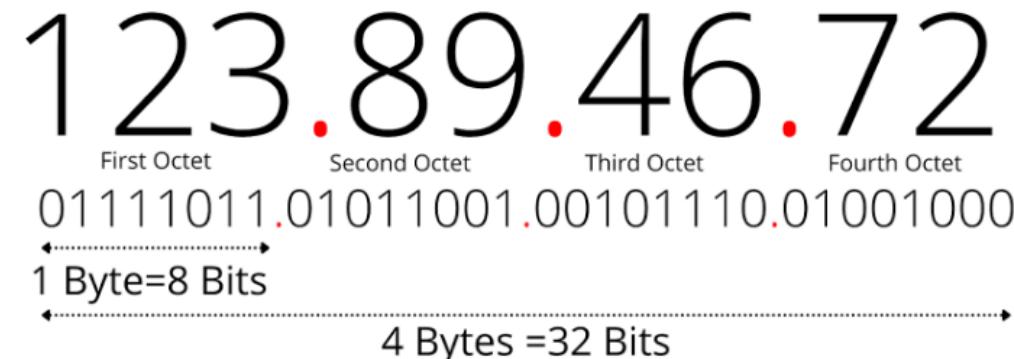


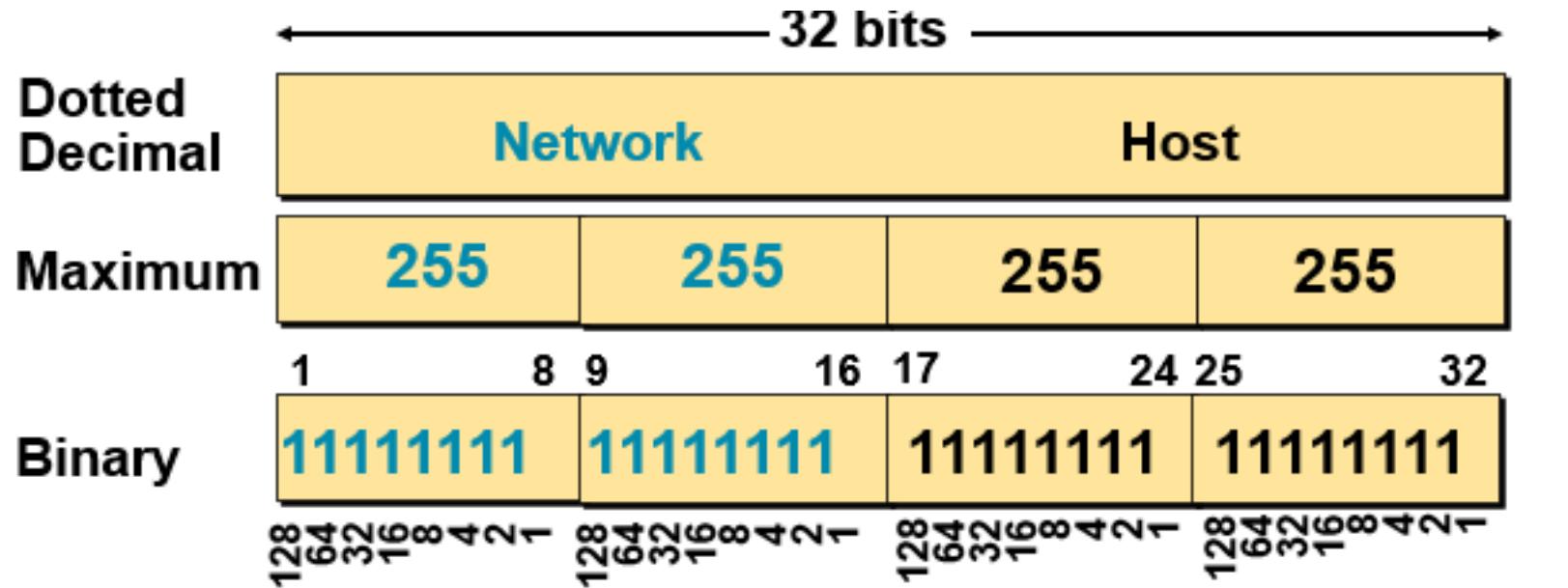
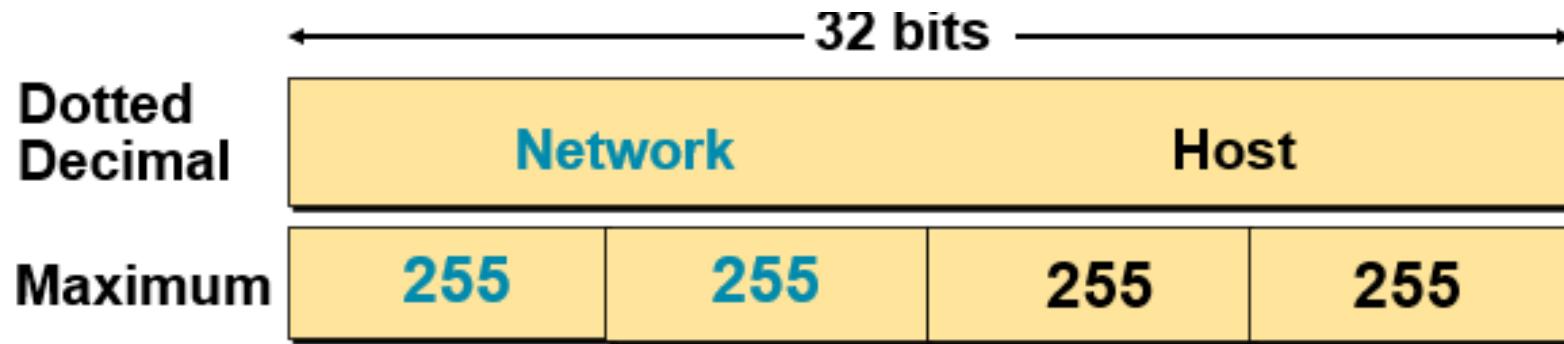
Week 10: Internet Protocol

IP Addressing

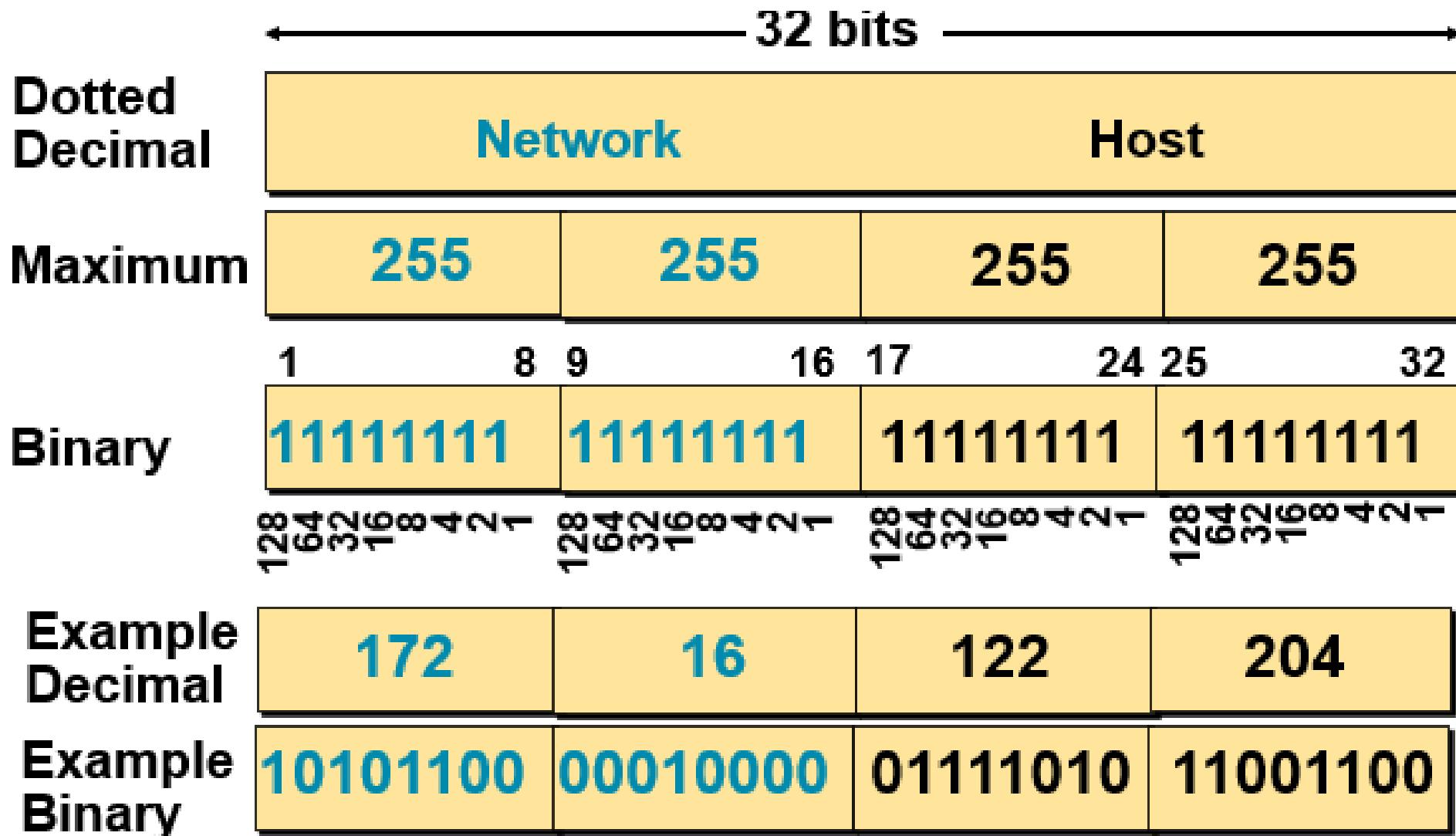
- An IP address has 32 bits divided into four octets
- To make the address easier to read, people use decimal numbers to represent the binary digits
 - Example: 192.168.1.1
- Dotted decimal notation
 - When binary IP addresses are written in decimal format



IP addressing



IP addressing



IP addressing classes

	8 bits	8 bits	8 bits	8 bits
Class A:	Network	Host	Host	Host
Class B:	Network	Network	Host	Host
Class C:	Network	Network	Network	Host
Class D:	Multicast			
Class E:	Research			

Multicasting is a technique developed to send packets from one device to many other devices.

IP addressing classes

Bits:	1	8 9	16 17	24 25	32
Class A:	0NNNNNNN	Host	Host	Host	
	Range (1-126)				
Class B:	10NNNNNN	Network	Host	Host	
	Range (128-191)				
Class C:	110NNNNN	Network	Network	Host	
	Range (192-223)				
Class D:	1110MMMM	Multicast Group	Multicast Group	Multicast Group	
	Range (224-239)				

IP addressing classes

- Class A
 - Reserved for governments and large corporations throughout the world
 - Each Class A address supports 16,777,214 hosts
- Class B
 - Addresses are assigned to large- and medium-sized companies
 - Each Class B address supports 65,534 hosts

IP addressing classes

Binary Place Values									Decimal Equivalent	Description
128	64	32	16	8	4	2	1			
0	0	0	0	0	0	0	0	= 0		Subnet identifier
0	0	0	0	0	0	0	1	= 1		Bottom of Class A range
0	1	1	1	1	1	1	0	= 126		Top of Class A range
0	1	1	1	1	1	1	1	= 127		Loopback address

Figure 4-1 Class A addresses begin with a number between 1 and 126

Binary Place Values									Decimal Equivalent	Description
128	64	32	16	8	4	2	1			
1	0	0	0	0	0	0	0	= 128		First Class B address
1	0	1	1	1	1	1	1	= 191		Last Class B address

Figure 4-2 Class B addresses begin with a number between 128 and 191

IP addressing classes

- Class C
 - Addresses are assigned to groups that do not meet the qualifications to obtain Class A or B addresses
 - Each Class C address supports 254 hosts
- Class D
 - Addresses (also known as multicast addresses) are reserved for multicasting
 - **Multicasting** is the sending of a stream of data (usually audio and video) to multiple computers simultaneously

IP addressing classes

Binary Place Values									Decimal Equivalent	Description
128	64	32	16	8	4	2	1			
1	1	0	0	0	0	0	0	= 192		First Class C address
1	1	0	1	1	1	1	1	= 223		Last Class C address

Figure 4-3 Class C addresses begin with numbers between 192 and 223

Binary Place Values									Decimal Equivalent	Description
128	64	32	16	8	4	2	1			
1	1	1	0	0	0	0	0	= 224		First Class D address
1	1	1	0	1	1	1	1	= 239		Last Class D address

Figure 4-4 Class D addresses begin with a number between 224 and 239

IP addressing classes

- Class E
 - Addresses are reserved for research, testing, and experimentation
 - The Class E range starts where Class D leaves off
- Private IP ranges
 - Many companies use private IP addresses for their internal networks
 - Will not be routable on the Internet
 - Gateway devices have network interface connections to the internal network and the Internet
 - Route packets between them

IP addressing classes

Binary Place Values								Decimal Equivalent	Description
128	64	32	16	8	4	2	1		
1	1	1	1	0	0	0	0	= 240	First Class E address
1	1	1	1	1	1	1	1	= 255	Last Class E address

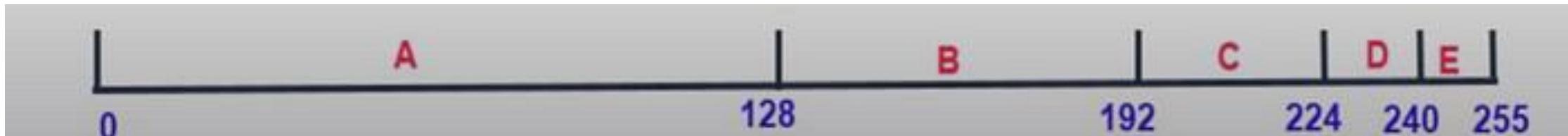
Figure 4-5 Class E addresses begin with a number between 240 and 255

Class	Private Address Range
A	10.x.x.x
B	172.16.x.x – 172.31.x.x
C	192.168.x.x

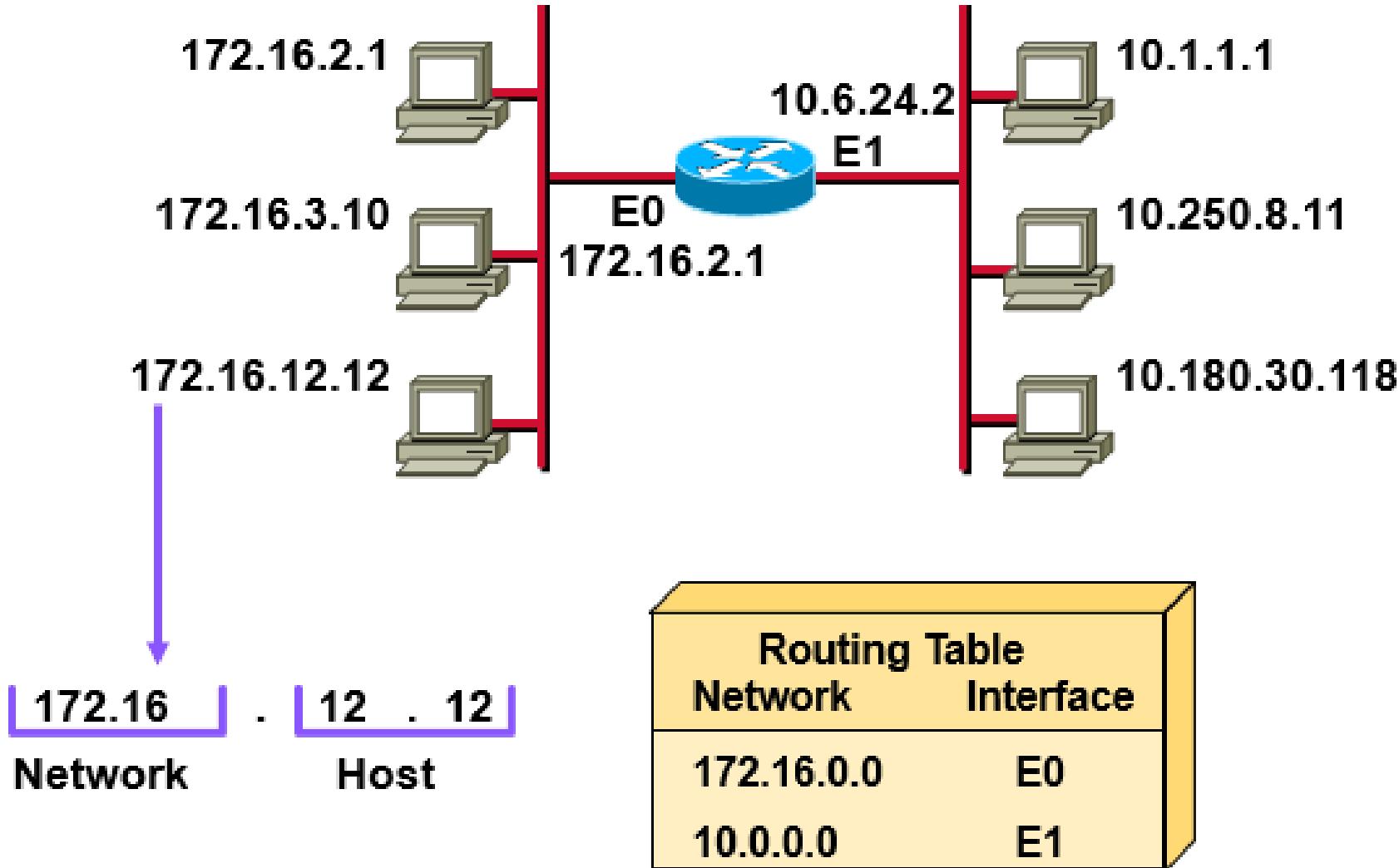
Table 4-2 The private IP ranges

IP addressing classes

Class	First Octet decimal (range)	First Octet binary (range)	IP range	Subnet Mask	Hosts per Network ID	# of networks
Class A	0—127	0XXXXXXX	0.0.0.0-127.255.255.255	255.0.0.0	$2^{24}-2$	2^7
Class B	128—191	10XXXXXX	128.0.0.0-191.255.255.255	255.255.0.0	$2^{16}-2$	2^{14}
Class C	192—223	110XXXXX	192.0.0.0-223.255.255.255	255.255.255.0	2^8-2	2^{21}
Class D (Multicast)	224—239	1110XXXX	224.0.0.0-239.255.255.255			
Class E (Experimental)	240—255	1111XXXX	240.0.0.0-255.255.255.255			



Host Addresses



Determining Available Host Addresses

Network	Host	
172	16	0 0
		16 මෙහෙතුම සැමවාන් N
10101100 00010000	00000000 00000000	1
	00000000 00000001	2
	00000000 00000011	3
	⋮ ⋮	⋮
	11111111 11111101	65534
	11111111 11111110	65535
	11111111 11111111	65536
	- 2	2
$2^{N-2} = 2^{16-2} = 65534$		65534

Examples

Address	Class	Network	Host
10.2.1.1	A	10.0.0.0	0.2.1.1
128.63.2.100	B	128.63.0.0	0.0.2.100
201.222.5.64	C	201.222.5.0	0.0.0.64
192.6.141.2	C	192.6.141.0	0.0.0.2
130.113.64.16	B	130.113.0.0	0.0.64.16
256.241.201.10	Nonexistent		

Subnet mask

- IP addresses identify both the network and the host
 - The division between the two is not specific to a certain number of octets
- **Subnet mask**
 - Indicates how much of the IP address represents the network or subnet
- Standard (default) subnet masks:
 - Class A subnet mask is 255.0.0.0
 - Class B subnet mask is 255.255.0.0
 - Class C subnet mask is 255.255.255.0

Subnetting Formulas

- Consider memorizing the following two formulas:

$2^y = \# \text{ of usable subnets}$ (where y is the number of bits borrowed)

$2^x - 2 = \# \text{ of usable hosts per subnet}$ (where x is the number of bits remaining in the host field after borrowing)

Subnetting Formulas

C Address	199.4.10.0	11000111.11000000.01000001.00000000
Standard mask	255.255.255.0	11111111.11111111.11111111.00000000
Mask	255.255.255.240	11111111.11111111.11111111.11110000

y = 4 (borrowed bits)

x = 4 (bits left in host field after borrowing)

Formulas:

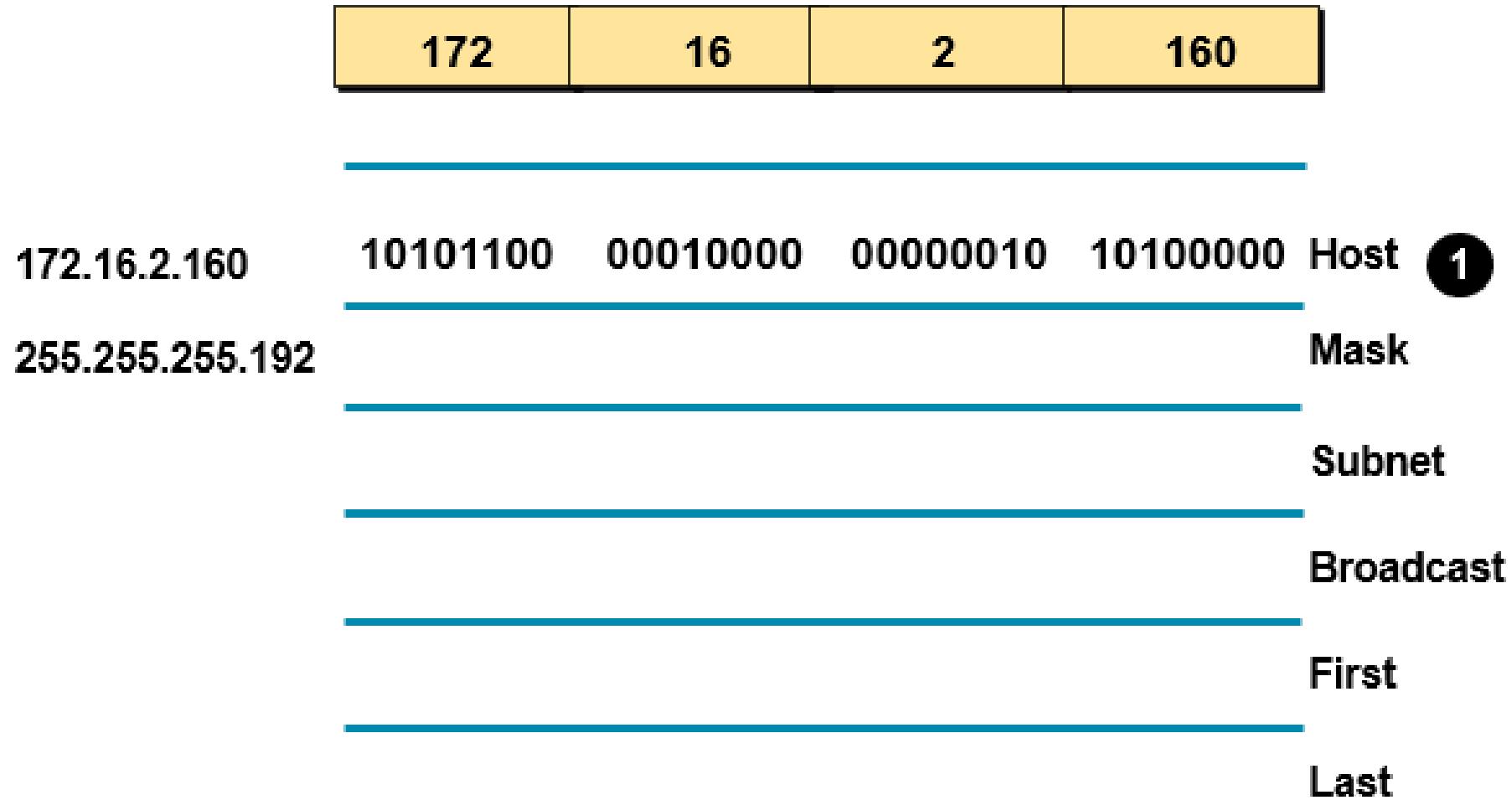
$$2^y = \# \text{ of usable subnets}$$

$$2^x - 2 = \# \text{ of usable hosts per subnet}$$

$$2^4 = 16 \text{ usable subnets}$$

$$2^4 - 2 = 14 \text{ usable hosts per subnet}$$

Example



172	16	2	160
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172.16.2.160

10101100 00010000 00000010 10100000 Host ①

255.255.255.192

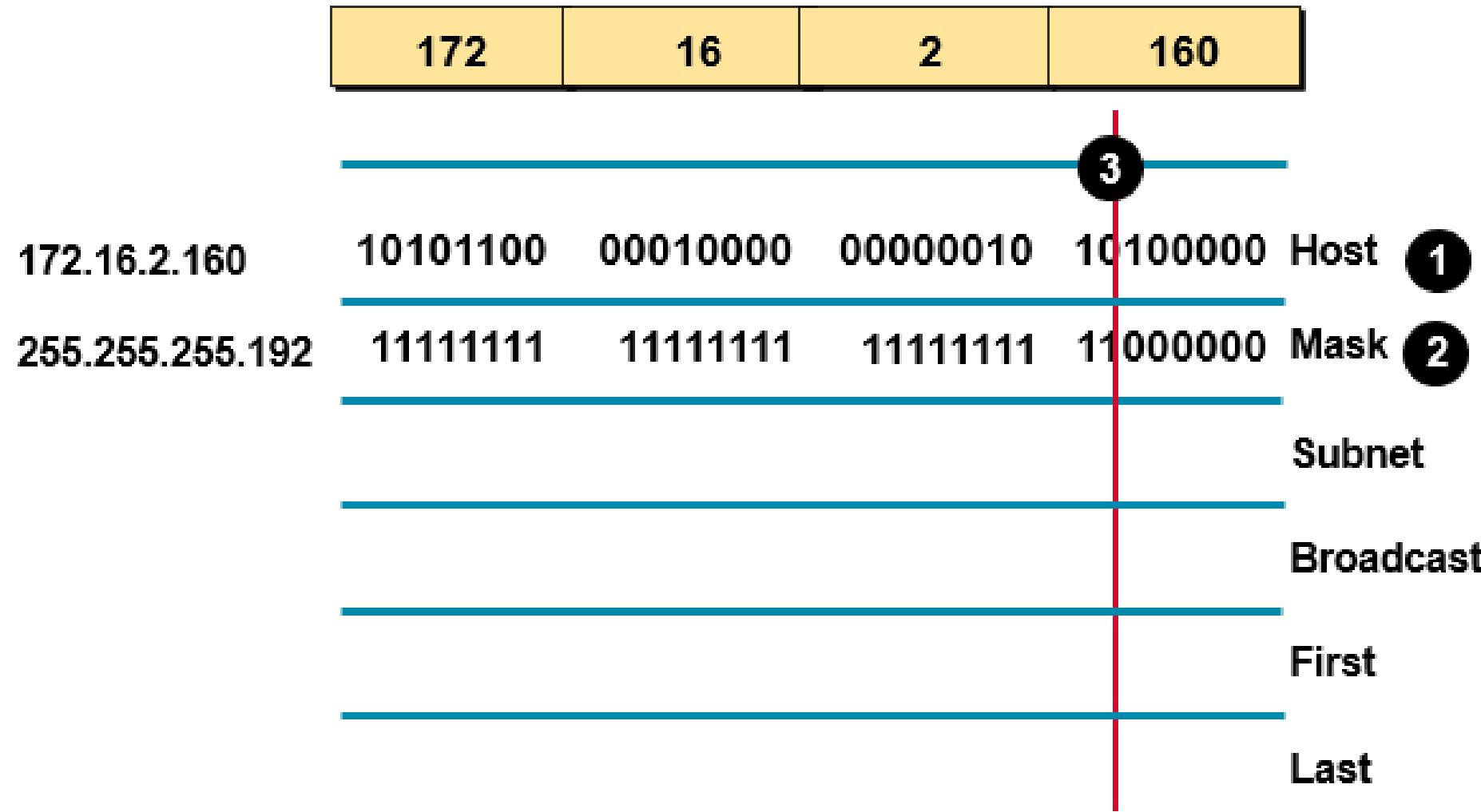
11111111 11111111 11111111 11000000 Mask ②

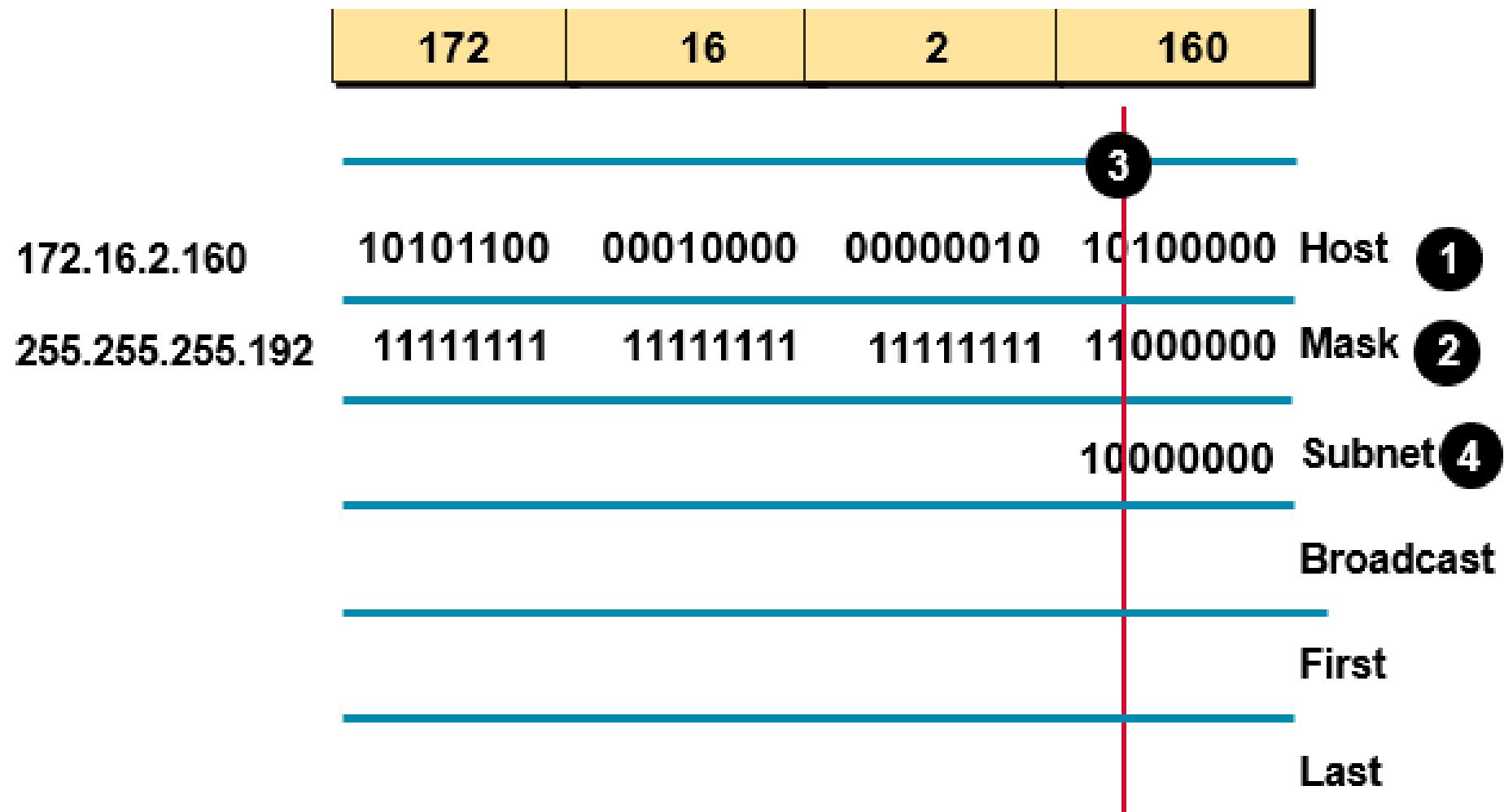
Subnet

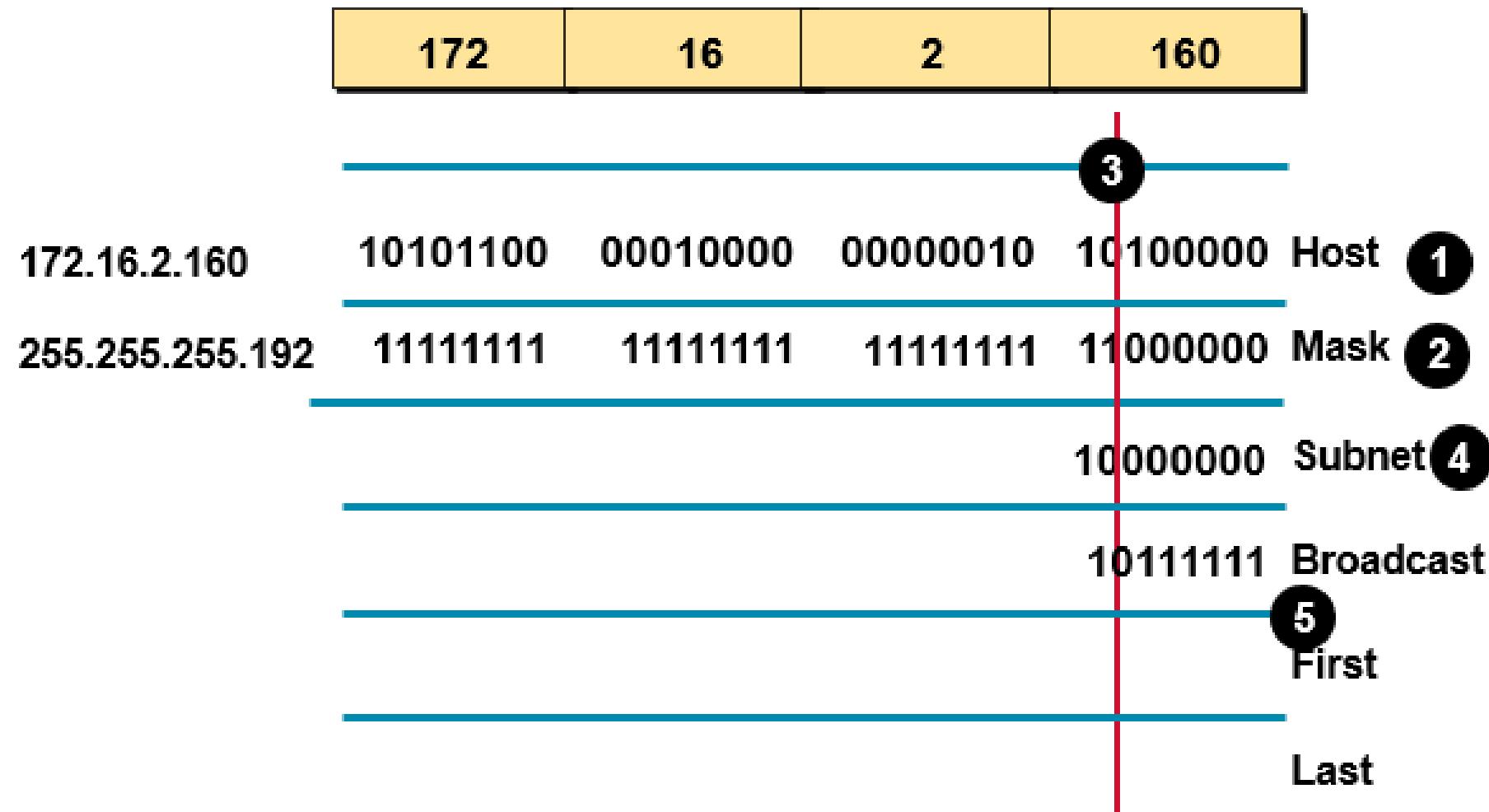
Broadcast

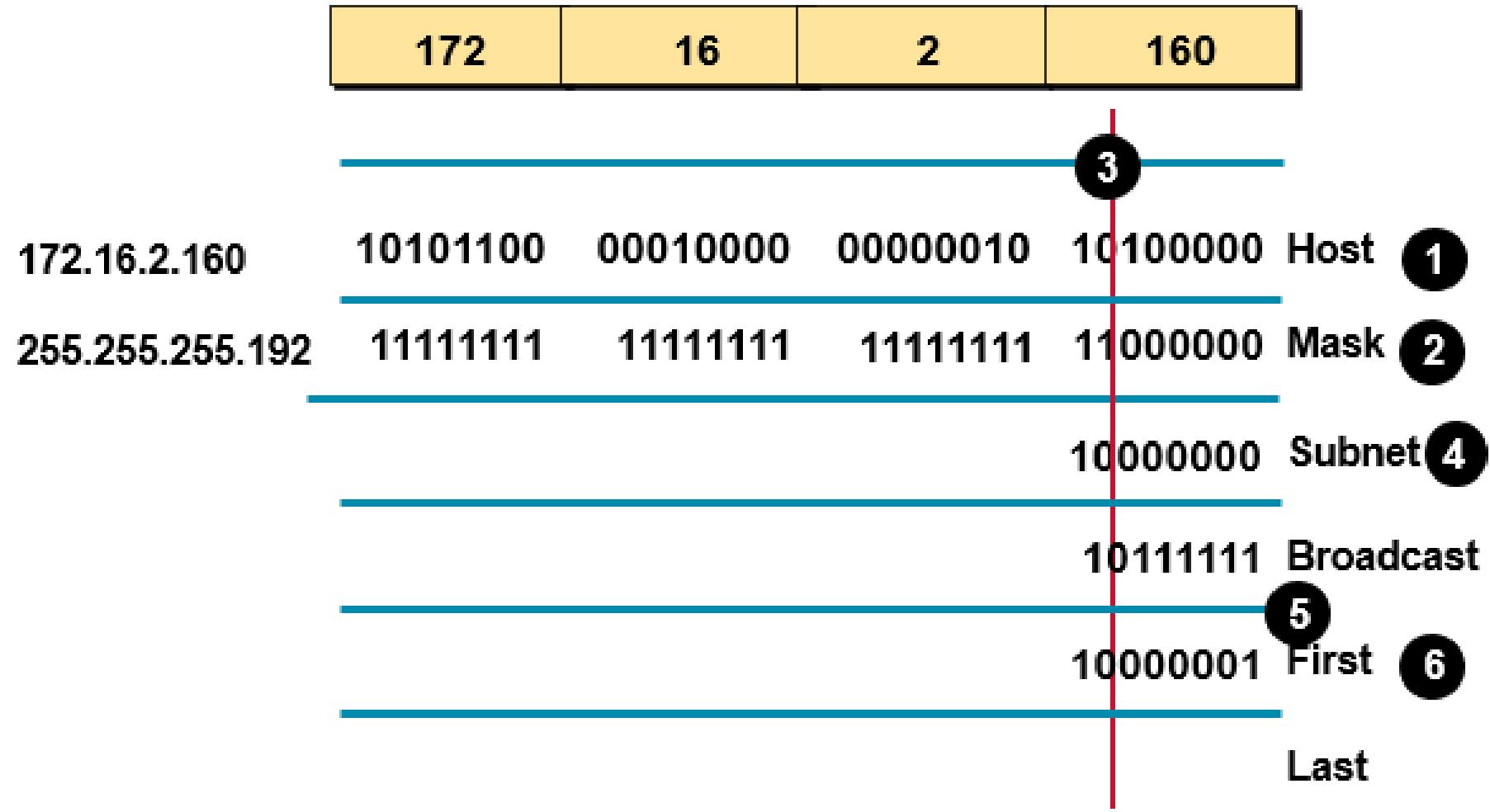
First

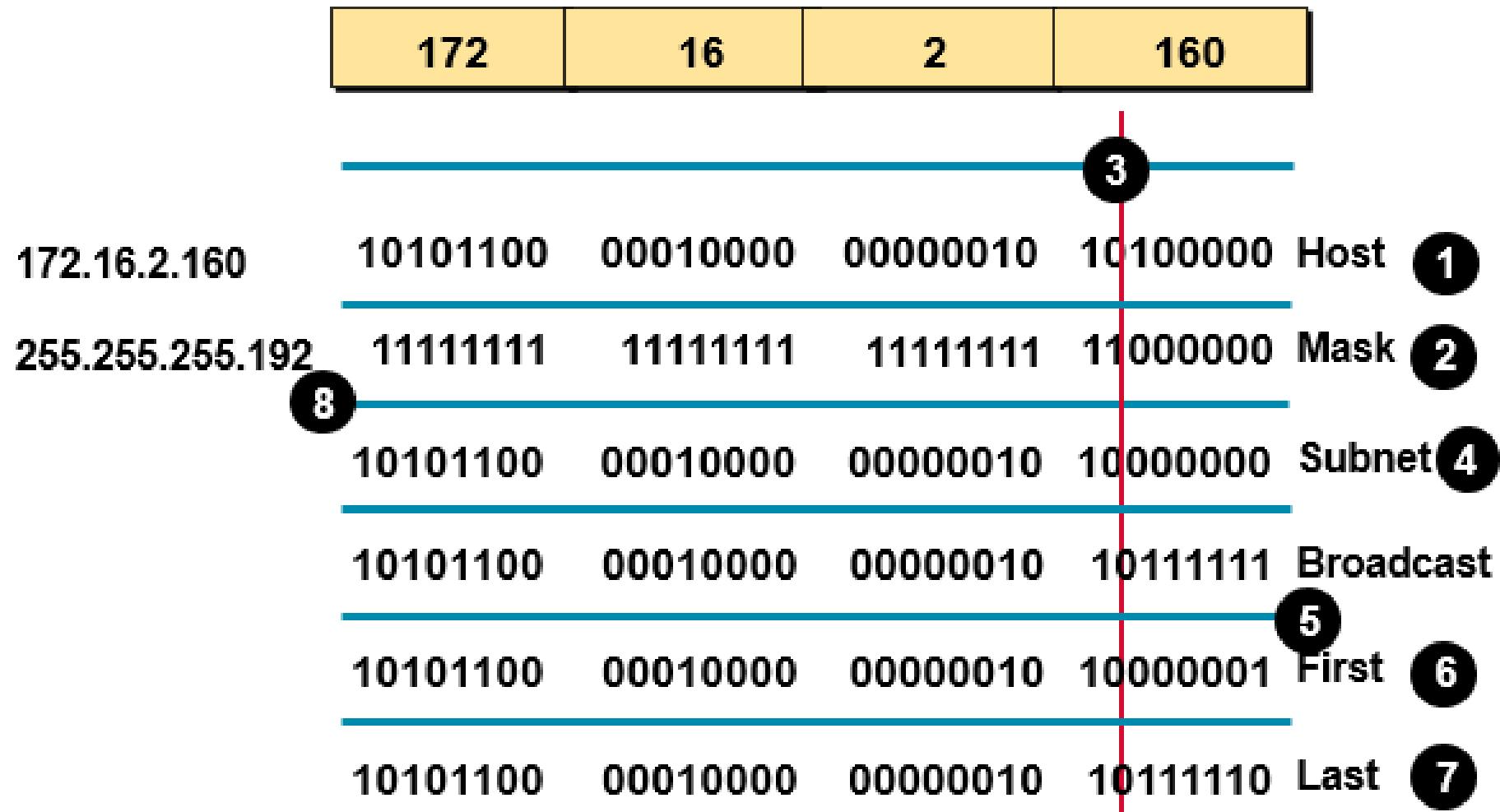
Last

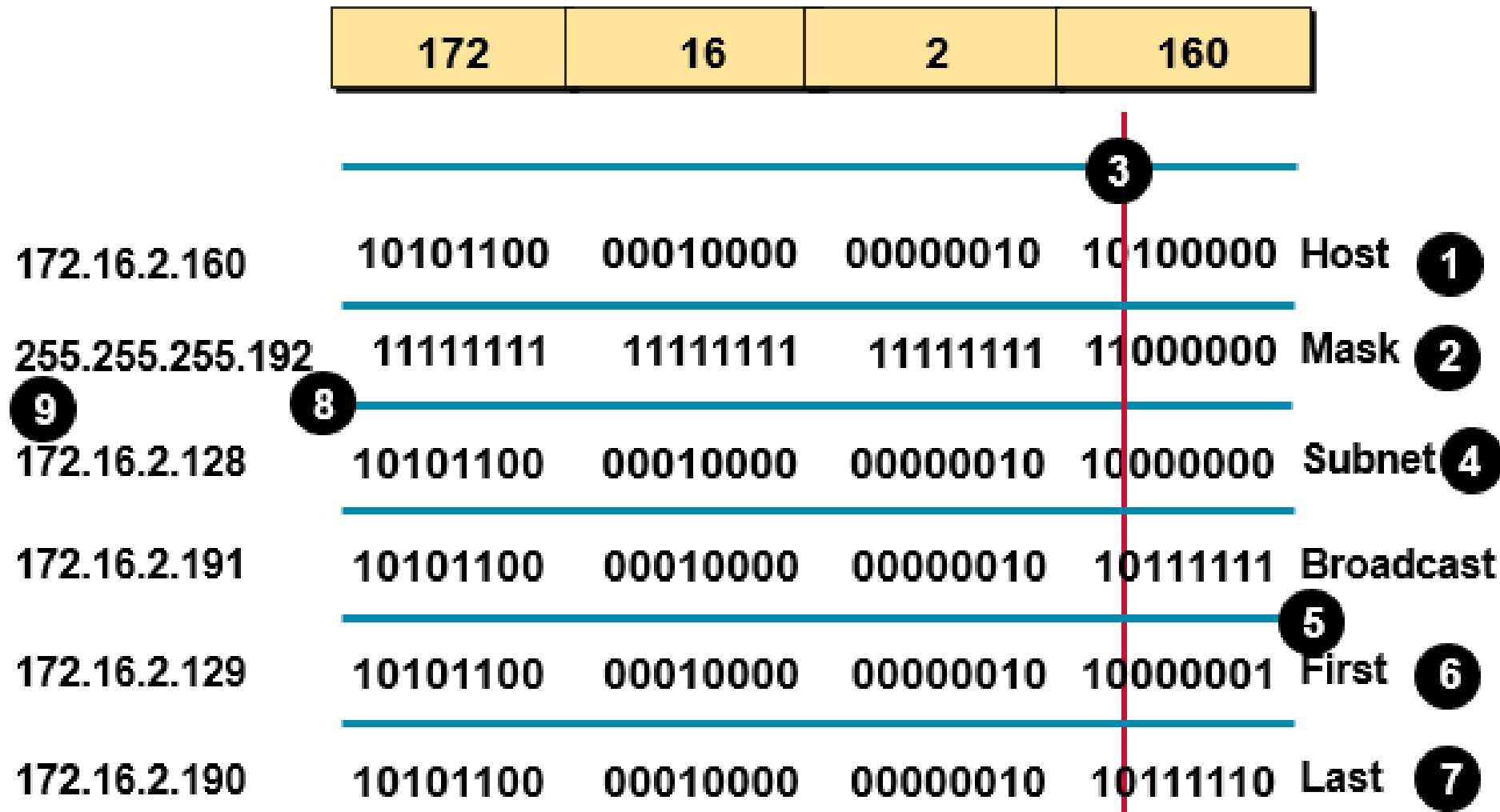












CIDR

CIDR notation: **192.168.43.0/26**

- Where the **/26** means 26 bits of the address are used as the network identifier
- In binary, the subnet mask translates to:
11111111.11111111.11111111.11000000
or **255.255.255.192** in decimal
- This would allow us to divide this address into **4 networks**, each with up to **62 hosts**

CIDR 192.168.43.0/26 Networks

<i>Network Address</i>	<i>Starting IP Address</i>	<i>Ending IP Address</i>	<i>Subnet Mask</i>
192.168.43.0	192.168.43.1	192.168.43.62	255.255.255.192
192.168.43.64	192.168.43.65	192.168.43.126	255.255.255.192
192.168.43.128	192.168.43.129	192.168.43.190	255.255.255.192
192.168.43.192	192.168.43.193	192.168.43.254	255.255.255.192

Public and Private IPv4 Addressing

- Registered IP addresses are not necessary for workstations that merely access resources on the Internet
- The three blocks of addresses allocated for private use are as follows:
 - 10.0.0.0/8
 - 172.16.0.0/12
 - 192.168.0.0/16