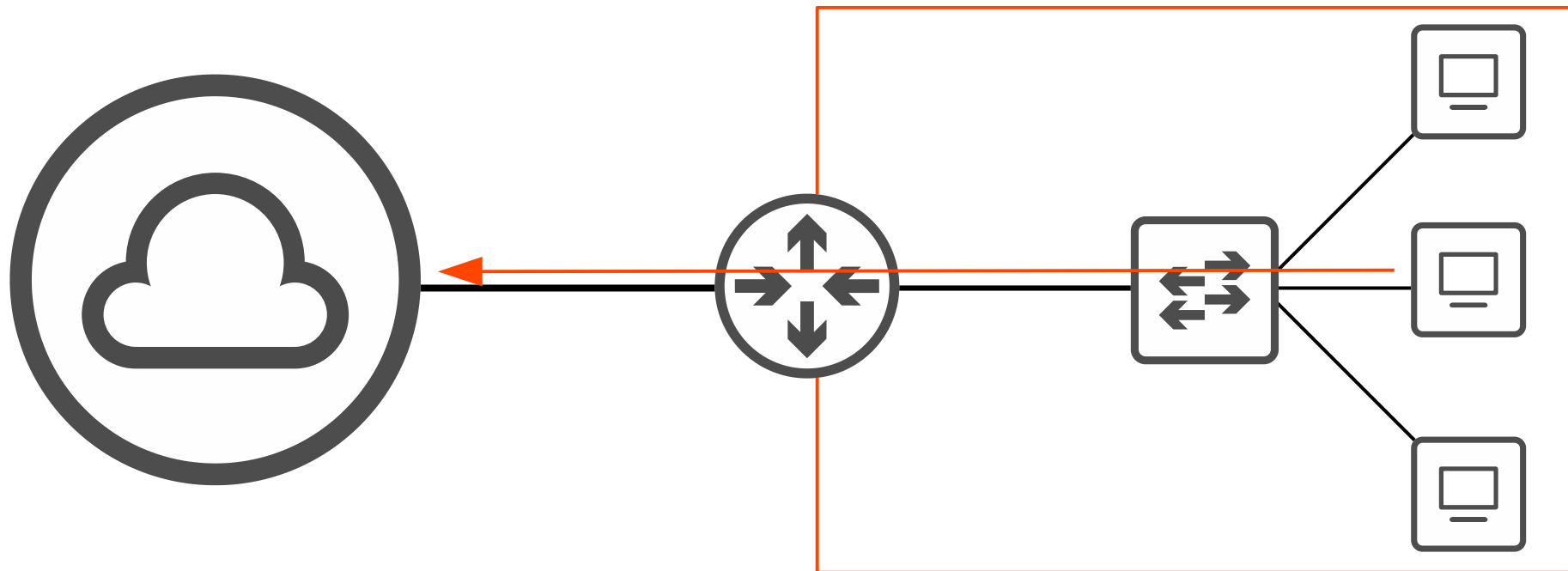




# CCNA 200-301 Day 7

## IPv4 Addressing



# OSI Model – Network Layer

7 Application

6 Presentation

5 Session

4 Transport

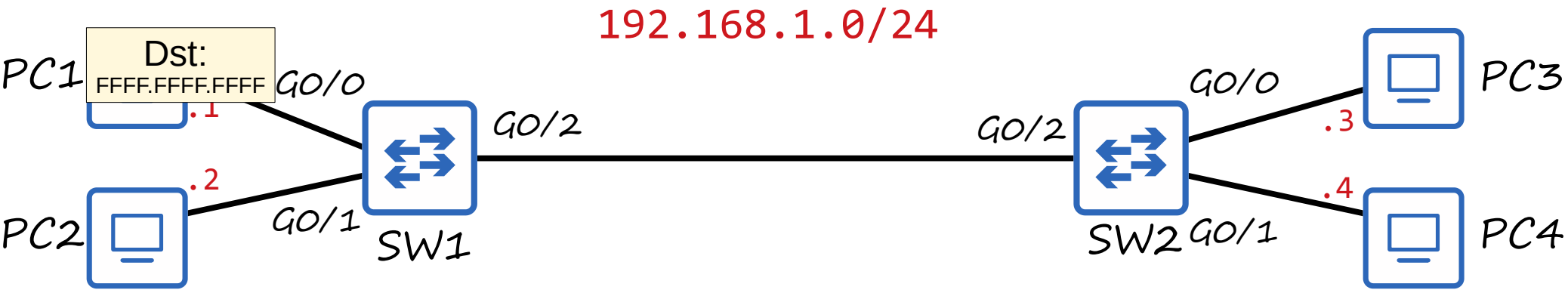
3 **Network**

2 Data Link

1 Physical

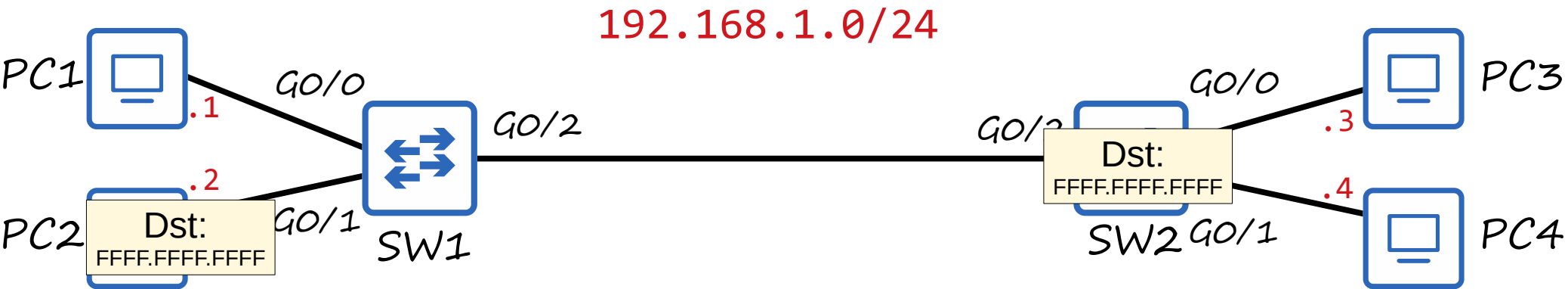
- Provides connectivity between end hosts on different networks (ie. outside of the LAN).
- Provides logical addressing (IP addresses).
- Provides path selection between source and destination.
- Routers operate at Layer 3.

# Routing



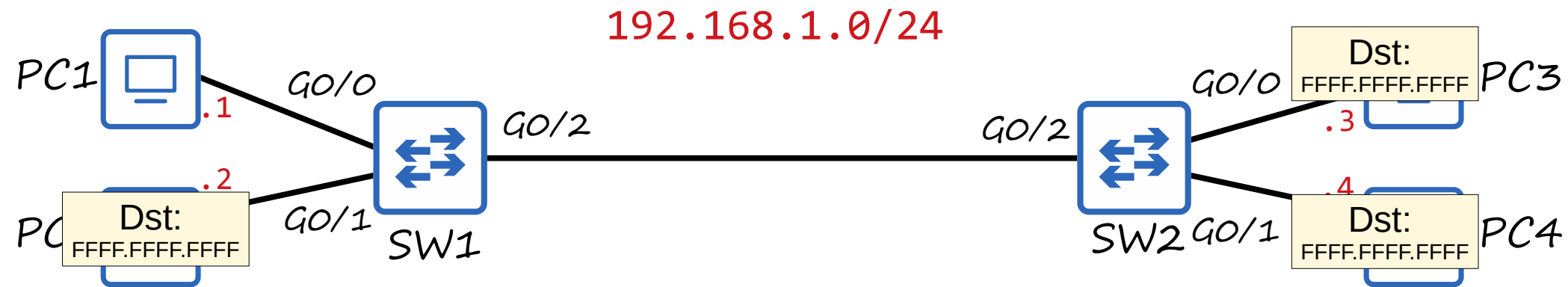


# Routing

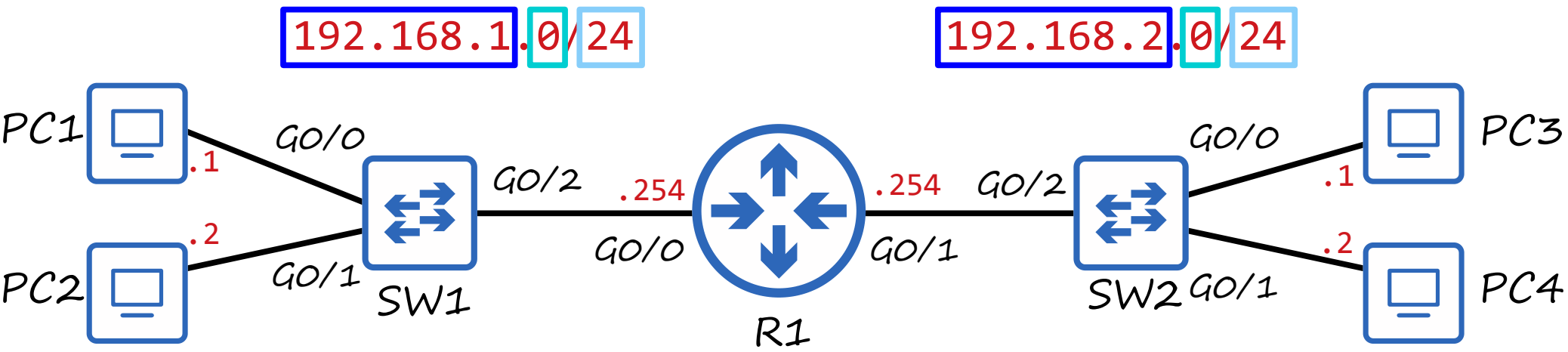


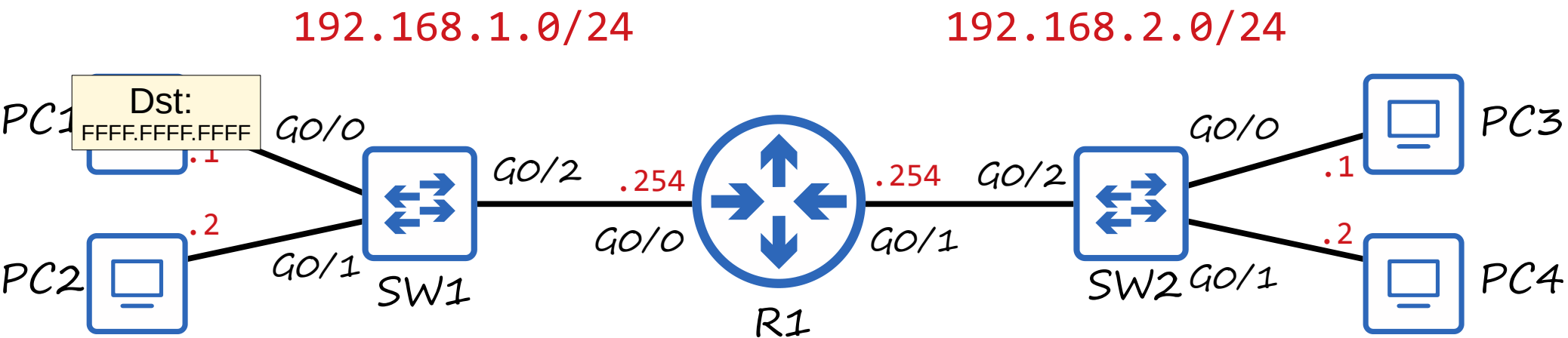


# Routing



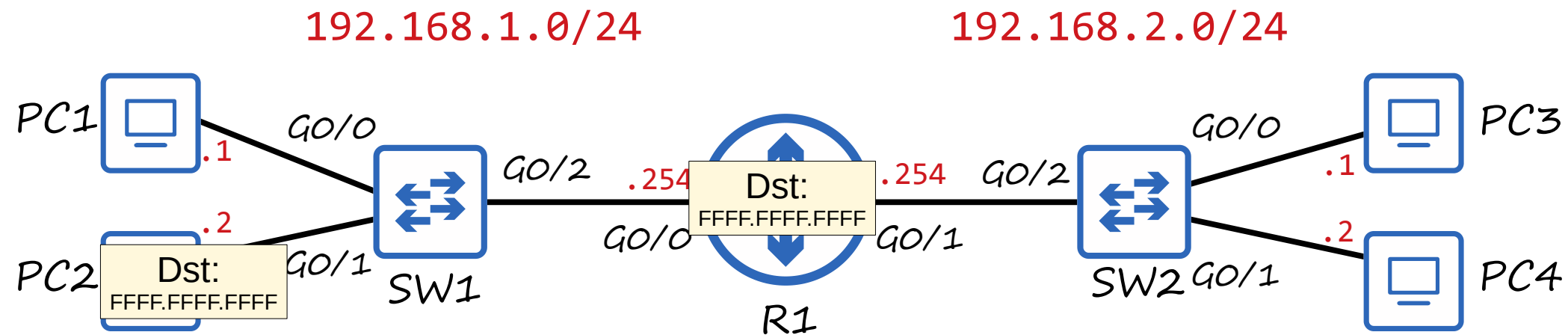
# Routing







# Routing





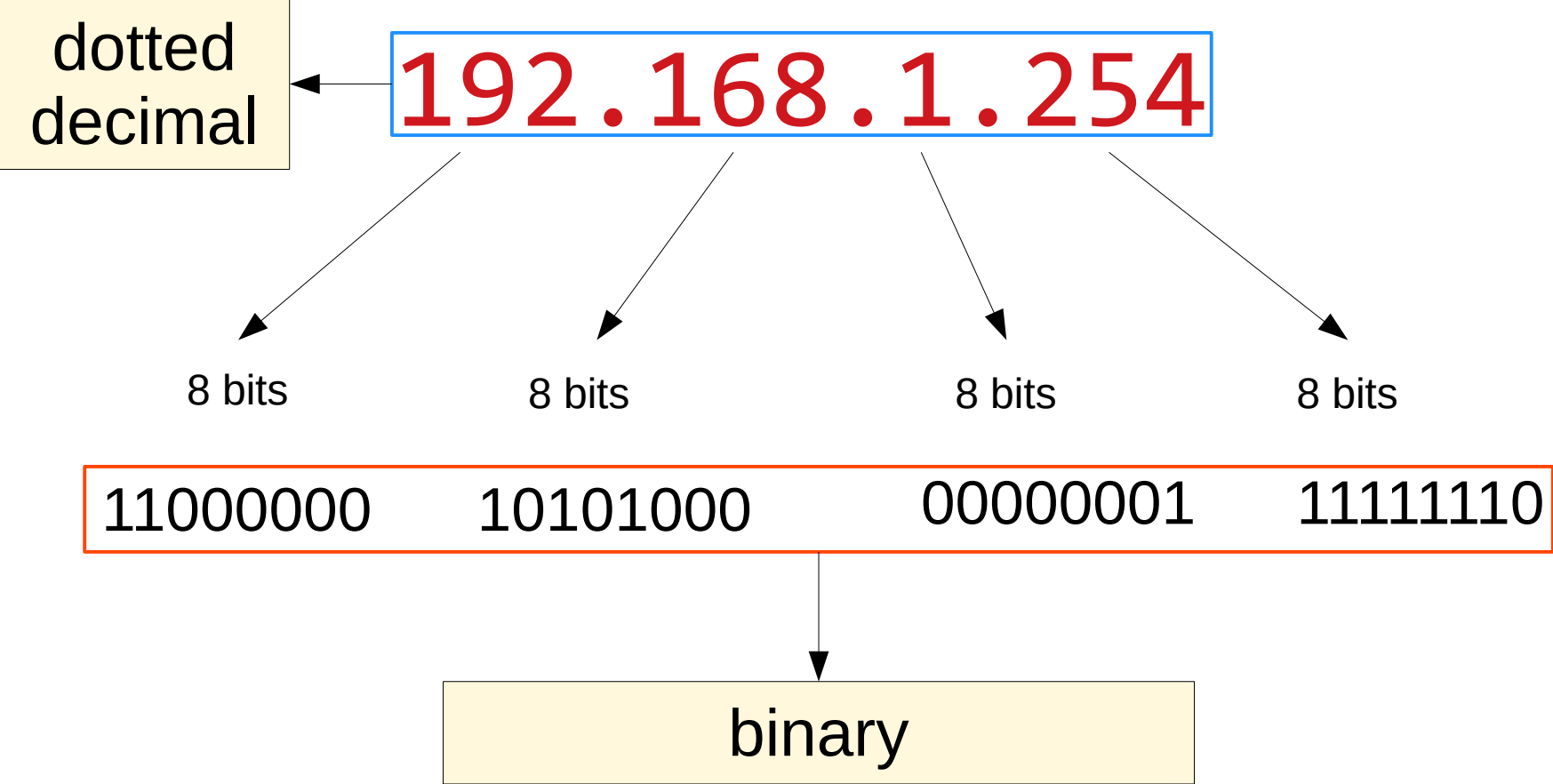
# IPv4 Header

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 present)																															
24	192																																
28	224																																
32	256																																

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

# IPv4 Addresses





# Decimal & Hexadecimal

Decimal  
(base 10)

3

$3 * 1000$

2

$2 * 100$

9

$9 * 10$

4

$4 * 1$

Hexadecimal  
(base 16)

C

$C * 256$   
(C = 12)

3072

D

$D * 16$   
(D = 13)

208

E

$E * 1$   
(E = 14)

14

+

+

= 3294

# IPv4 Addresses

dotted  
decimal

192.168.1.254

8 bits

8 bits

8 bits

8 bits

11000000

10101000

00000001

11111110

binary

# Binary (base 2)

192



1

1

0

0

0

0

0

0

$1 * 128$

$1 * 64$

$0 * 32$

$0 * 16$

$0 * 8$

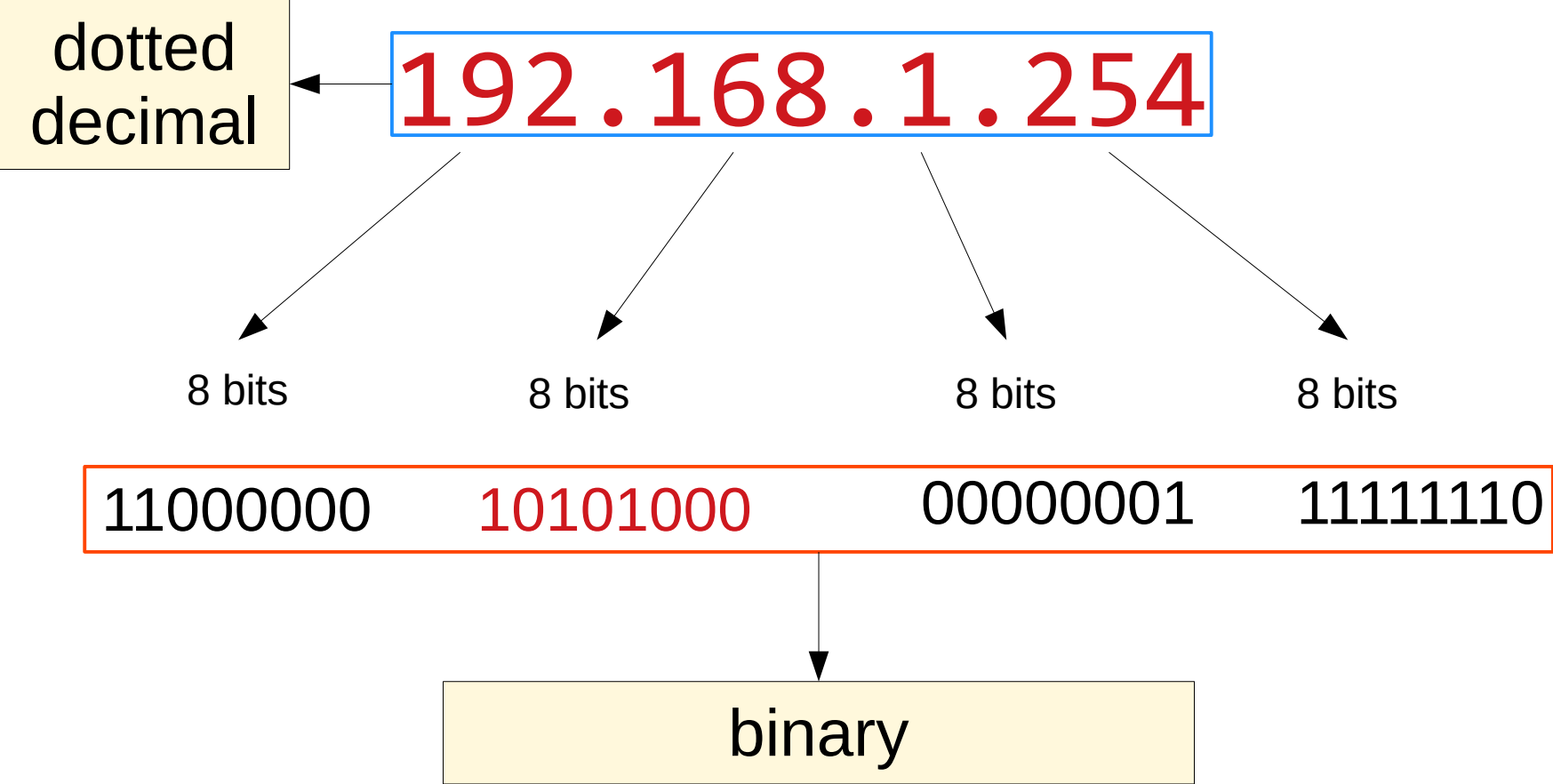
$0 * 4$

$0 * 2$

$0 * 1$

$$128 + 64 = 192$$

# IPv4 Addresses



# Binary (base 2)

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

# IPv4 Addresses

dotted  
decimal

192.168.1.254

8 bits

8 bits

8 bits

8 bits

11000000

10101000

00000001

11111110

binary



# Binary (base 2)

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



# IPv4 Addresses

dotted  
decimal

192.168.1.254

8 bits

8 bits

8 bits

8 bits

11000000

10101000

00000001

11111110

binary

# Binary (base 2)

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

# IPv4 Addresses

192.168.1.254

8 bits

8 bits

8 bits

8 bits

11000000

10101000

00000001

11111110

octet

octet

octet

octet

# Binary → Decimal (1)

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

= 143

# Binary → Decimal (2)

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

= 118

# Binary $\rightarrow$ Decimal (3)

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

$$= 236$$

# Decimal → Binary (1)

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



# Decimal → Binary (2)

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

# Decimal → Binary (3)

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

# Binary

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

= 0

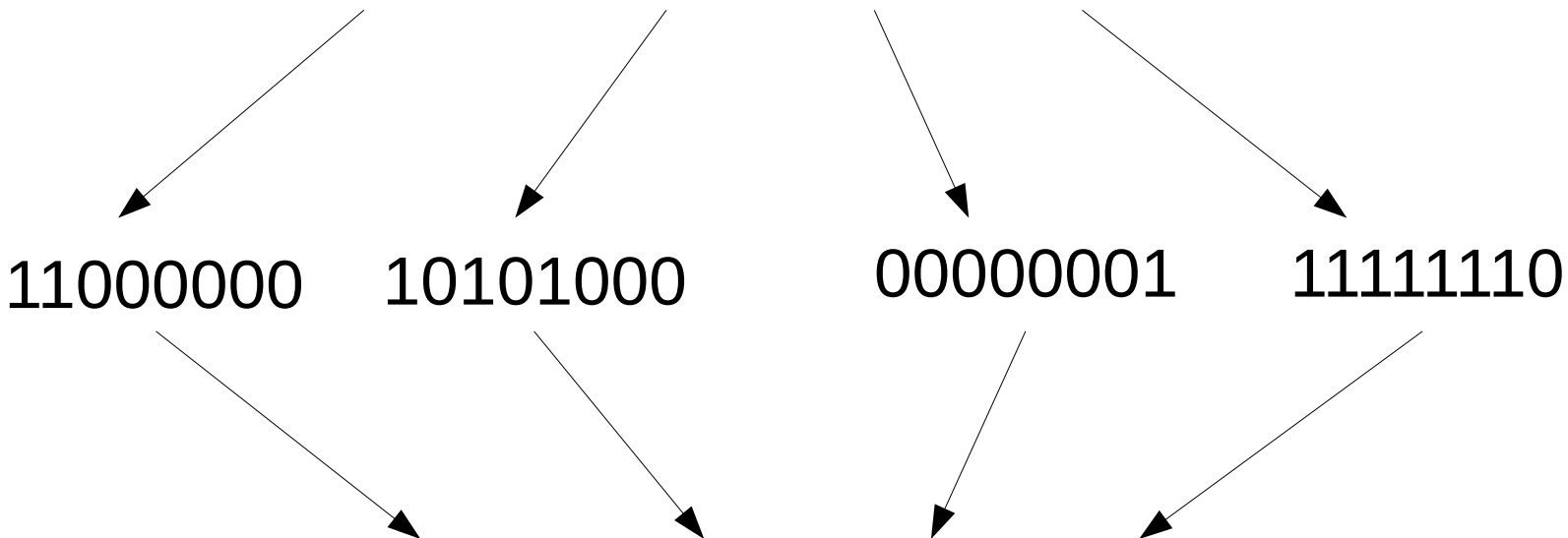
128	64	32	16	8	4	2	1
1	1	1	1	1	1	1	1

= 255



# IPv4 Addresses

11000000101010000000000011111110

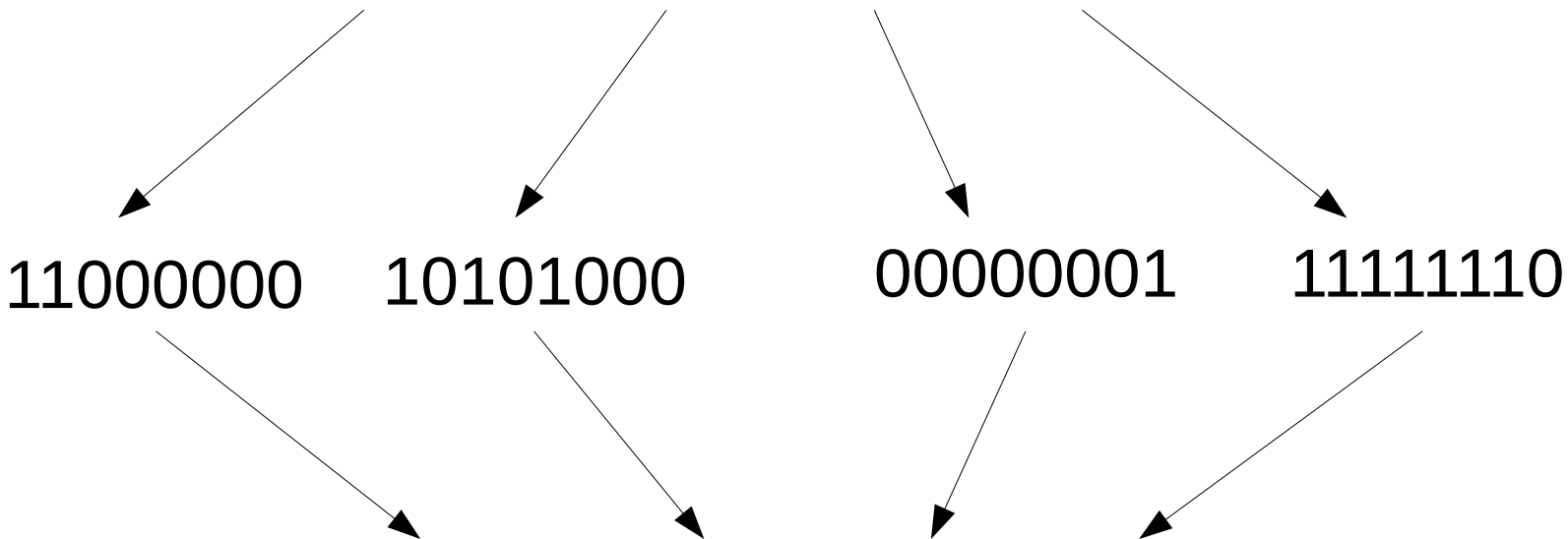


192.168.1.254 /24



# IPv4 Addresses

11000000101010000000000011111110

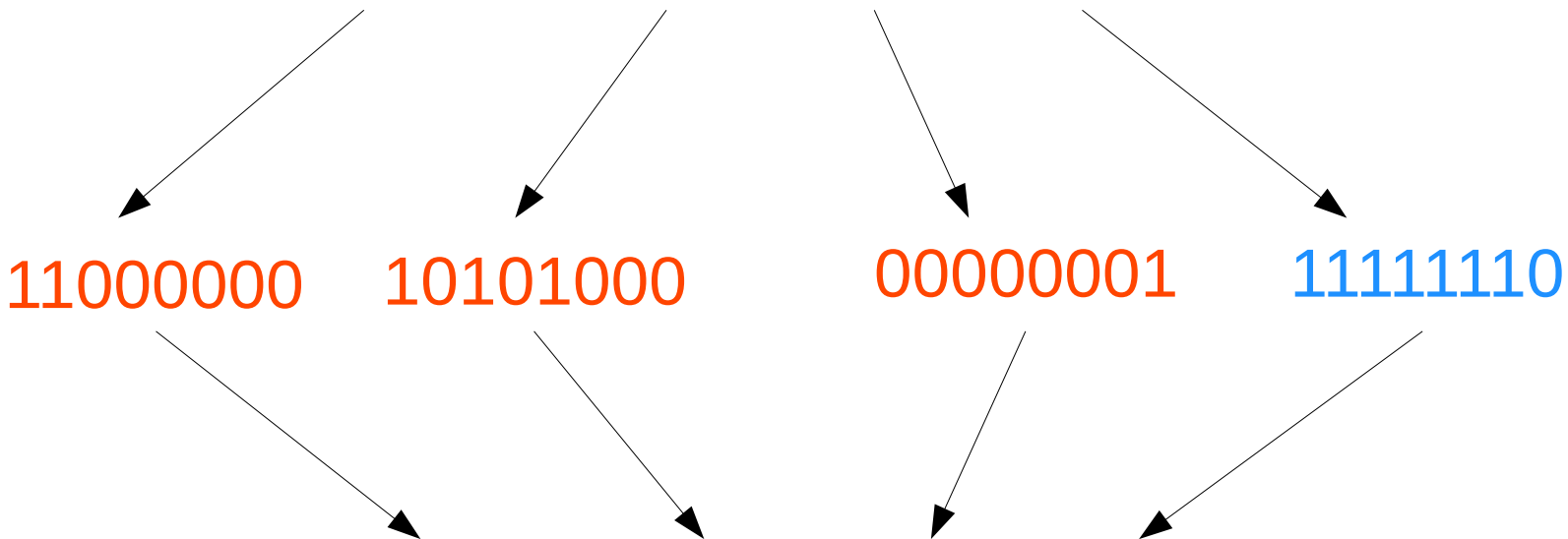


192.168.1.254 /24



# IPv4 Addresses

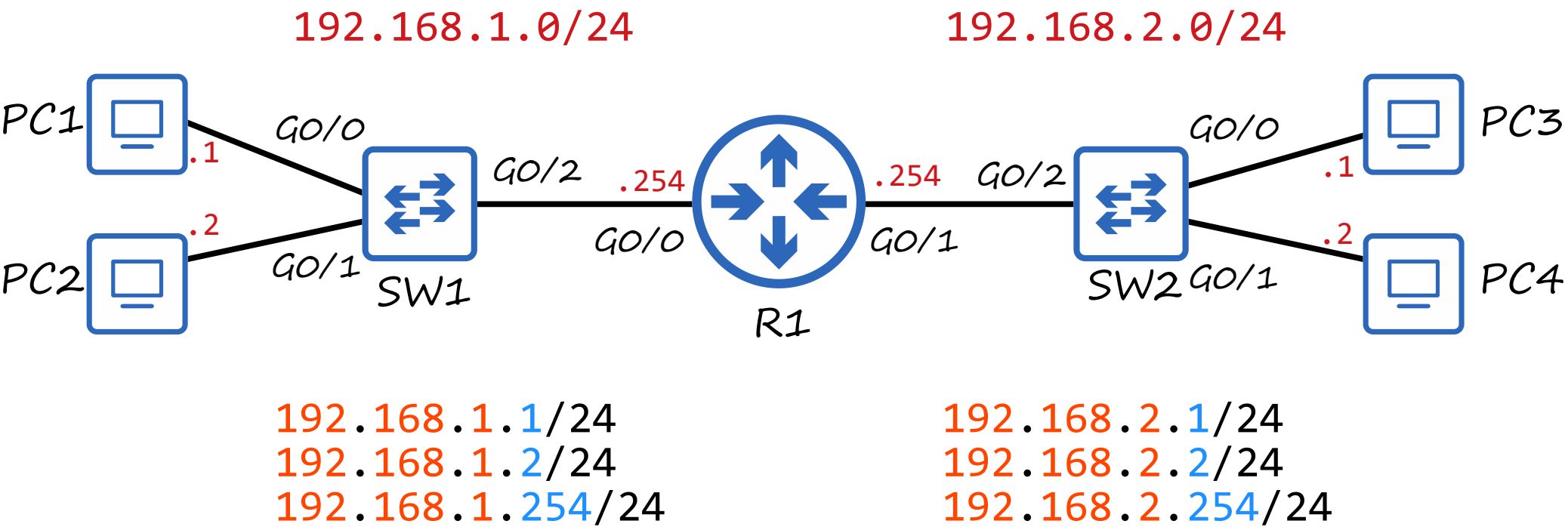
110000001010100000000000011111110



192.168.1.254 /24

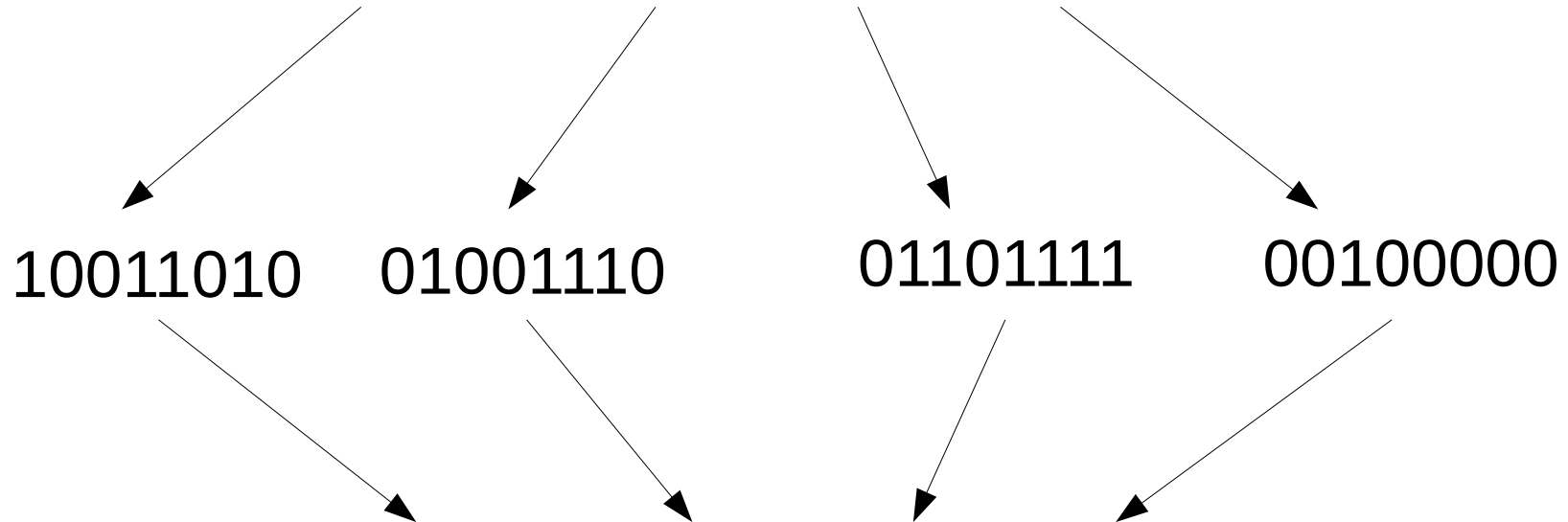


# IPv4 Addresses



# IPv4 Addresses

10011010010011100110111100100000



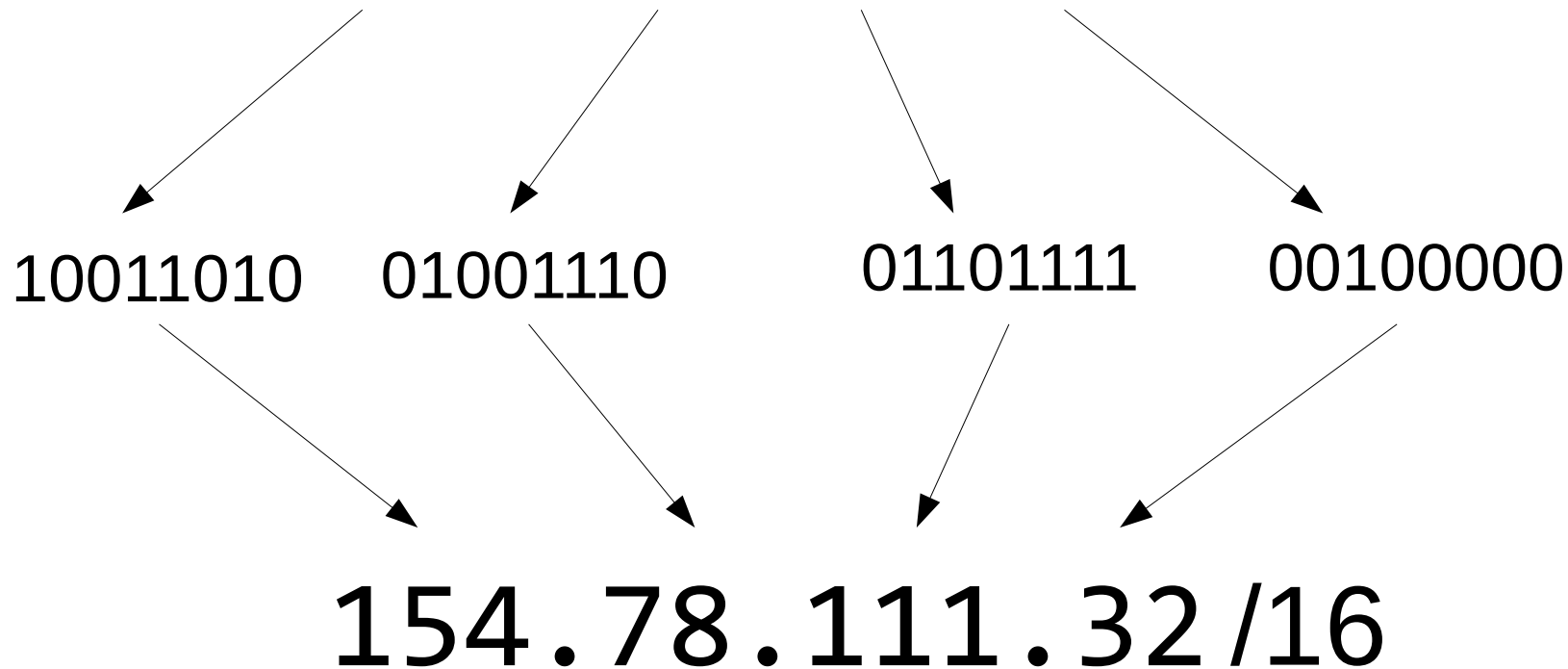
154.78.111.32 /16





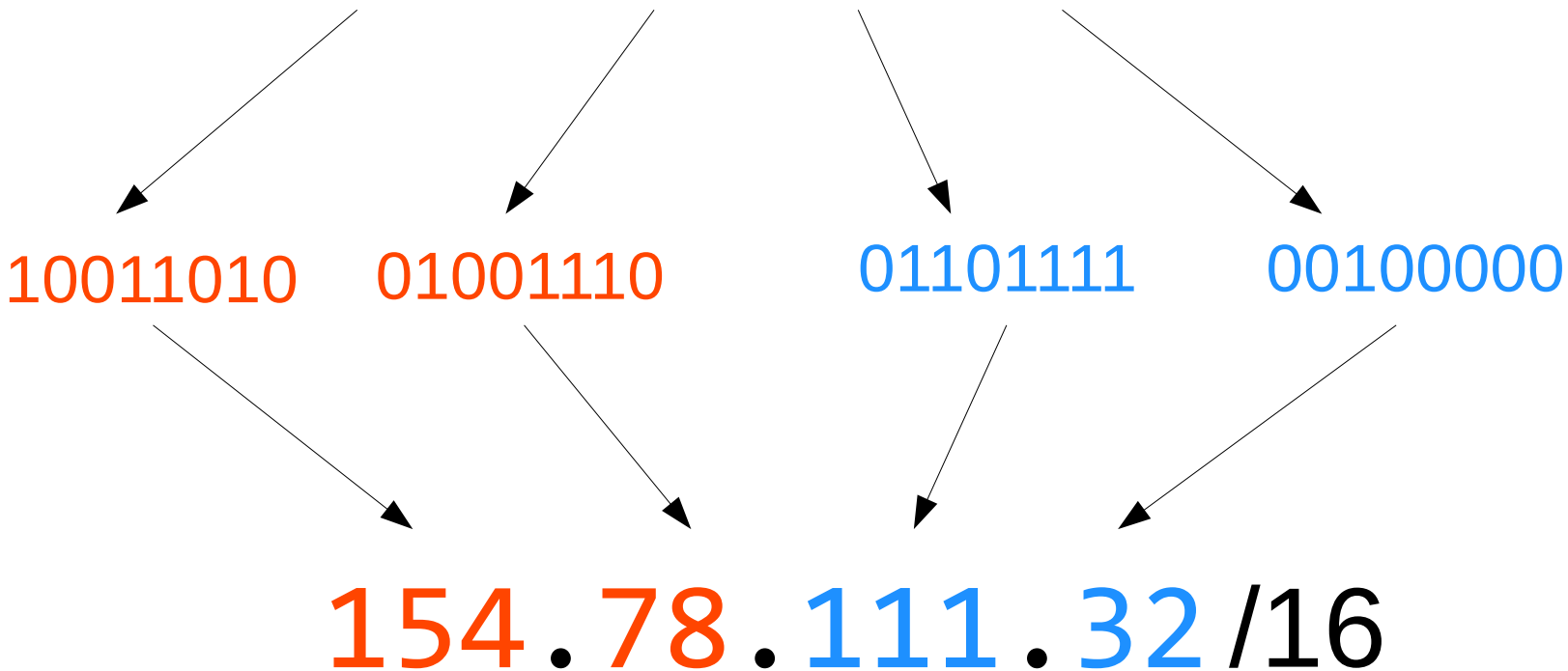
# IPv4 Addresses

10011010010011100110111100100000



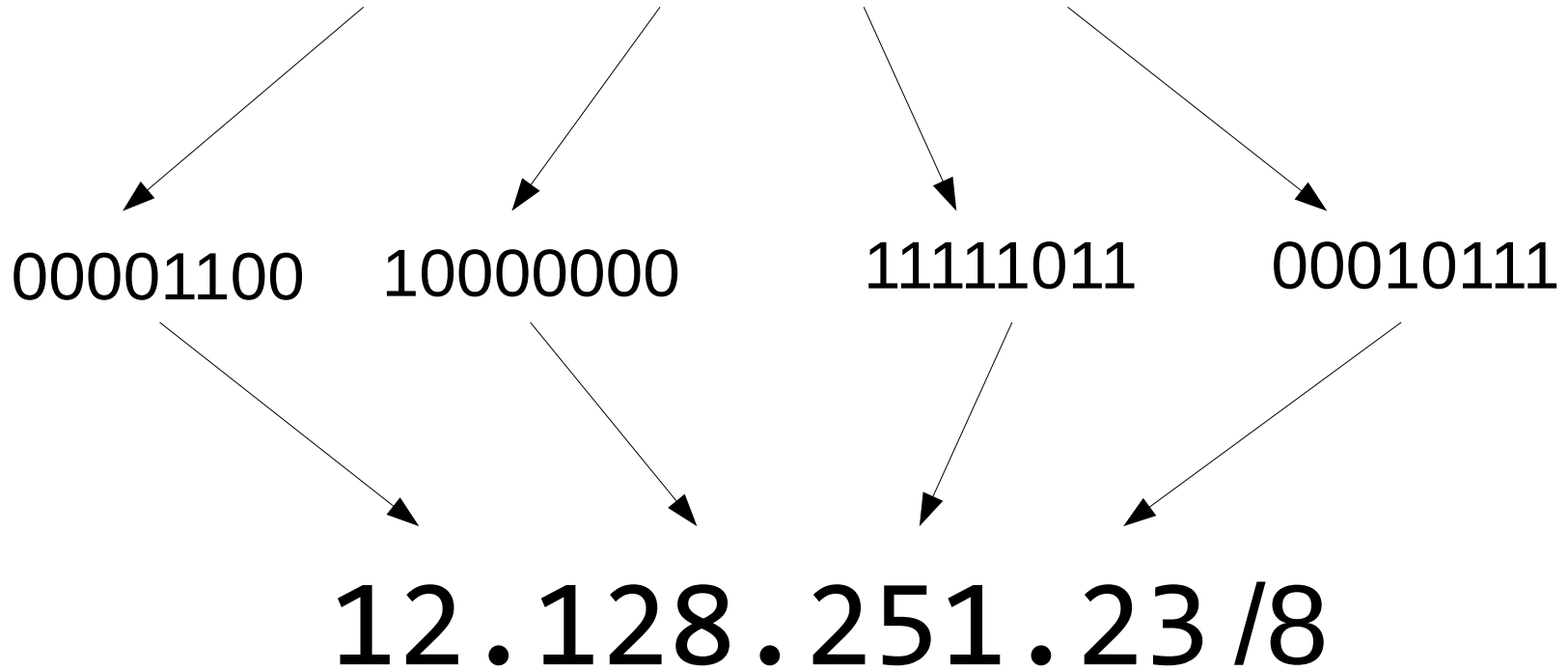
# IPv4 Addresses

10011010010011100110111100100000



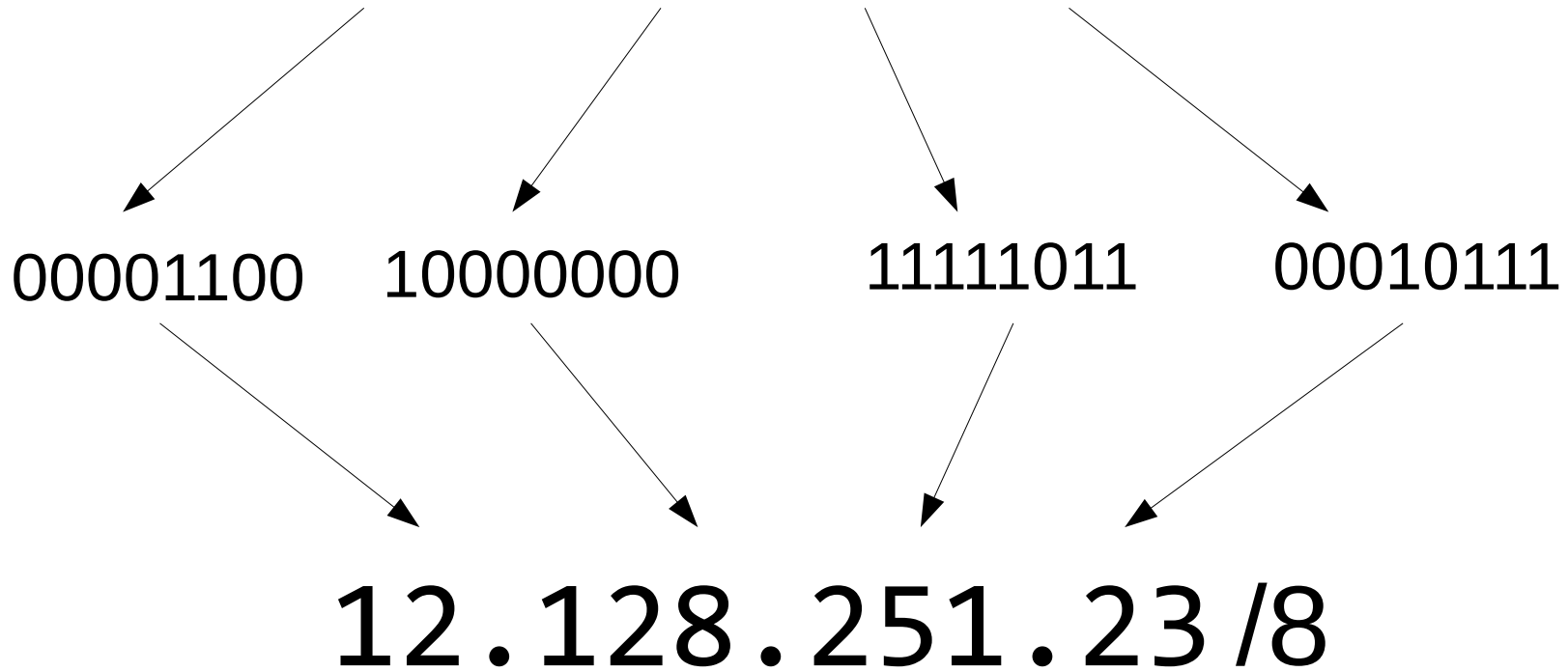
# IPv4 Addresses

00001100100000001111101100010111

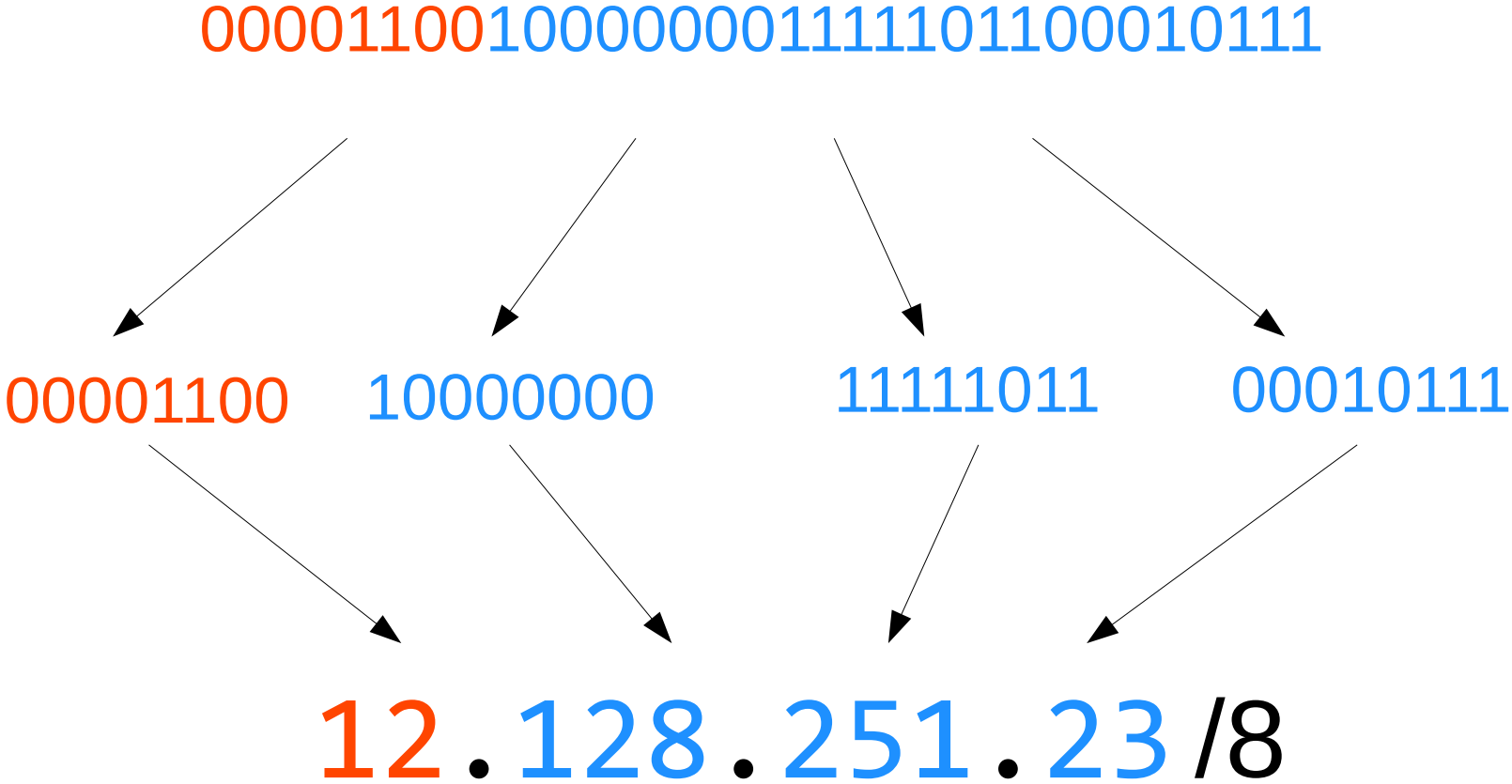


# IPv4 Addresses

00001100100000001111101100010111



# IPv4 Addresses



# 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) →



# Loopback Addresses

- 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

# IPv4 Address Classes

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 <i>network number</i> bit field	Size of <i>rest</i> 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

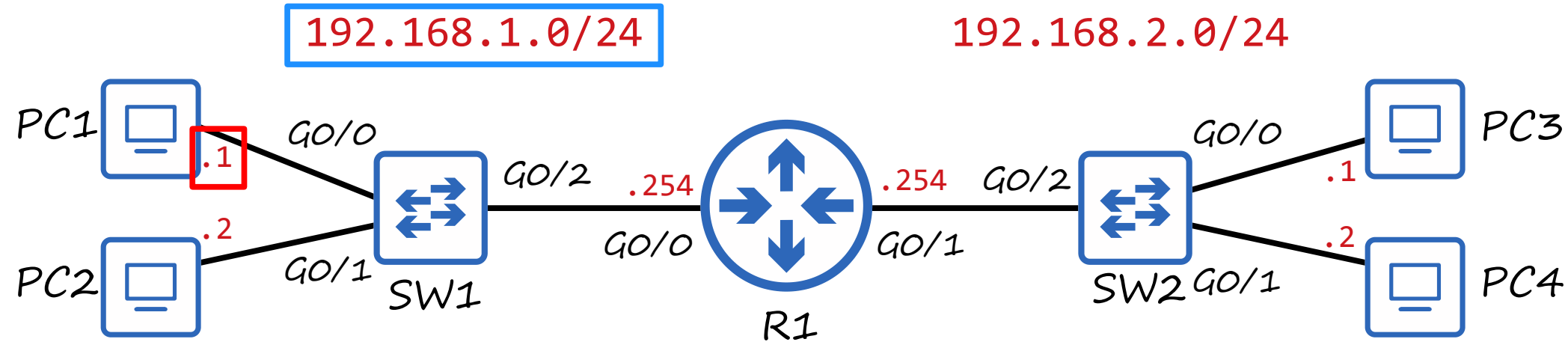
(11111111 11111111 00000000 00000000)

Class C: /24

255.255.255.0

(11111111 11111111 11111111 00000000)

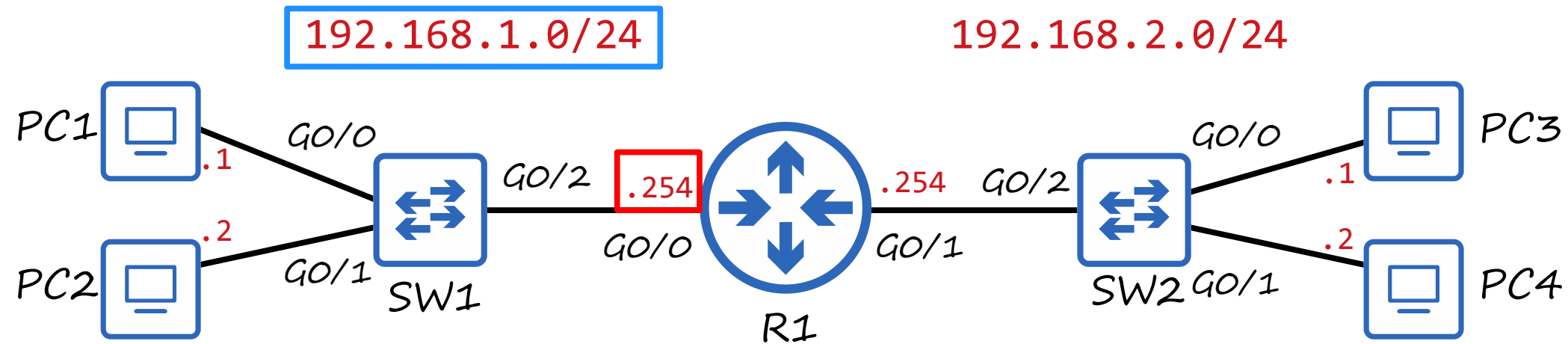
# Network Address



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

The network address CANNOT be assigned to a host.

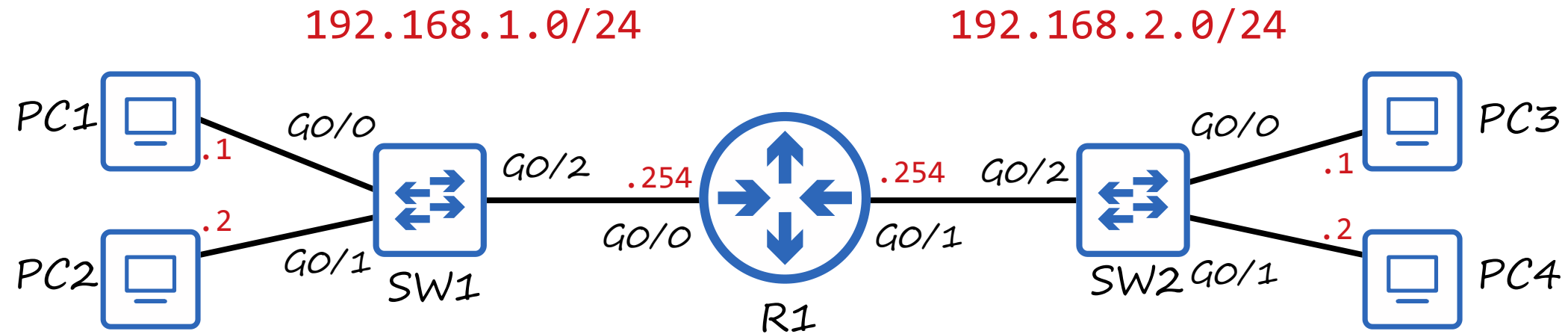
# Broadcast Address



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

The broadcast address CANNOT be assigned to a host.

# Broadcast Address



Dst. IP: 192.168.1.255

Dst. MAC: FFFF.?????.FFFF

- Dotted decimal & binary
- Network portion / host portion of IPv4 addresses
- IPv4 address classes
- Prefix lengths / netmasks
- Network addresses / broadcast addresses





# QUIZ

## Quiz Question 1

*Convert the following IPv4 address to dotted decimal notation:*

00111111 00111000 11100111 00010011

63.56.231.19

## Quiz Question 2

*Convert the following IPv4 address to dotted decimal notation:*

11110011 01111111 01100010 00000001

243.127.98.1

## Quiz Question 3

*Convert the following IPv4 address to dotted decimal notation:*

01101111 00000110 01011001 11000111

111.6.89.199

## Quiz Question 4

*Convert the following IPv4 address to dotted decimal notation:*

11001111 11000110 00101111 01001100

207.198.47.76

## Quiz Question 5

*Convert the following IPv4 address to dotted decimal notation:*

01100100 11001001 00100001 11111101

100.201.33.253

## Quiz Question 6

*Convert the following IPv4 address to binary notation:*

88.46.90.91

01011000 00101110 01011010 01011011

## Quiz Question 7

*Convert the following IPv4 address to binary notation:*

221.234.246.163

11011101 11101010 11110110 10100011



## Quiz Question 8

*Convert the following IPv4 address to binary notation:*

3.41.143.222

00000011 00101001 10001111 11011110

## Quiz Question 9

*Convert the following IPv4 address to binary notation:*

10.200.231.91

00001010 11001000 11100111 01011011

## Quiz Question 10

*Convert the following IPv4 address to binary notation:*

248.87.255.152

11111000 01010111 11111111 10011000