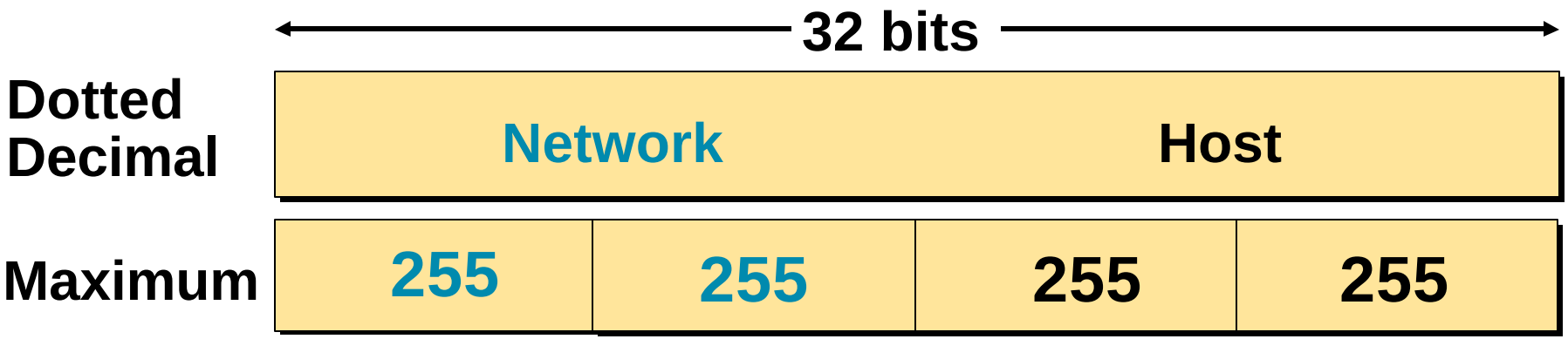
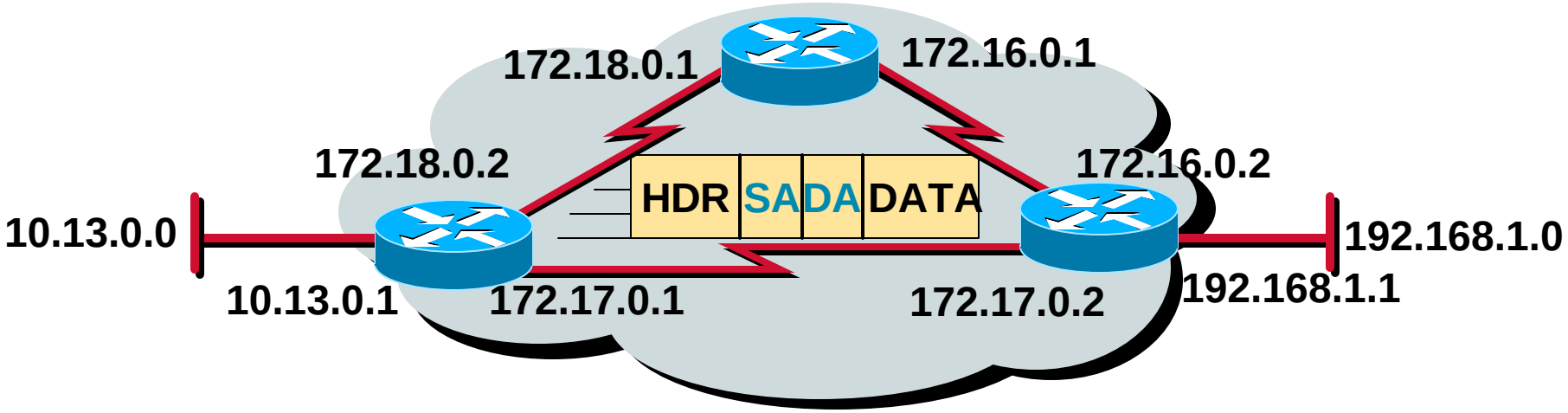
IP Addresses

IP Addressing

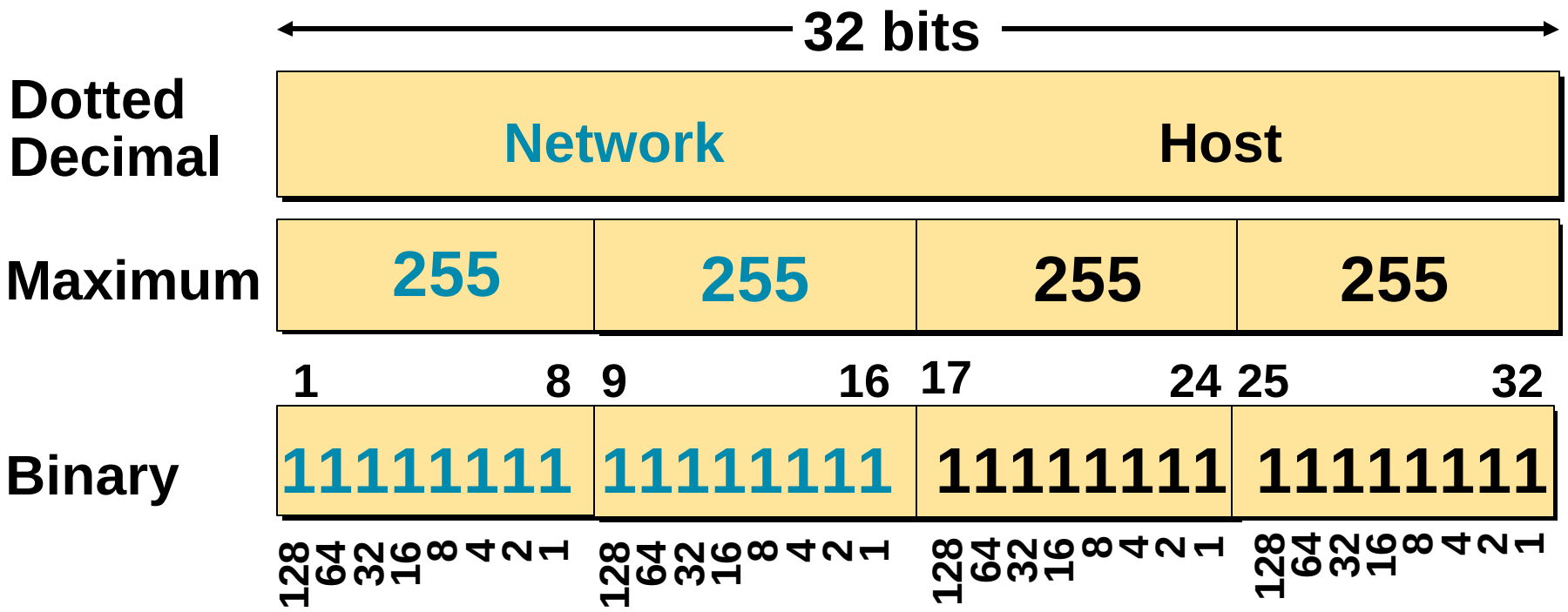


Introduction to IP Addresses

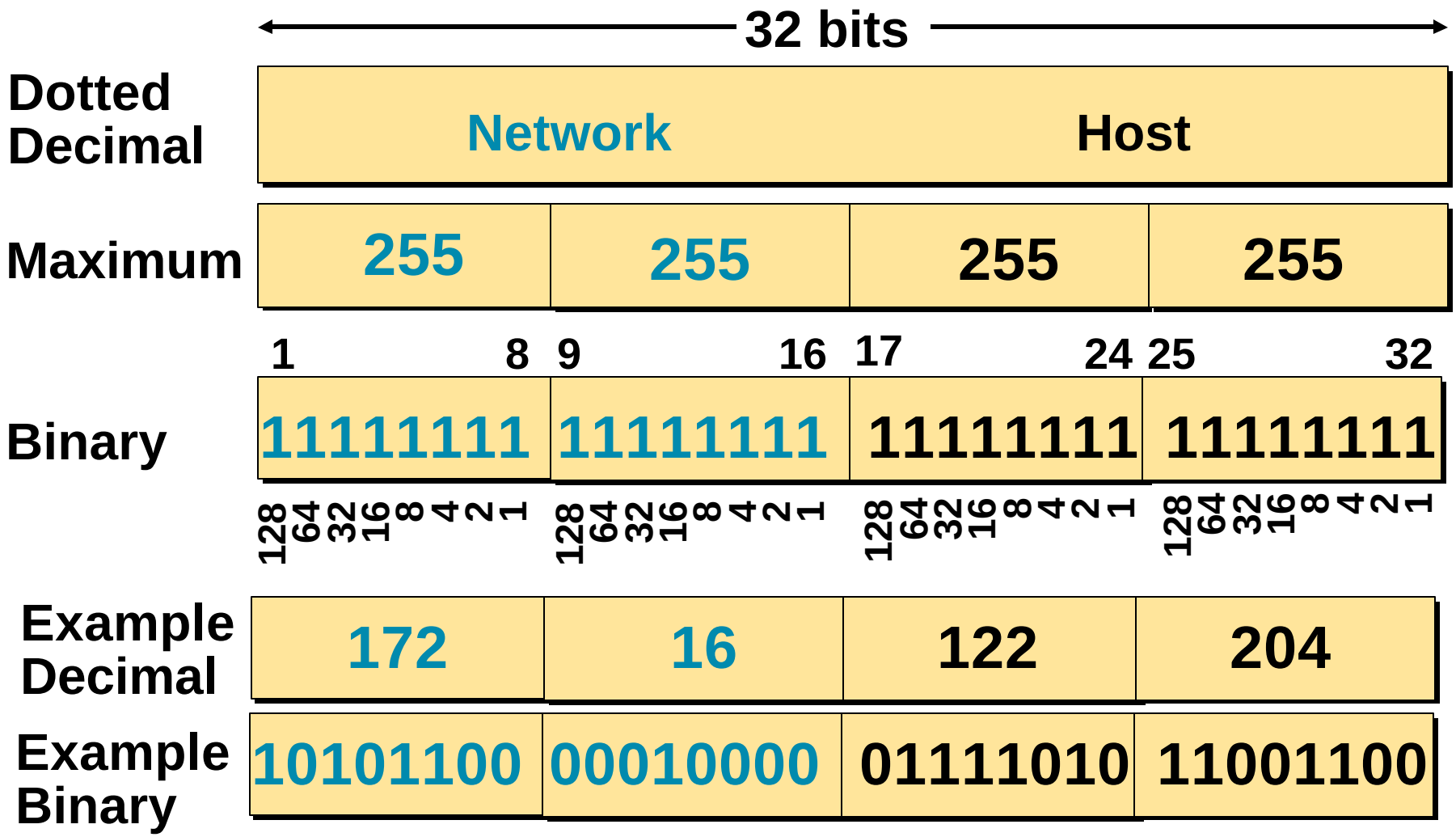


- Unique addressing allows communication between end stations
- Path choice is based on destination address

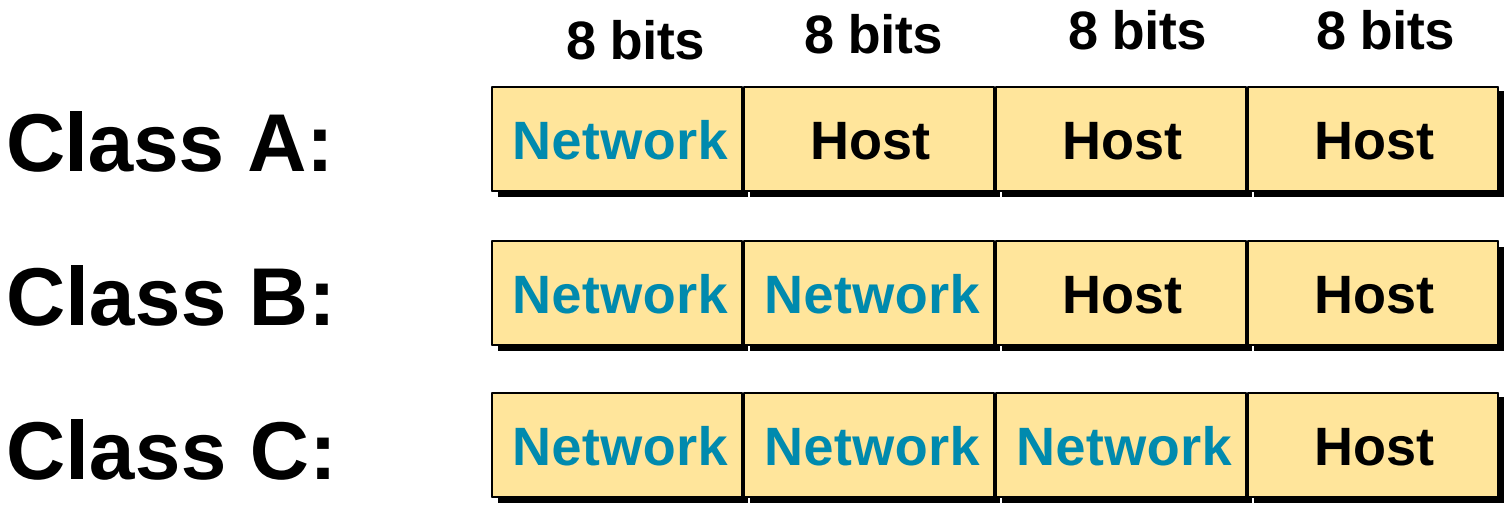
IP Addressing



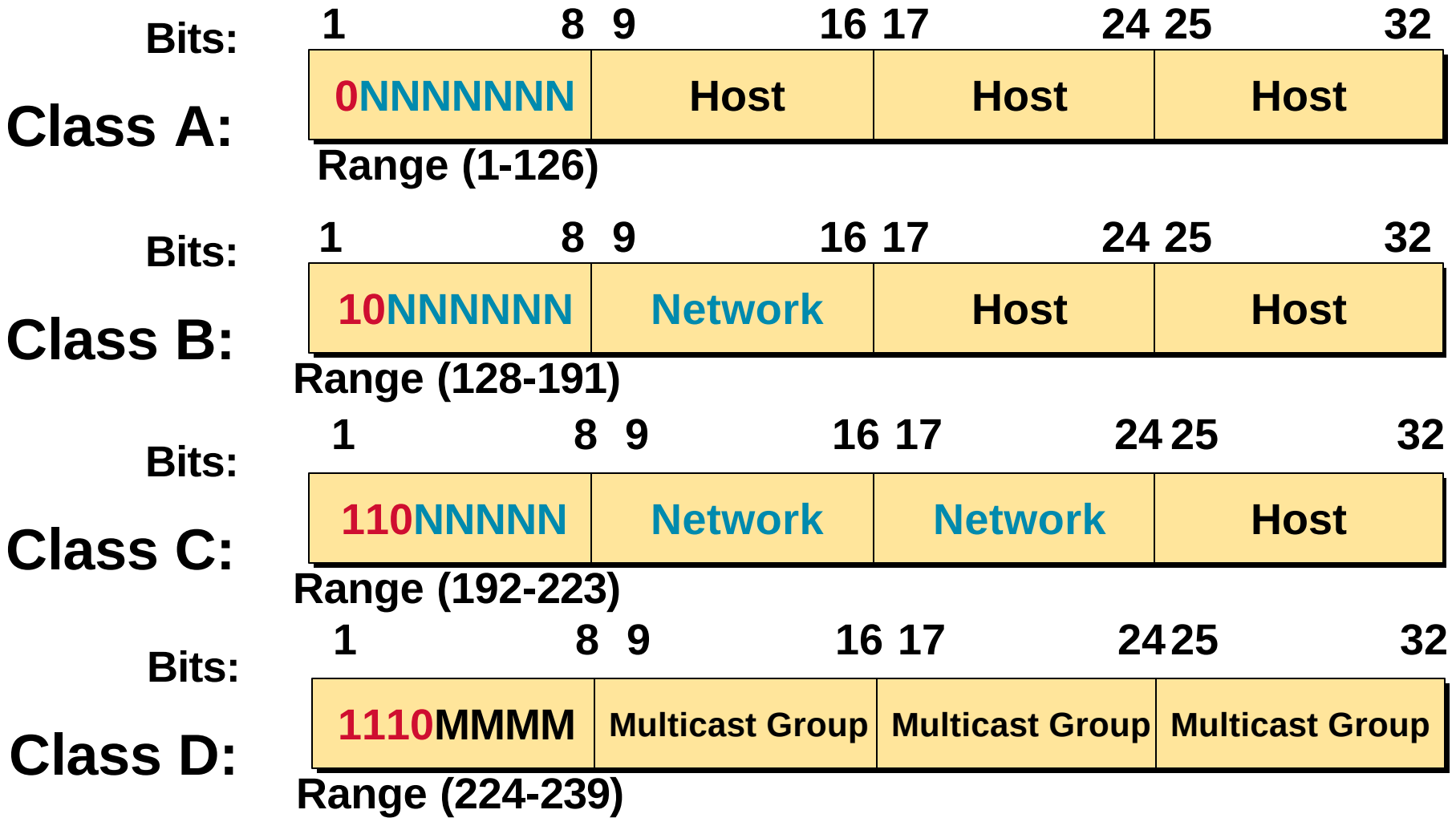
IP Addressing



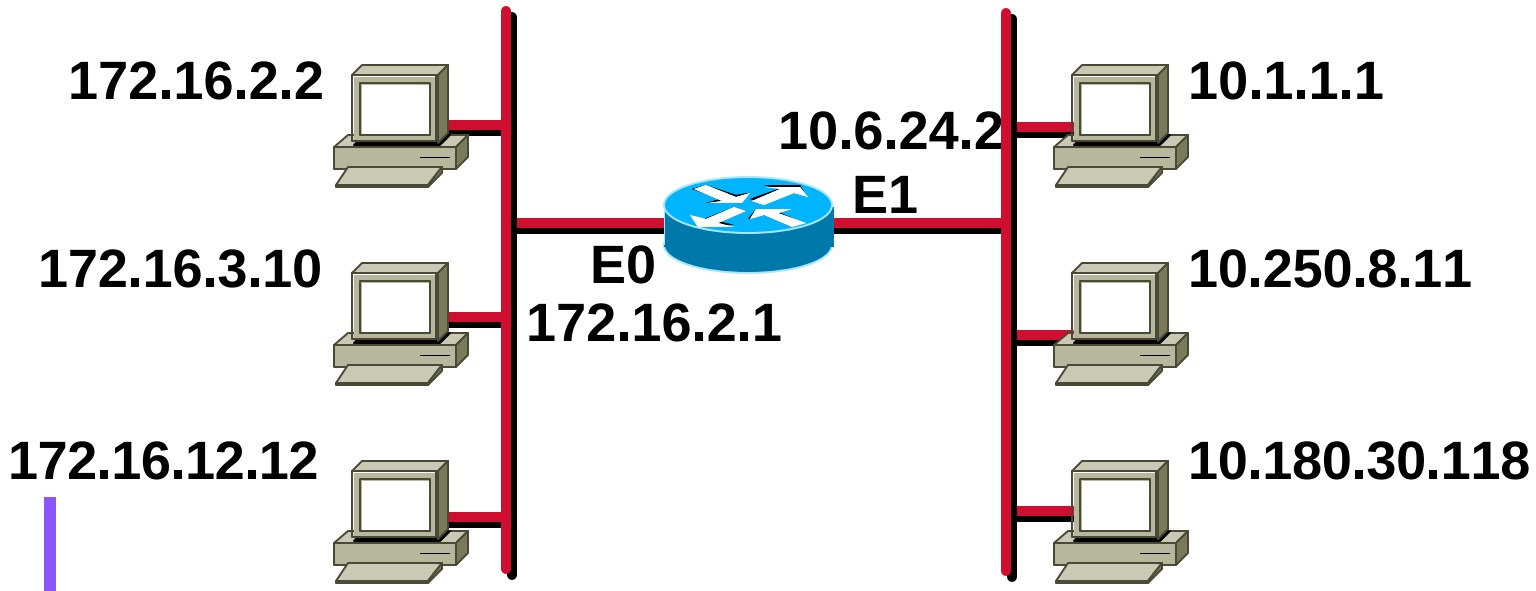
IP Address Classes



IP Address Classes



Host Addresses

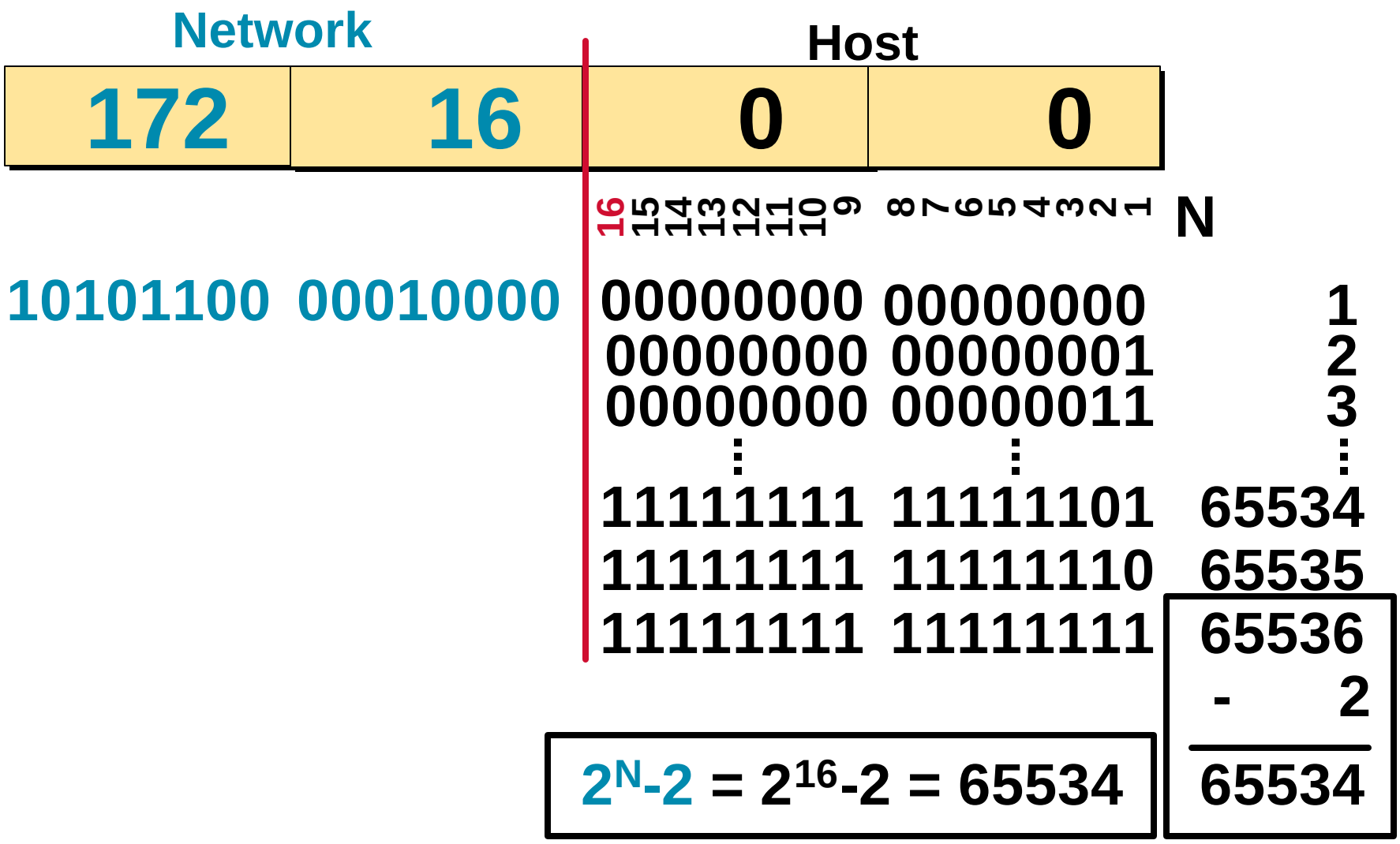


172.16 . 12 . 12

Network Host

Routing Table	
Network	Interface
172.16.0.0	E0
10.0.0.0	E1

Determining Available Host Addresses



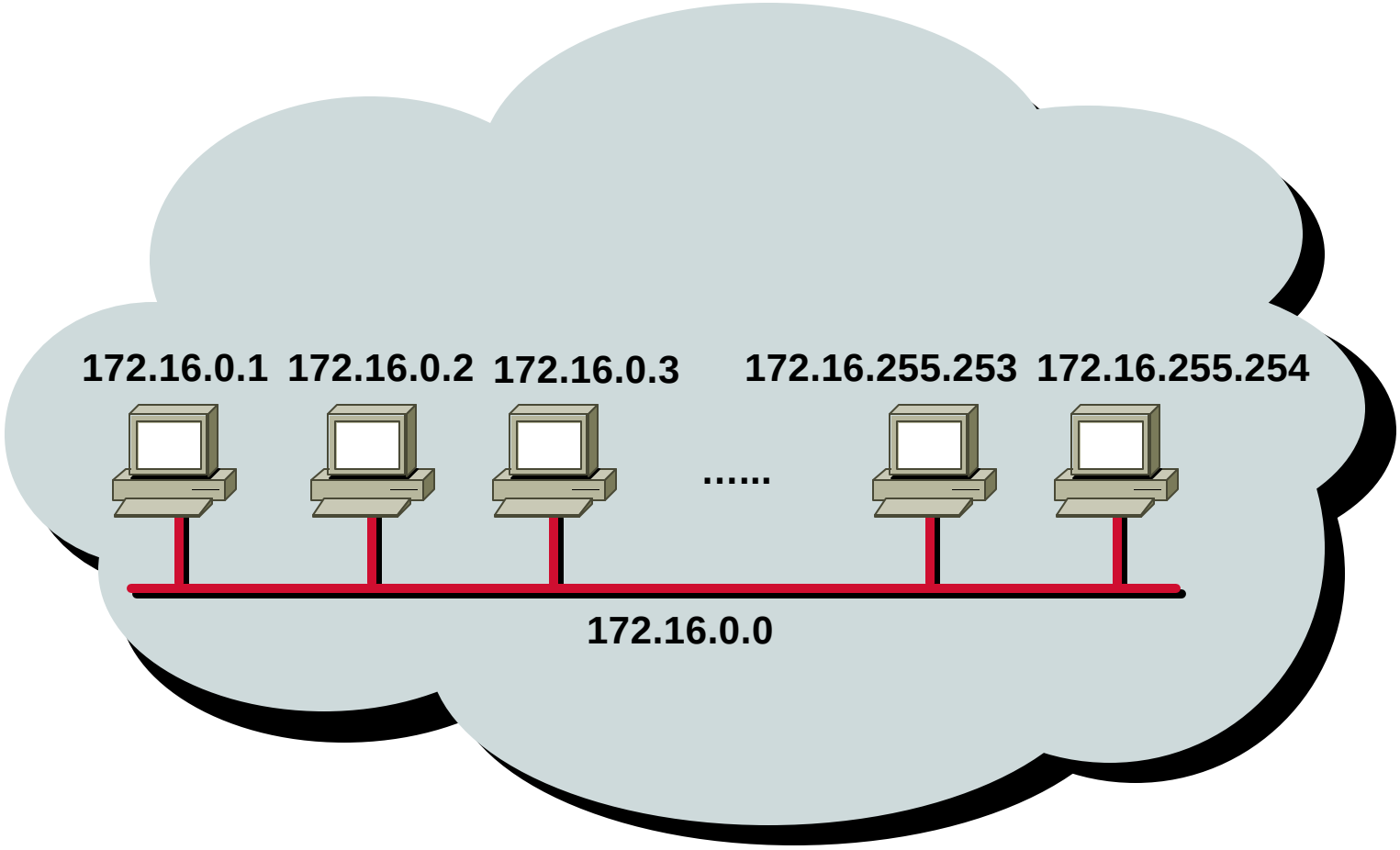
IP Address Classes Exercise

Address	Class	Network	Host
10.2.1.1			
128.63.2.100			
201.222.5.64			
192.6.141.2			
130.113.64.16			
256.241.201.10			

IP Address Classes Exercise Answers

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		

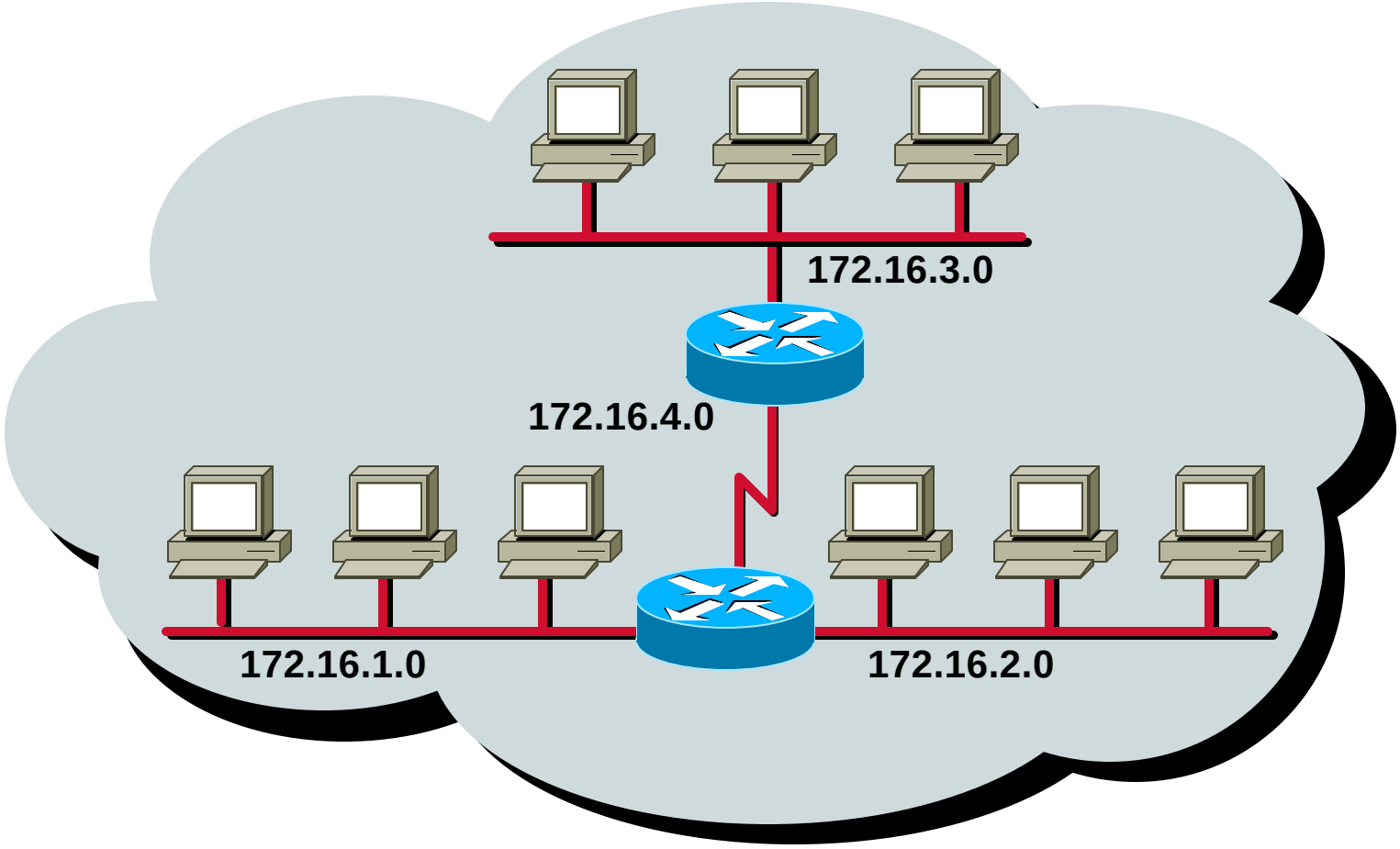
Addressing without Subnets



Network 172.16.0.0

Cisco.com

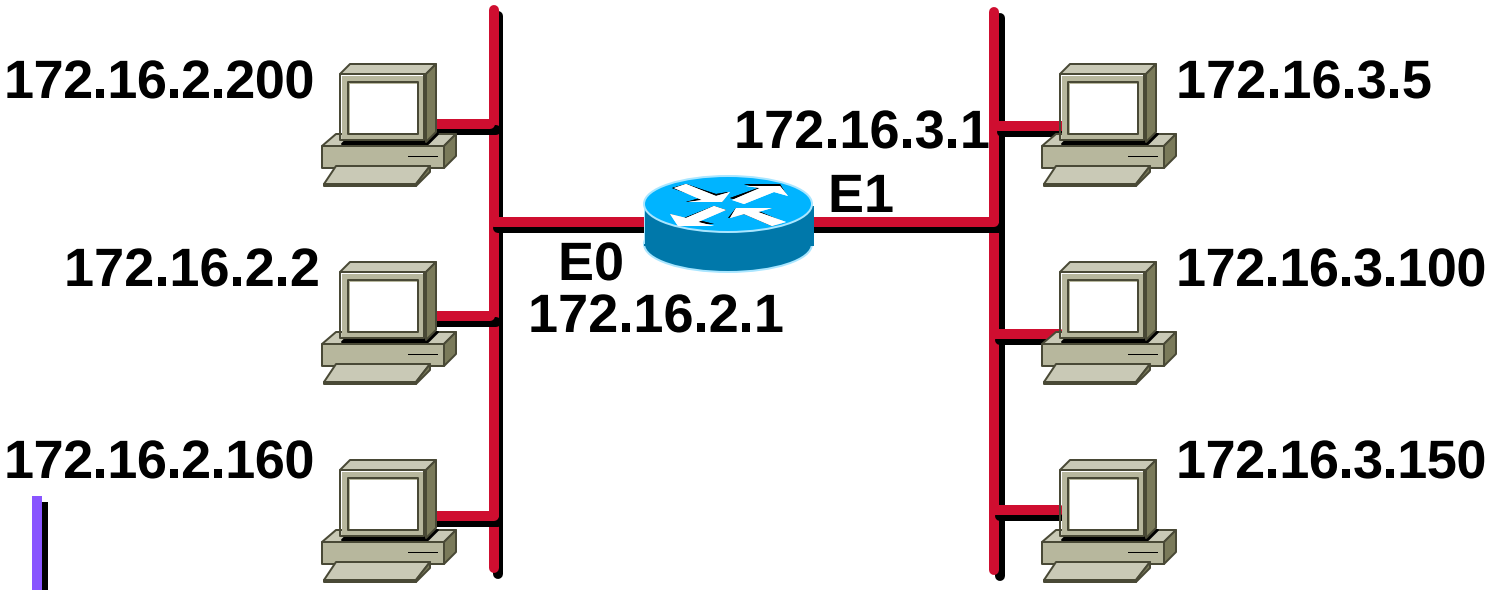
Addressing with Subnets

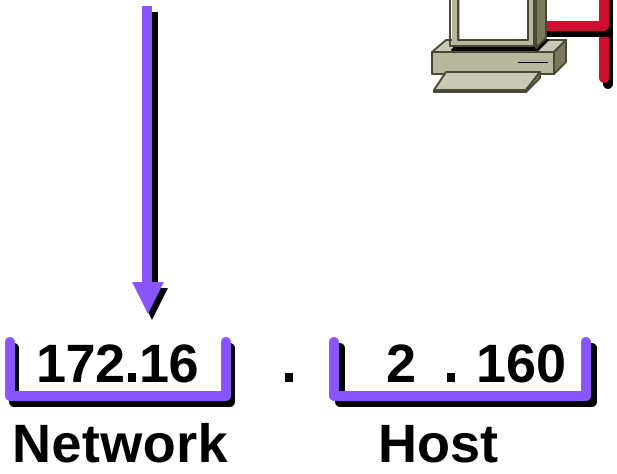


Network 172.16.0.0

Cisco.com

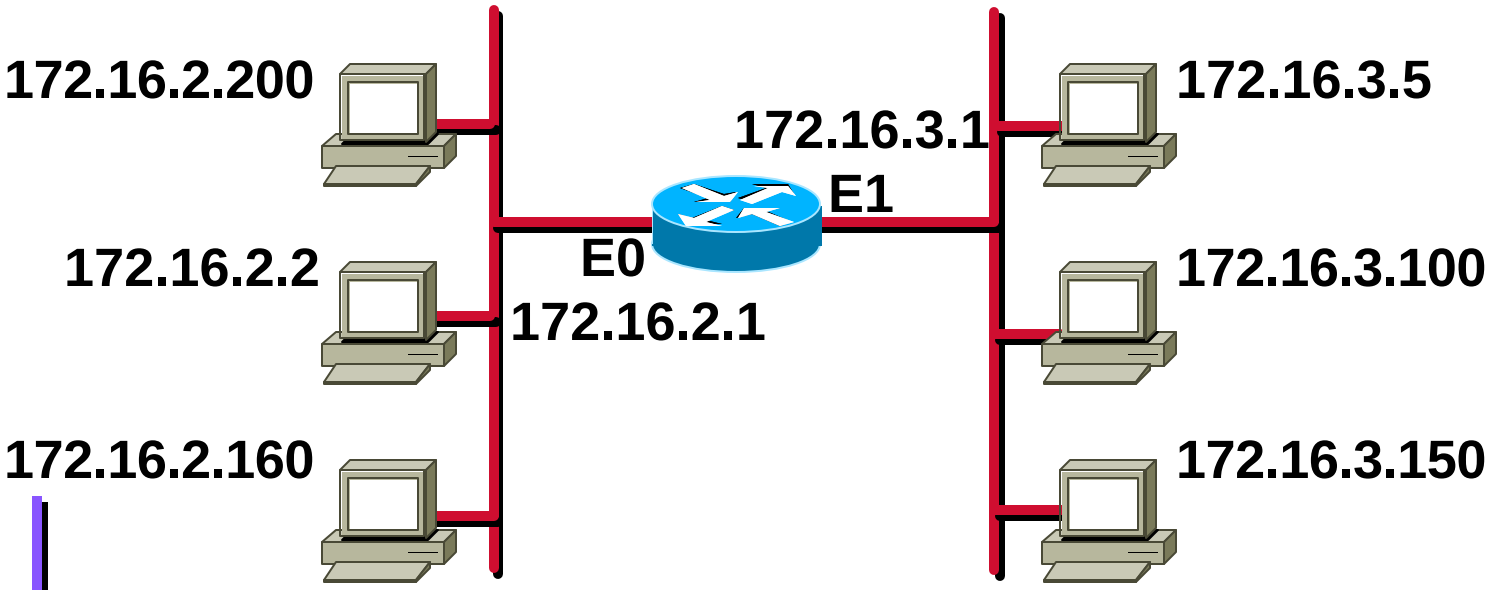
Subnet Addressing

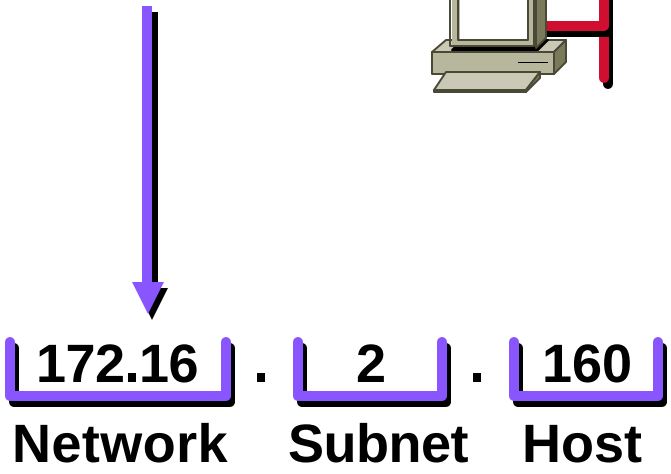




New Routing Table	
Network	Interface
172.16.0.0	E0
172.16.0.0	E1

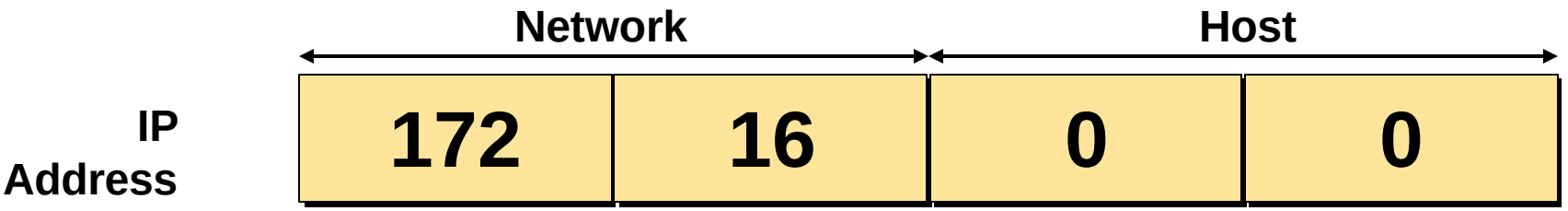
Subnet Addressing

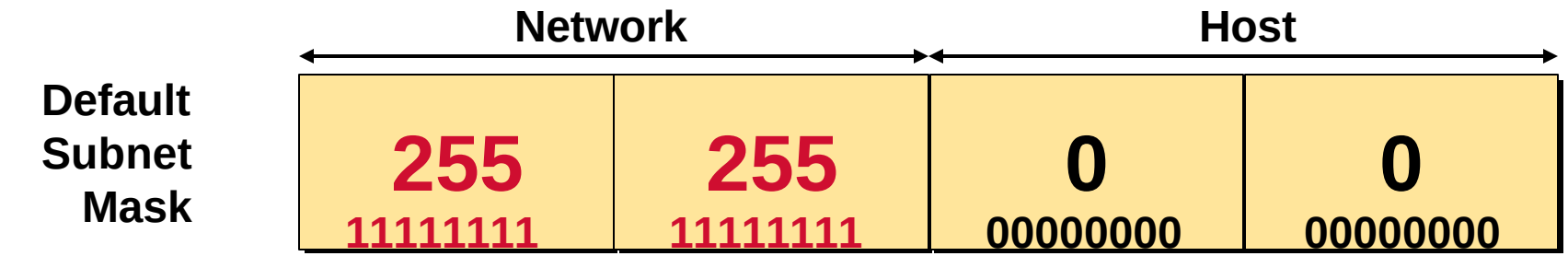




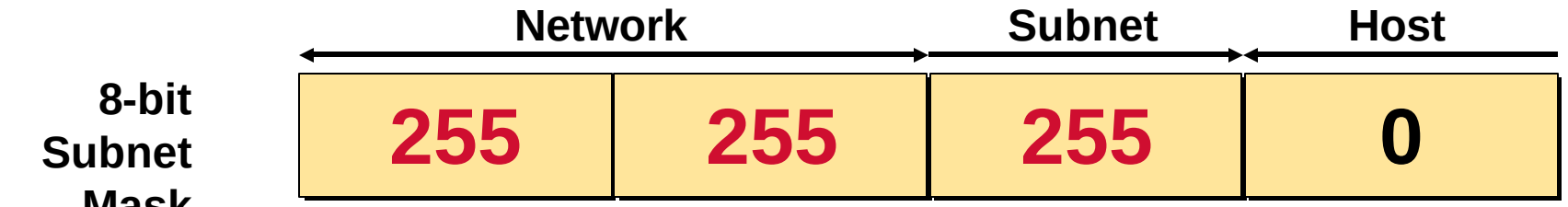
New Routing Table	
Network	Interface
172.16.2.0	E0
172.16.3.0	E1

Subnet Mask





Also written as "/16" where 16 represents the number of 1s in the mask.

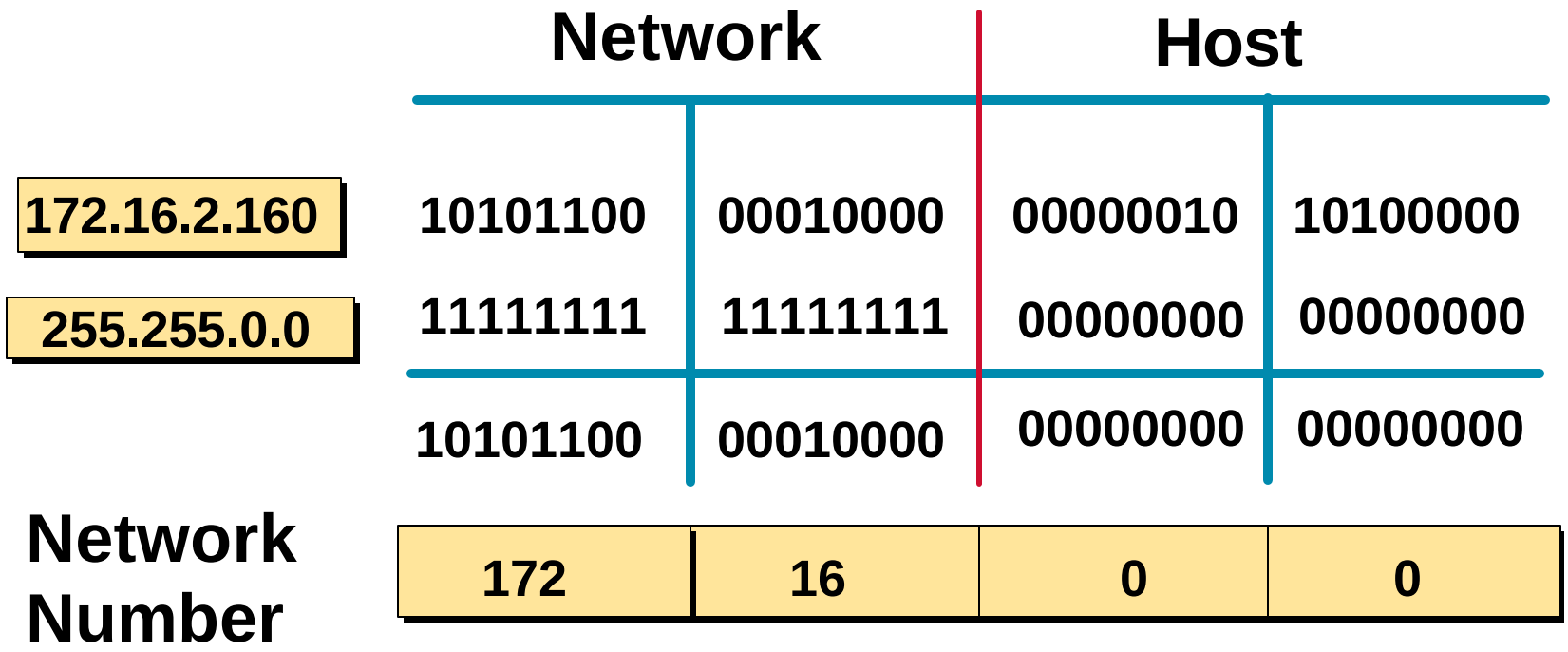


Also written as "/24" where 24 represents the number of 1s in the mask.

Decimal Equivalents of Bit Patterns

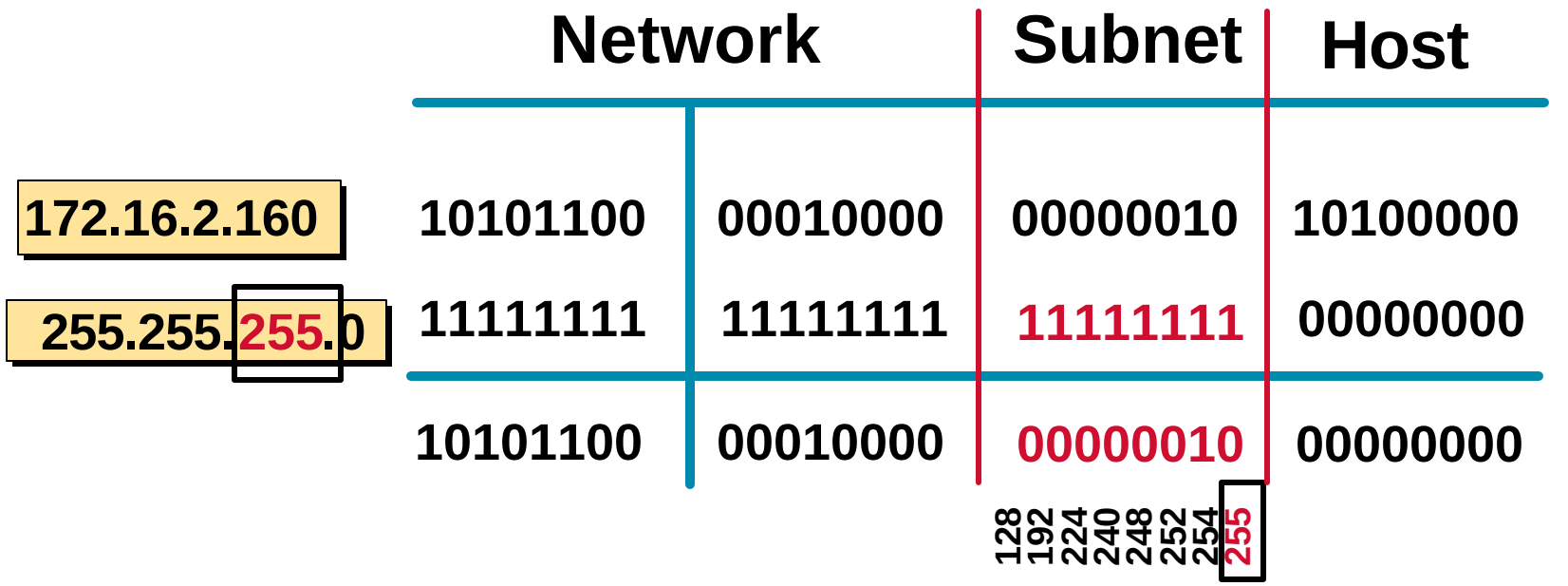
128	64	32	16	8	4	2	1		
0	0	0	0	0	0	0	0	=	0
1	0	0	0	0	0	0	0	=	128
1	1	0	0	0	0	0	0	=	192
1	1	1	0	0	0	0	0	=	224
1	1	1	1	0	0	0	0	=	240
1	1	1	1	1	0	0	0	=	248
1	1	1	1	1	1	0	0	=	252
1	1	1	1	1	1	1	0	=	254
1	1	1	1	1	1	1	1	=	255

Subnet Mask without Subnets



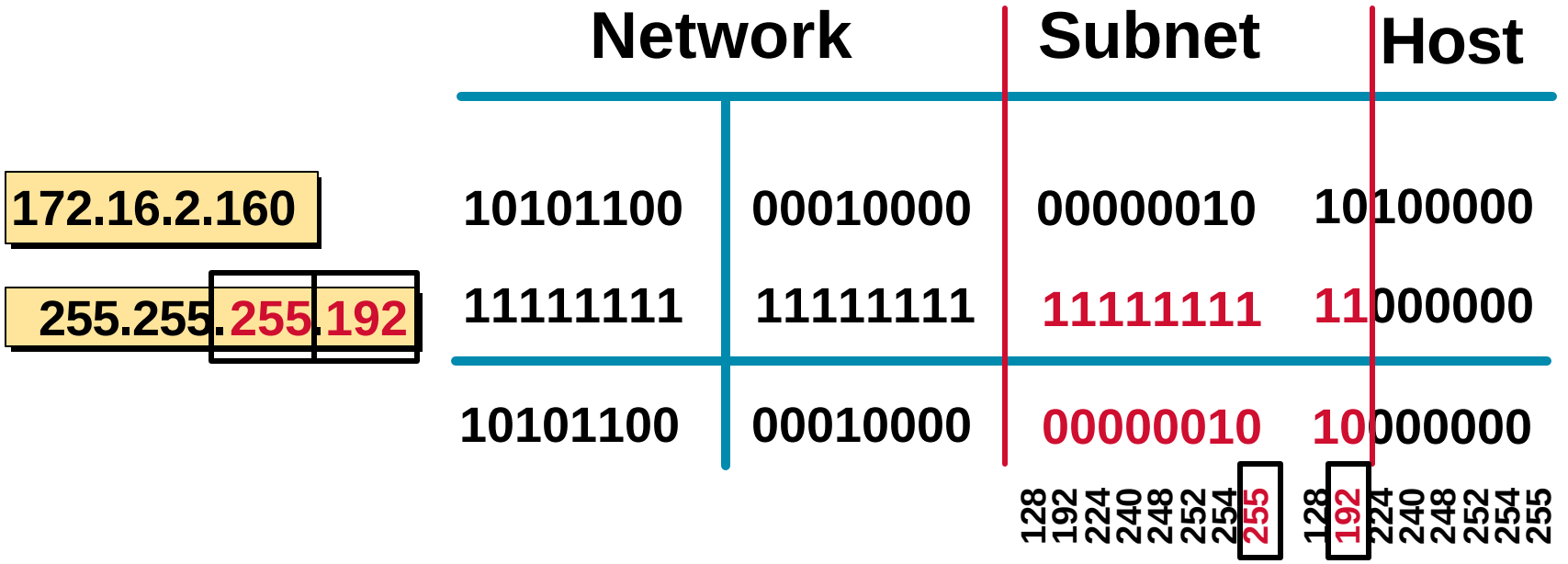
Subnets not in use—the default

Subnet Mask with Subnets



Network number extended by eight bits

Subnet Mask with Subnets (cont.)



Network Number

172	16	2	128

Network number extended by ten bits

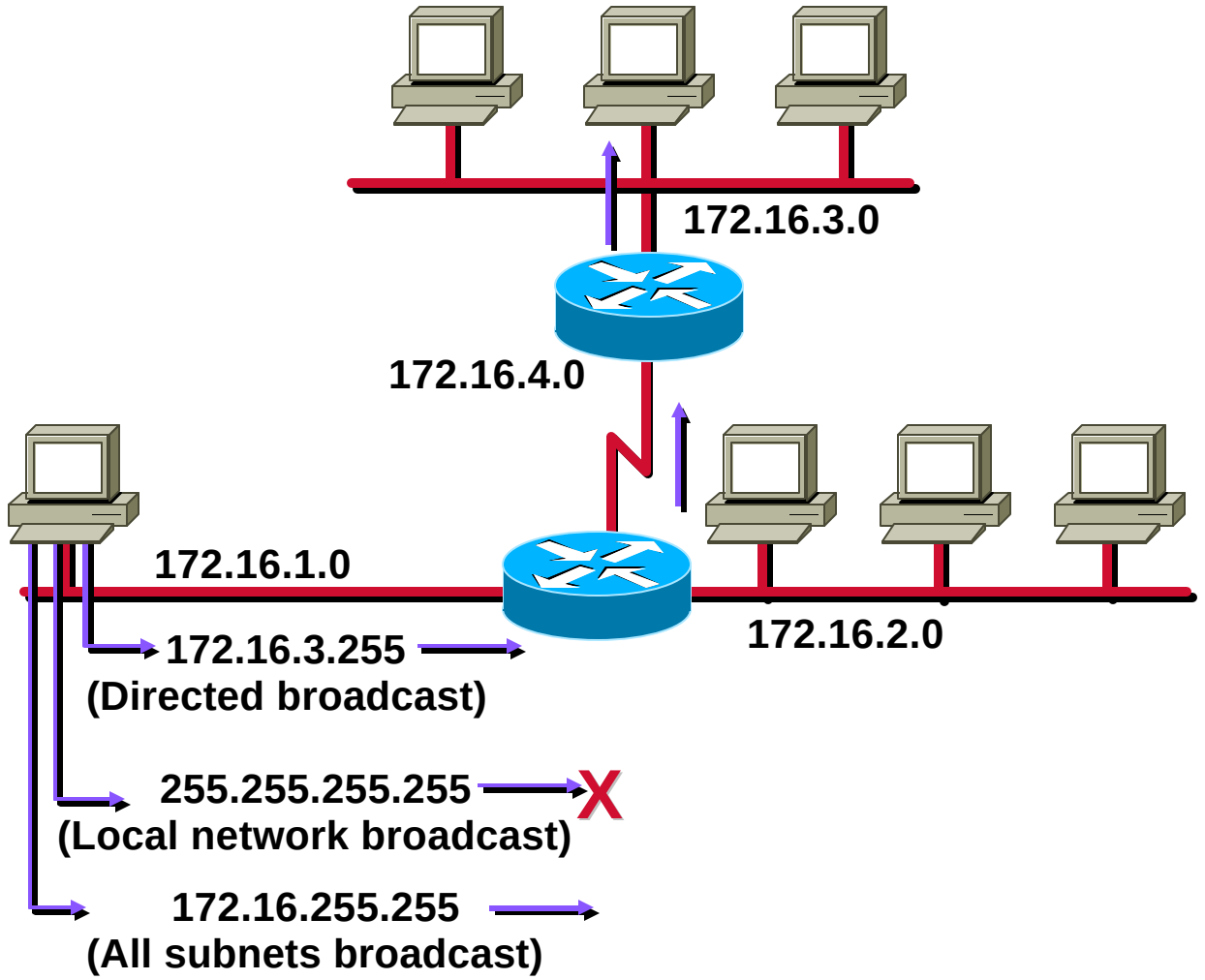
Subnet Mask Exercise

Address	Subnet Mask	Class	Subnet
172.16.2.10	255.255.255.0		
10.6.24.20	255.255.240.0		
10.30.36.12	255.255.255.0		

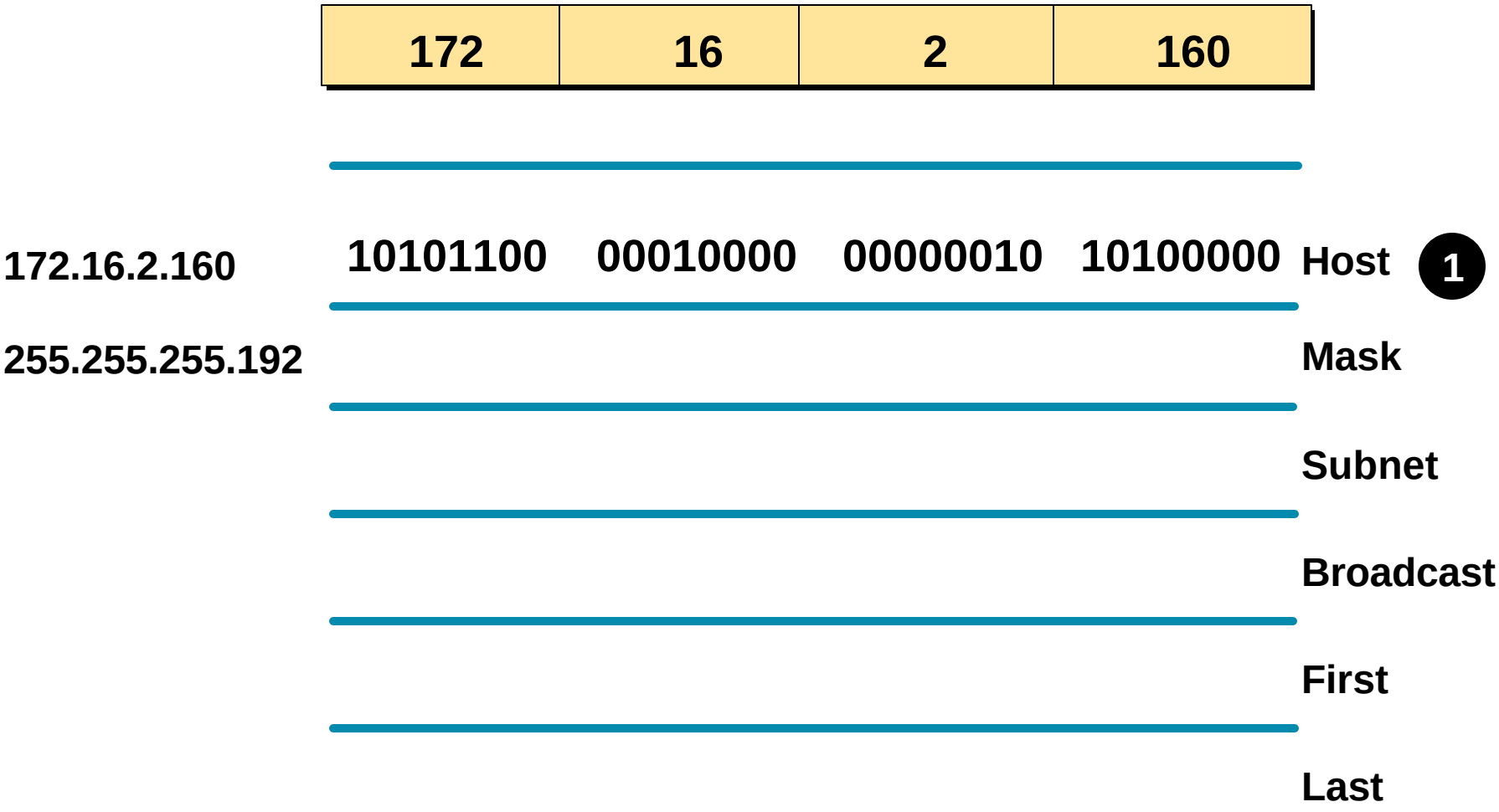
Subnet Mask Exercise Answers

Address	Subnet Mask	Class	Subnet
172.16.2.10	255.255.255.0	B	172.16.2.0
10.6.24.20	255.255.240.0	A	10.6.16.0
10.30.36.12	255.255.255.0	A	10.30.36.0

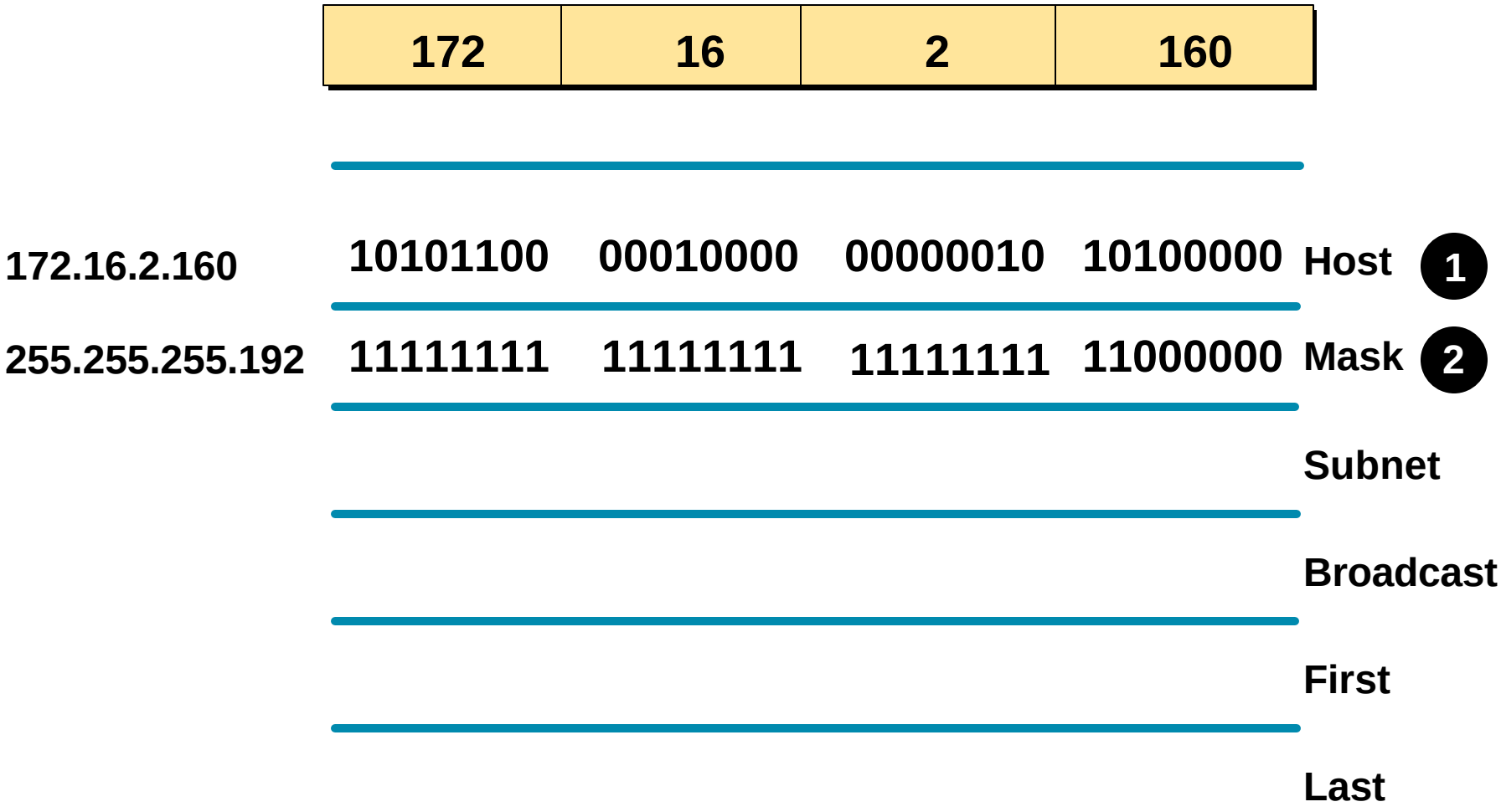
Broadcast Addresses



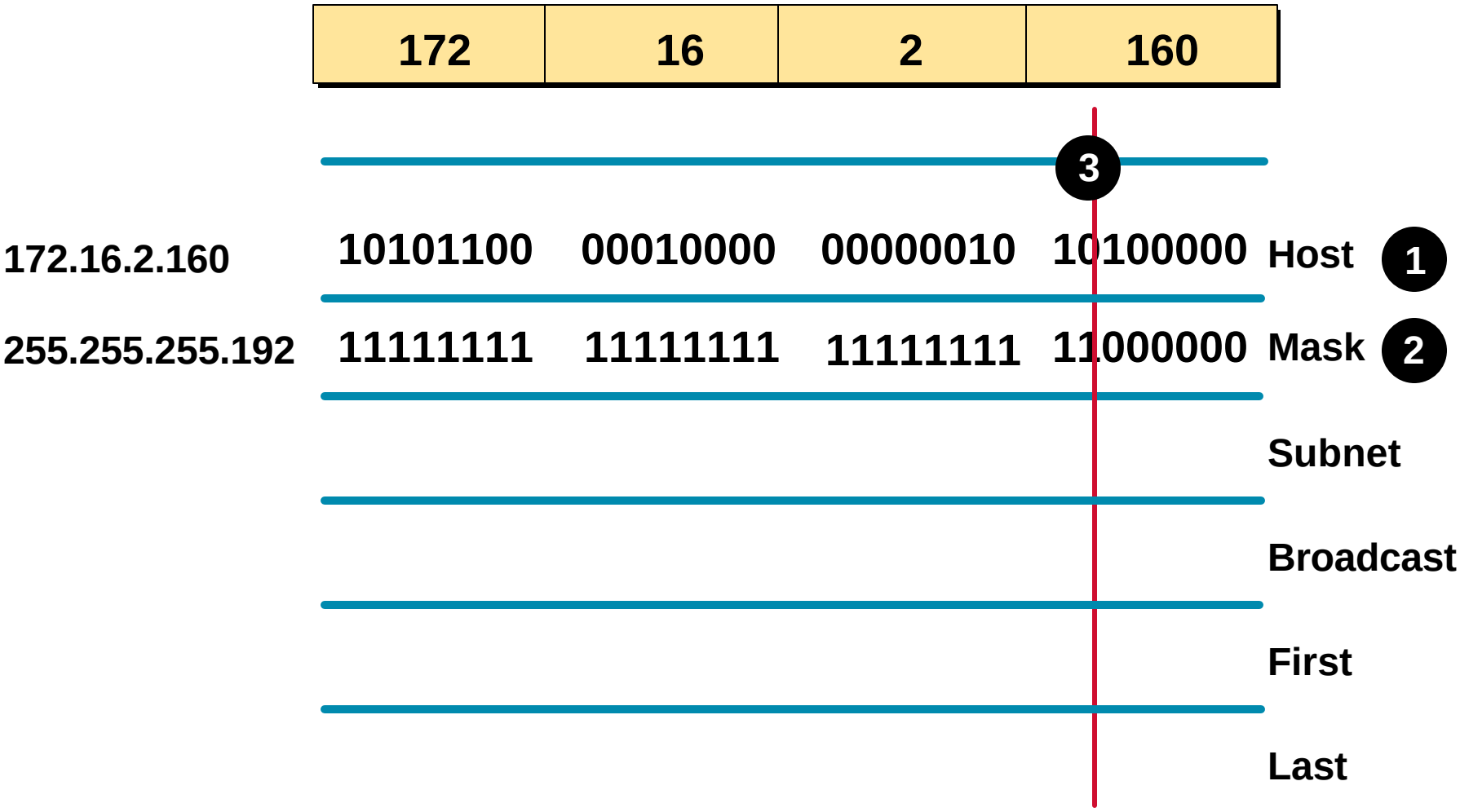
Addressing Summary Example



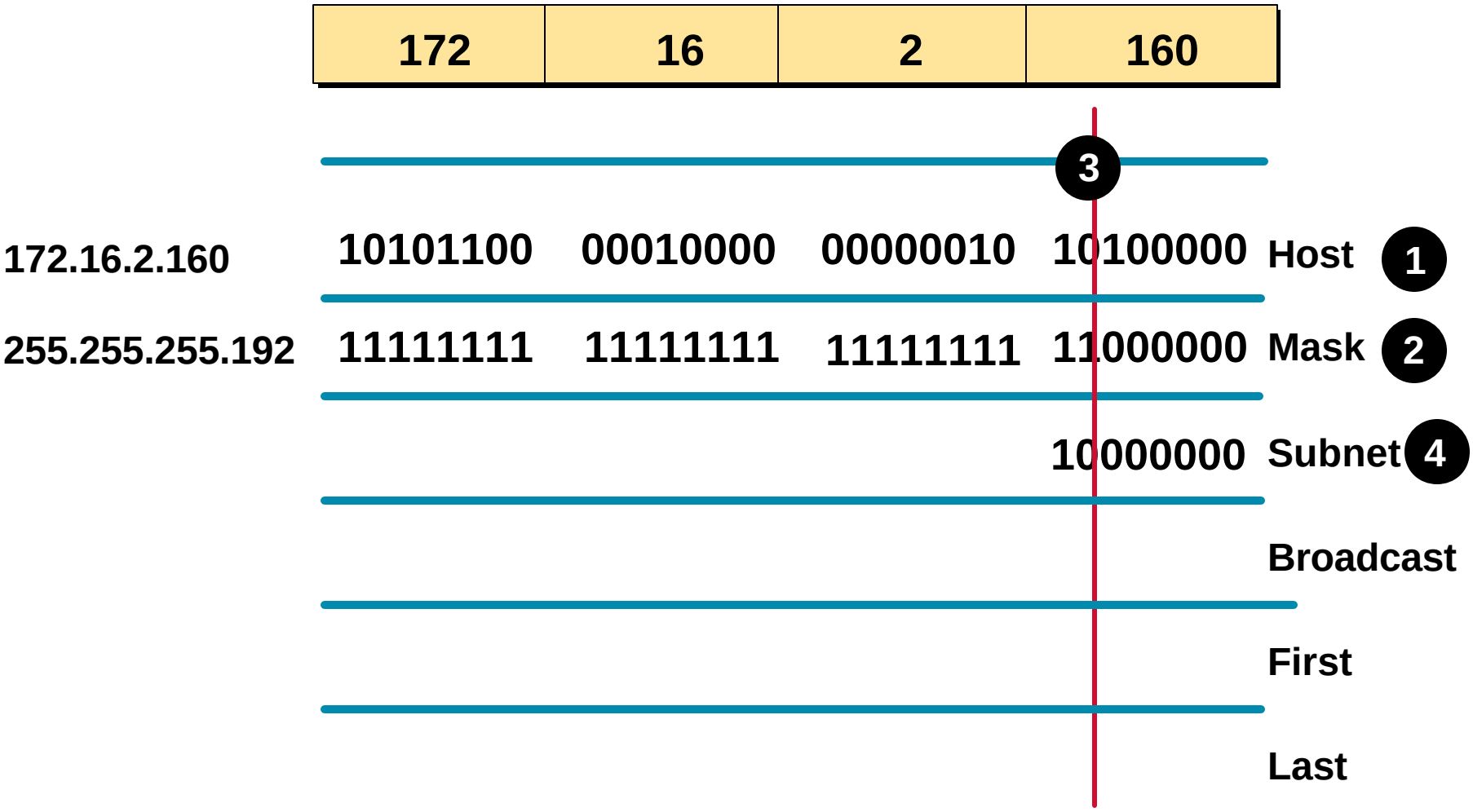
Addressing Summary Example



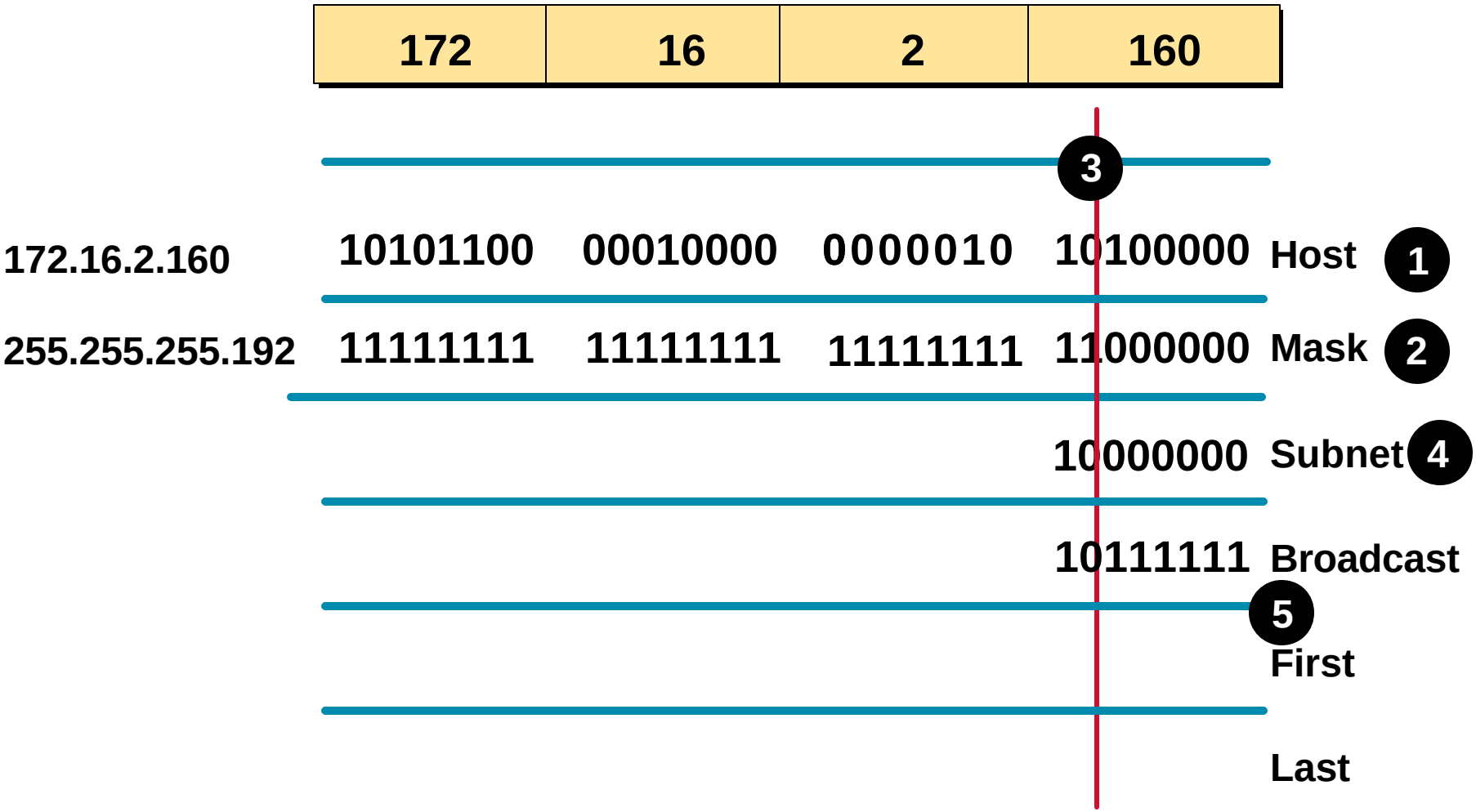
Addressing Summary Example



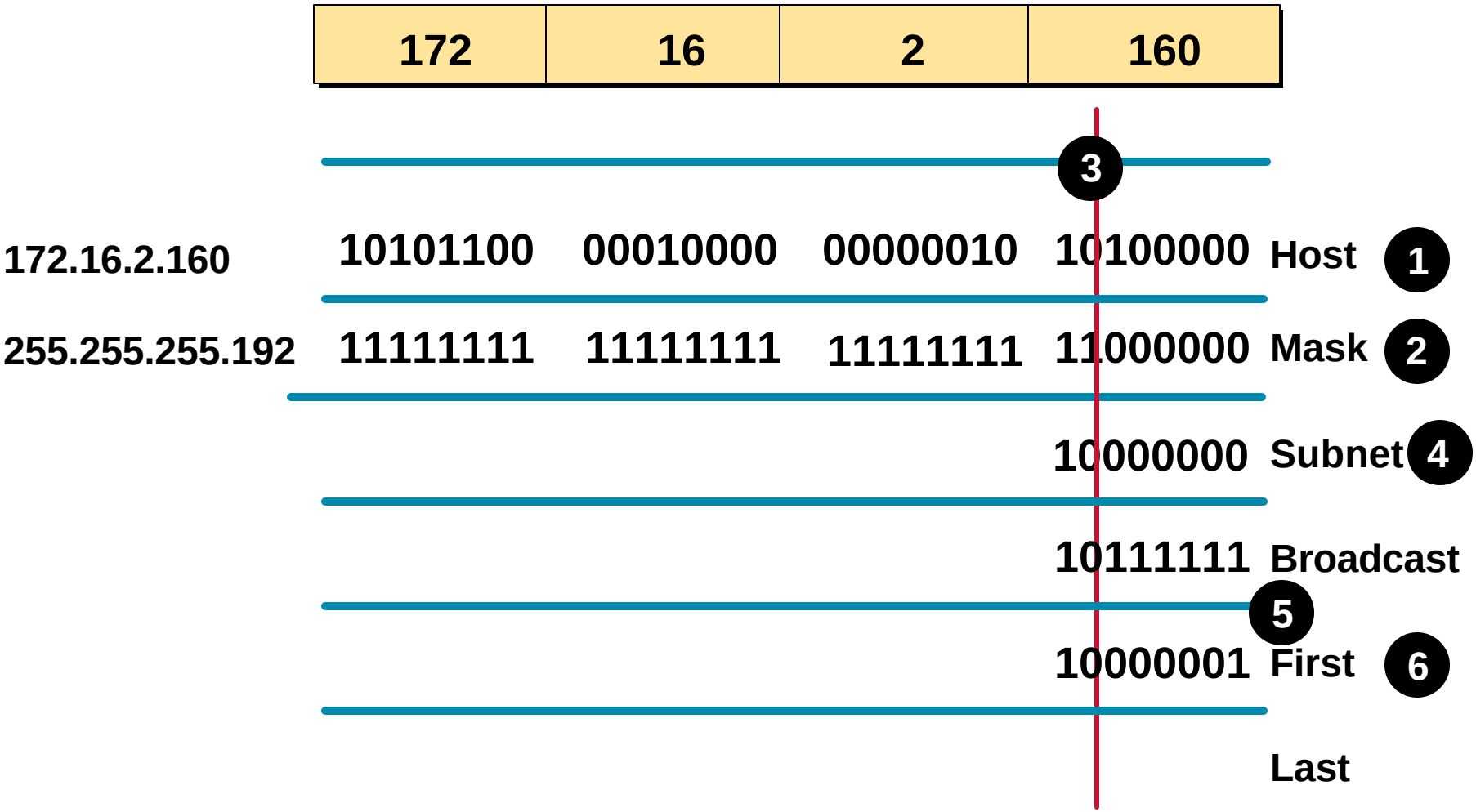
Addressing Summary Example



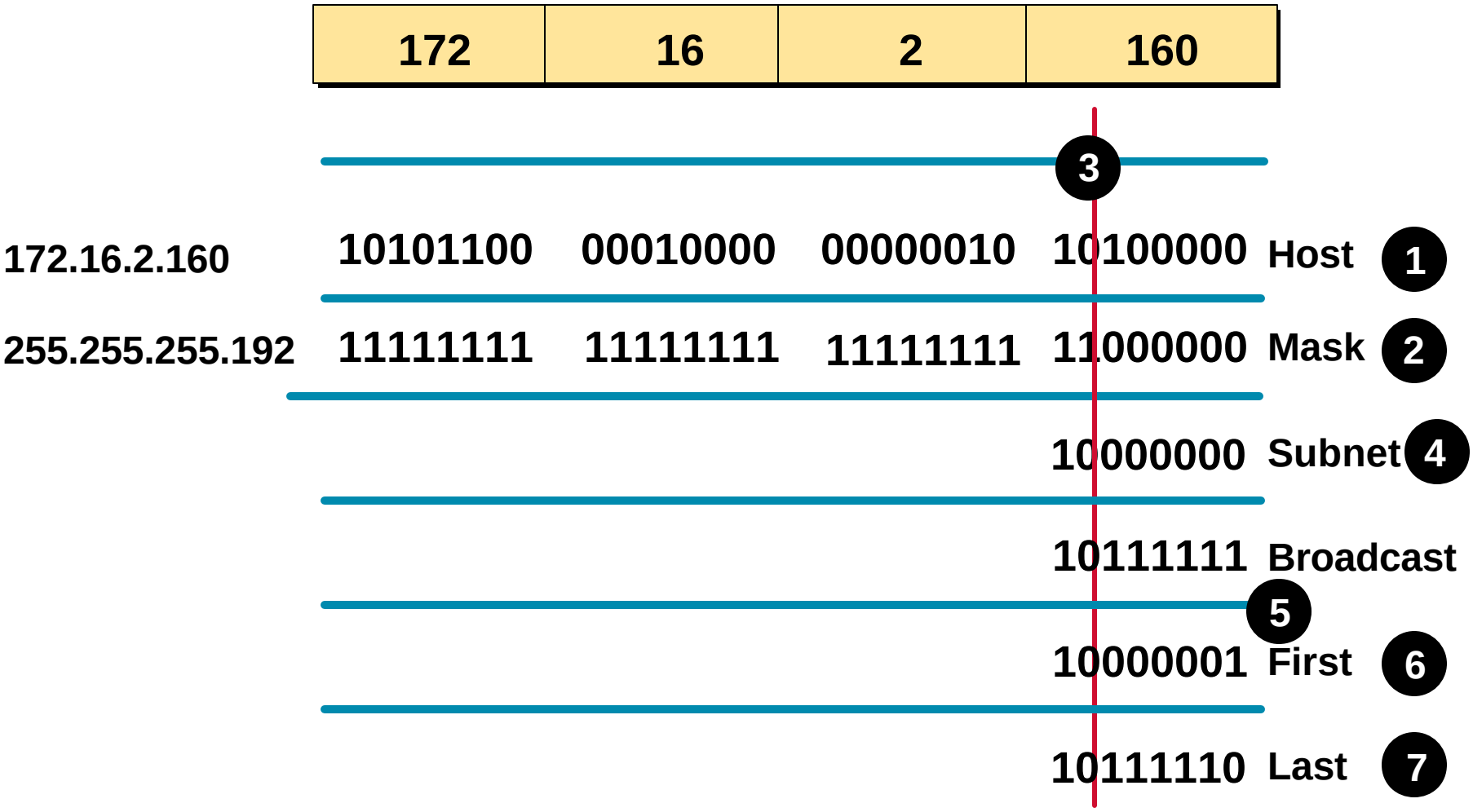
Addressing Summary Example



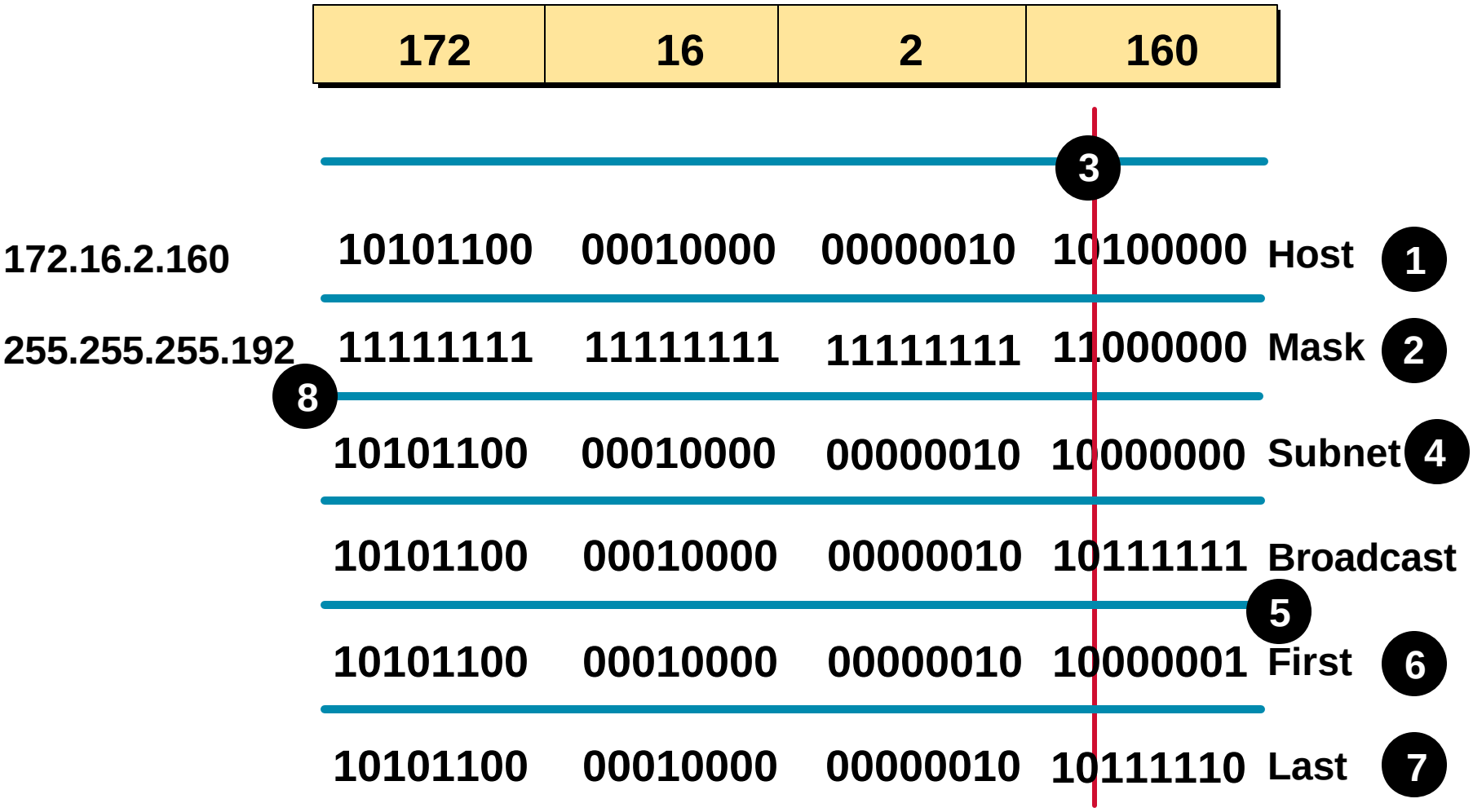
Addressing Summary Example



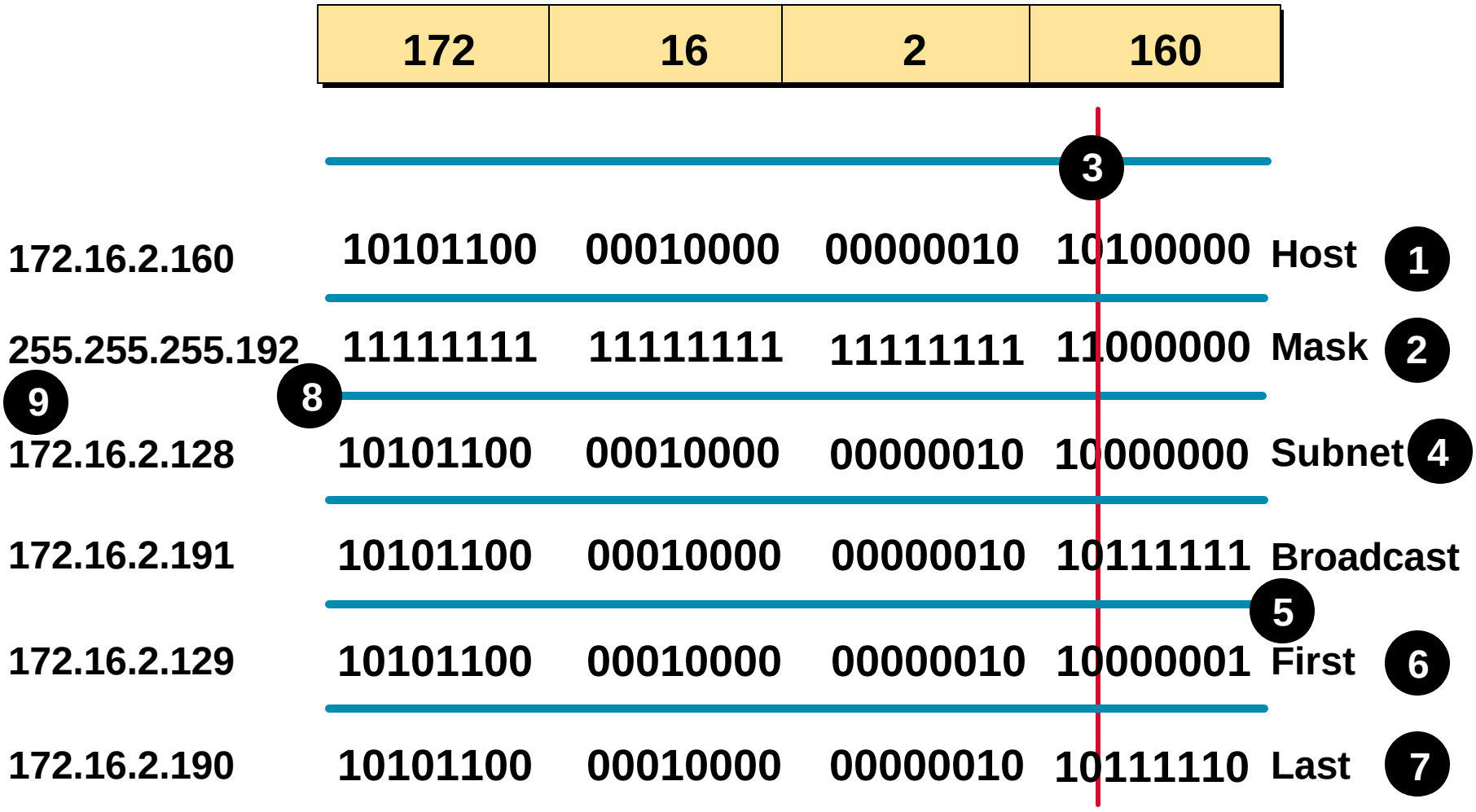
Addressing Summary Example



Addressing Summary Example



Addressing Summary Example



Class B Subnet Example

IP Host Address: 172.16.2.121
Subnet Mask: 255.255.255.0

	Network	Network	Subnet	Host
172.16.2.121:	10101100	00010000	00000010	01111001
255.255.255.0:	11111111	11111111	11111111	00000000
Subnet:	10101100	00010000	00000010	00000000
Broadcast:	10101100	00010000	00000010	11111111

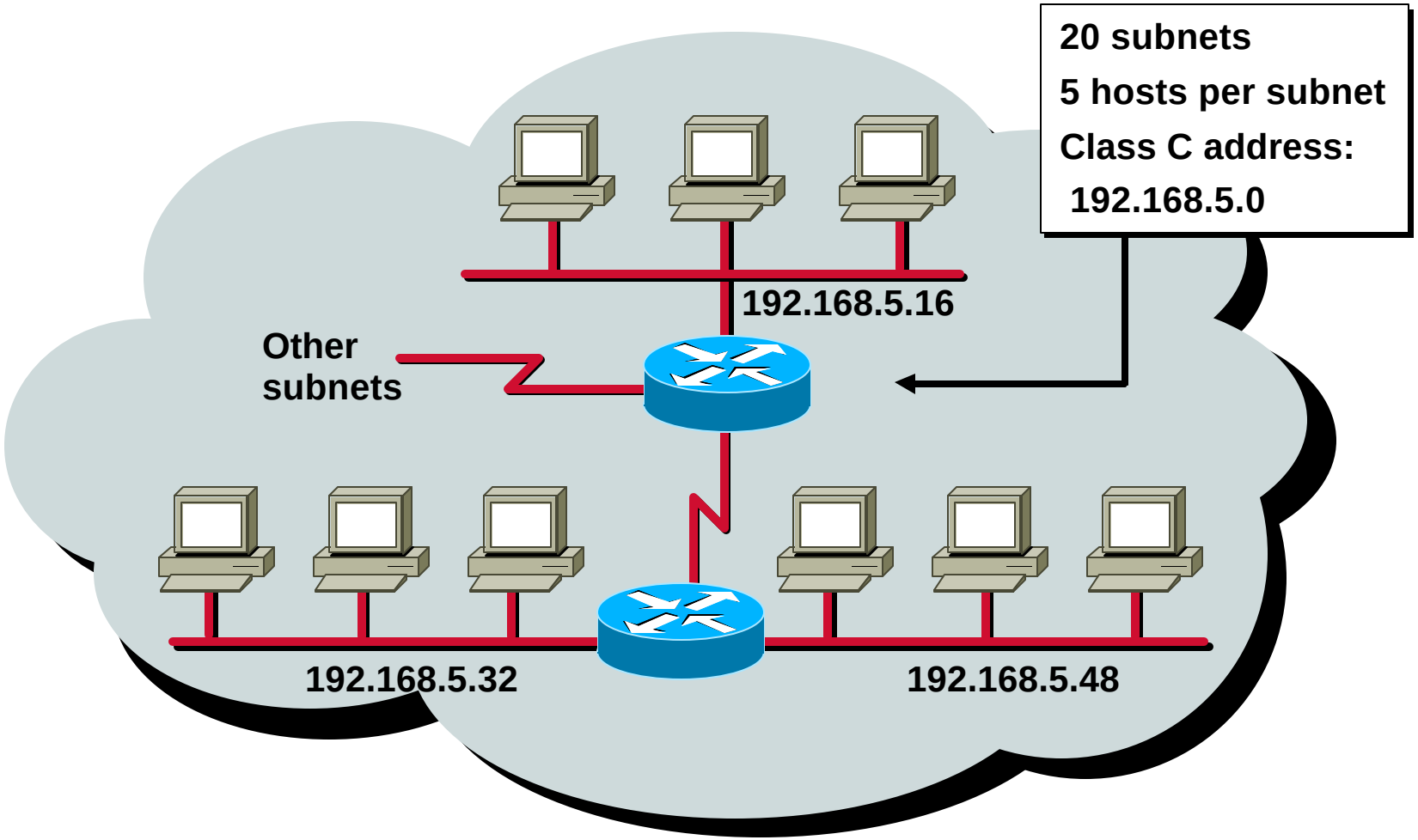
Subnet Address = 172.16.2.0

Host Addresses = 172.16.2.1–172.16.2.254

Broadcast Address = 172.16.2.255

Eight bits of subnetting

Subnet Planning



Class C Subnet Planning Example

IP Host Address: 192.168.5.121
Subnet Mask: 255.255.255.248

	Network	Network	Network	Subnet	Host
192.168.5.121:	11000000	10101000	00000101	01111	001
255.255.255.248:	11111111	11111111	11111111	11111	000
Subnet:	11000000	10101000	00000101	01111	000
Broadcast:	11000000	10101000	00000101	01111	111

Subnet Address = 192.168.5.120

Host Addresses = 192.168.5.121–192.168.5.126

Broadcast Address = 192.168.5.127

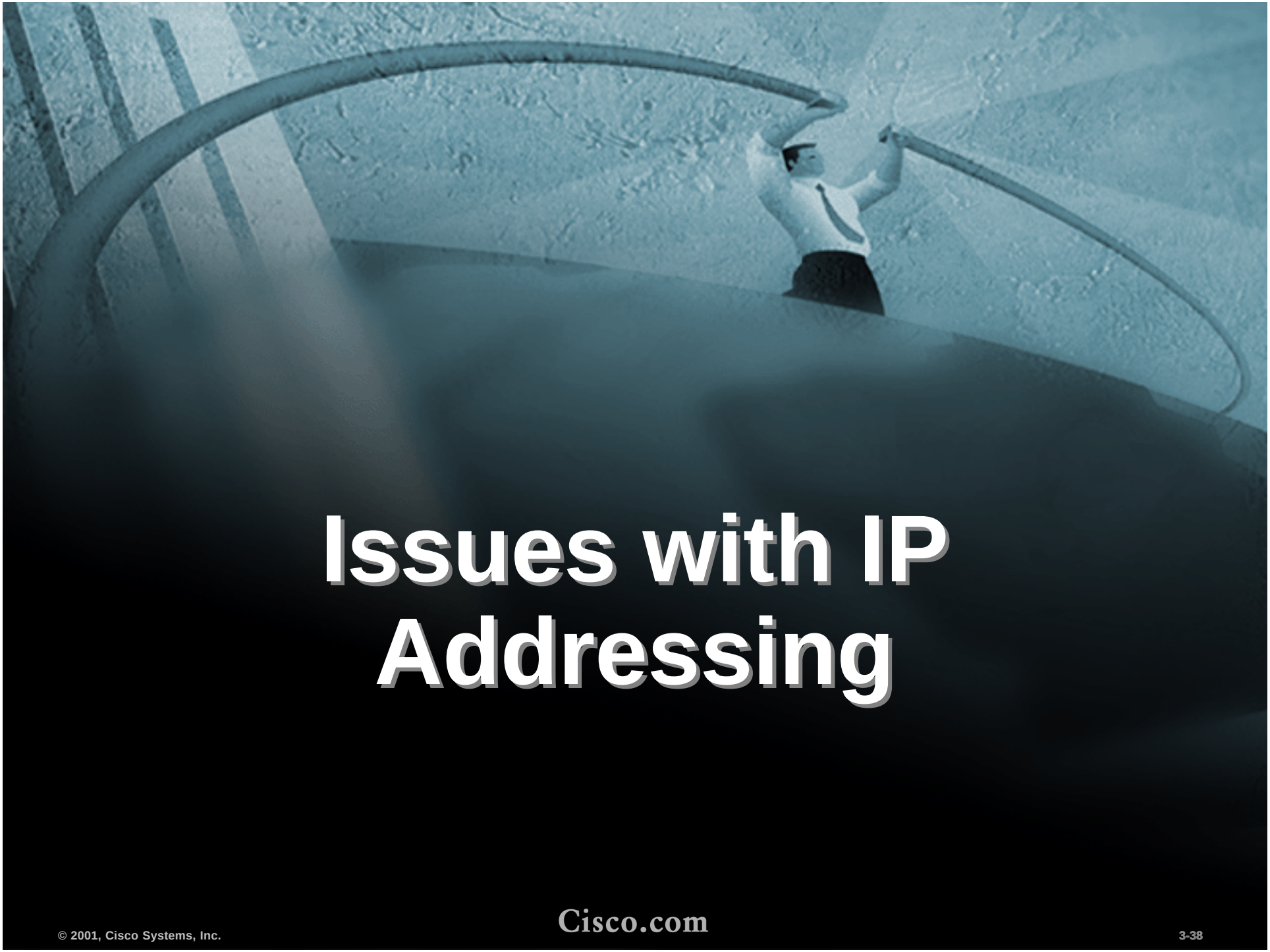
Five Bits of Subnetting

Broadcast Addresses Exercise

Address	Subnet Mask	Class	Subnet	Broadcast
201.222.10.60	255.255.255.248			
15.16.193.6	255.255.248.0			
128.16.32.13	255.255.255.252			
153.50.6.27	255.255.255.128			

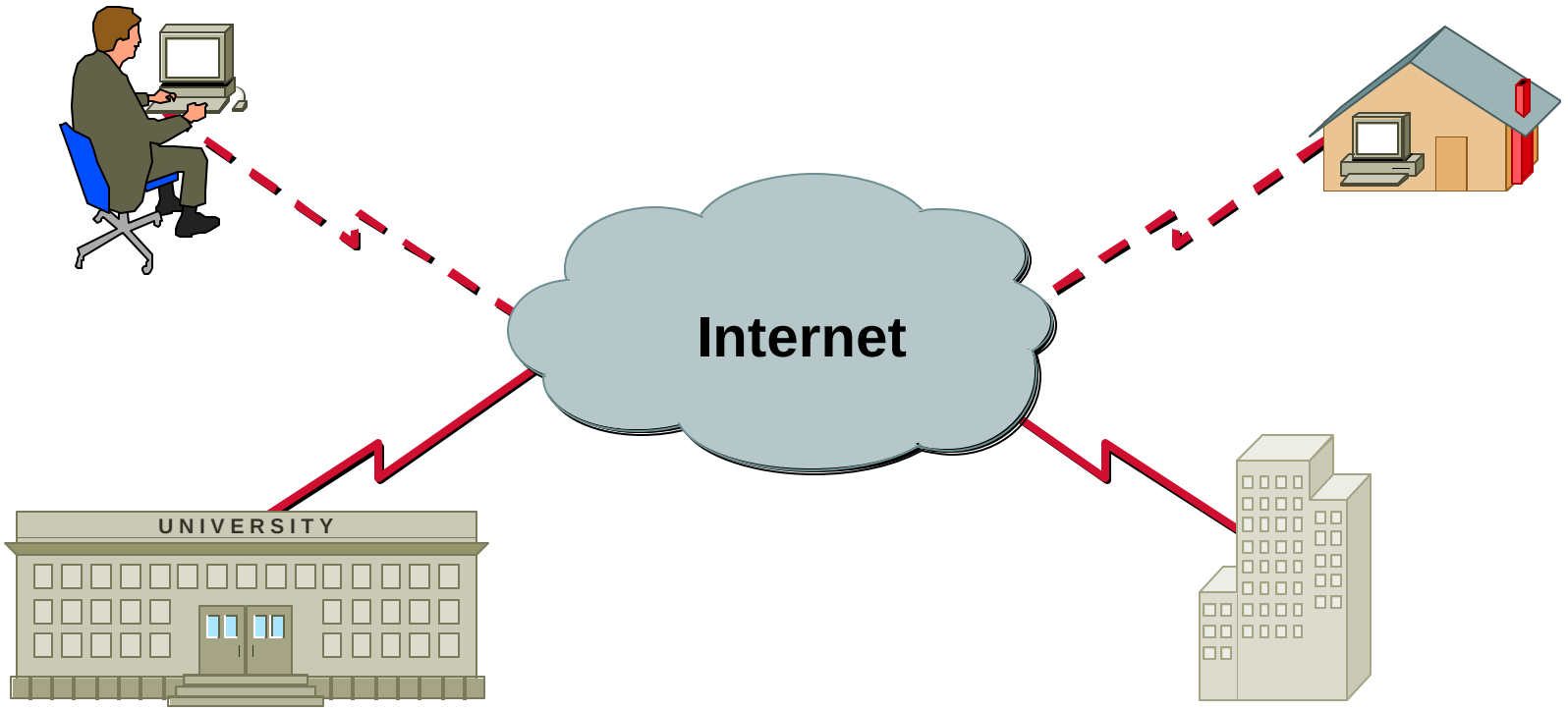
Broadcast Addresses Exercise Answers

Address	Subnet Mask	Class	Subnet	Broadcast
201.222.10.60	255.255.255.248	C	201.222.10.56	201.222.10.63
15.16.193.6	255.255.248.0	A	15.16.192.0	15.16.199.255
128.16.32.13	255.255.255.252	B	128.16.32.12	128.16.32.15
153.50.6.27	255.255.255.128	B	153.50.6.0	153.50.6.127



Issues with IP Addressing

Issues with IP Addressing



- **IP address exhaustion**
- **Routing table growth**

IP Addressing Solutions

- Subnet masking, RFCs 950, 1812
- Address allocation for private Internets, RFC 1918
- Network Address Translation, RFC 1631
- Hierarchical addressing
- Variable-length subnet masks, RFC 1812
- Route summarization, RFC 1518
- Classless interdomain routing, RFCs 1518, 1519, 2050

Subnetting Overview

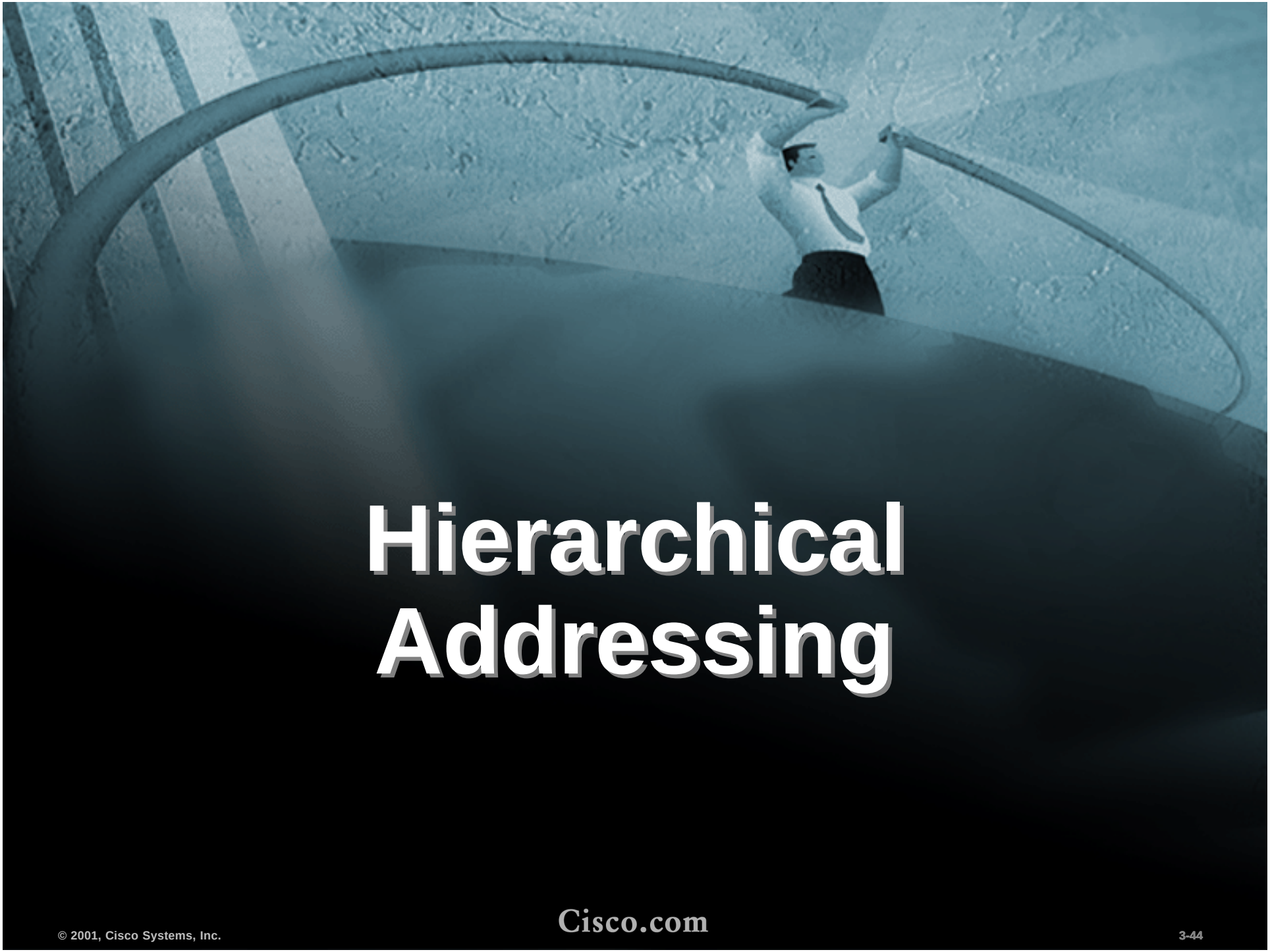
- Moving the network boundary to the right creates additional subnetworks at the expense of fewer hosts on each segment
- The new mask will contain additional contiguous 1s indicating by how many bits the network portion has been extended
  - The formula 2^n, where *n* equals the number of extended bits, indicates the maximum number of subnets created

IP Address Classes

- IP address and associated mask are represented in 32-bit dotted decimal
  - Other formats are commonly used
- Decimal value in the first octet determines the class of the address
  - 001 - 126 = Class A
  - 128 - 191 = Class B
  - 192 - 223 = Class C
  - 224 - 239 = Class D
  - 240 - 254 = Class E

Address Class Usage

- Address classes A, B, and C are available for Internet use
- Some Class D multicast addresses are used by routing protocols
  - OSPF—224.0.0.5, 224.0.0.6
  - RIPv2—224.0.0.9
  - EIGRP—224.0.0.10
- Other Class D multicast addresses are used by videoconferencing or other applications

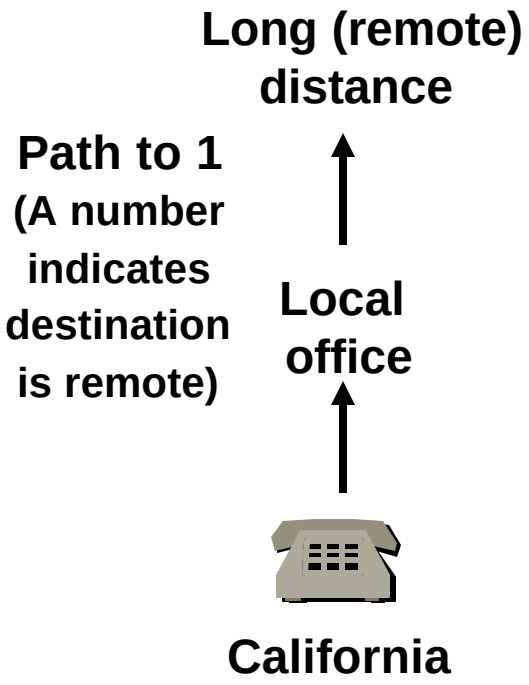


Hierarchical Addressing

Planning an IP Address Hierarchy

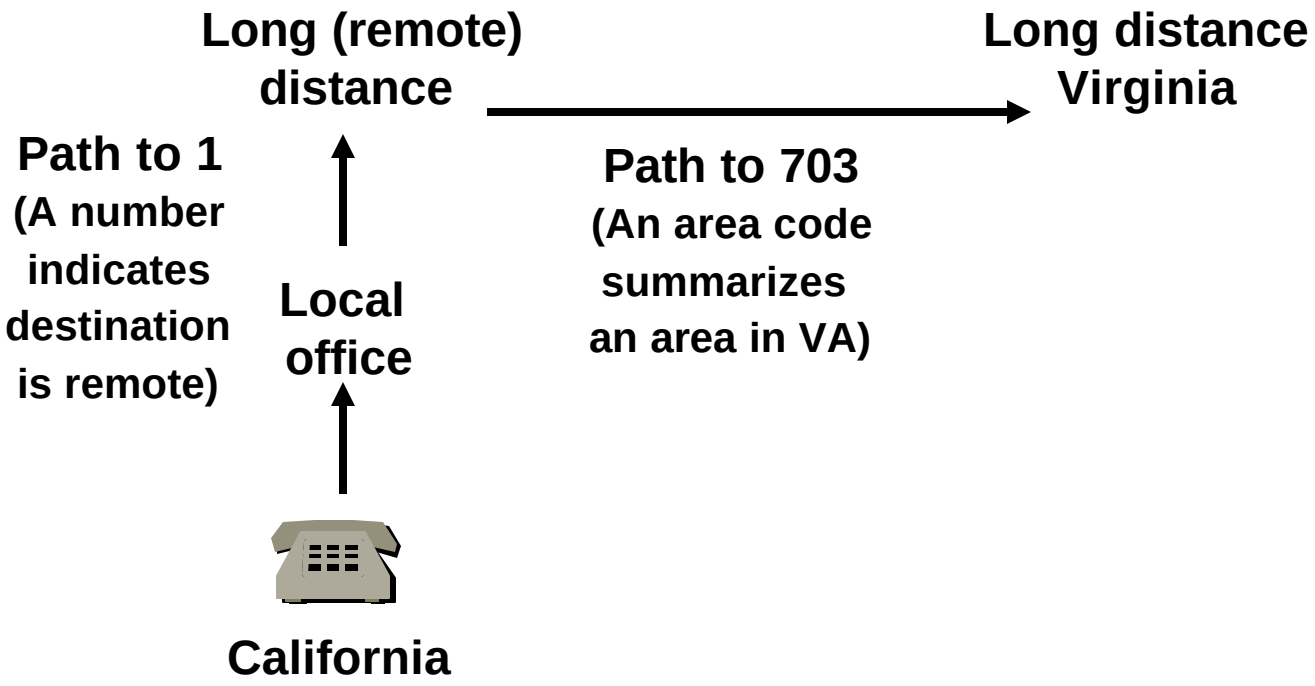
Does a telephone switch in California know how to reach a specific phone in Virginia? (1-703-555-1212)

Planning an IP Address Hierarchy (cont.)



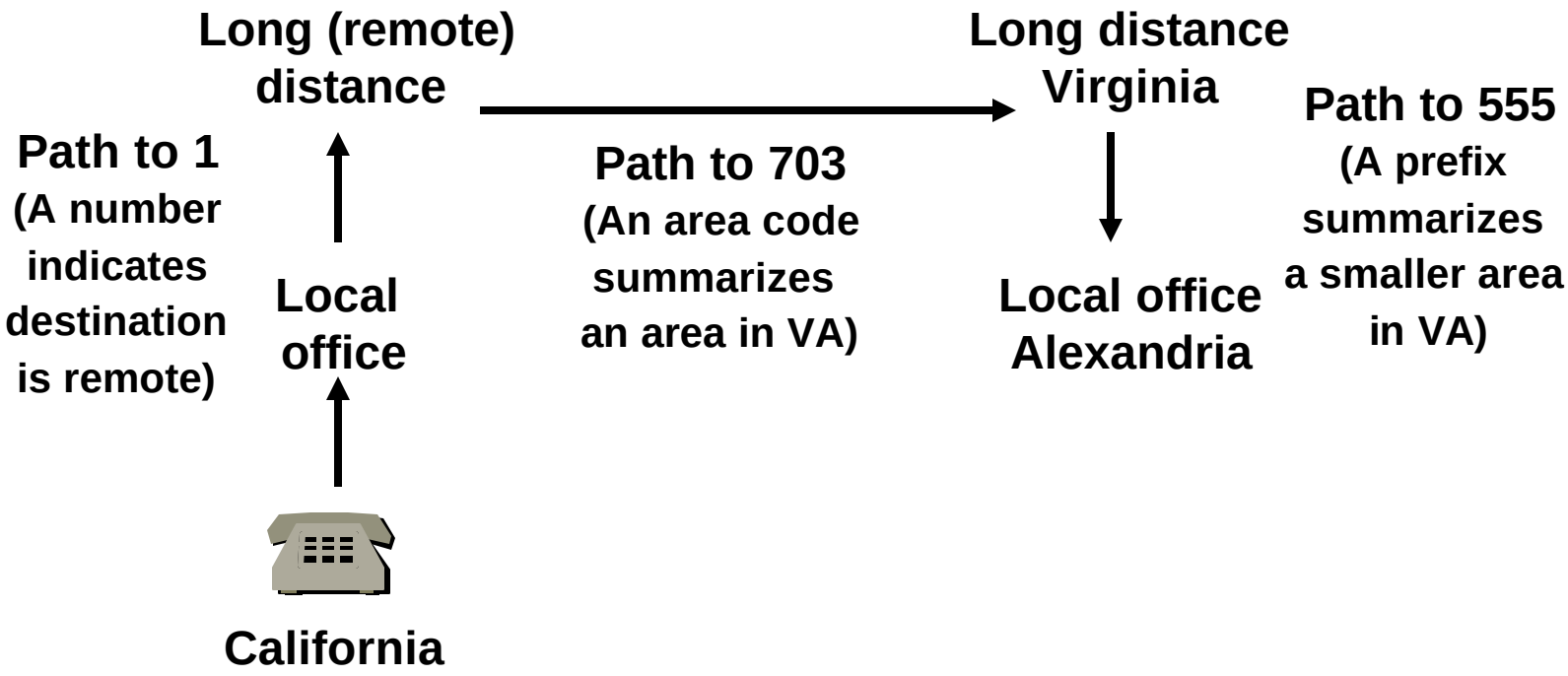
Does a telephone switch in California know how to reach a specific phone in Virginia? (1-703-555-1212)

Planning an IP Address Hierarchy (cont.)



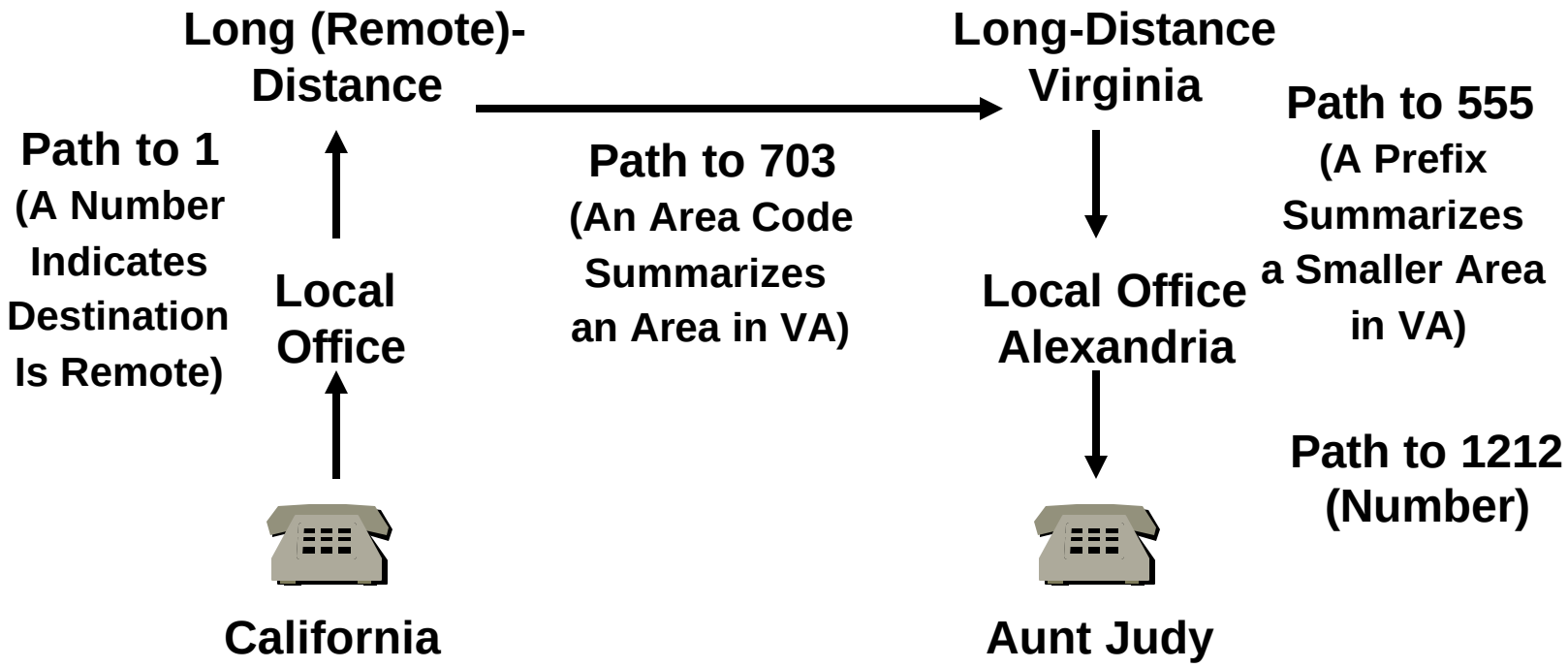
Does a telephone switch in California know how to reach a specific phone in Virginia? (1-703-555-1212)

Planning an IP Address Hierarchy (cont.)



Does a telephone switch in California know how to reach a specific phone in Virginia? (1-703-555-1212)

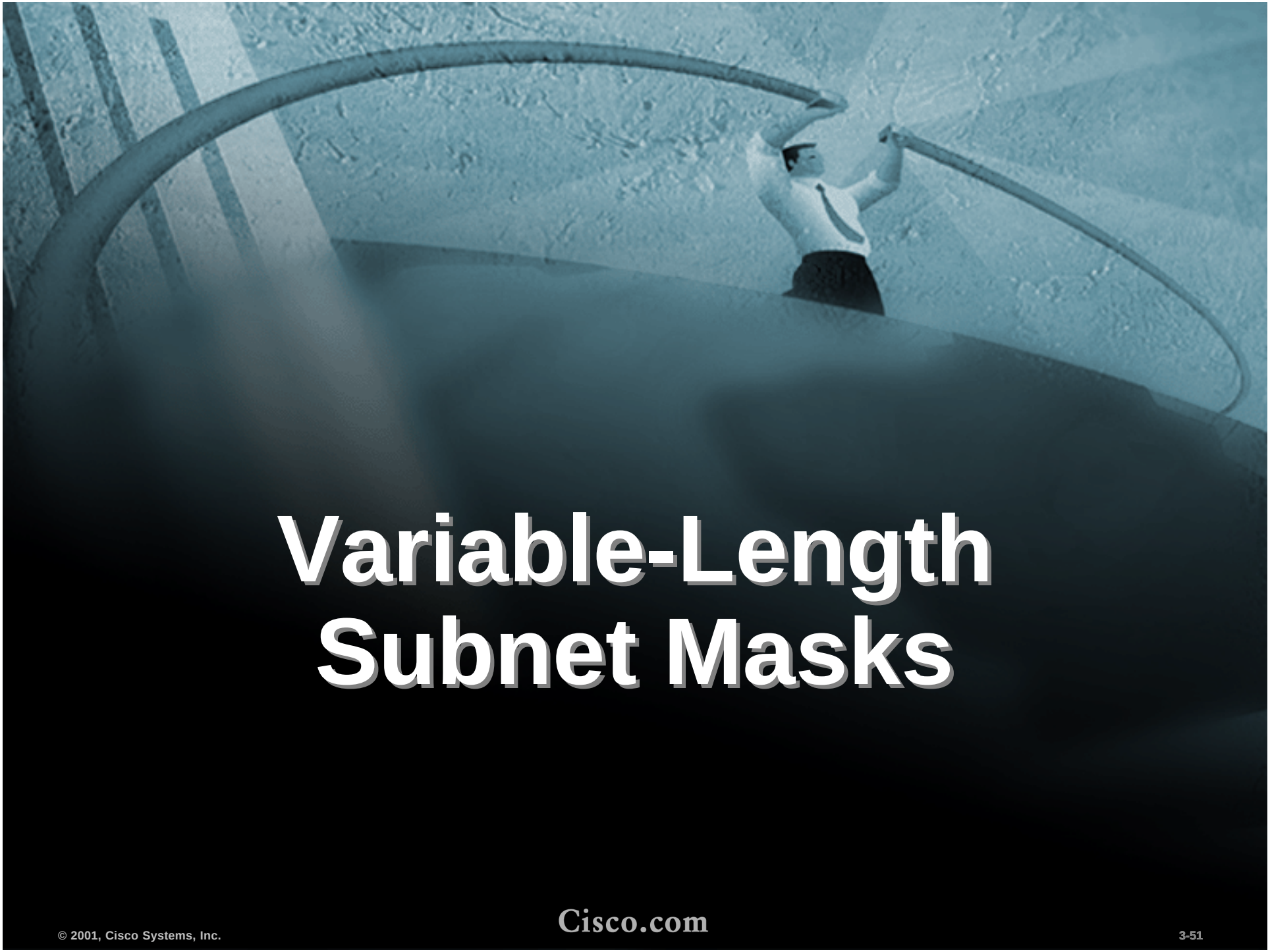
Planning an IP Address Hierarchy (cont.)



- Does a telephone switch in California know how to reach a specific phone (1-703-555-1212) in Virginia?

Benefits of Hierarchical Addressing

- Reduced number of route table entries
  - Summarize multiple addresses into route summaries
- Efficient allocation of addresses
  - Contiguous address assignment allows you to use all possible addresses

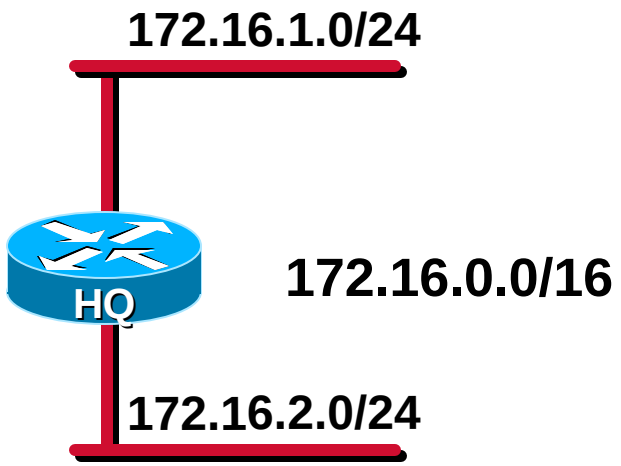


Variable-Length Subnet Masks

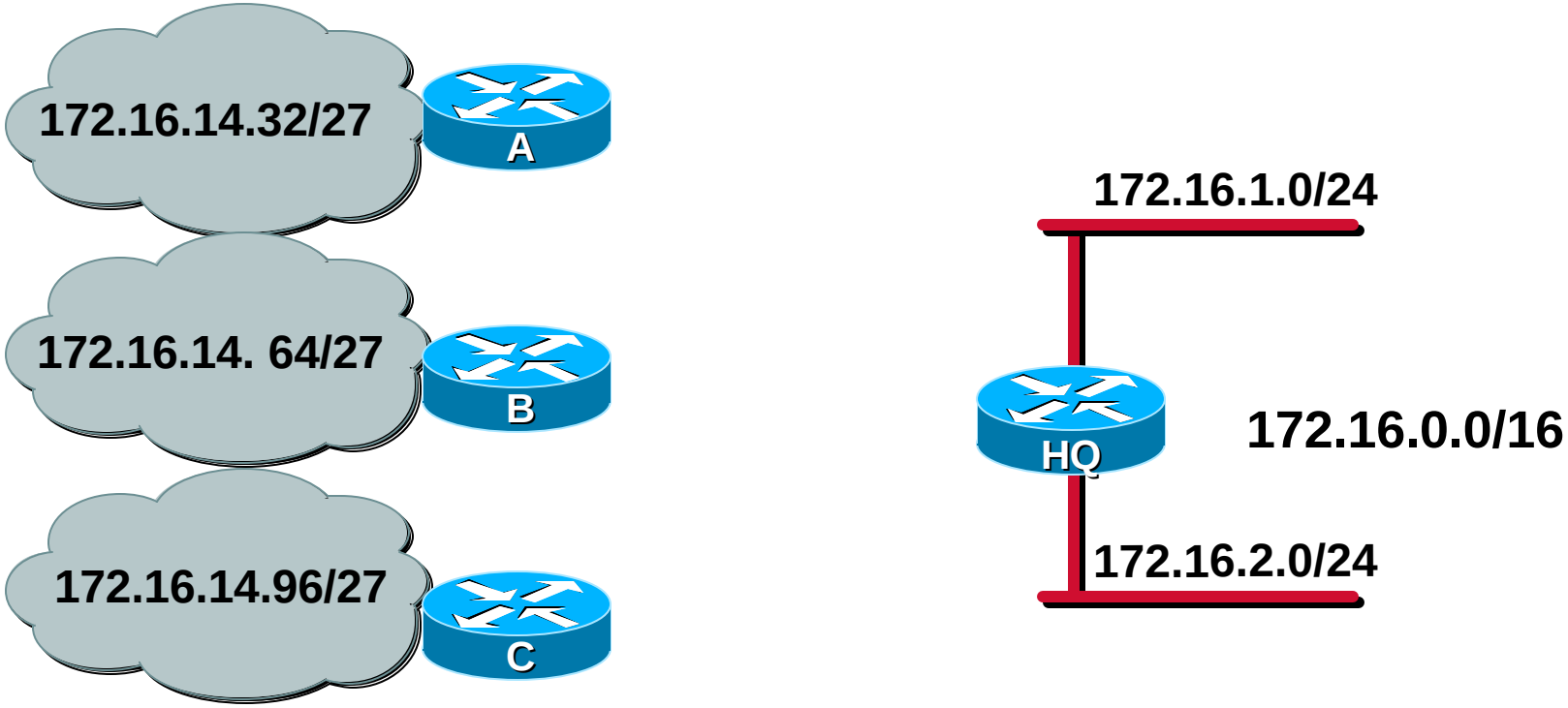
What Is a Variable-Length Subnet Mask?

172.16.0.0/16

What Is a Variable-Length Subnet Mask? (cont.)

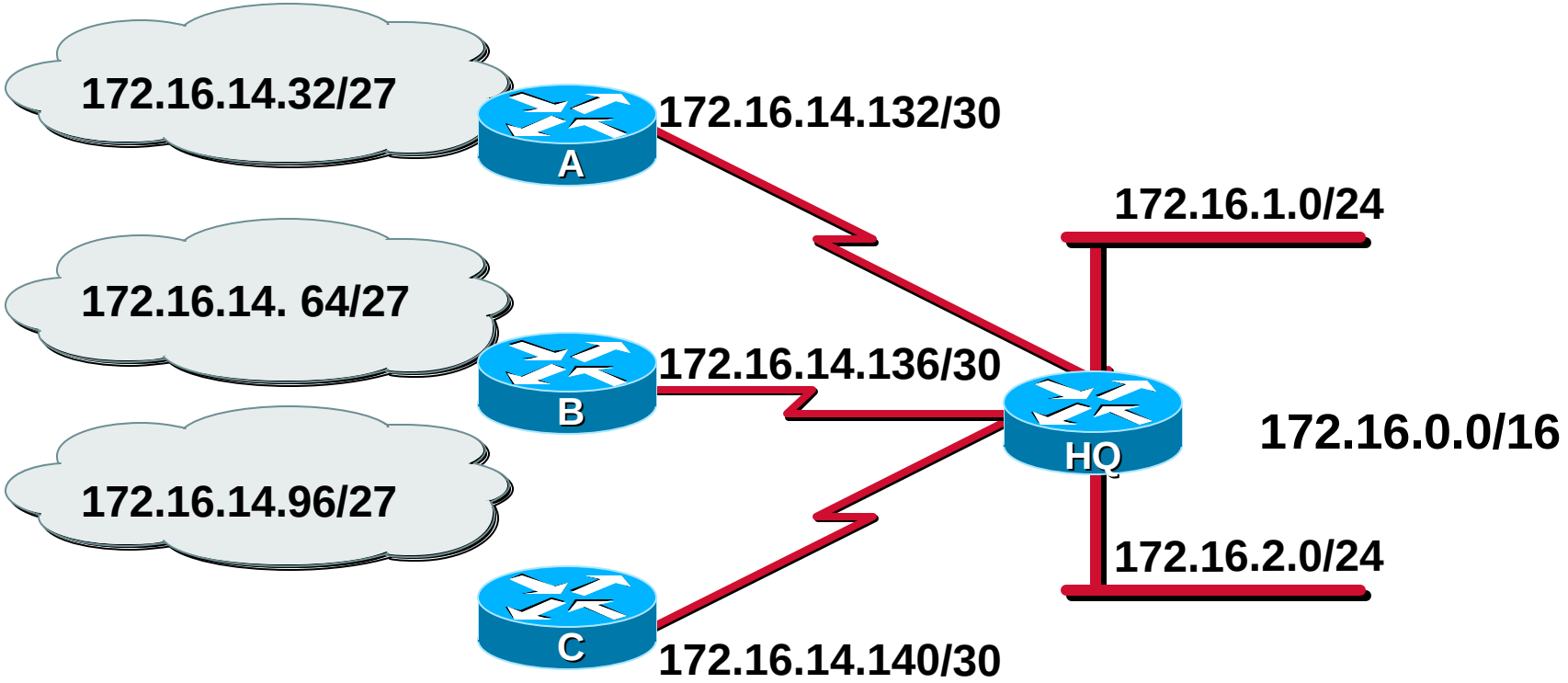


What Is a Variable-Length Subnet Mask? (cont.)



- **Subnet 172.16.14.0/24 is divided into smaller subnets:**
  - **Subnet with one mask at first (/27)**

What Is a Variable-Length Subnet Mask? (cont.)



- Subnet 172.16.14.0/24 is divided into smaller subnets:
  - Subnet with one mask at first (/27)
  - Then further subnet one of the unused /27 subnets into multiple /30 subnets

Calculating VLSMs

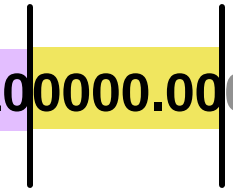
Subnetted Address: 172.16.32.0/20

In Binary 10101100. 00010000.00100000.00000000

Calculating VLSMs (cont.)

Subnetted Address: 172.16.32.0/20
In Binary 10101100. 00010000.00100000.00000000

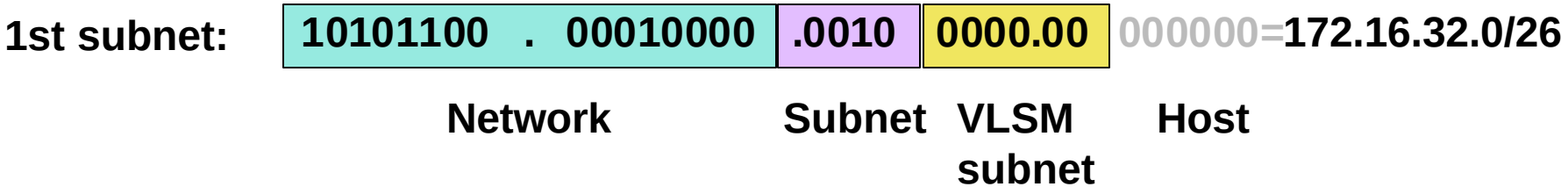
VLSM Address: 172.16.32.0/26
In Binary 10101100. 00010000.00100000.00000000



Calculating VLSMs (cont.)

Subnetted Address: 172.16.32.0/20
In Binary 10101100. 00010000.00100000.00000000

VLSM Address: 172.16.32.0/26
In Binary 10101100. 00010000.00100000.00**000000**



Calculating VLSMs (cont.)

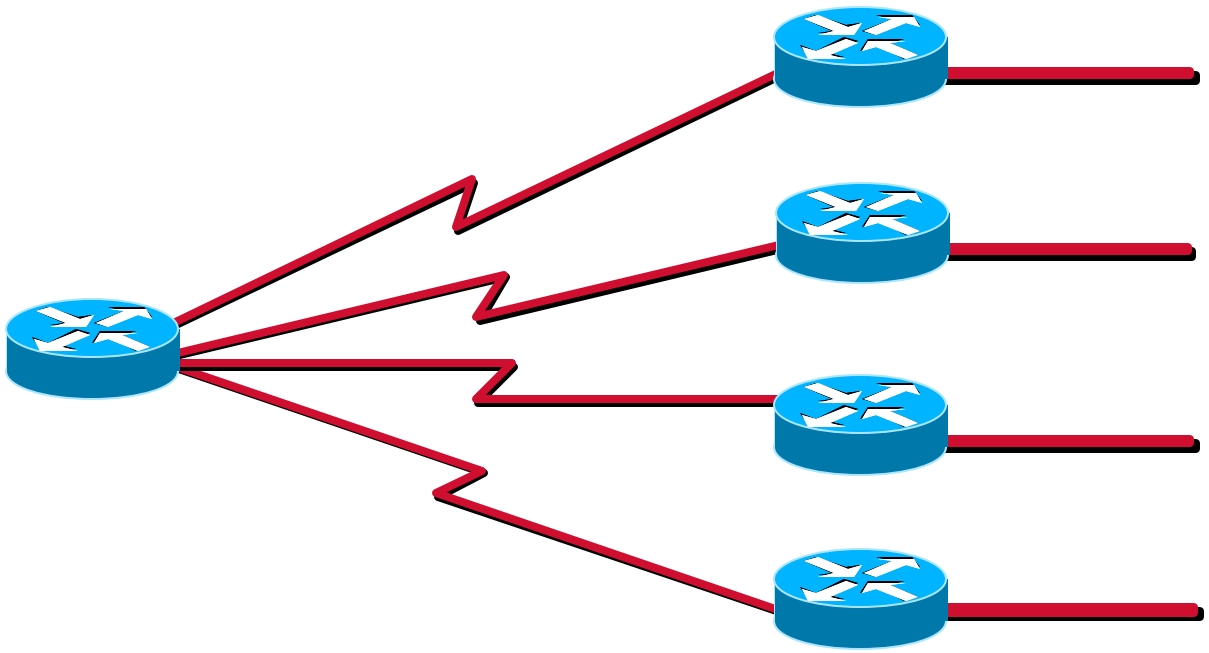
Subnetted Address: 172.16.32.0/20
In Binary 10101100. 00010000.0010**0000.00000000**

VLSM Address: 172.16.32.0/26
In Binary 10101100. 00010000.0010**0000.00**000000

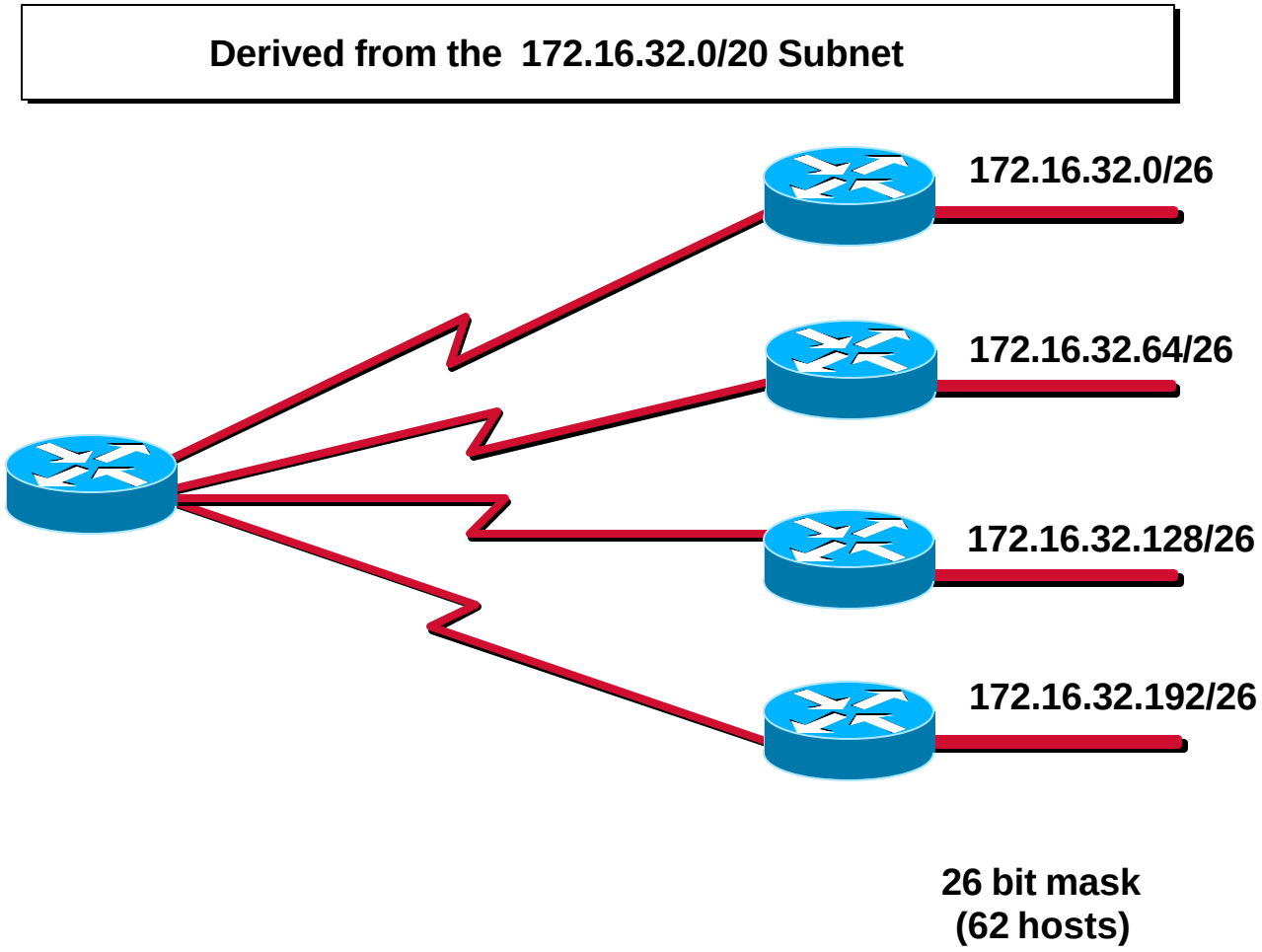
1st subnet:	10101100	. 00010000	.0010	0000.00	000000=	172.16.32.0/26
2nd subnet:	172	. 16	.0010	0000.01	000000=	172.16.32.64/26
3rd subnet:	172	. 16	.0010	0000.10	000000=	172.16.32.128/26
4th subnet:	172	. 16	.0010	0000.11	000000=	172.16.32.192/26
5th subnet:	172	. 16	.0010	0001.00	000000=	172.16.33.0/26
	Network		Subnet	VLSM Subnet	Host	

A Working VLSM Example

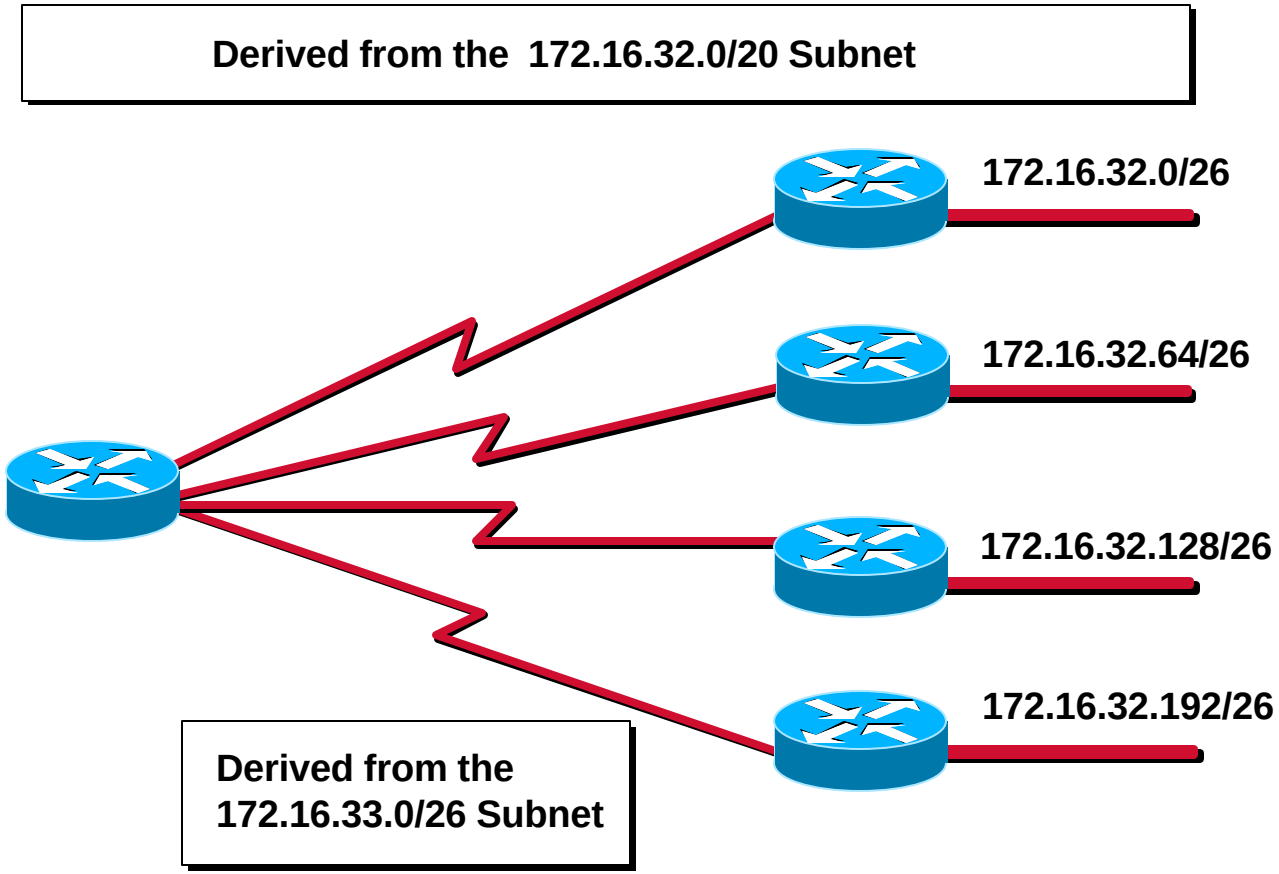
Derived from the 172.16.32.0/20 Subnet



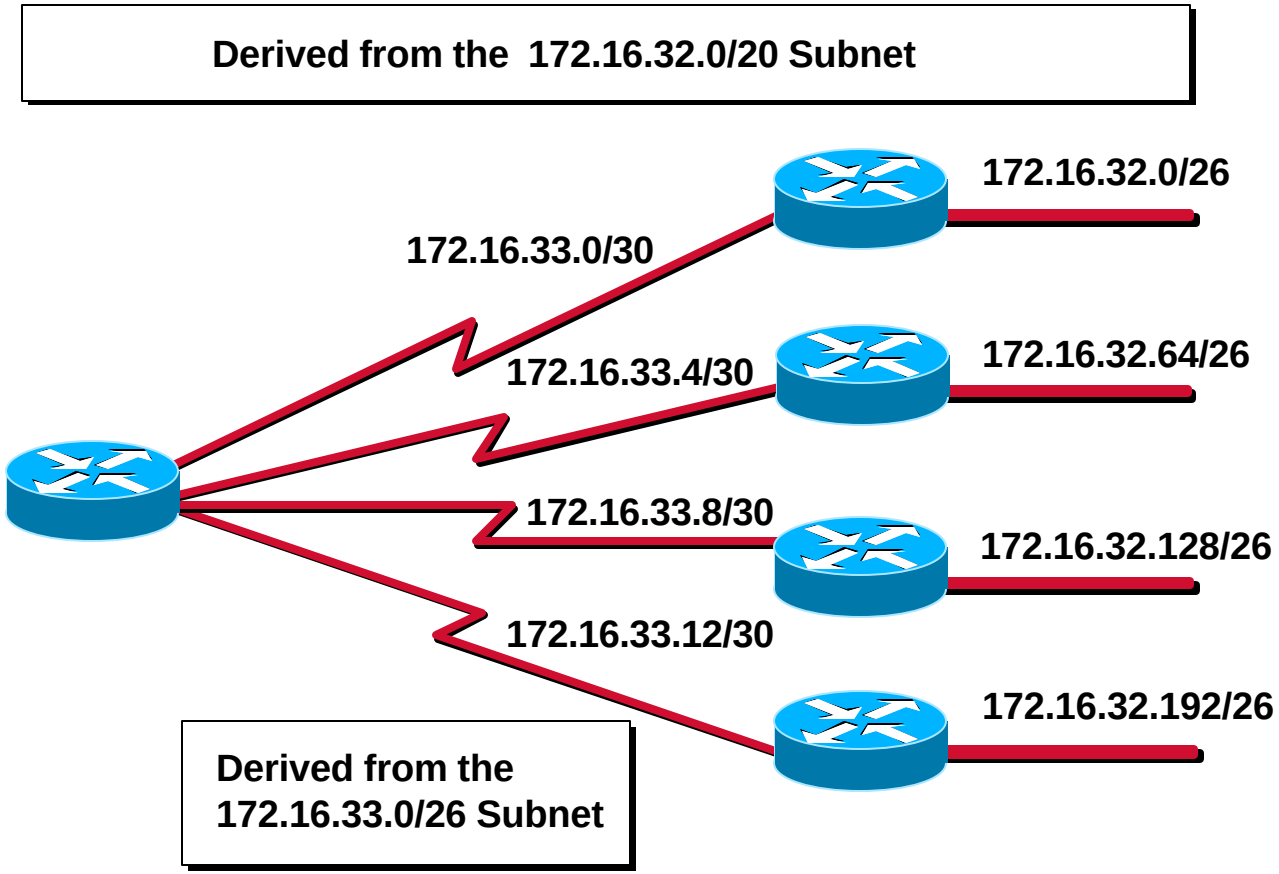
A Working VLSM Example (cont.)



A Working VLSM Example (cont.)



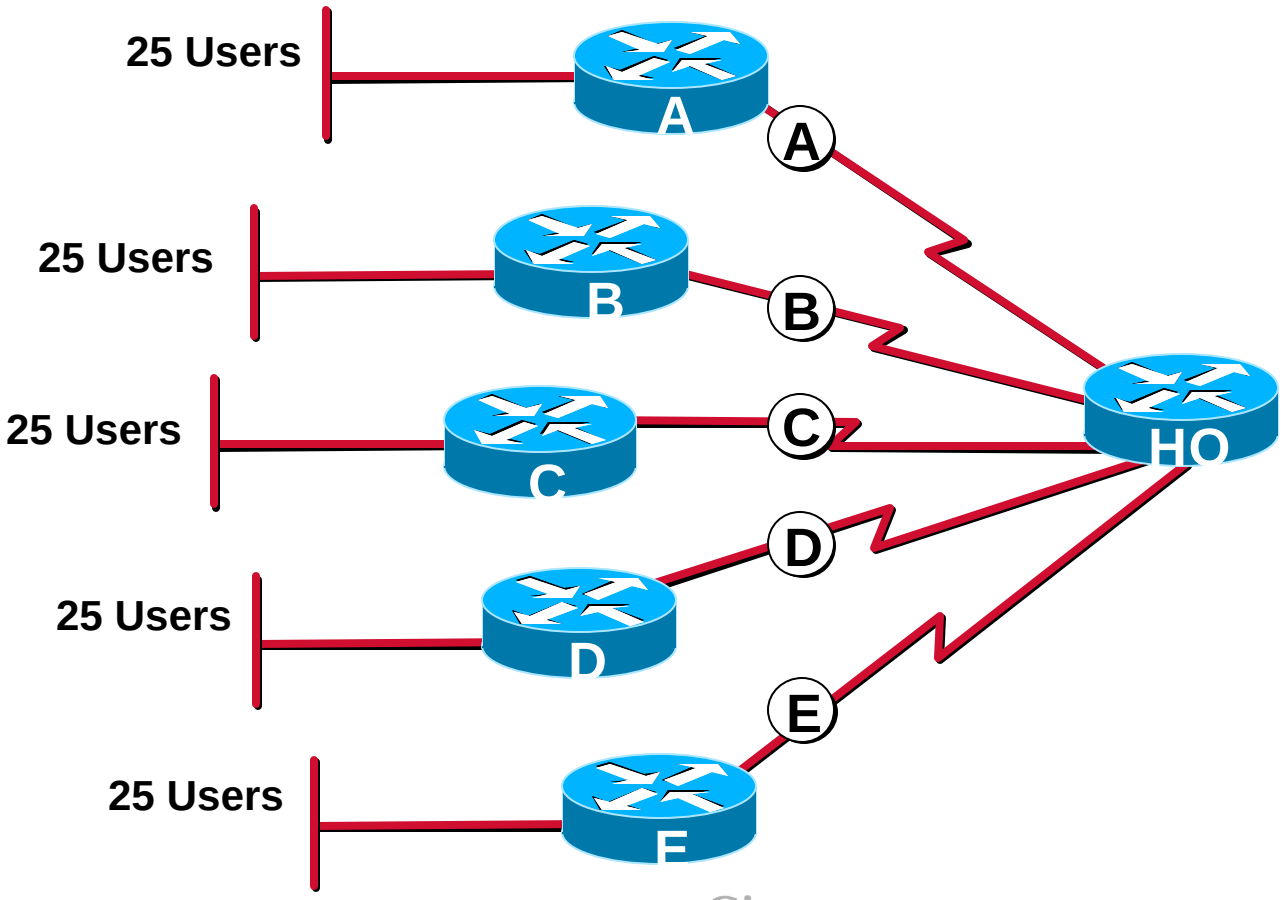
A Working VLSM Example (cont.)



Written Exercise

Written Exercise: Calculating VLSMs

Using VLSMs, define appropriate subnets for addressing the networks using 192.168.49.0/24.



Addresses for WAN Links

A Serial _____

B Serial _____

C Serial _____

D Serial _____

E Serial _____