CCNA 200-301 Day 7

IPv4 Addressing
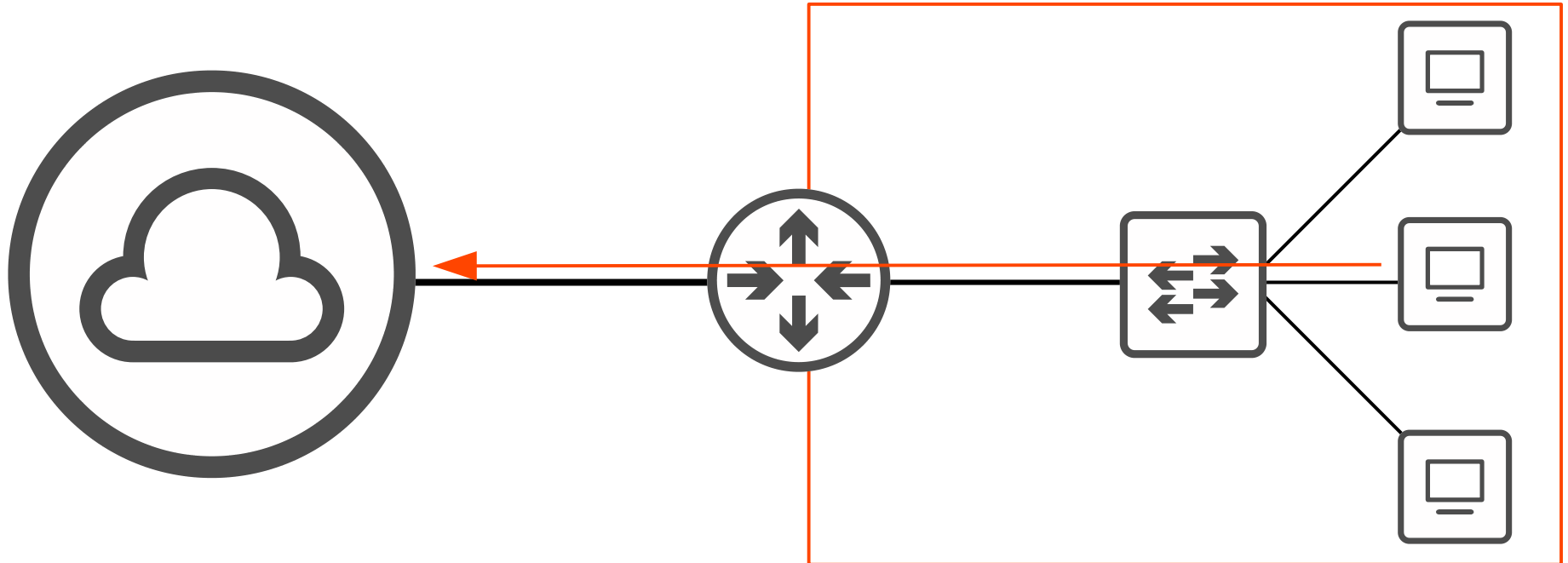
OSI Model – Network Layer

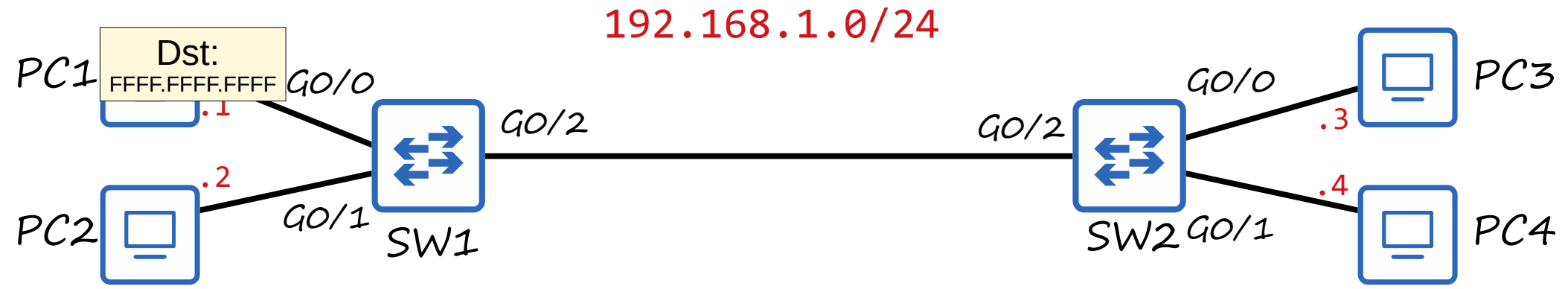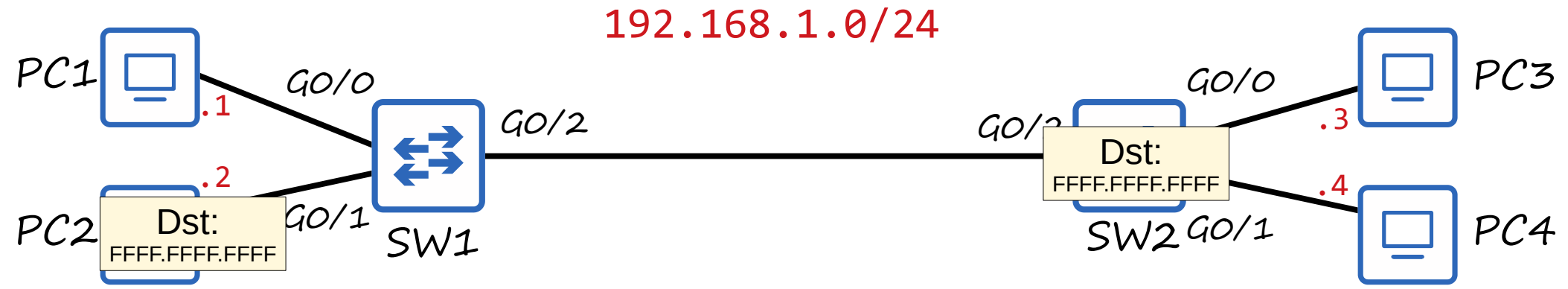|		
7	Application	
6	Presentation	
5	Session	
4	Transport	
3	**Network**	
2	Data Link	
1	Physical	

- Provides connectivity between end hosts on different networks (ie. outside of the LAN).
- Provides logical addressing (IP addresses).
- Provides path selection between source and destination.
- Routers operate at Layer 3.

Routing

PC1   Dst: FFFF.FFFF.FFFF   G0/0

192.168.1.0/24

PC3   .3

PC4   .4

.1

.2

PC2   G0/1   SW1

G0/2   G0/2   SW2   G0/1

G0/0

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Routing

PC1 .1

G0/0

192.168.1.0/24

PC2 .2

Dst:
FFFF.FFFF.FFFF

G0/1

G0/2 SW1

G0/2

Dst:
FFFF.FFFF.FFFF

SW2 G0/1

G0/0

PC3 .3

.4

PC4

Routing

192.168.1.0/24

192.168.2.0/24

PC1

Dst:
FFFF.FFFF.FFFF

.1

G0/0

.2

PC2

G0/1

SW1

G0/2

.254

G0/0

R1

G0/1

.254

G0/2

SW2

G0/0

.1

PC3

.2

PC4

G0/1
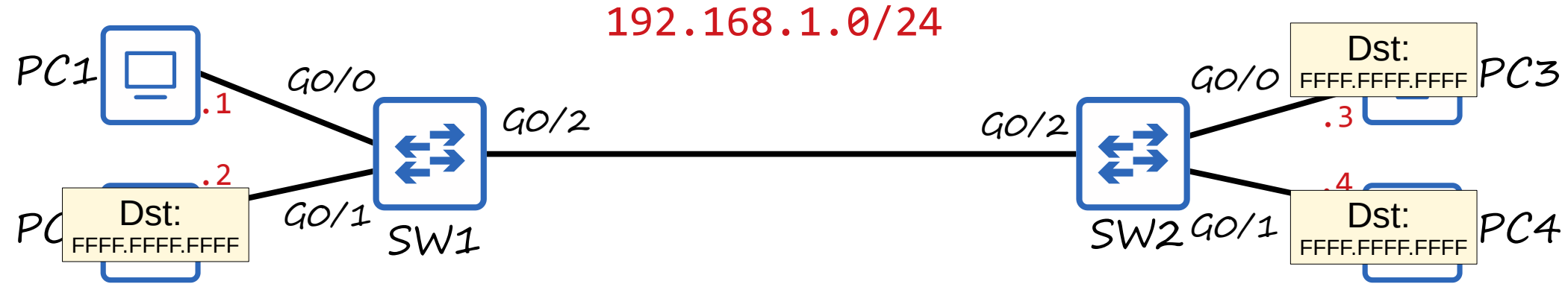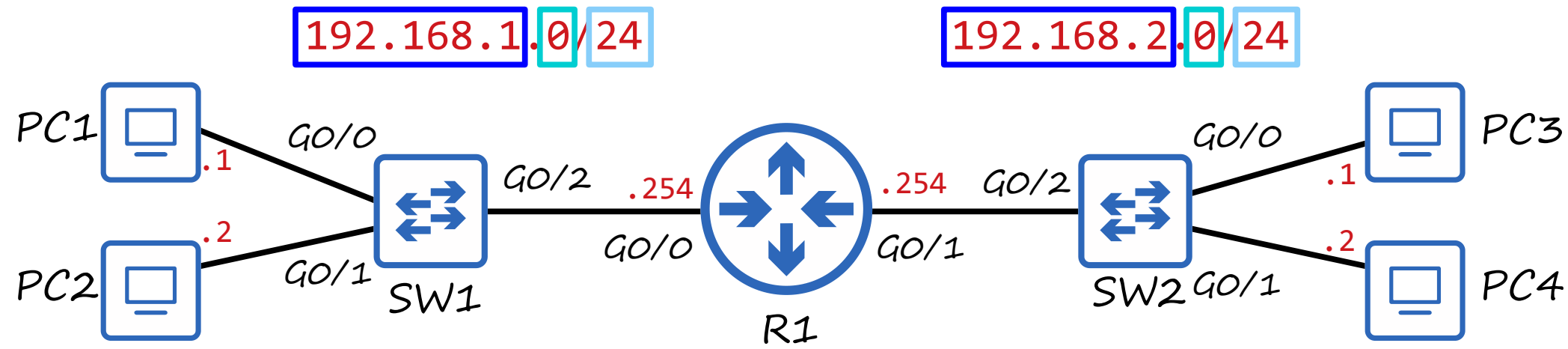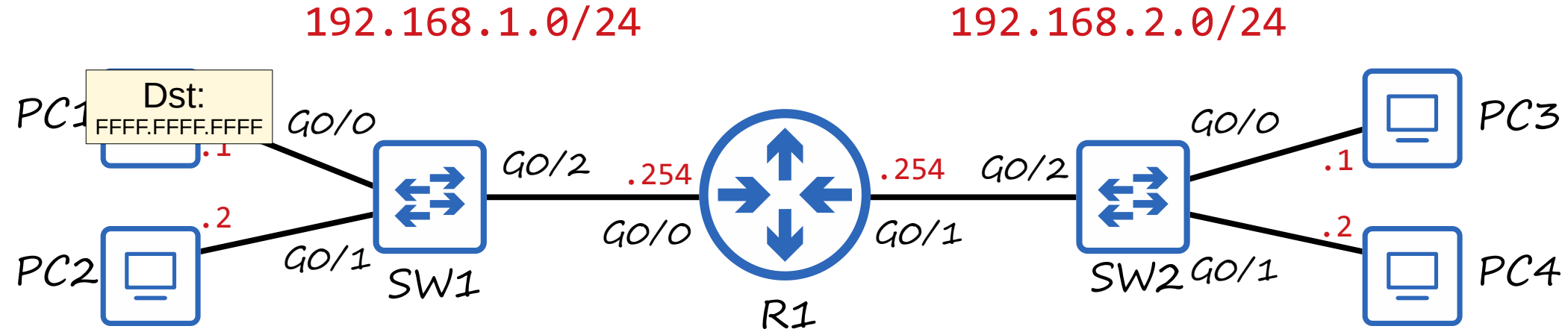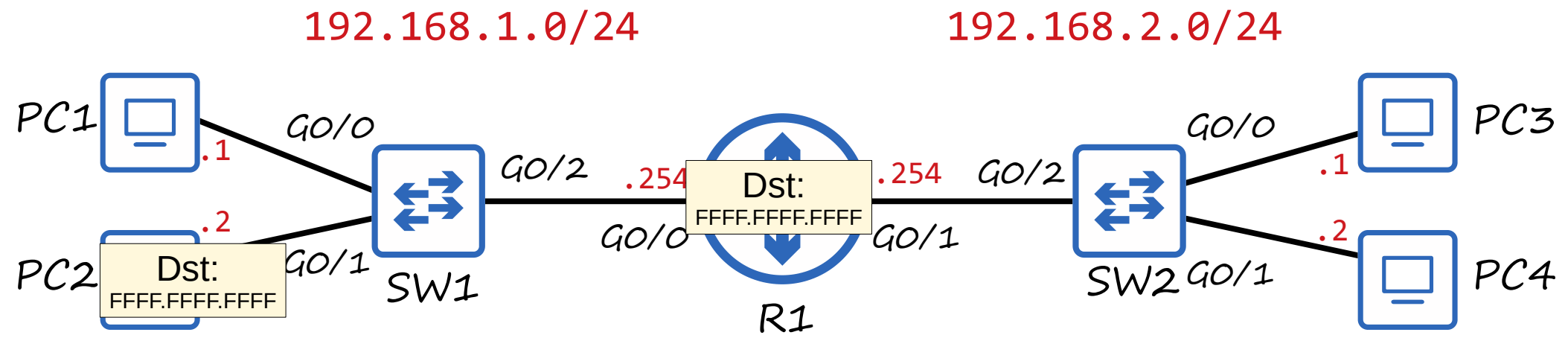
IPv4 Header

IPv4 Header Format

Offsets	Octet	0								1								2								3							
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0	Version				IHL				DSCP						ECN		Total Length															
4	32	Identification																Flags			Fragment Offset												
8	64	Time To Live								Protocol								Header Checksum															
12	96	Source IP Address																															
16	128	Destination IP Address																															
20	160	Options (if I...)																															
24	192																																
28	224																																
32	256																																

IP address are 32 bits (4 bytes) in length.

IPv4 Addresses

dotted decimal ← 192.168.1.254

8 bits   8 bits   8 bits   8 bits

11000000   10101000   00000001   11111110

binary

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Decimal
(base 10)

3   2   9   4

3 * 1000   2 * 100   9 * 10   4 * 1

Hexadecimal
(base 16)

C   D   E

C * 256   D * 16   E * 1
(C = 12)   (D = 13)   (E = 14)

3072   +   208   +   14   = 3294

IPv4 Addresses

dotted
decimal

192.168.1.254

8 bits   8 bits   8 bits   8 bits

11000000   10101000   00000001   11111110

binary

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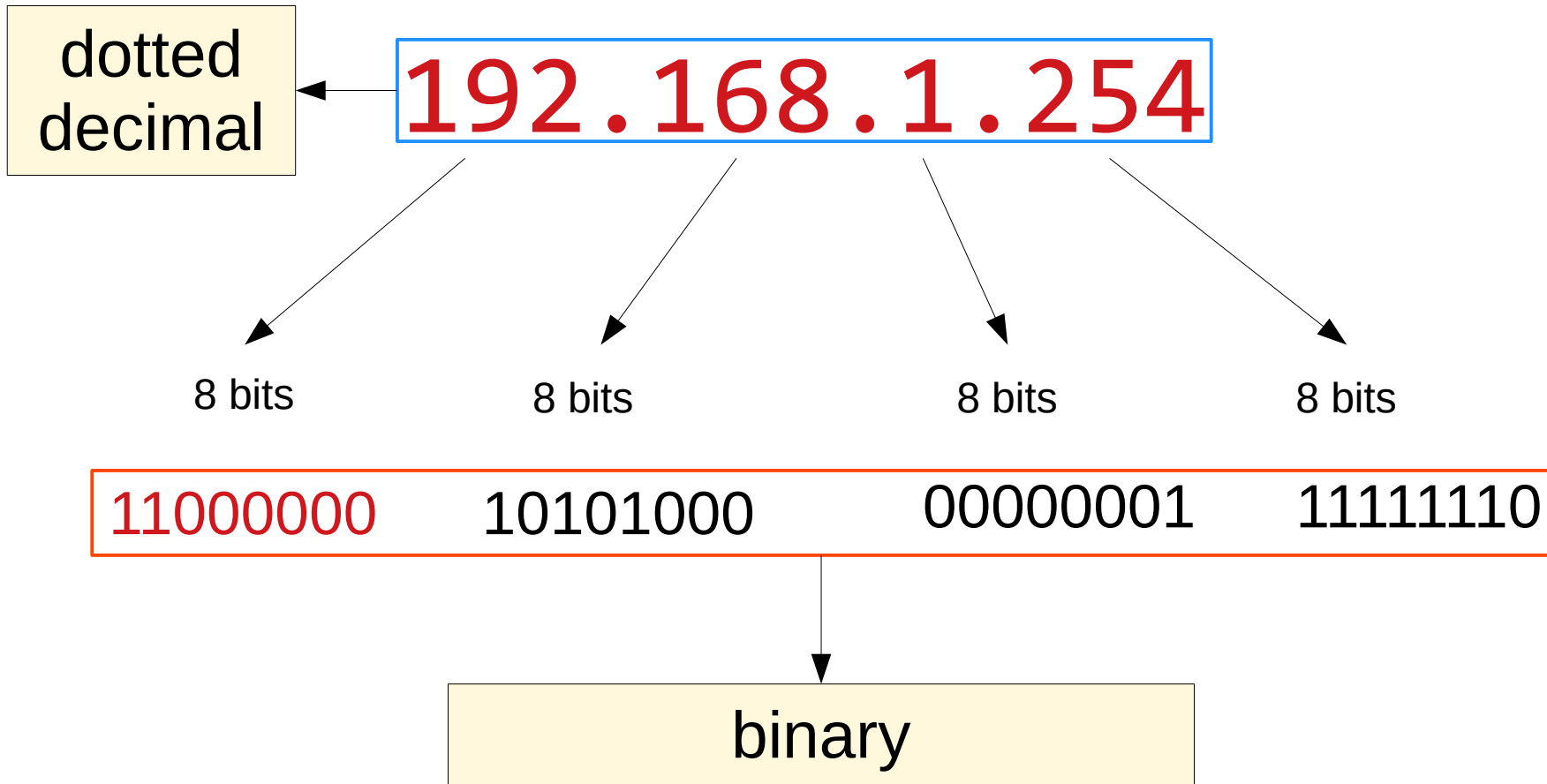
192

| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

1 * 128 **1 * 64** 0 * 32 0 * 16 0 * 8 0 * 4 0 * 2 0 * 1

128 + 64 = 192

dotted decimal

192.168.1.254

8 bits   8 bits   8 bits   8 bits

11000000   10101000   00000001   11111110
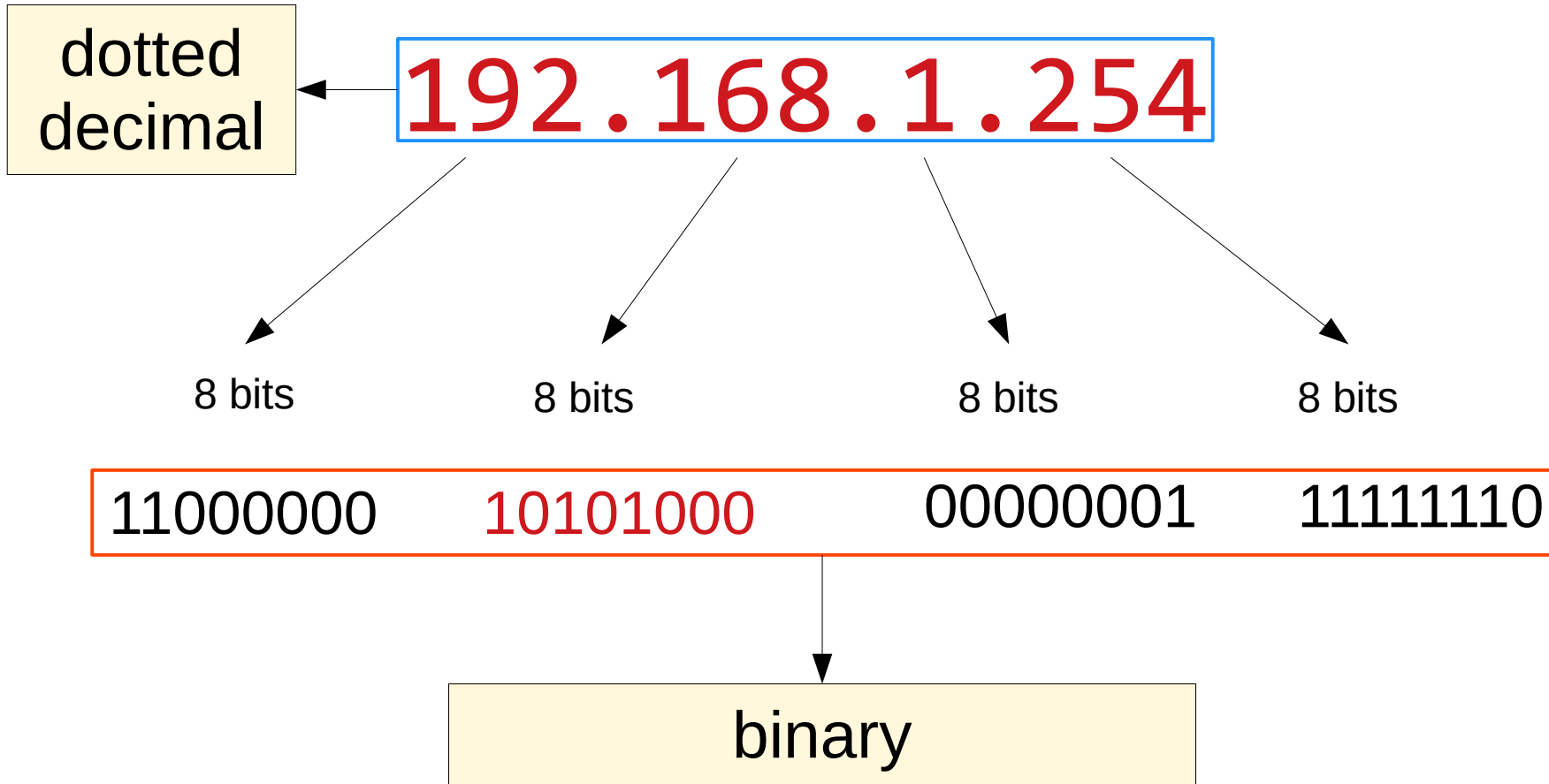
binary

168

1	0	1	0	1	0	0	0
1 * 128	0 * 64	**1 * 32**	0 * 16	**1 * 8**	0 * 4	0 * 2	0 * 1

128 + 32 + 8 = 168

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dotted
decimal

192.168.1.254

8 bits

8 bits

8 bits

8 bits

11000000

10101000

00000001

11111110

binary

1

0   0   0   0   0   0   0   1

0 * 128   0 * 64   0 * 32   0 * 16   0 * 8   0 * 4   0 * 2   **1 * 1**

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IPv4 Addresses

dotted decimal

192.168.1.254

8 bits 8 bits 8 bits 8 bits

11000000 10101000 00000001 11111110

binary

254

1	1	1	1	1	1	1	0
1 * 128	1 * 64	1 * 32	1 * 16	1 * 8	1 * 4	1 * 2	0 * 1

128 + 64 + 32 + 16 + 8 + 4 + 2 = 254

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192.168.1.254

8 bits   8 bits   8 bits   8 bits

11000000   10101000   00000001   11111110

octet   octet   octet   octet

128	64	32	16	8	4	2	1
1	0	0	0	1	1	1	1

128   +   8 + 4 + 2 + 1

= 143

128	64	32	16	8	4	2	1
0	1	1	1	0	1	1	0
	64 +	32 +	16	+	4 +	2	

= 118

1	1	1	0	1	1	0	0
128	+ 64	+ 32	+	8	+ 4		

$$= 236$$

221

128	64	32	16	8	4	2	1
1	1	0	1	1	1	0	1
221	93		29	13	5		1
-128	-64		-16	-8	-4		-1
= 93	= 29		= 13	= 5	= 1		= 0

11011101

127

128	64	32	16	8	4	2	1
0	1	1	1	1	1	1	1
	127	63	31	15	7	3	1
	-64	-32	-16	-8	-4	-2	-1
	= 63	= 31	= 15	= 7	= 3	= 1	= 0

01111111

207

128	64	32	16	8	4	2	1
1	1	0	0	1	1	1	1

207	79			15	7	3	1
-128	-64			-8	-4	-2	-1
= 79	= 15			= 7	= 3	= 1	= 0

11001111

128	64	32	16	8	4	2	1
0	0	0	0	0	0	0	0

= 0

128	64	32	16	8	4	2	1
1	1	1	1	1	1	1	1

= 255

11000000101010000000000111111110

11000000   10101000   00000001   11111110

192.168.1.254 /24

11000000101010000000000111111110

11000000 10101000 00000001 11111110

192.168.1.254 /24

11000000101010000000000111111110

11000000   10101000   00000001   11111110
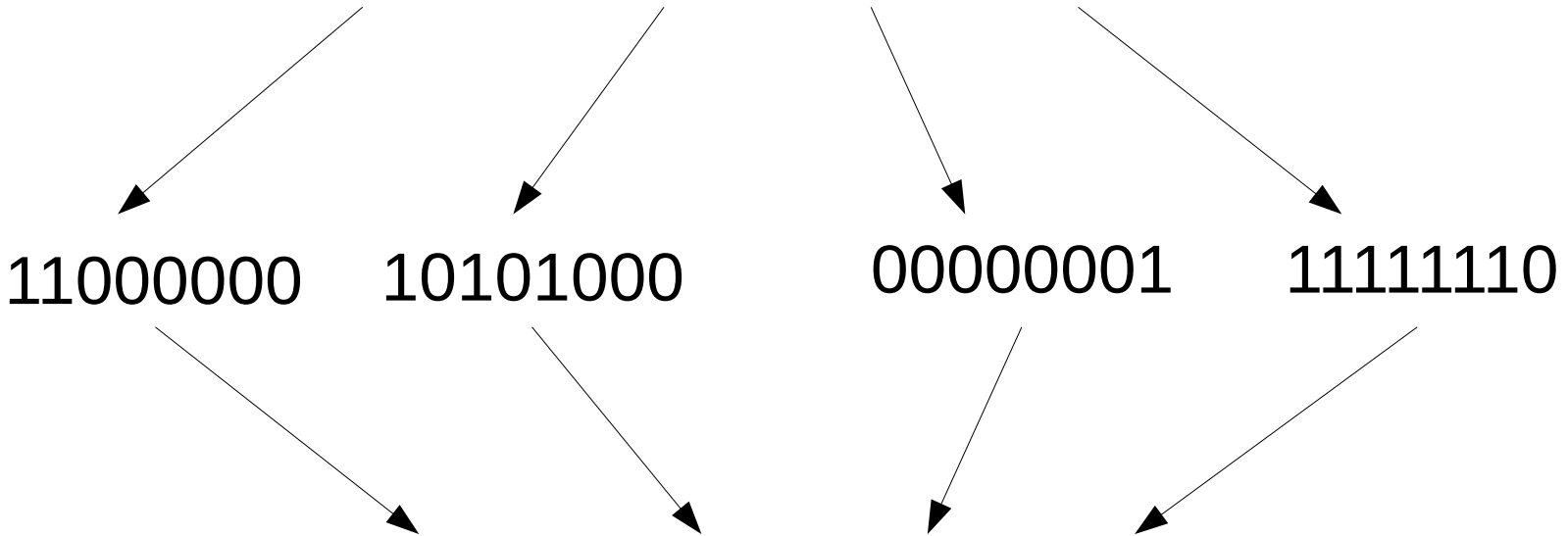
192.168.1.254 /24

IPv4 Addresses

192.168.1.0/24
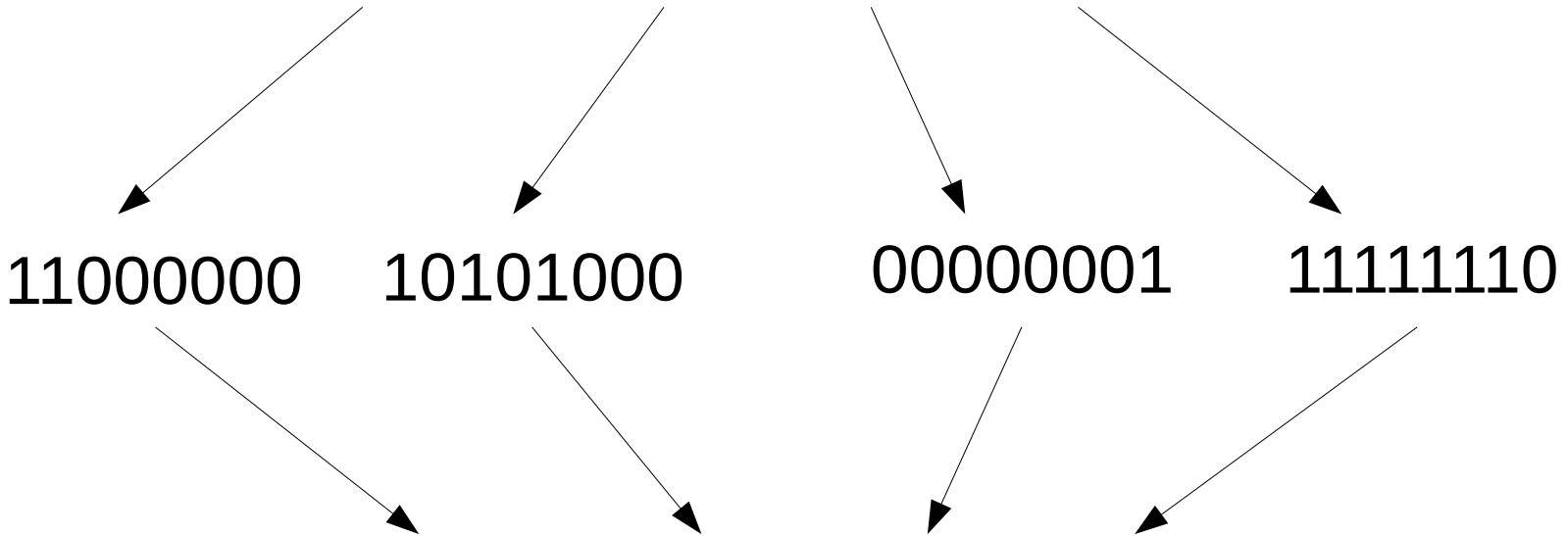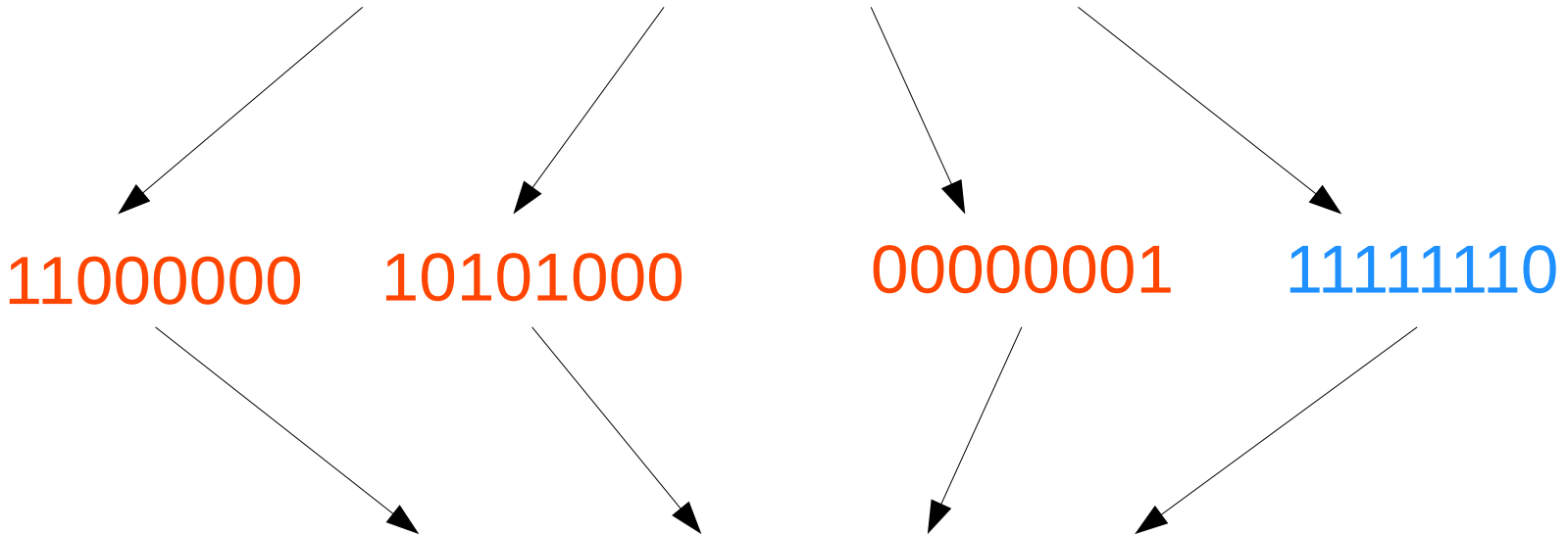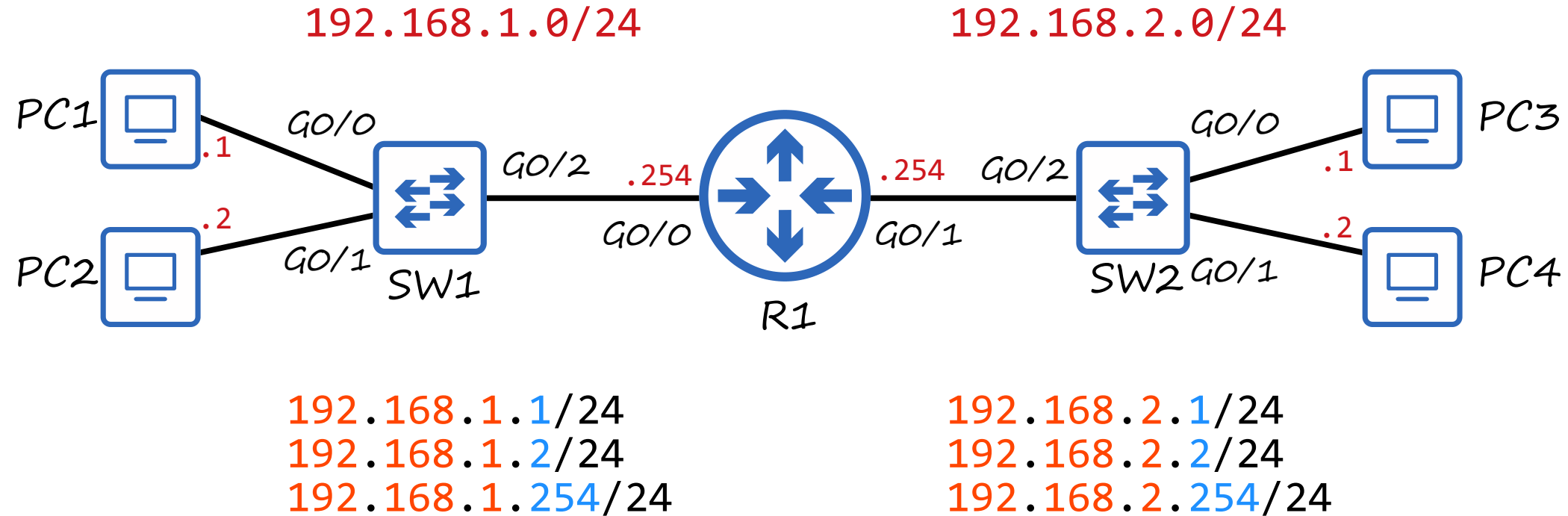
192.168.2.0/24

PC1

PC2

GO/0

GO/1

.1

.2

SW1

GO/2

.254

GO/0

GO/1

R1

.254

GO/1

GO/2

SW2

GO/0

GO/1

.1

.2

PC3

PC4

192.168.1.1/24
192.168.1.2/24
192.168.1.254/24

192.168.2.1/24
192.168.2.2/24
192.168.2.254/24

10011010010011100110111100100000

10011010   01001110   01101111   00100000

154.78.111.32 /16

10011010010011100110111100100000
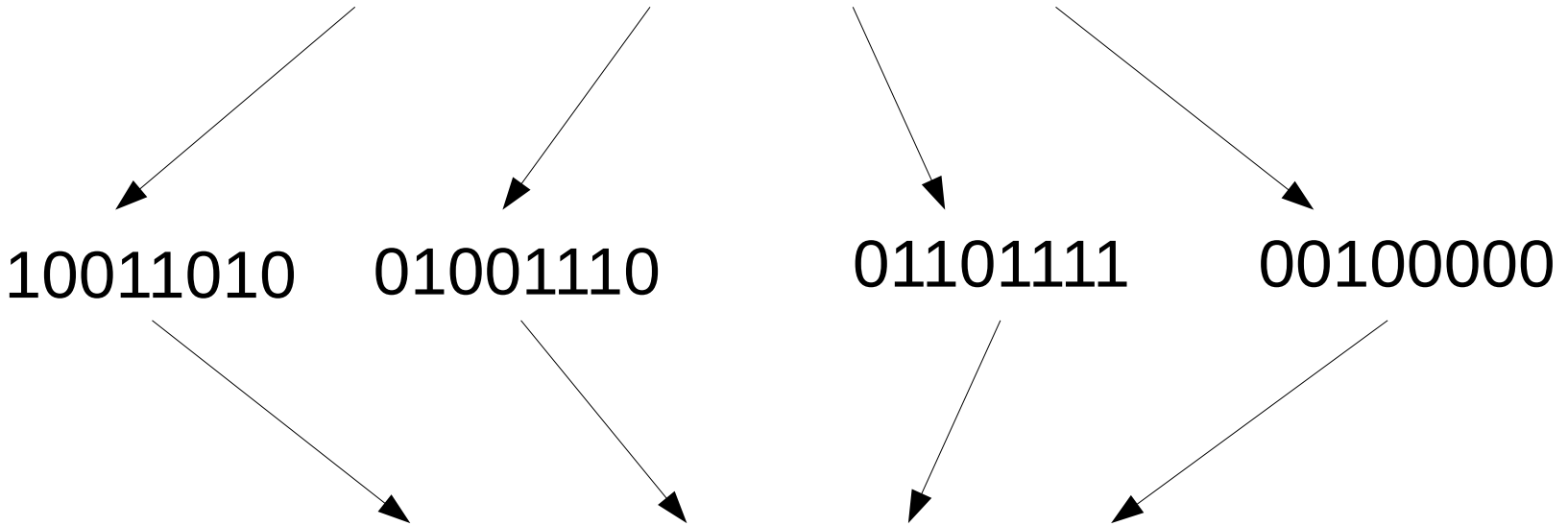
10011010   01001110   01101111   00100000

154.78.111.32 /16

00001100100000001111101100010111
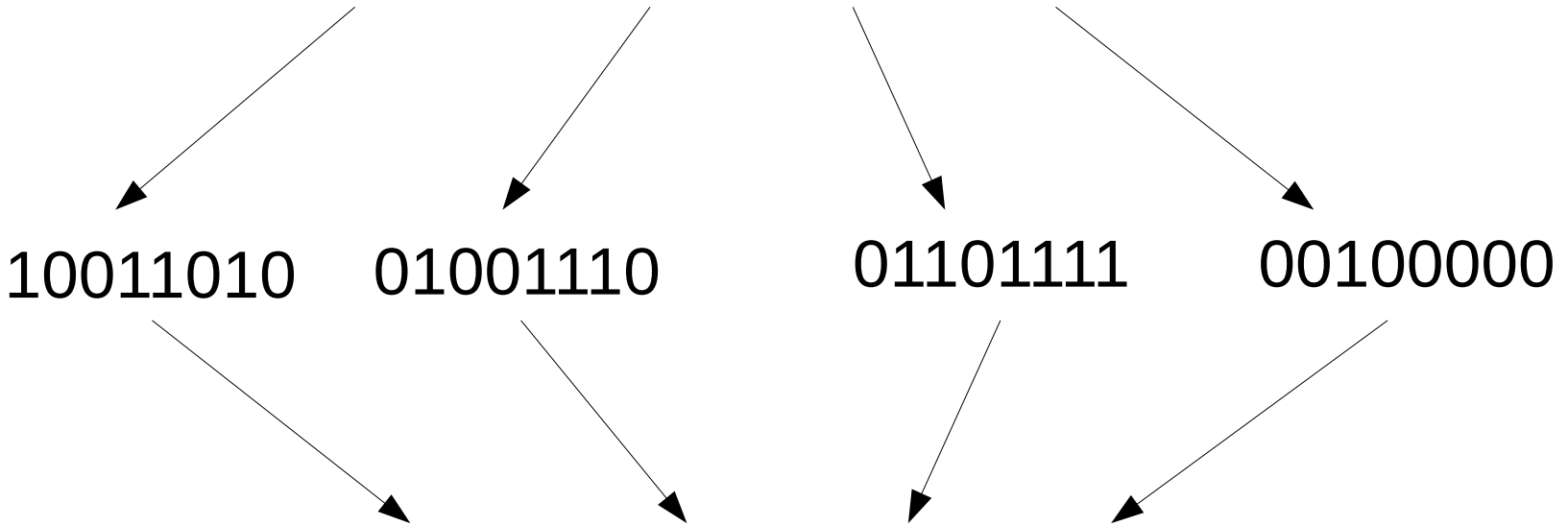
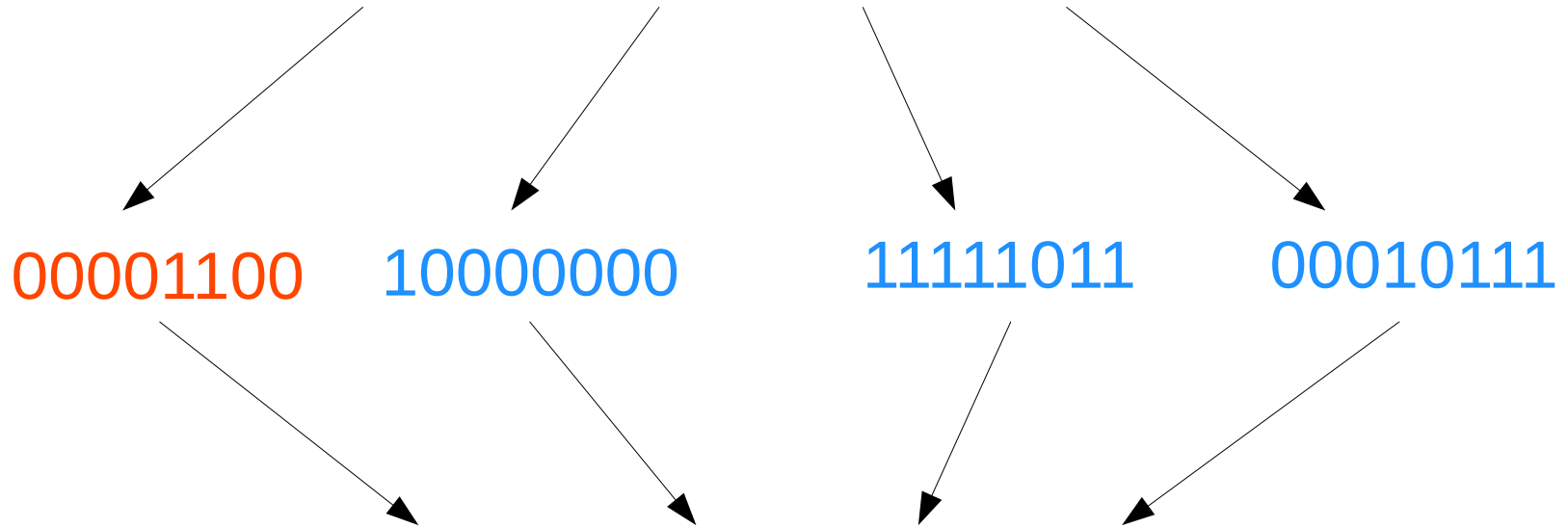00001100   10000000   11111011   00010111

12.128.251.23 /8
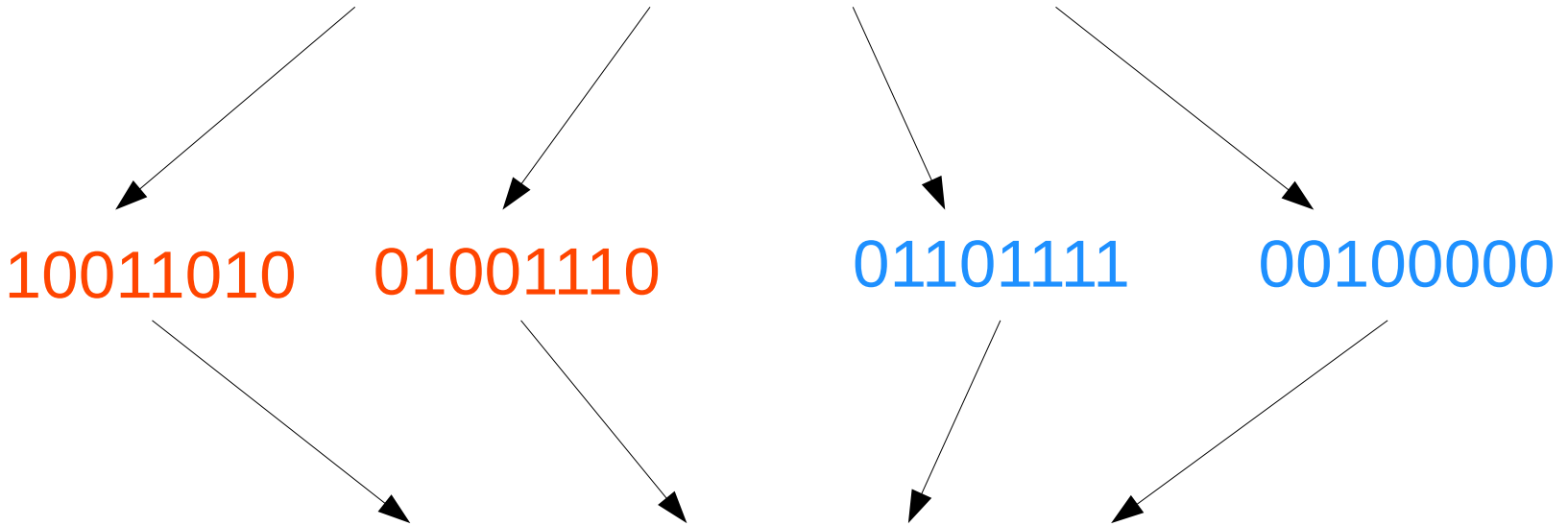
00001100100000001111101100010111

00001100   10000000   11111011   00010111
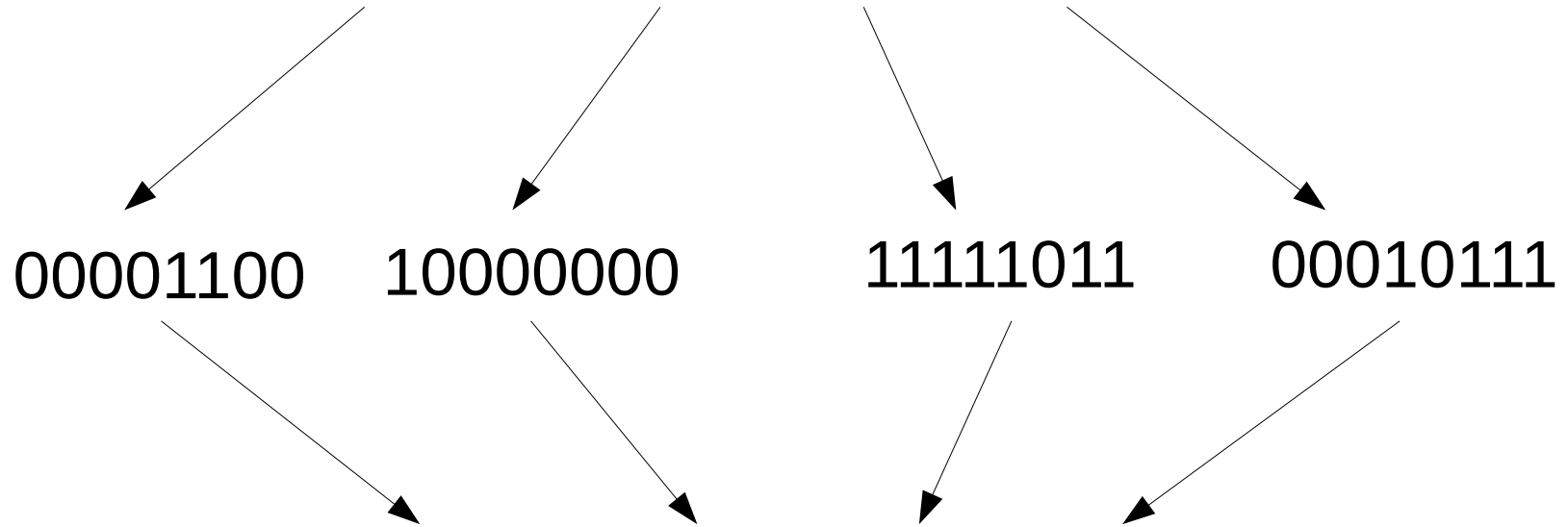
12.128.251.23 /8

IPv4 Address Classes

Class	First octet	First octet numeric range
A	0xxxxxxx	0-127
B	10xxxxxx	128-191
C	110xxxxx	192-223
D	1110xxxx	224-239
E	1111xxxx	240-255

IPv4 Address Classes

Class	First octet	First octet numeric range
A	0xxxxxxx	0-127
B	10xxxxxx	128-191
C	110xxxxx	192-223
D	1110xxxx	224-239
E	1111xxxx	240-255

Multicast addresses ➡

Reserved (experimental) ➡

- Address range 127.0.0.0 – 127.255.255.255
- Used to test the 'network stack' (think OSI, TCP/IP model) on the local device

```
C:\Users\user>ping 127.0.0.1

Pinging 127.0.0.1 with 32 bytes of data:
Reply from 127.0.0.1: bytes=32 time<1ms TTL=128
Reply from 127.0.0.1: bytes=32 time<1ms TTL=128
Reply from 127.0.0.1: bytes=32 time<1ms TTL=128
Reply from 127.0.0.1: bytes=32 time<1ms TTL=128

Ping statistics for 127.0.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

```
C:\Users\user>ping 127.23.68.241

Pinging 127.23.68.241 with 32 bytes of data:
Reply from 127.23.68.241: bytes=32 time<1ms TTL=128
Reply from 127.23.68.241: bytes=32 time<1ms TTL=128
Reply from 127.23.68.241: bytes=32 time<1ms TTL=128
Reply from 127.23.68.241: bytes=32 time<1ms TTL=128

Ping statistics for 127.23.68.241:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

IPv4 Address Classes

Class	First octet	First octet numeric range	Prefix Length
A	0xxxxxxx	0-127	/8
B	10xxxxxx	128-191	/16
C	110xxxxx	192-223	/24

Class A: 12.128.251.23/8

Class B: 154.78.111.32 /16

Class C: 192.168.1.254 /24

IPv4 Address Classes

Class	Leading bits	Size of *network number* bit field	Size of *rest* bit field	Number of networks	Addresses per network
Class A	0	8	24	128 (2^7)	16,777,216 (2^{24})
Class B	10	16	16	16,384 (2^{14})	65,536 (2^{16})
Class C	110	24	8	2,097,152 (2^{21})	256 (2^8)

Netmask

Class A: /8   255.0.0.0

(11111111 00000000 00000000 00000000)
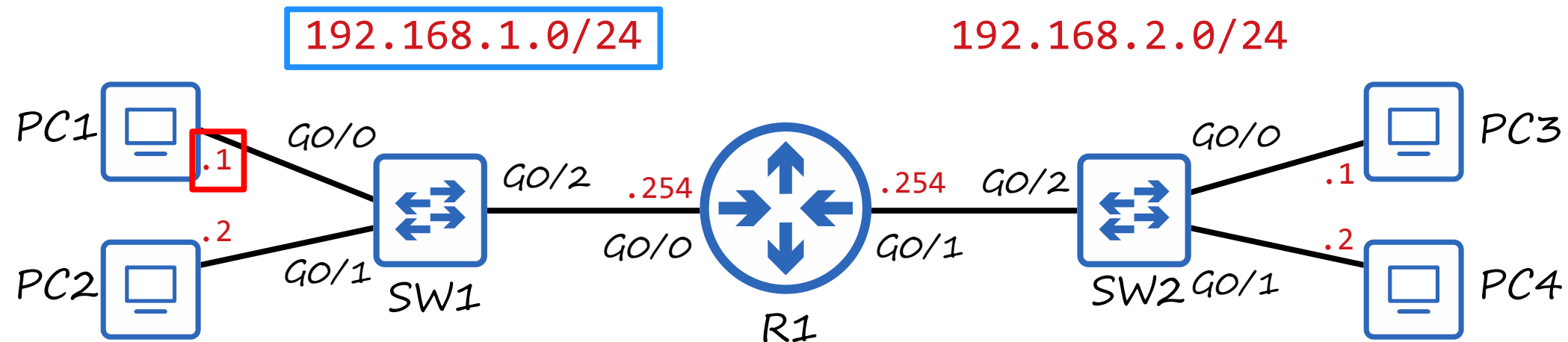
Class B: /16   255.255.0.0

(11111111 11111111 00000000 00000000)

Class C: /24   255.255.255.0
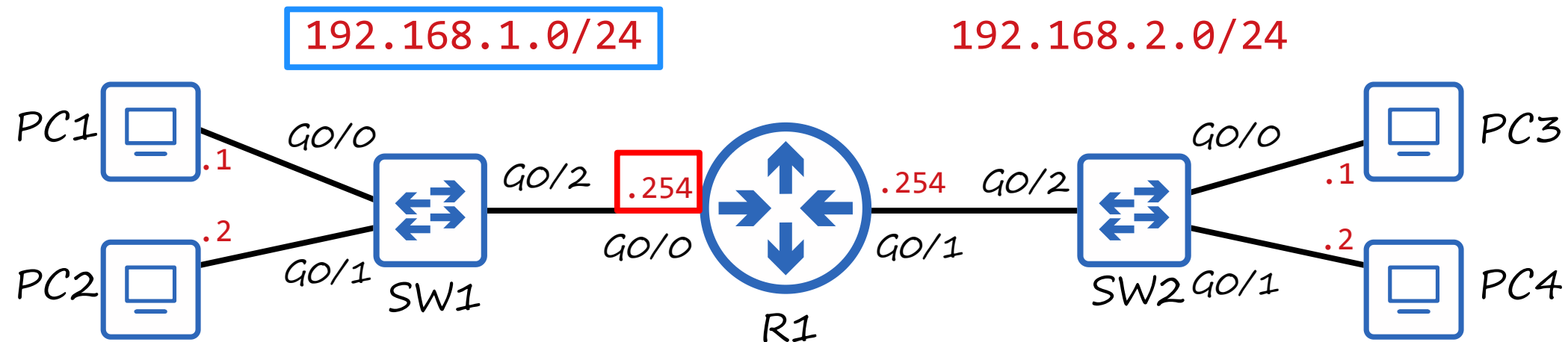
(11111111 11111111 11111111 00000000)

192.168.1.0/24   192.168.2.0/24

PC1 .1   G0/0

SW1   G0/2   .254   R1   .254   G0/2   SW2

G0/0   G0/1

PC2 .2   G0/1

G0/0   G0/0   G0/1   G0/1

PC3 .1

PC4 .2

Host portion of the address is all **O**'s = **Network Address**

The **network address** CANNOT be assigned to a host.

Host portion of the address is all **1**'s = **Broadcast Address**

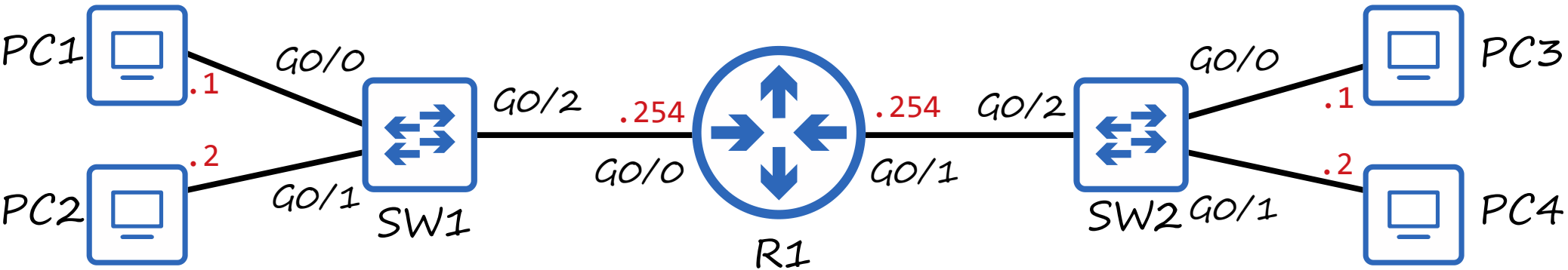The **broadcast address** CANNOT be assigned to a host.

Broadcast Address

192.168.1.0/24

192.168.2.0/24

PC1 .1

G0/0

PC2 .2

G0/1

SW1

G0/2

.254

G0/0

R1

.254

G0/1

G0/2

SW2

G0/0

.1 PC3

G0/1

.2 PC4

Dst. IP: 192.168.1.255

Dst. MAC: FFFF.FFFF.FFFF

- Dotted decimal & binary

- Network portion / host portion of IPv4 addresses

- IPv4 address classes

- Prefix lengths / netmasks

- Network addresses / broadcast addresses

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QUIZ

Convert the following IPv4 address to dotted decimal notation:

00111111 00111000 11100111 00010011

63.56.231.19

Convert the following IPv4 address to dotted decimal notation:

11110011 01111111 01100010 00000001

243.127.98.1

Convert the following IPv4 address to dotted decimal notation:

01101111 00000110 01011001 11000111

111.6.89.199

Convert the following IPv4 address to dotted decimal notation:

11001111 11000110 00101111 01001100

207.198.47.76

Convert the following IPv4 address to dotted decimal notation:

01100100 11001001 00100001 11111101

100.201.33.253

Convert the following IPv4 address to binary notation:

88.46.90.91

01011000 00101110 01011010 01011011

Convert the following IPv4 address to binary notation:

221.234.246.163

11011101 11101010 11110110 10100011

Convert the following IPv4 address to binary notation:

3.41.143.222

00000011 00101001 10001111 11011110

Convert the following IPv4 address to binary notation:

10.200.231.91

00001010 11001000 11100111 01011011

Convert the following IPv4 address to binary notation:

248.87.255.152

11111000 01010111 11111111 10011000