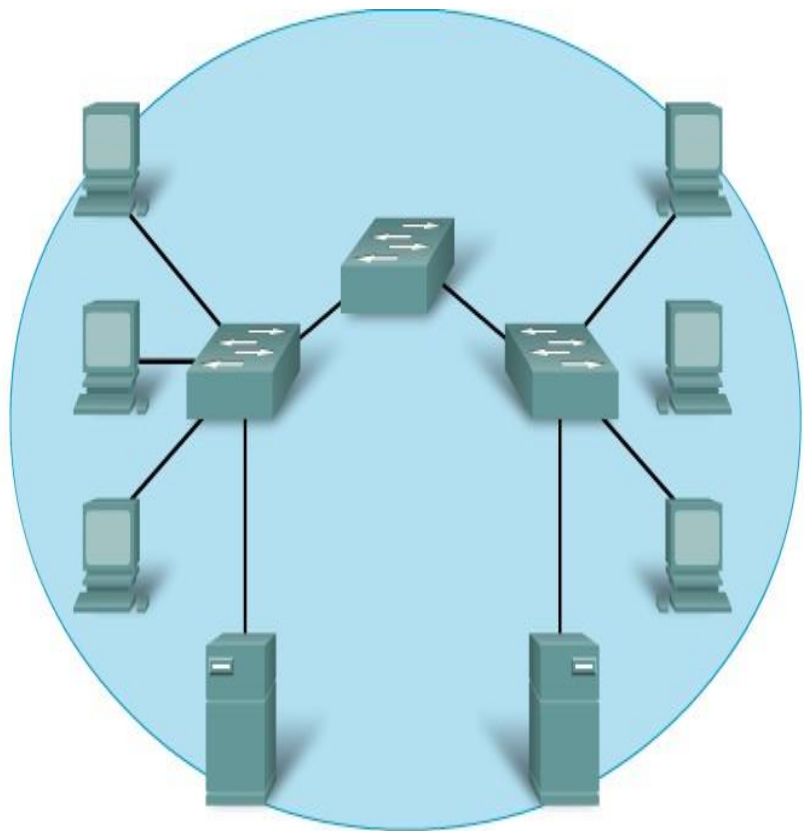


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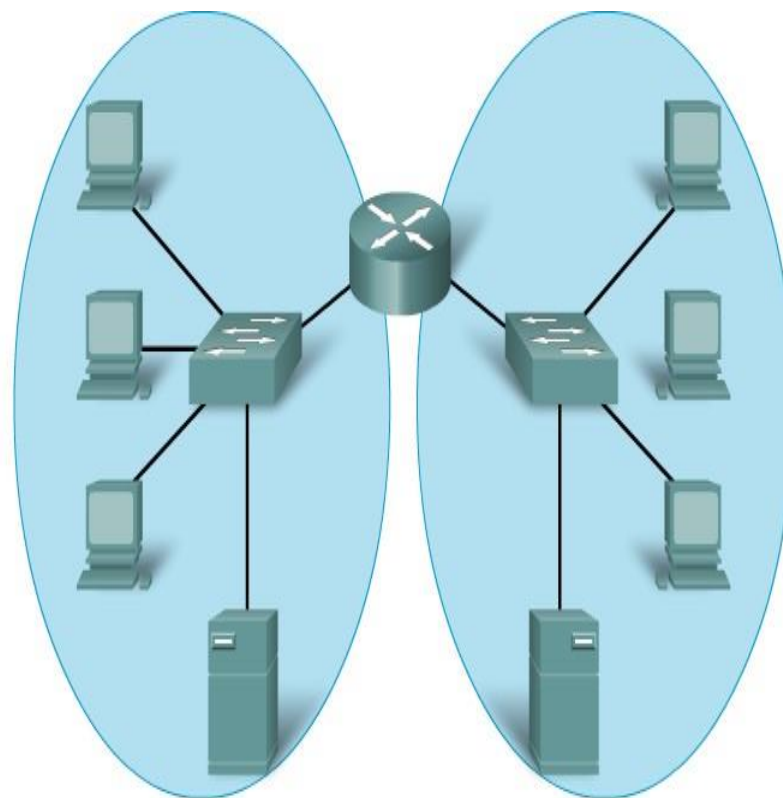
Segmentation of networks

- Purpose of network segmentation are:-
 - Increase Network performance
 - Increase Network Security
 - Increase Network Management

Increase Network performance

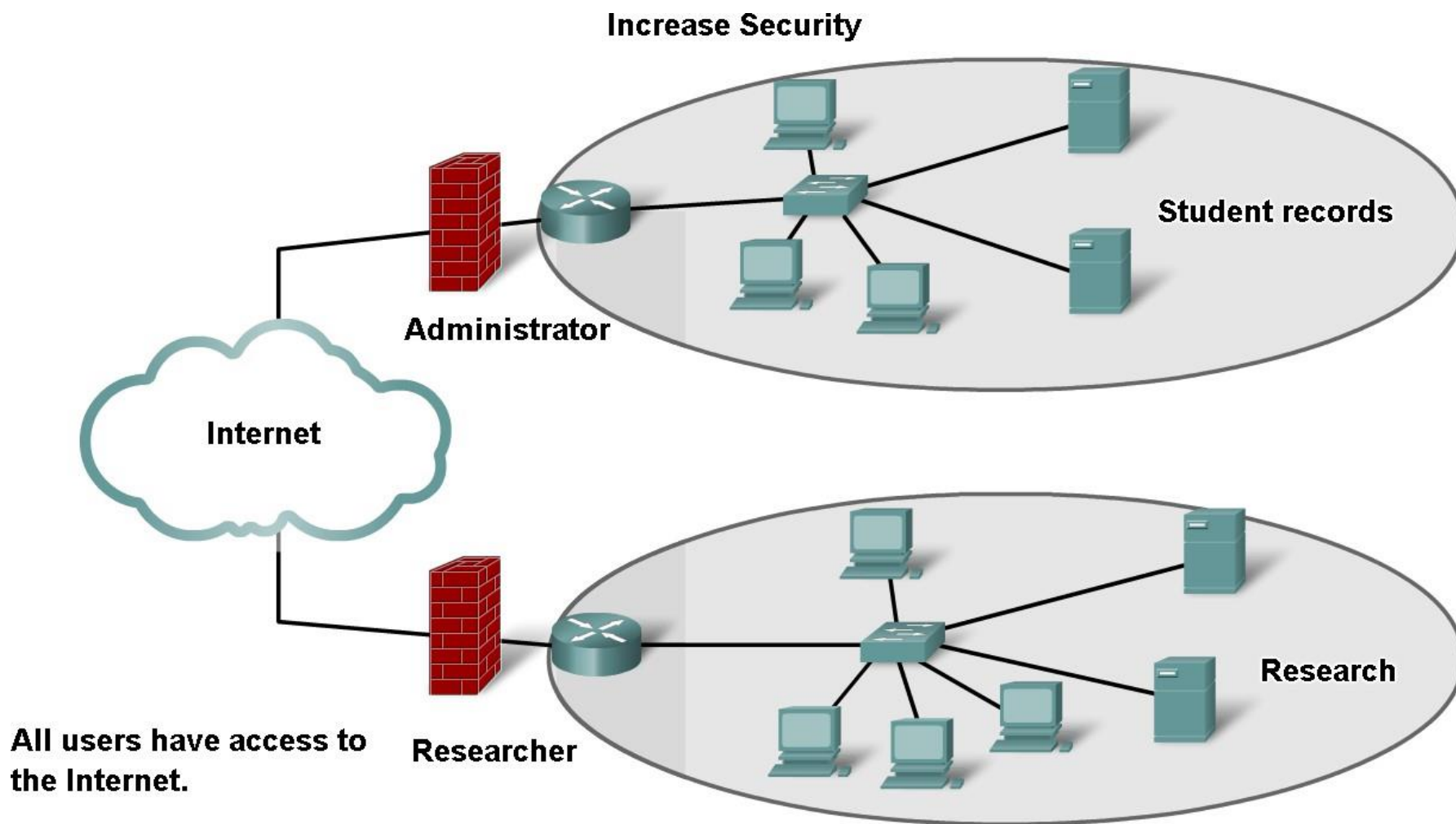


All devices in this network are connected in one broadcast domain when the switch is set to the factory default settings. Since switches forward broadcasts by default, broadcasts are processed by all devices in this network.

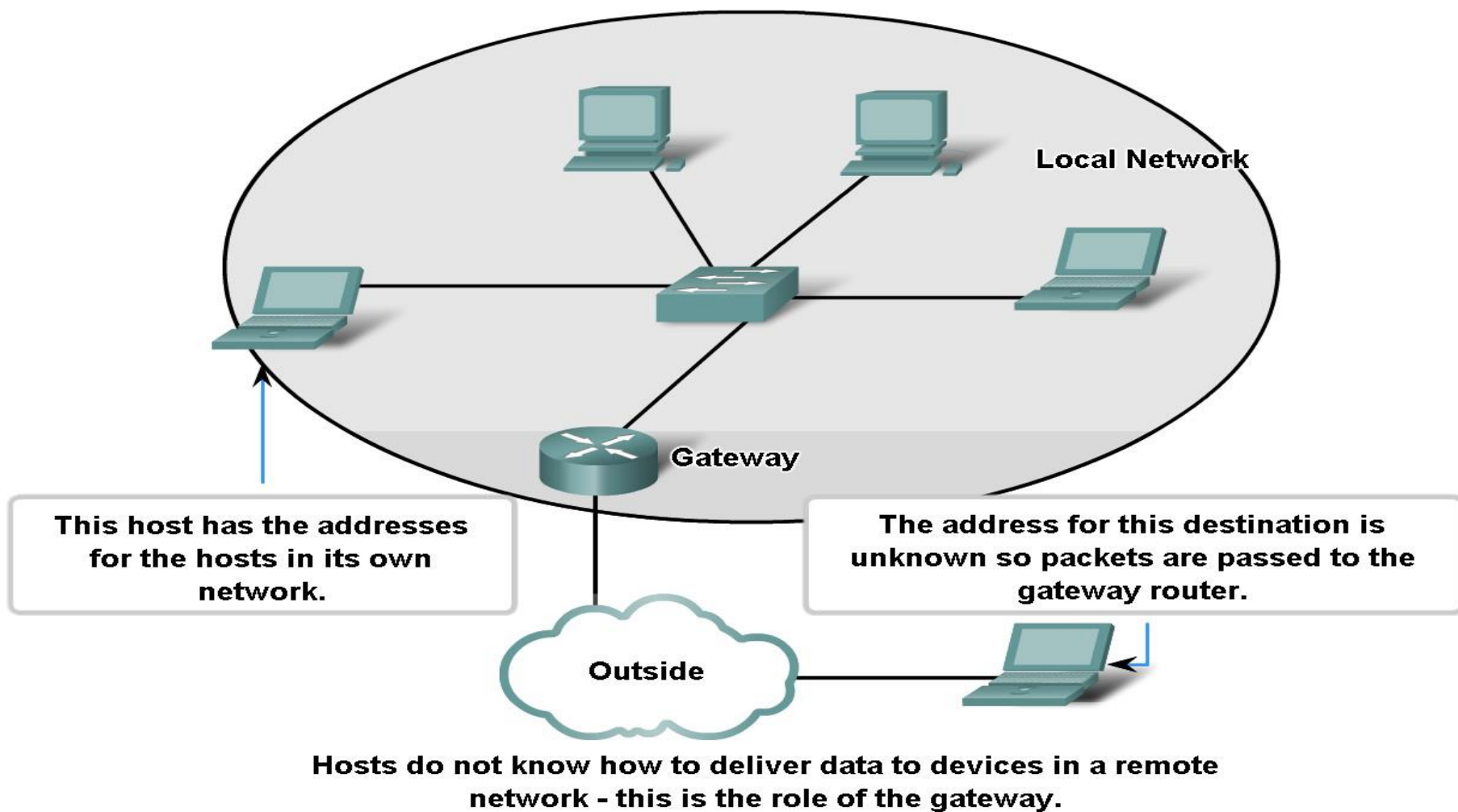


Replacing the middle switch with a router creates 2 IP subnets, hence, 2 distinct broadcast domains. All devices are connected but local broadcasts are contained.

Increase Network Security



Increase Network manageability



IP Address Classes

(Classful IP Addressing)

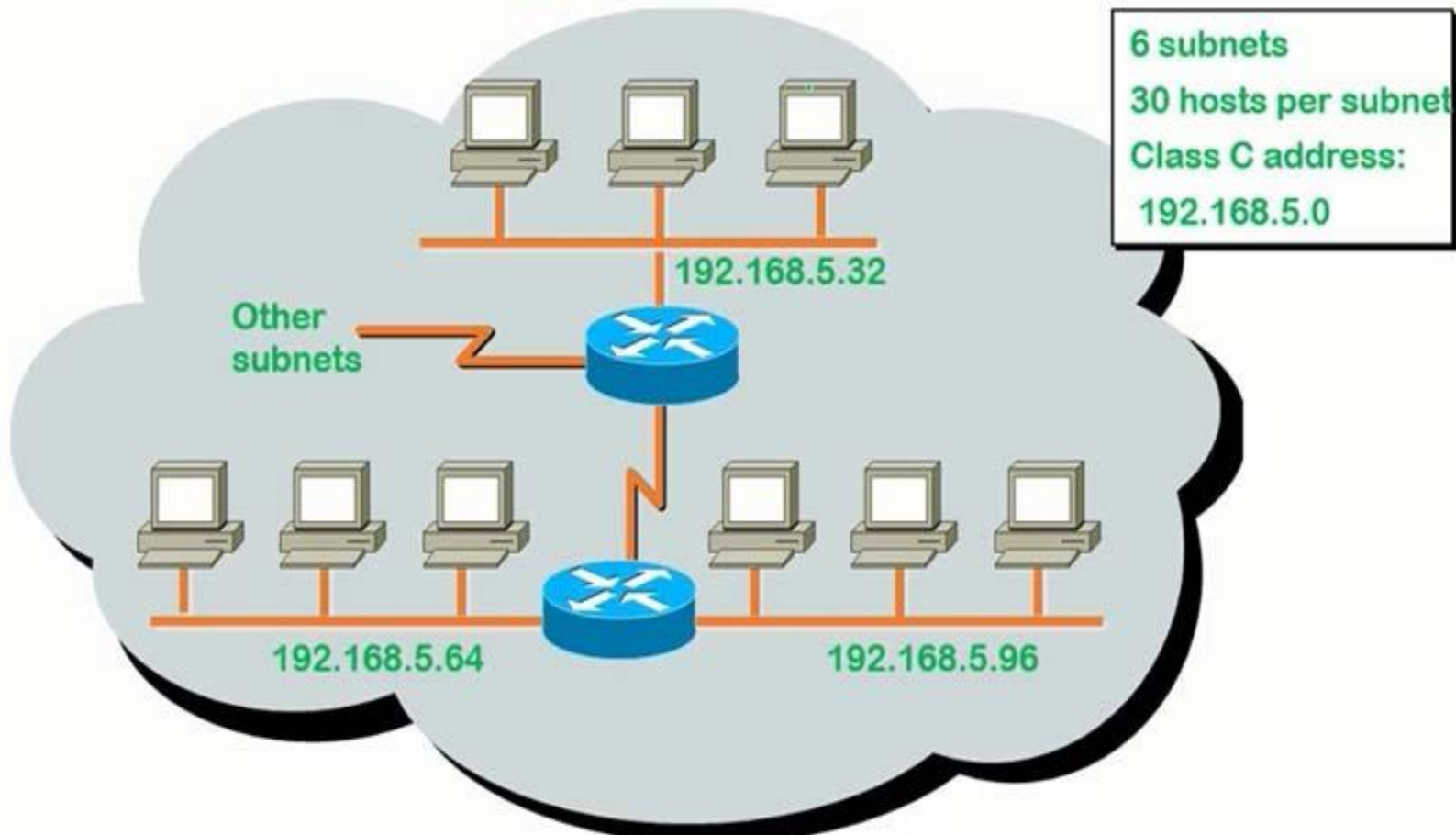
Class A	1 to 126	Mask	255.0.0.0
Class B	128 to 191	Mask	255.255.0.0
Class C	192 to 223	Mask	255.255.255.0
Class D	224 to 239		Multicast
Class E			For Research

Class A ...	.	Network	.	Host	.	Host	.	Host
Class B ...	.	Network	.	Network	.	Host	.	Host
Class C ...	.	Network	.	Network	.	Network	.	Host

Subnetting

Because the fast
deployment of internet, the
IP addresses become not
enough

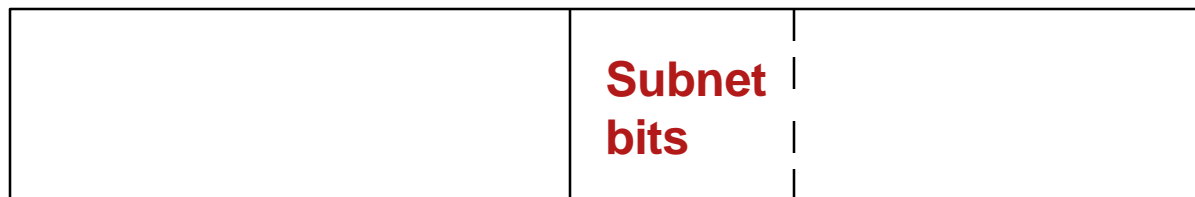
Addressing with Subnets



Subnetting

- Subnetting a network means to use the subnet mask to divide the network and break a large network up into smaller, more efficient and manageable segments, or subnets.
- Subnetting is done by taking part of host bits then add it to the network part

**IP
address**

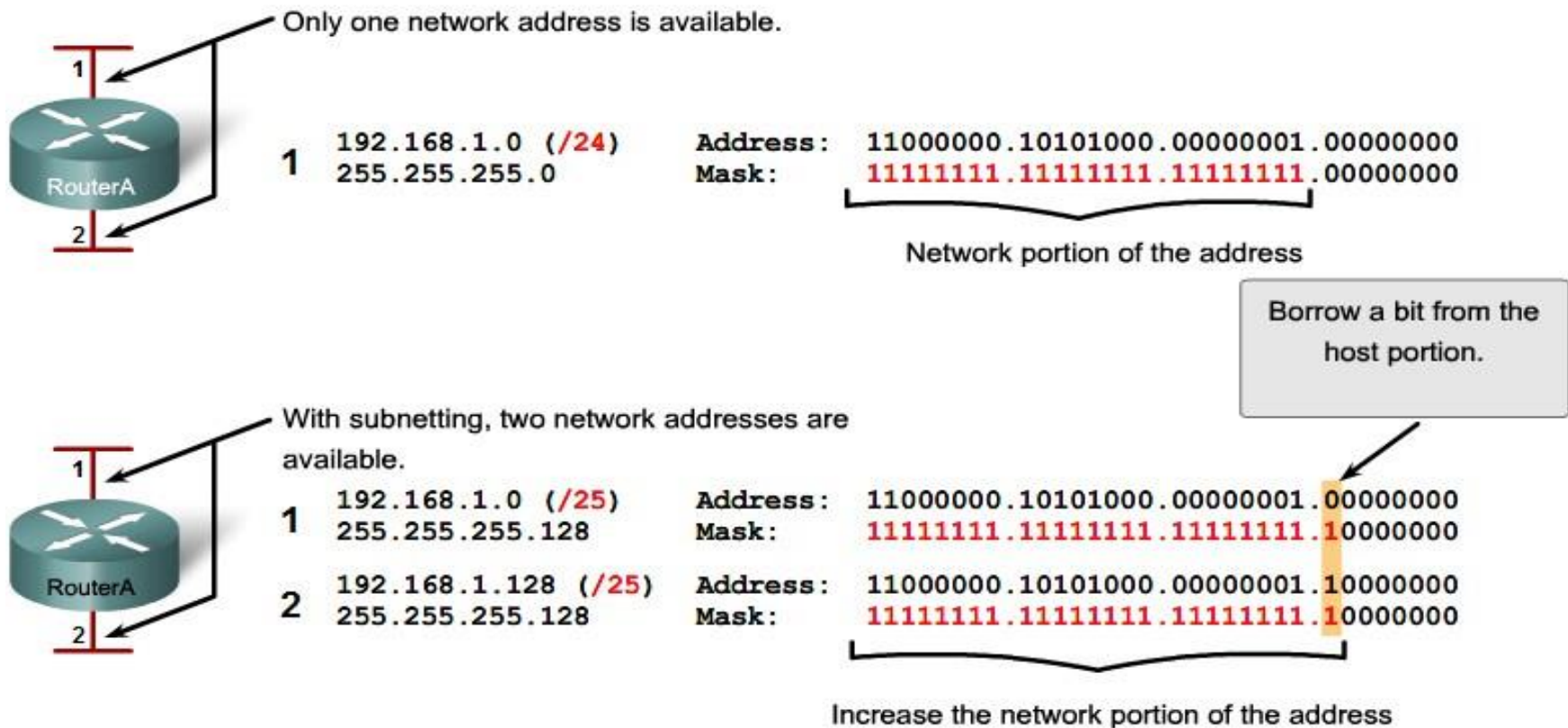


Subnetting Example 1

Divide network 192.168.1.0/24 into 2 subnets

2 subnets need 1 bit

Borrowing Bits for Subnets



Subnetting

Borrowing Bits for Subnets

Addressing Scheme: Example of 2 networks

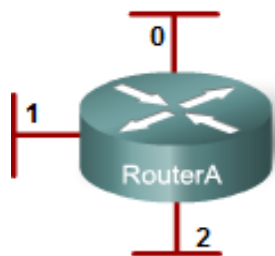
Subnet	Network address	Host range	Broadcast address
0	192.168.1.0/25	192.168.1.1 - 192.168.1.126	192.168.1.127
1	192.168.1.128/25	192.168.1.129 - 192.168.1.254	192.168.1.255

Subnetting Example 2

Divide network 192.168.1.0/24 into 4 subnets

4 subnets need 2 bits

Borrowing Bits for Subnets



-	192.168.1.0 (/24)	Address:	11000000.10101000.00000001.00000000
	255.255.255.0	Mask:	11111111.11111111.11111111.00000000
0	192.168.1.0 (/26)	Address:	11000000.10101000.00000001.00000000
	255.255.255.192	Mask:	11111111.11111111.11111111.11000000
1	192.168.1.64 (/26)	Address:	11000000.10101000.00000001.01000000
	255.255.255.192	Mask:	11111111.11111111.11111111.11000000
2	192.168.1.128 (/26)	Address:	11000000.10101000.00000001.10000000
	255.255.255.192	Mask:	11111111.11111111.11111111.11000000
3	192.168.1.192 (/26)	Address:	11000000.10101000.00000001.11000000
	255.255.255.192	Mask:	11111111.11111111.11111111.11000000

Two bits are borrowed to provide four subnets.

Unused address in this example.

A 1 in these positions in the mask means that these values are part of the network address.

More subnets are available, but fewer addresses are available per subnet.

Subnetting

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

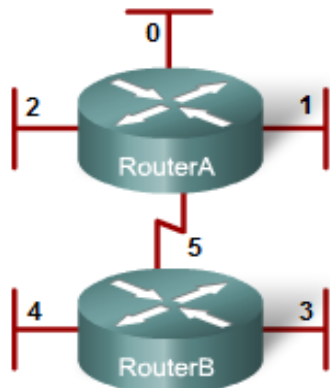
Subnetting Example 3

Divide network 192.168.1.0/24 into 6 subnets

6 subnets need 3 bits

Borrowing Bits for Subnets

Start with this address	-	192.168.1.0 (/24)	Address:	11000000.10101000.00000001.00000000
		255.255.255.0	Mask:	11111111.11111111.11111111.00000000
Make 8 subnets	0	192.168.1.0 (/27)	Address:	11000000.10101000.00000001.00000000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	1	192.168.1.32 (/27)	Address:	11000000.10101000.00000001.00100000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	2	192.168.1.64 (/27)	Address:	11000000.10101000.00000001.01000000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	3	192.168.1.96 (/27)	Address:	11000000.10101000.00000001.01100000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	4	192.168.1.128 (/27)	Address:	11000000.10101000.00000001.10000000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	5	192.168.1.160 (/27)	Address:	11000000.10101000.00000001.10100000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	6	192.168.1.192 (/27)	Address:	11000000.10101000.00000001.11000000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000
	7	192.168.1.224 (/27)	Address:	11000000.10101000.00000001.11100000
		255.255.255.224	Mask:	11111111.11111111.11111111.11100000



Three bits are borrowed to provide eight subnets.

Subnetting

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 Example 4

Divide network 172.168.0.0/16 into 8 subnets

Solution :

- 8 subnets need 3 bits
- subnet mask = 255.255.224.0
- interesting octet is 224
- hop count = $256 - 224 = 32$
- The first subnet is **172.16.0.0/19** —————> **172.16.0.1-172.16.31.254**
- The second subnet is **172.16.32.0/19** —————> **172.16.32.1 -172.16.63.254**
- The third subnet is **172.16.64.0/19** —————> **172.16.64.1-172.16.127.254**
- The 8th subnet is **172.16.224.0/19** —————> **172.16.224.1-172.16.255.254**

Subnetting Example 5

Divide network 10.0.0.0/10 into 4 subnets

Solution :

- 4subnets need 2 bits
- subnet mask = 255.240.0. 0
- interesting octet is 240
- hop count = 256 – 240= 16
- The first subnet is 10.0.0.0/12 —————> 10.0.0.1-10.15.255.254
- The second subnet is 10.16.0.0/12 —————> 10.16.0.1-10.31.255.254
- The third subnet is 10.32.0.0/12 —————> 10.32.0.1-10.47.255.254
- The fourth subnet is 10.48.0.0/12 —————> 10.48.0.1-172.65.255.254

Subnetting Example 6

192.168.5.0/24
5 Subnet, 30 Host

First note 192.168.5.0 class C
Default mask = 255.255.255.0

No of network = $2^n \geq 5$ n=3
No of host = $2^5 - 2 = 30$

The subnet mask is 255.255.255.11100000
255.255.255.224

192.168.5.0	192	168	5	00000000	
255.255.255.224	255	255	255	11100000	Mask
192.168.5.0	192	168	5	00000000	Subnet
192.168.5.31	192	168	5	00011111	Broadcast
192.168.5.32	192	168	5	00100000	
255.255.255.224	255	255	255	11100000	Mask
192.168.5.32	192	168	5	00100000	Subnet
192.168.5.63	192	168	5	00111111	Broadcast
192.168.5.64	192	168	5	01000000	
192.168.5.95	192	168	5	01011111	Broadcast
192.168.5.96	192	168	5	01100000	Subnet
192.168.5.127	192	168	5	01111111	Broadcast

Network

000	-----	0
001	-----	32
010	-----	64
011	-----	96
100	-----	128
101	-----	160
110	-----	192
111	-----	224

Subnetting Example 6 (another solution)

192.168.5.0/24
5 Subnet, 30 Host

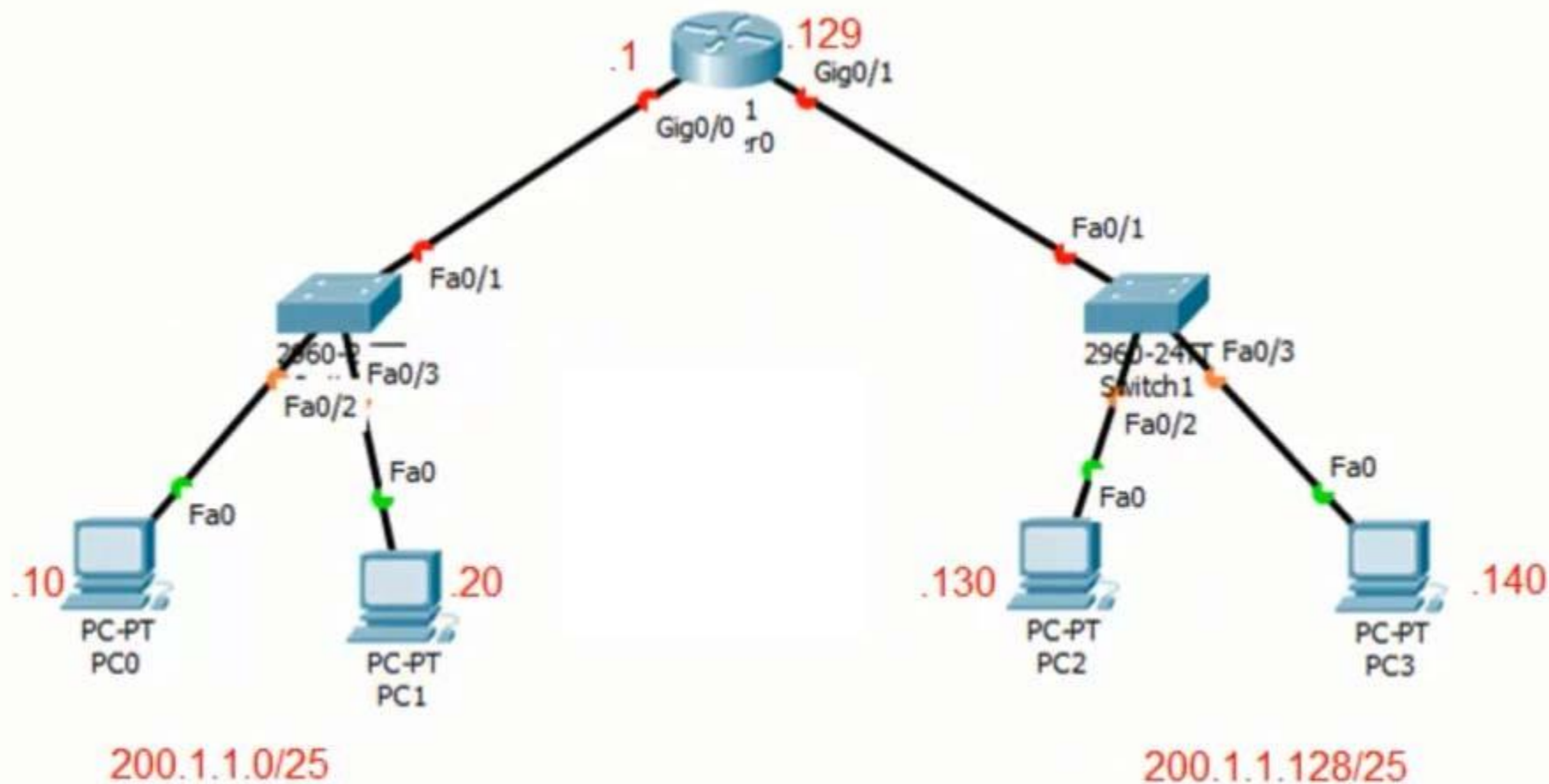
- 5 subnets need 3 bits
- subnet mask = 255.255.255.224
or /27
- hop count = 32

192.168.5.0	----- F 192.168.5.1	----- L 192.168.5.30
	----- NET ID 192.168.5.0	----- Broad Cast 192.168.5.31
192.168.5.32	----- F 192.168.5.33	----- L 192.168.5.62
	----- NET ID 192.168.5.32	----- Broad Cast 192.168.5.63
192.168.5.64	----- F 192.168.5.65	----- L 192.168.5.94
	----- NET ID 192.168.5.64	----- Broad Cast 192.168.5.95
192.168.5.96	----- F 192.168.5.97	----- L 192.168.5.126
	----- NET ID 192.168.5.96	----- Broad Cast 192.168.127
192.168.5.128	----- F 192.168.5.129	----- L 192.168.5.158
	----- NET ID 192.168.5.128	----- Broad Cast 192.168.5.159
192.168.5.160	----- F 192.168.5.161	----- L 192.168.5.190
	----- NET ID 192.168.5.160	----- Broad Cast 192.168.5.191
192.168.5.192	----- F 192.168.5.193	----- L 192.168.5.222
	----- NET ID 192.168.5.192	----- Broad Cast 192.168.5.223
192.168.5.224	----- F 192.168.5.225	----- L 192.168.5.254
	----- NET ID 192.168.5.224	----- Broad Cast 192.168.5.255

Subnetting Example 7

- CIDR Block: (Classless Inter-domain Routing)
- 200.1.1.0/24
- Required 2 networks

- Network: 200.1.1.0/25
 Broadcast: 200.1.1.127
 HostMin: 200.1.1.1
 HostMax: 200.1.1.126
- Network: 200.1.1.128/25
 Broadcast: 200.1.1.255
 HostMin: 200.1.1.129
 HostMax: 200.1.1.254



Subnetting Example 8

192.168.5.0/24
30 Subnet

- 30 subnets need 5 bits
- subnet mask = 255.255.255.248 (or /29)
- hop count = 8

192.168.5.0	----- F	192.168.5.1	----- L	192.168.5. 6
	-----	NET ID 192.168.5.0	-----	Broad Cast 192.168.5. 7
192.168.5. 8	----- F	192.168.5. 9	----- L	192.168.5. 14
	-----	NET ID 192.168.5. 8	-----	Broad Cast 192.168.5. 15



Subnetting Example 9

192.168.5.0/24
12 Subnet

- 12 subnets need 4 bits
- subnet mask = 255.255.255.240 (or /28)
- hop count = 16
- No of host= $2^4 - 2 = 14$

192.168.5.0	----- F	192.168.5.1	----- L	192.168.5.14
	-----	NET ID 192.168.5.0	-----	Broad Cast 192.168.5.15
192.168.5.16	----- F	192.168.5.17	----- L	192.168.5.30
	-----	NET ID 192.168.5.16	-----	Broad Cast 192.168.5.31



Subnetting Example 10

170.1.0.0 / 16

5 Subnet

Class B	17	18	19	20	21	22	23	24
	128	64	32	16	8	4	2	1
	128	192	224	240	248	252	254	255

- 5 subnets need 3 bits
- subnet mask = 255.255.224.0 (or /19)
- hop count = 32
- No of host = $2^{13} - 2$

NET ID	F	L	Broad Cast
<u>170.1.0.0</u>	<u>170.1.0.1</u>	<u>170.1.31.254</u>	<u>170.1.31.255</u>
<u>170.1.32.0</u>	<u>170.1.32.1</u>	<u>170.1.63.254</u>	<u>170.1.63.255</u>
<u>170.1.64.0</u>	<u>170.1.64.1</u>	<u>170.1.95.254</u>	<u>170.1.95.255</u>
<u>170.1.96.0</u>	<u>170.1.96.1</u>	<u>170.1.127.254</u>	<u>170.1.127.255</u>
<u>170.1.128.0</u>	<u>170.1.128.1</u>	<u>170.1.159.254</u>	<u>170.1.159.255</u>
<u>170.1.160.0</u>	<u>170.1.160.1</u>	<u>170.1.191.254</u>	<u>170.1.191.255</u>
<u>170.1.192.0</u>	<u>170.1.192.1</u>	<u>170.1.223.254</u>	<u>170.1.223.255</u>
<u>170.1.224.0</u>	<u>170.1.224.1</u>	<u>170.1.255.254</u>	<u>170.1.255.255</u>

Subnetting Example 11

10.0.0.0 /8 5 Subnet

- 5 subnets need 3 bits
- subnet mask = 255.224.0.0 (or /11)
- hop count = 32
- No of host = $2^{21} - 2$

10.0.0.0
10.32.0.0
10.64.0.0
10.96.0.0
10.128.0.0
10.160.0.0
10.192.0.0
10.224.0.0

