

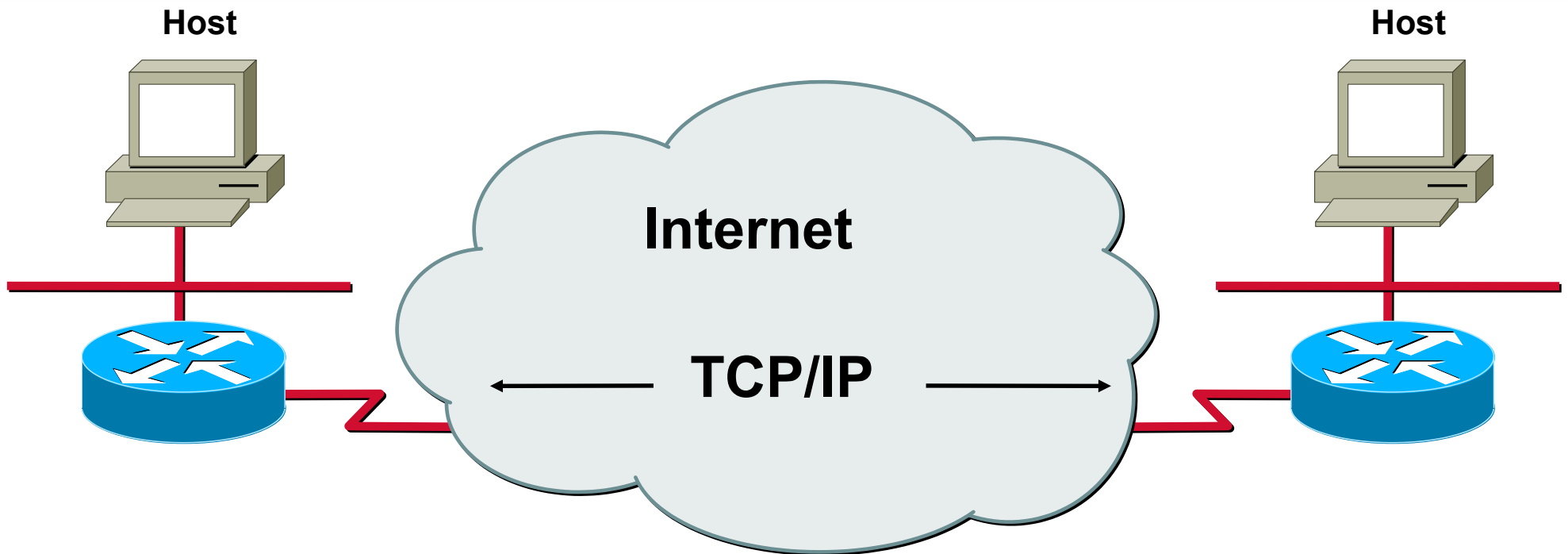


## Chapter 8

# Networks with TCP/IP

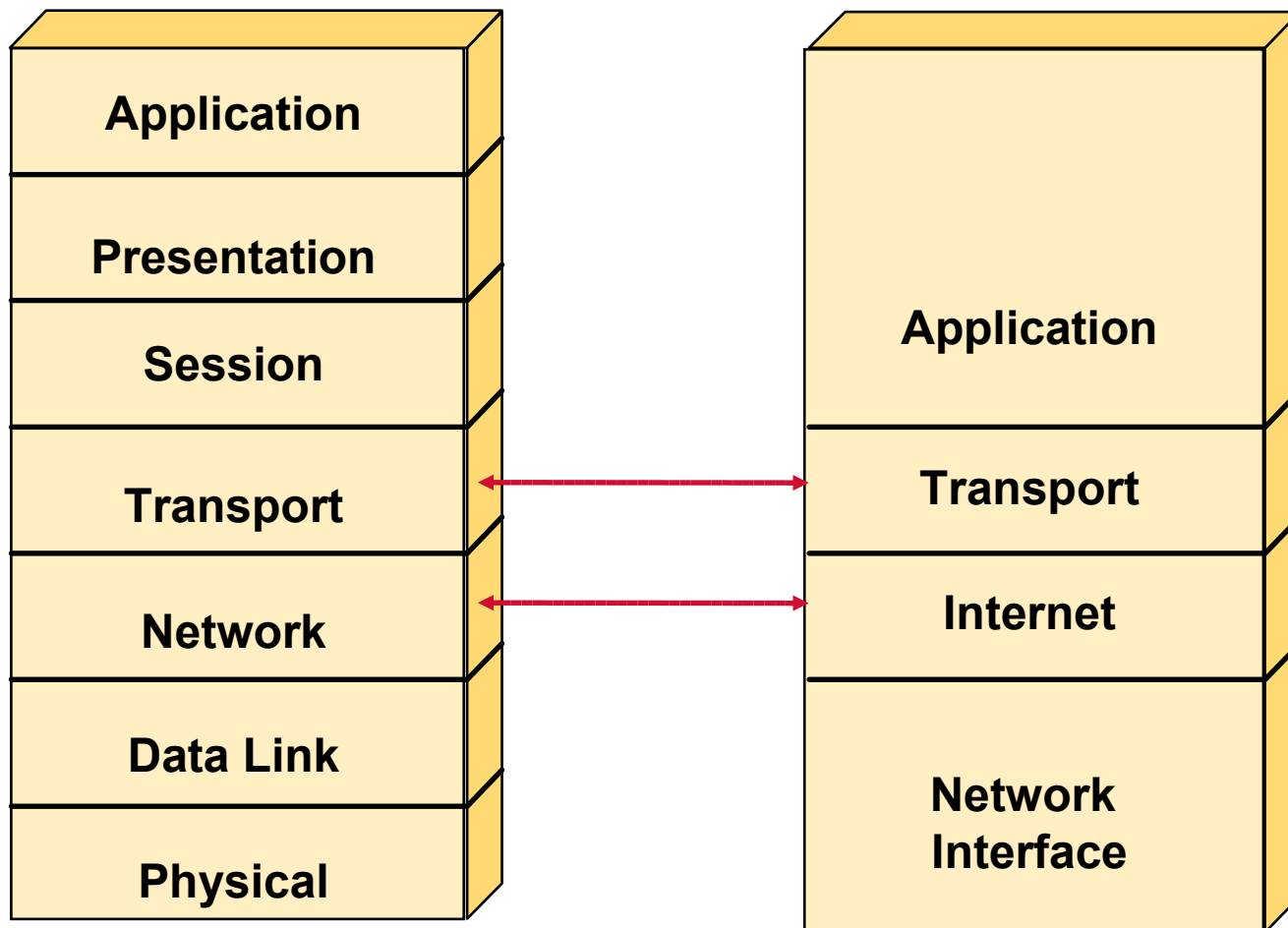


# Introduction to TCP/IP

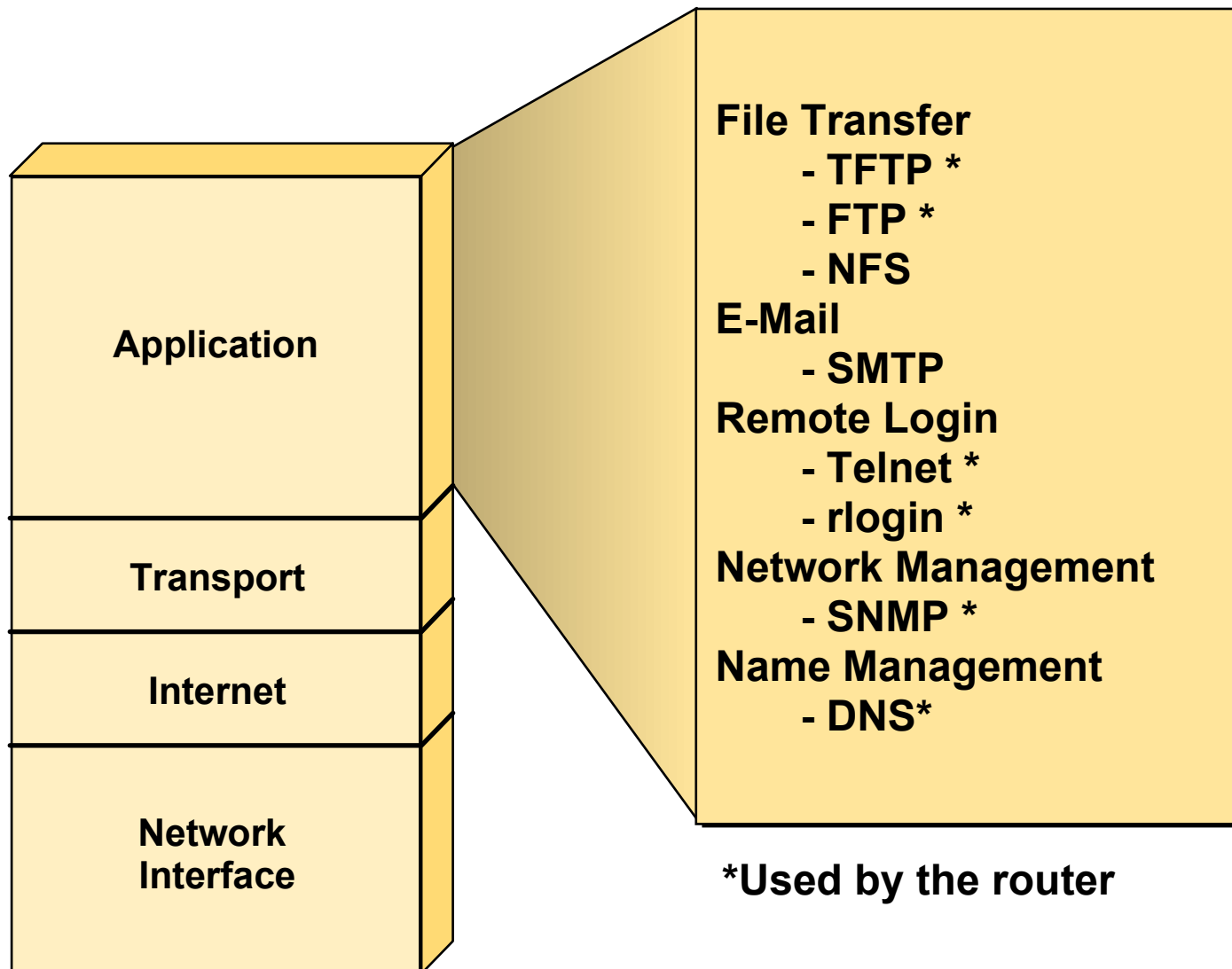


**Early protocol suite**  
**Universal**

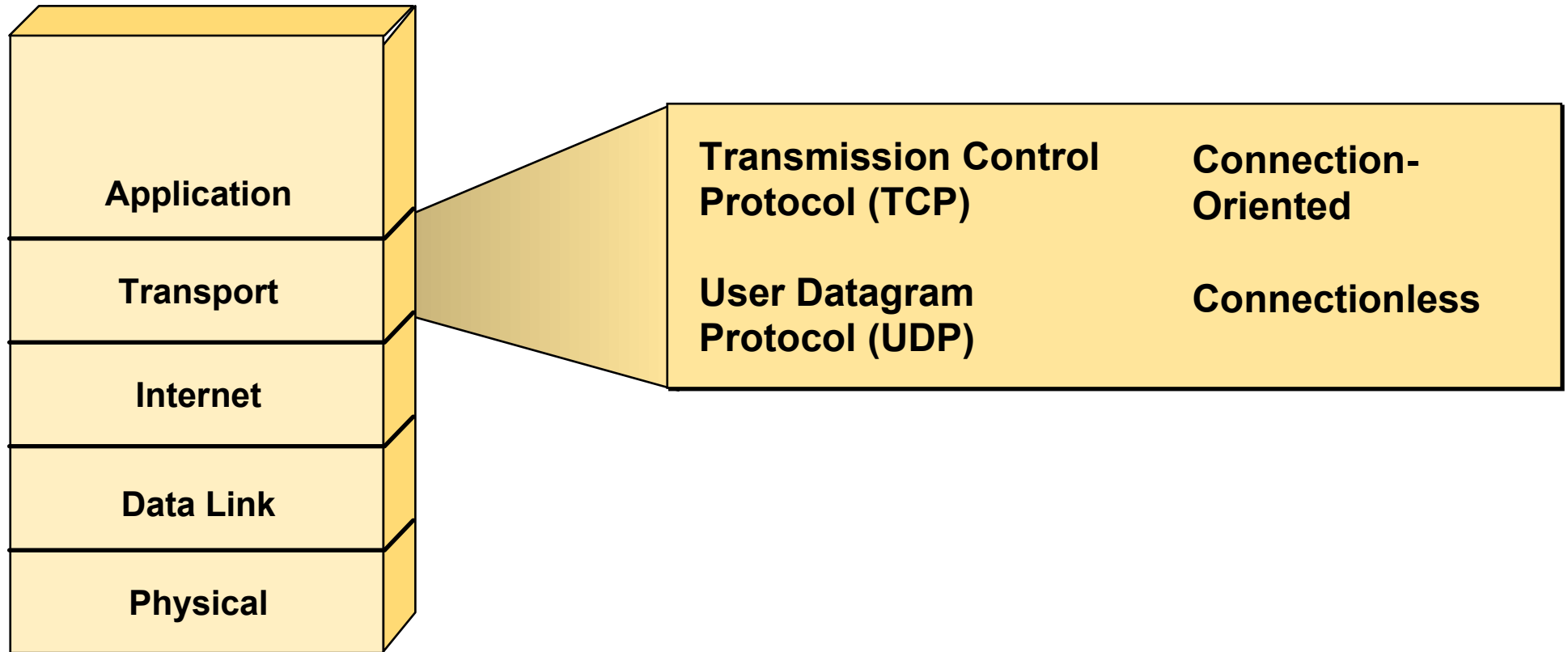
# TCP/IP Protocol Stack



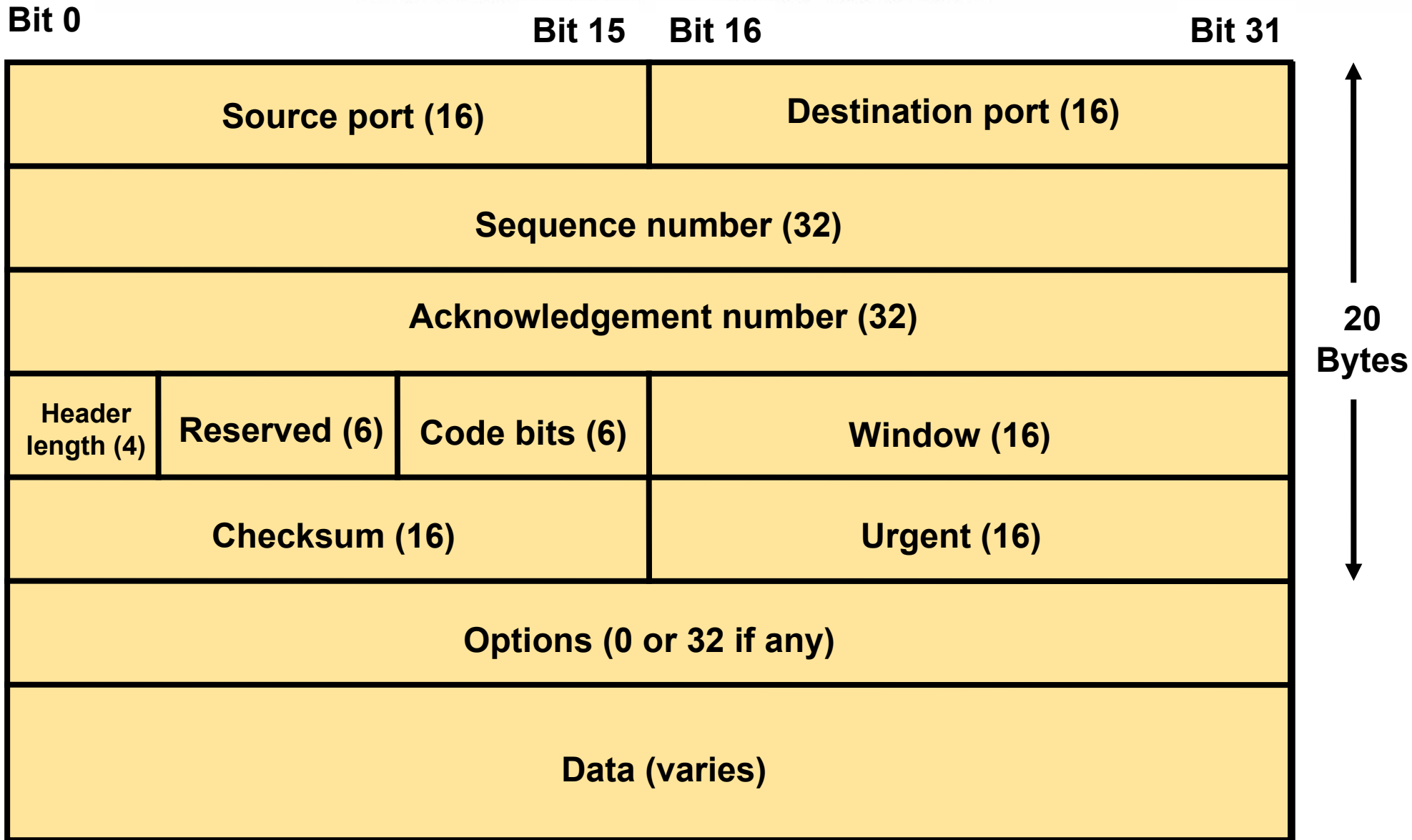
# Application Layer Overview



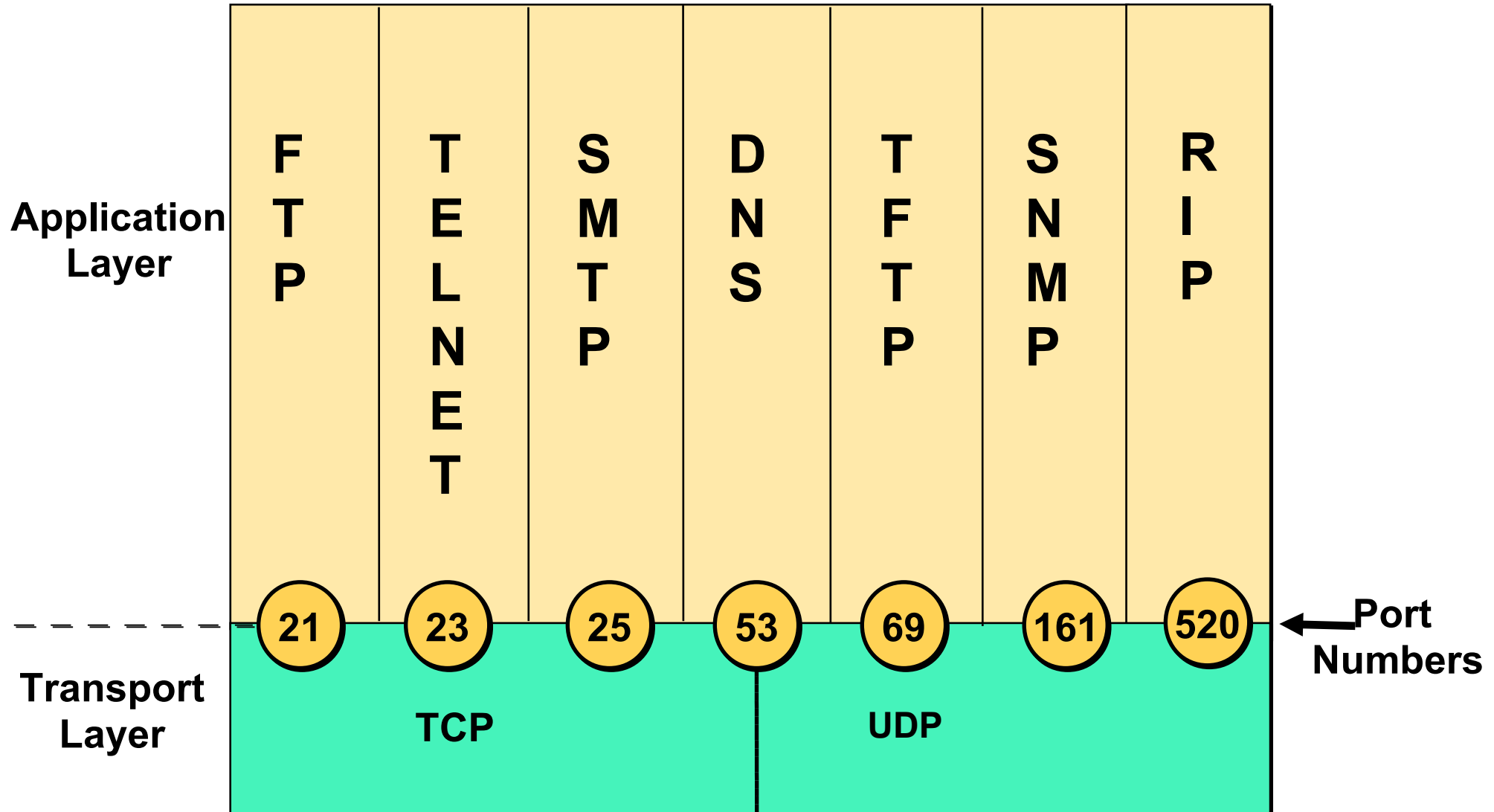
# Transport Layer Overview



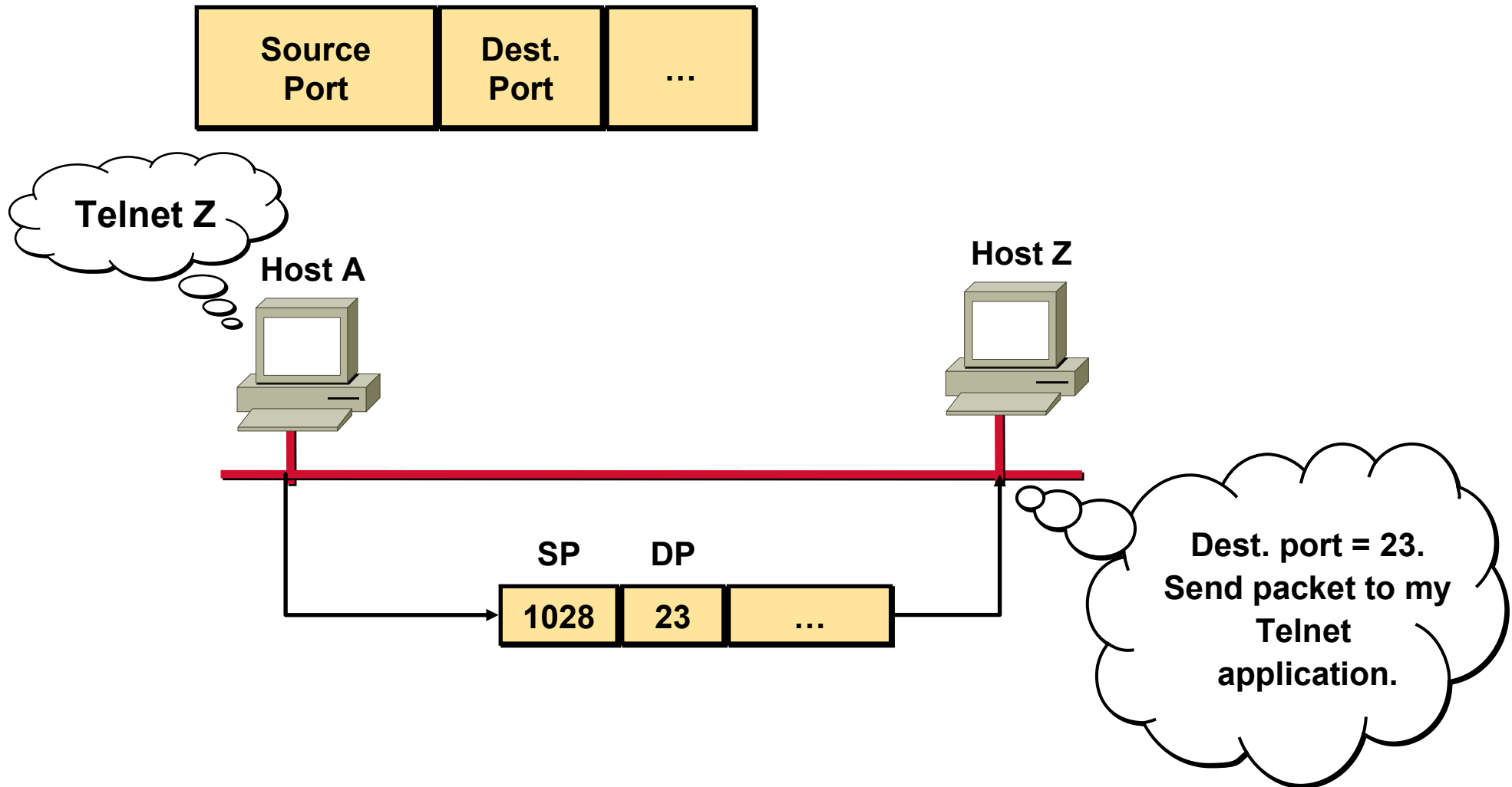
# TCP Segment Format



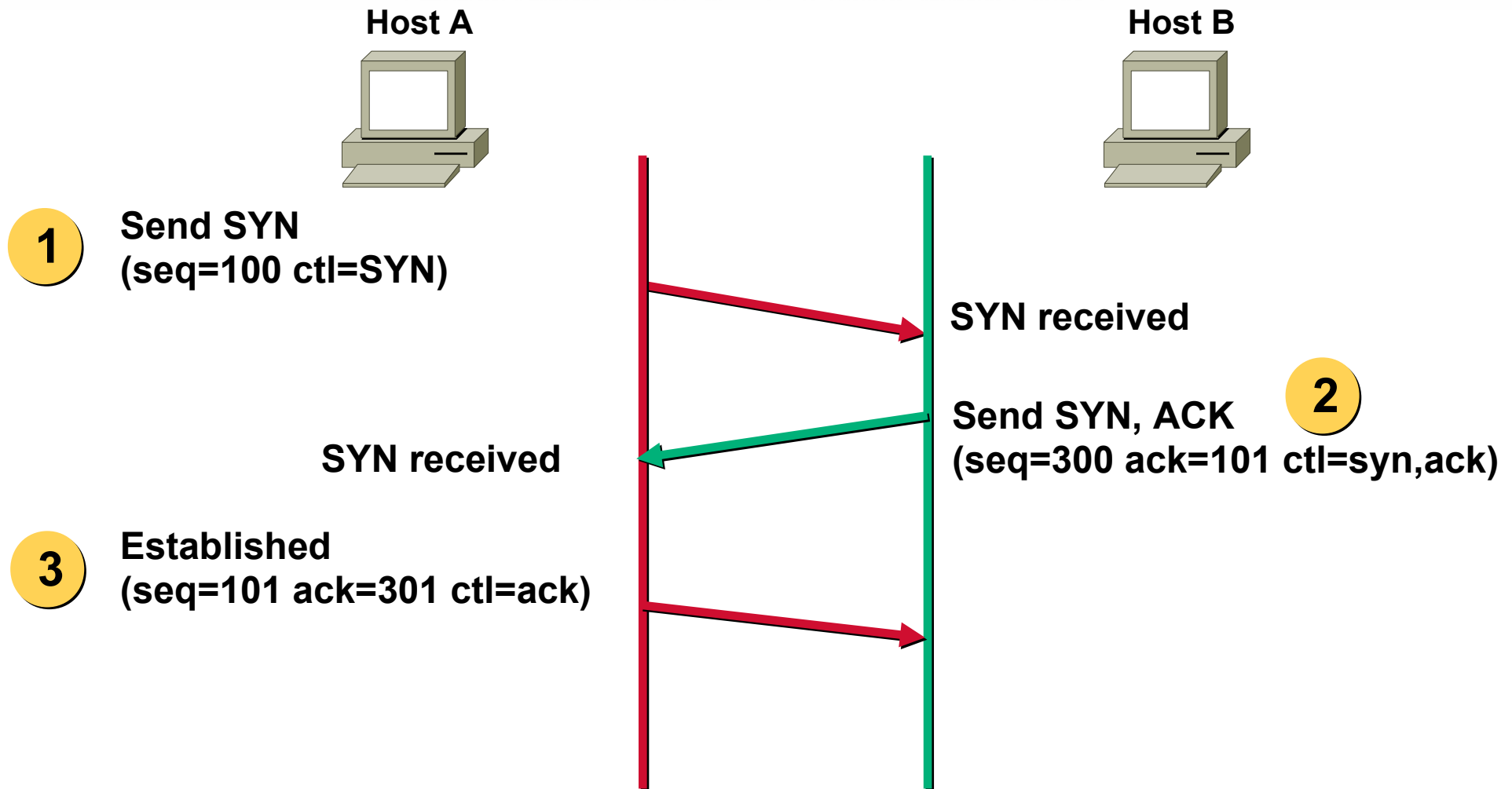
# Port Numbers



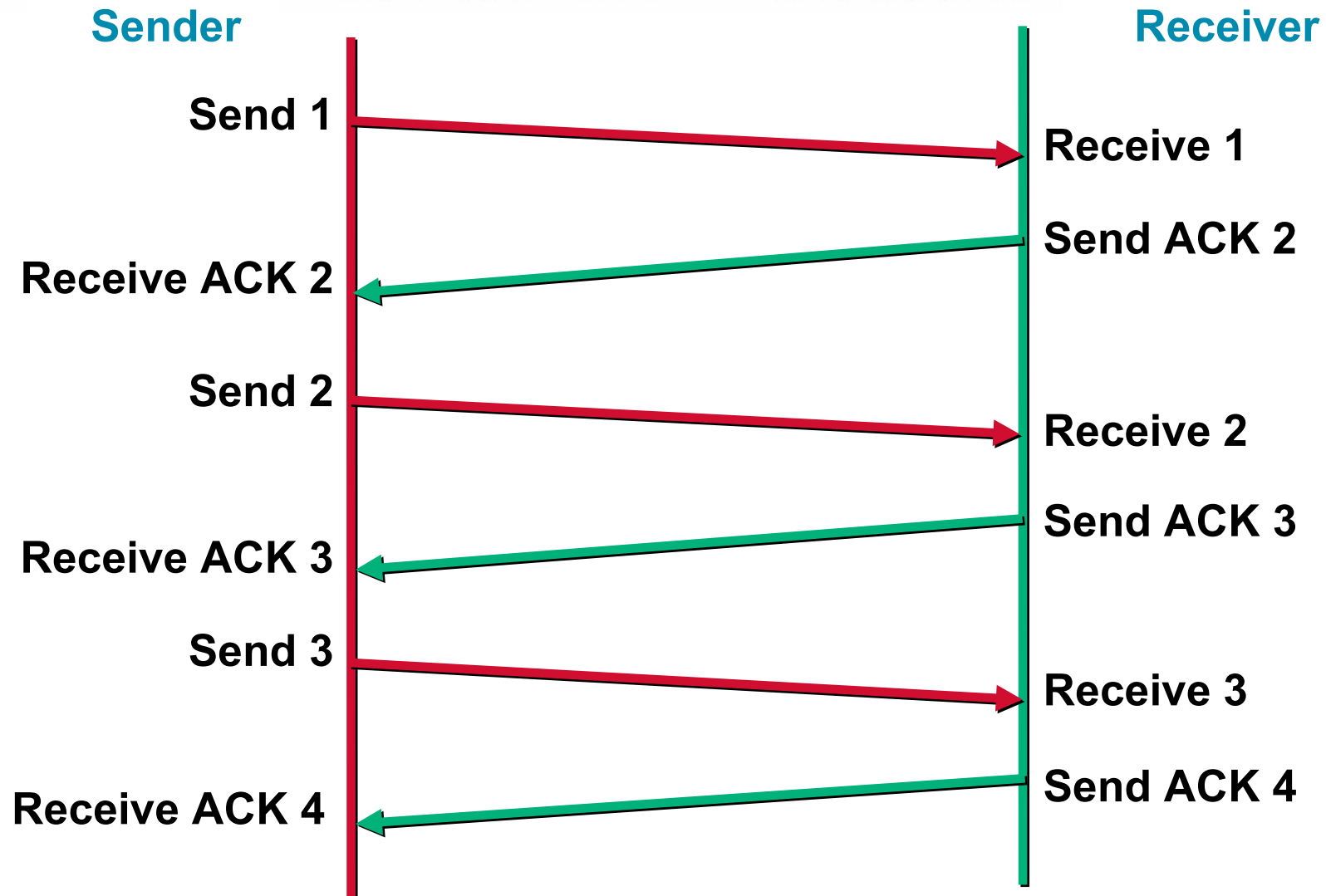
# TCP Port Numbers



# TCP Three Way Handshake/ Open Connection



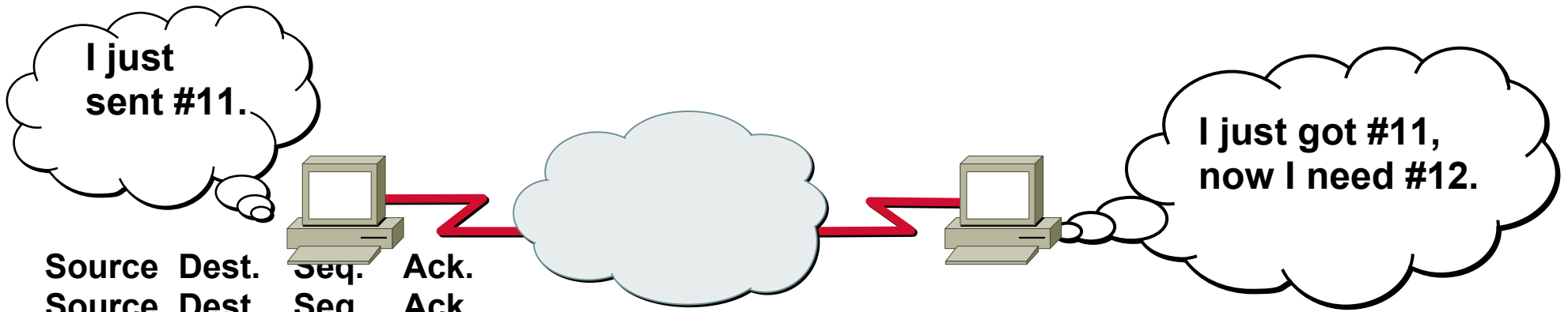
# TCP Simple Acknowledgment



Window size = 1

# TCP Sequence and Acknowledgment Numbers

Source Port	Dest. Port	Sequence #	Acknowledgement #	...
-------------	------------	------------	-------------------	-----



Source Dest. Seq. Ack.  
 Source Dest. Seq. Ack.

1028	23	10	1
------	----	----	---



1028	23	11	2
------	----	----	---



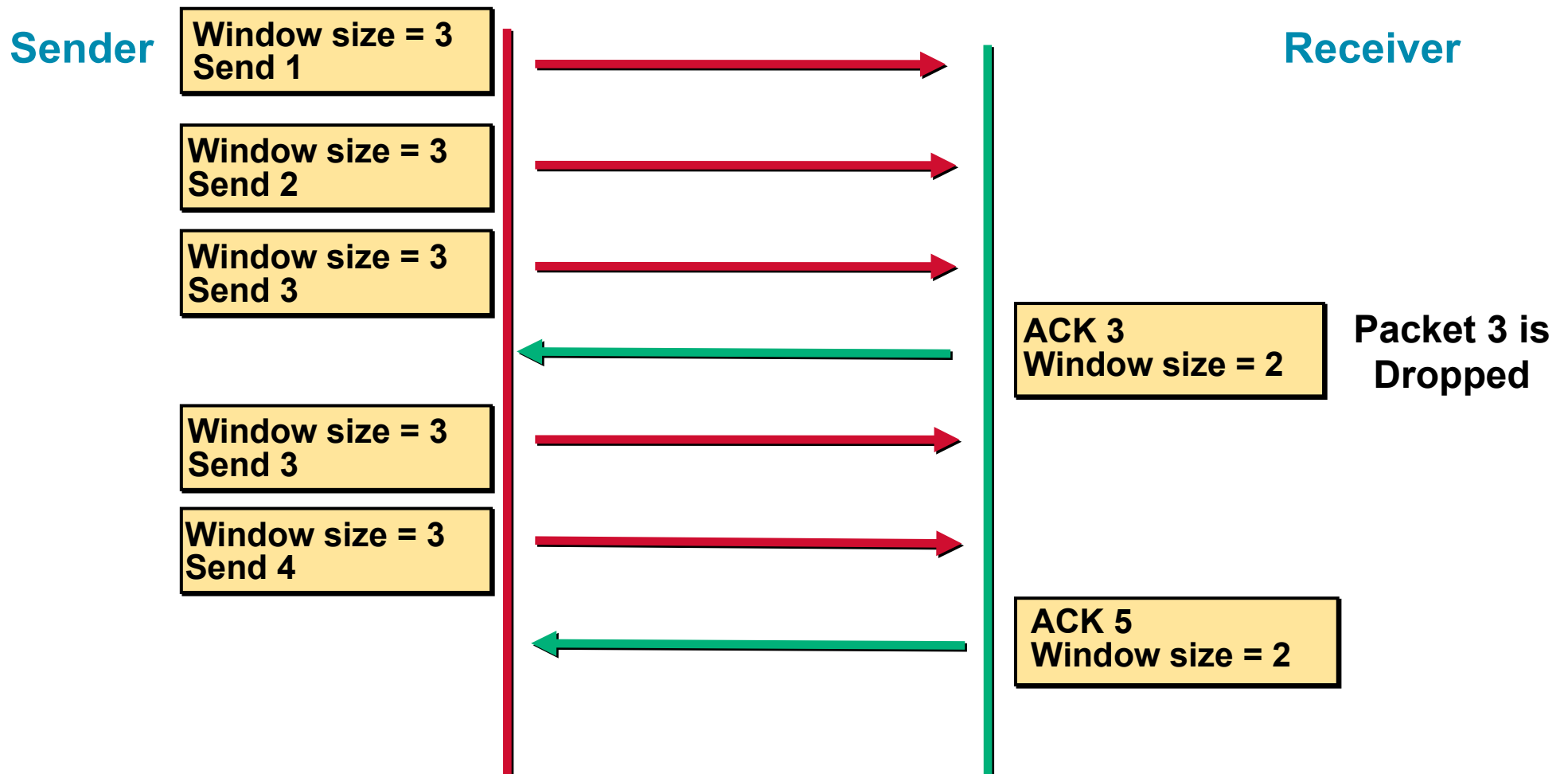
Source Dest. Seq. Ack.

23	1028	1	11
----	------	---	----

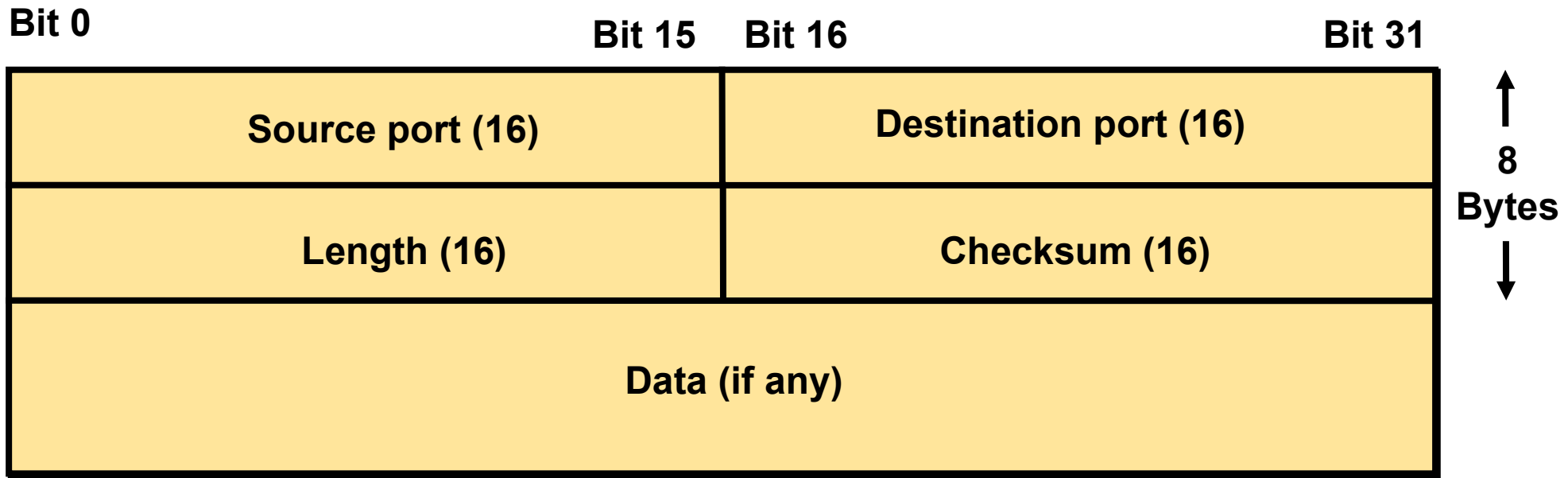
Source Dest. Seq. Ack.

23	1028	2	12
----	------	---	----

# TCP Windowing

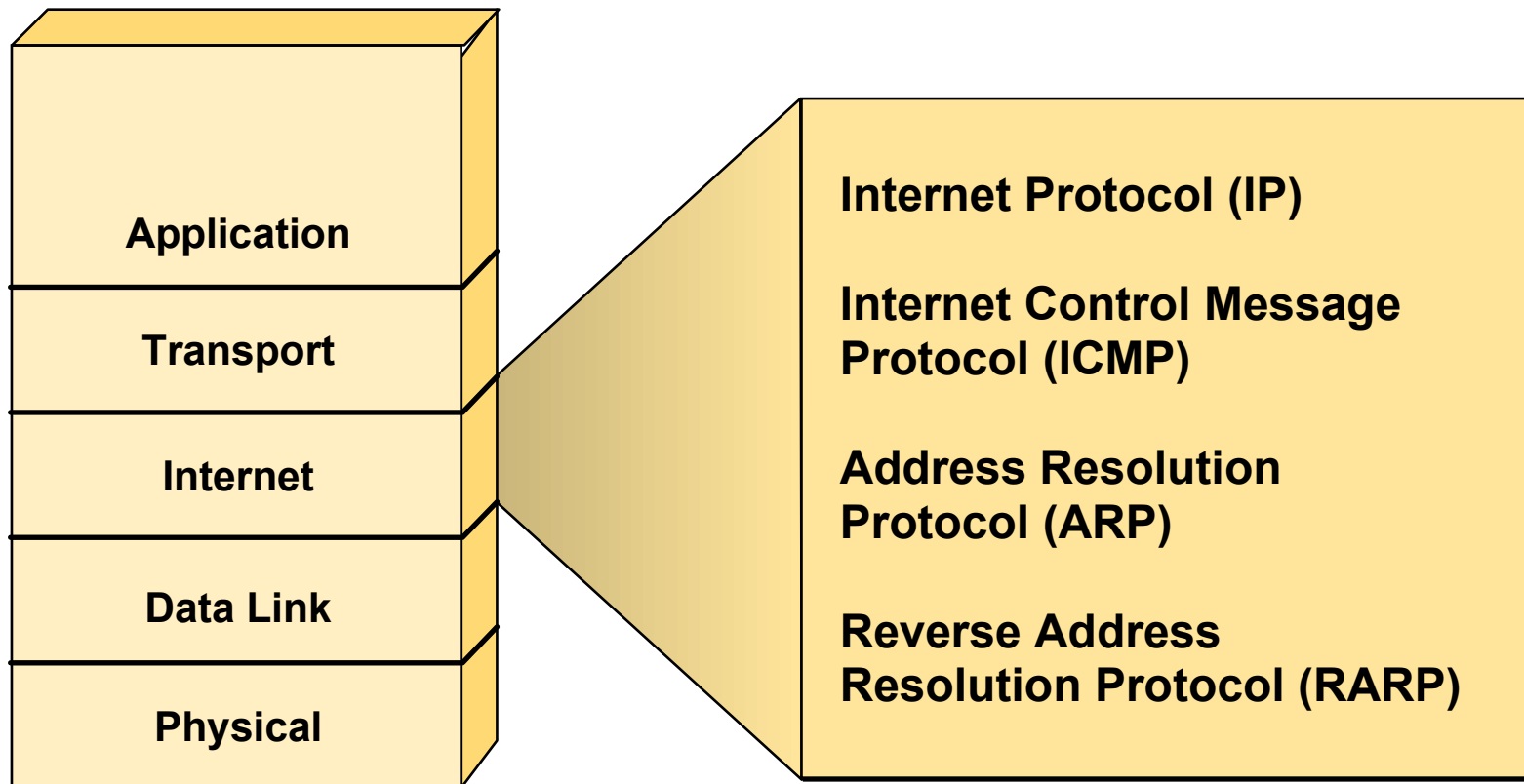


# UDP Segment Format



**No sequence or acknowledgment fields**

# Internet Layer Overview



**OSI network layer corresponds to the  
TCP/IP internet layer**

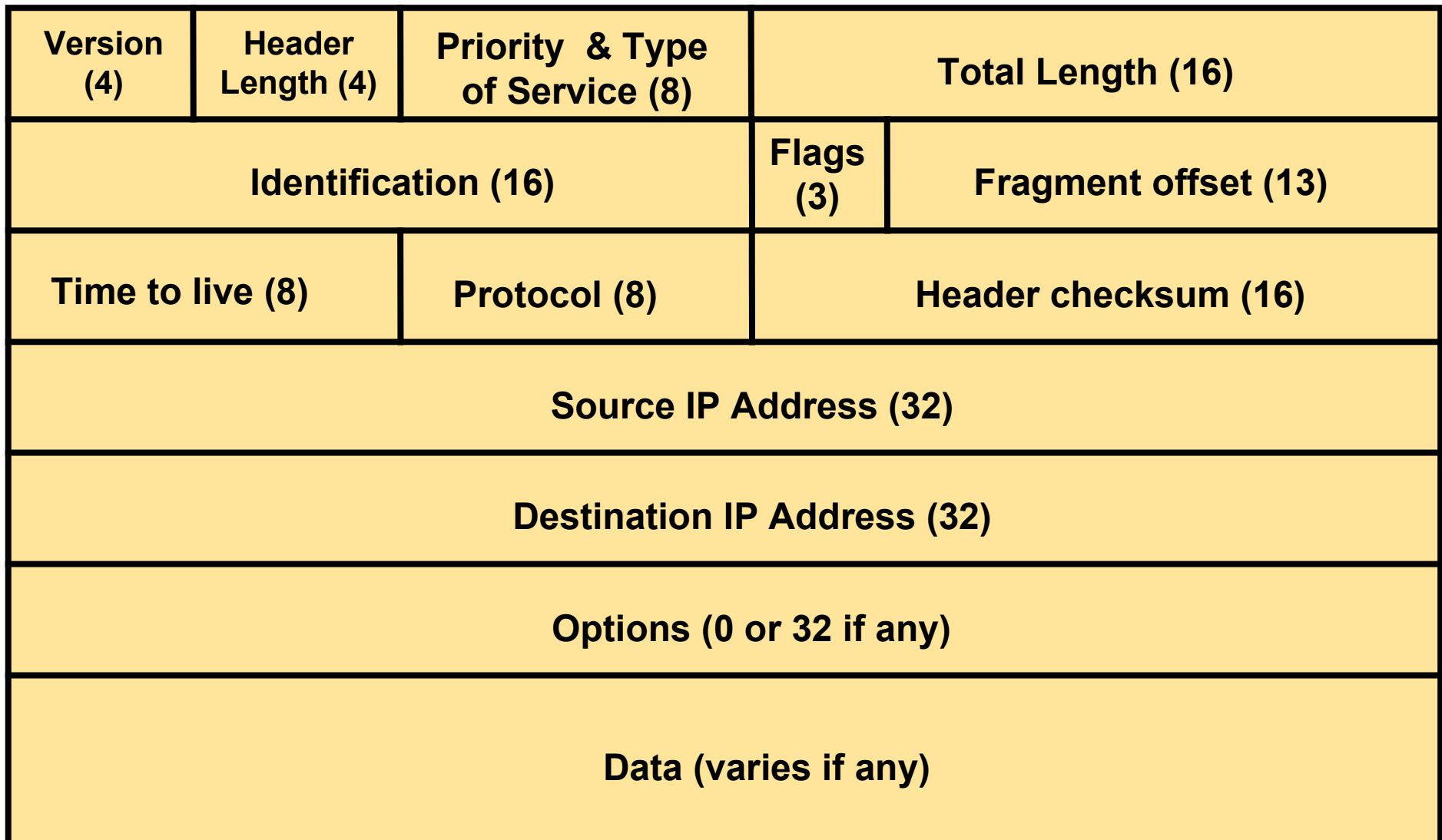
# IP Datagram

Bit 0

Bit 15

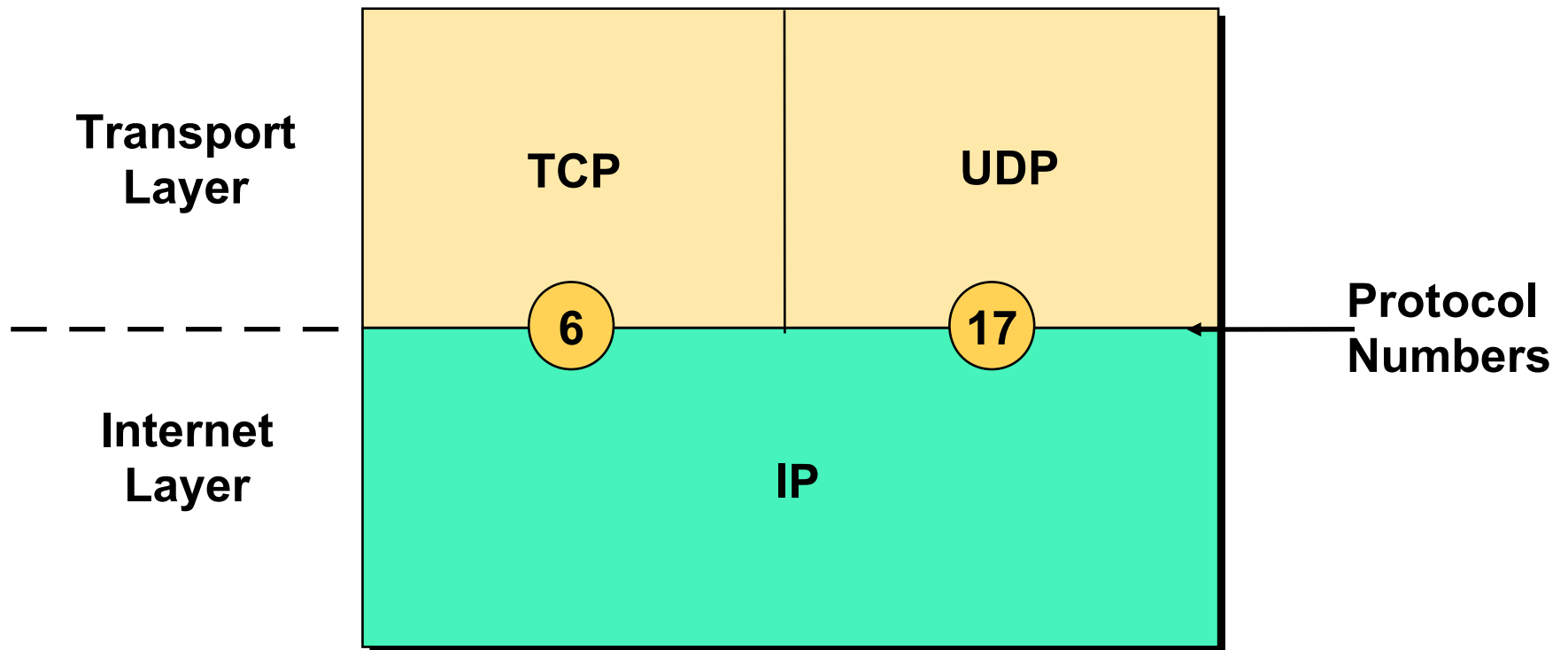
Bit 16

Bit 31



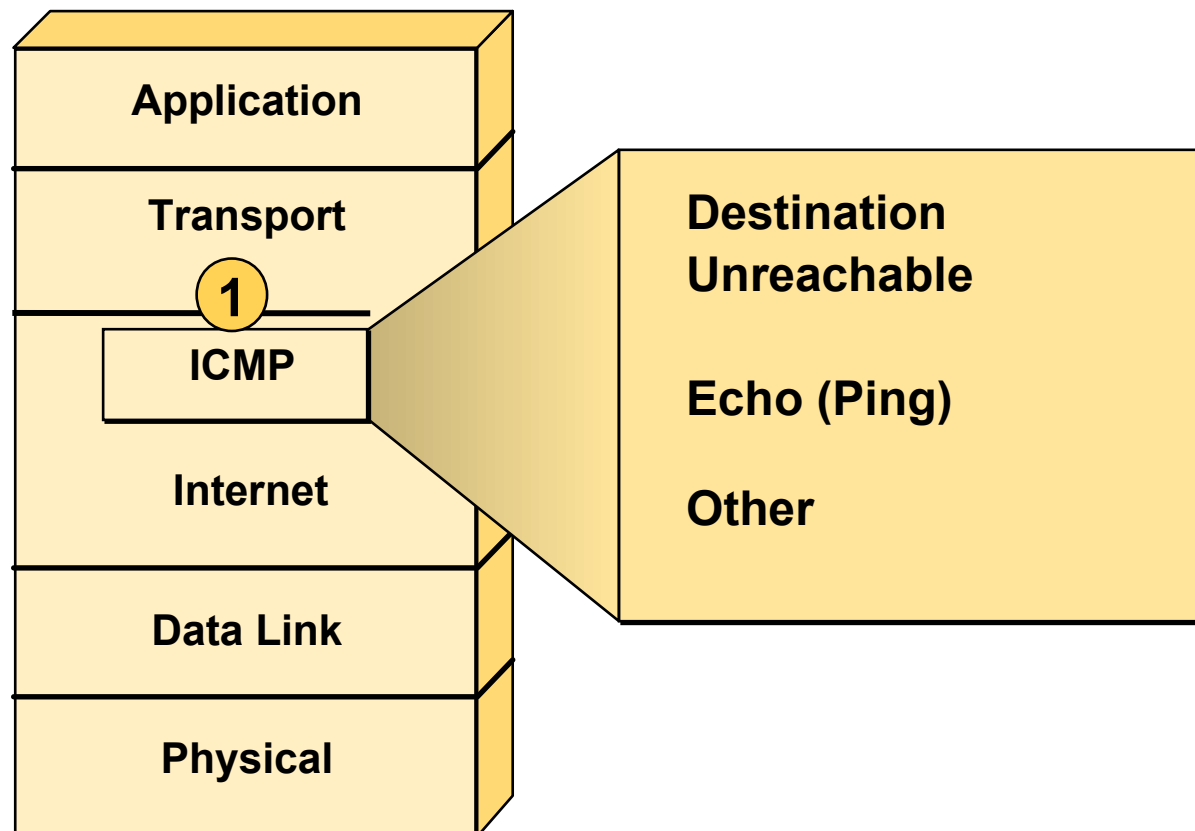
20 Bytes

# Protocol Field

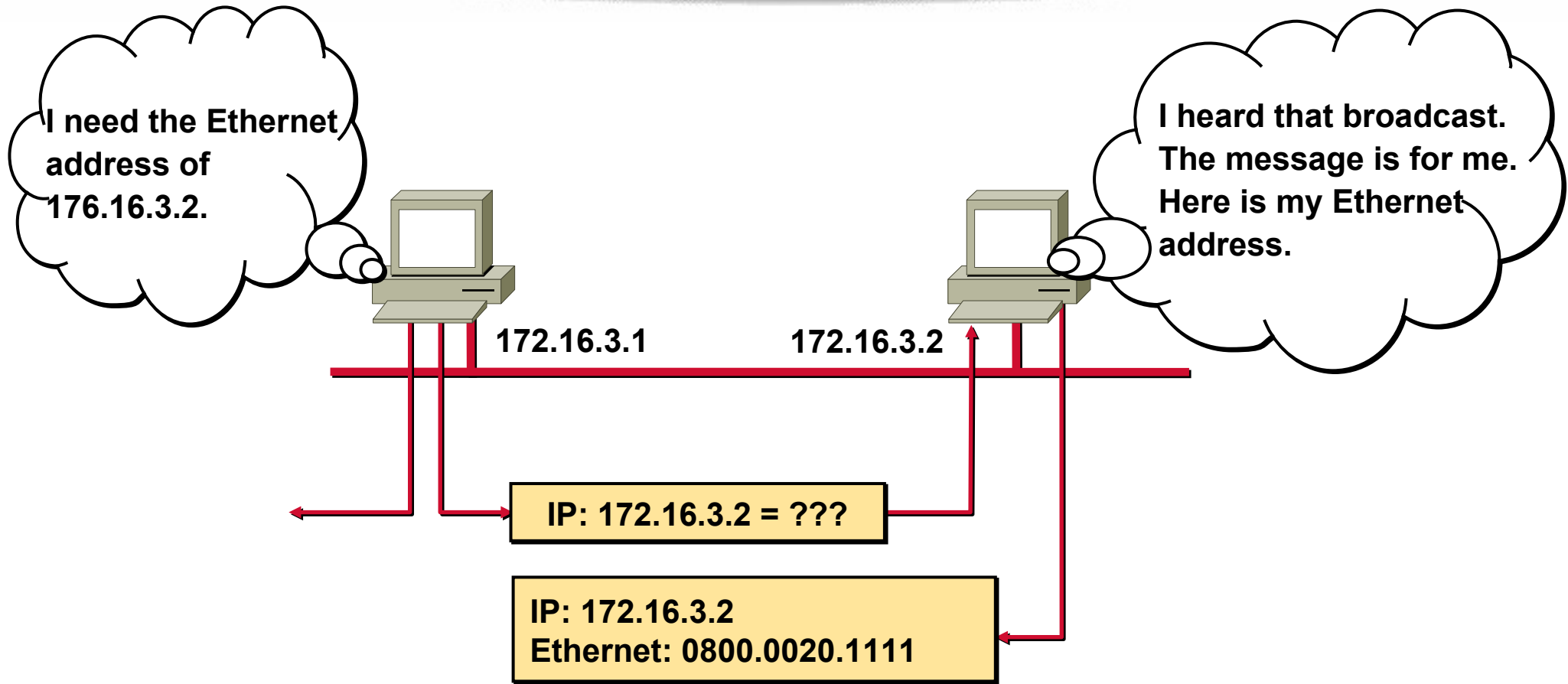


**Determines destination upper-layer protocol**

# Internet Control Message Protocol



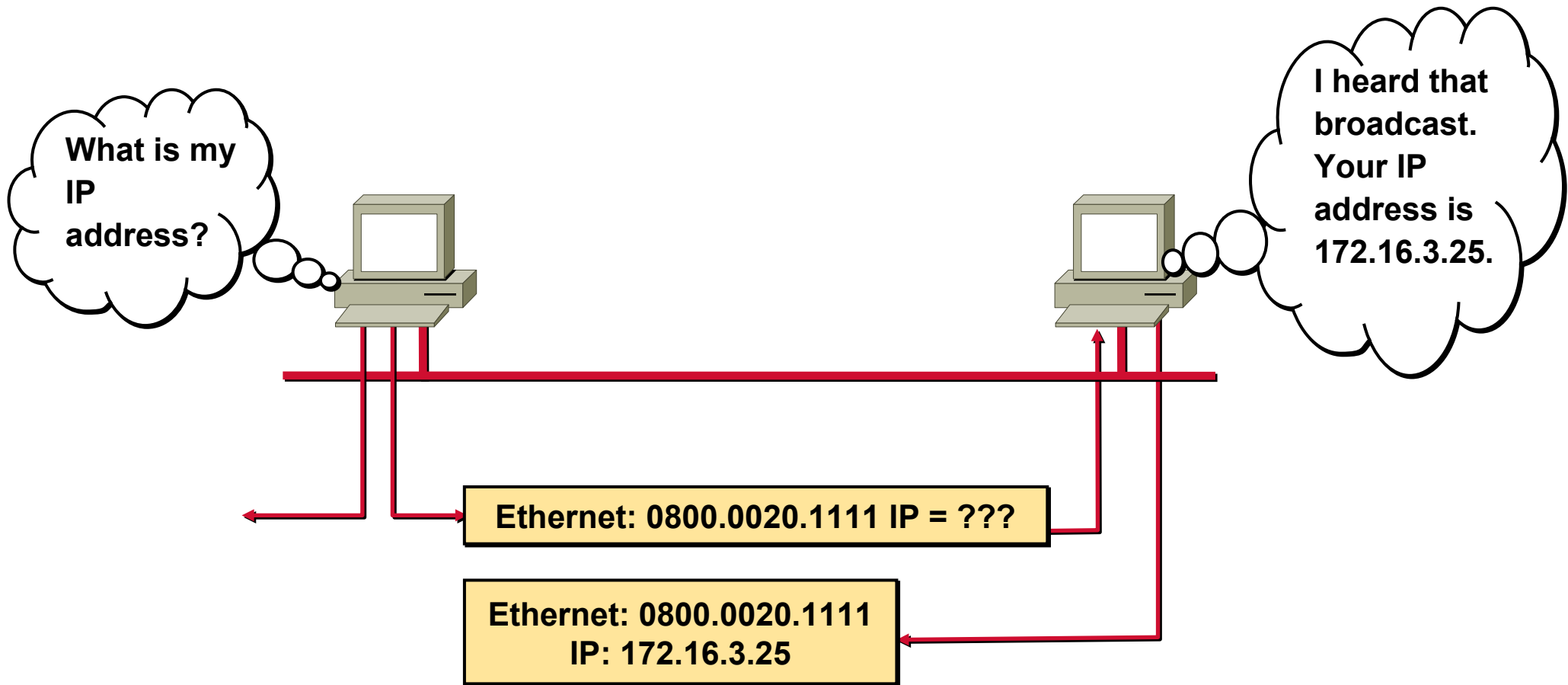
# Address Resolution Protocol



Map IP  Ethernet

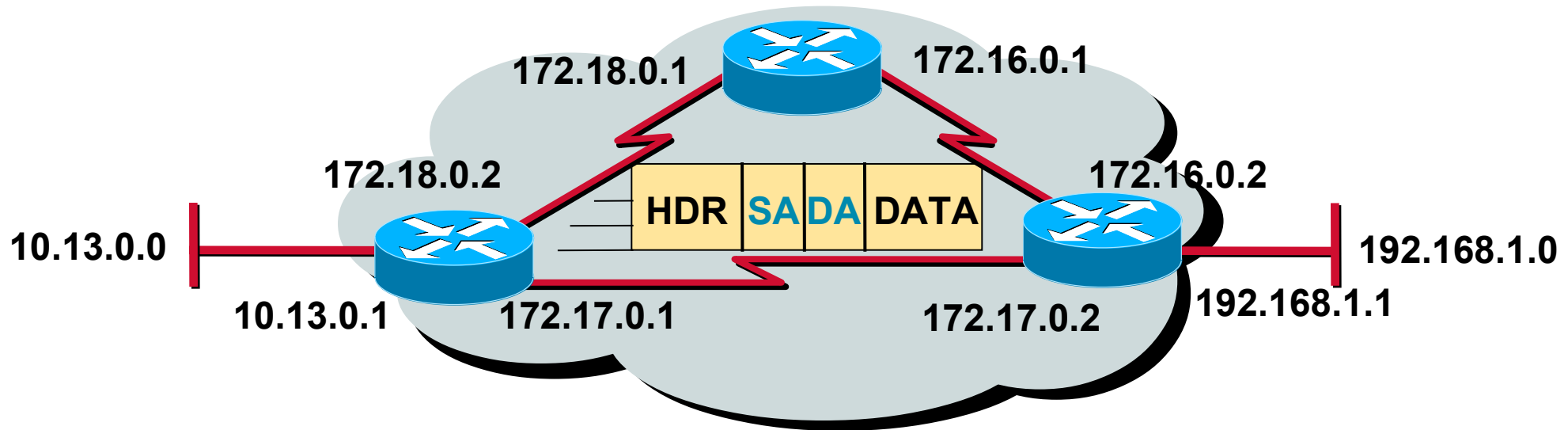
Local ARP

# Reverse ARP



**Map Ethernet → IP**

# Introduction to TCP/IP Addresses



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

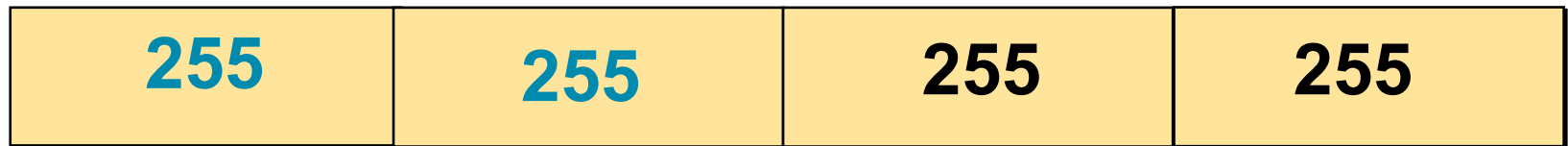
# IP Addressing

← 32 bits →

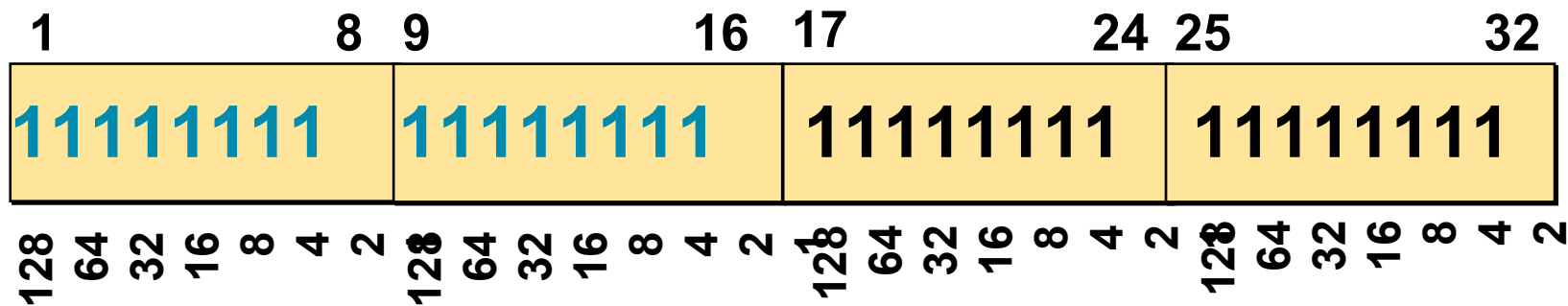
**Dotted  
Decimal**



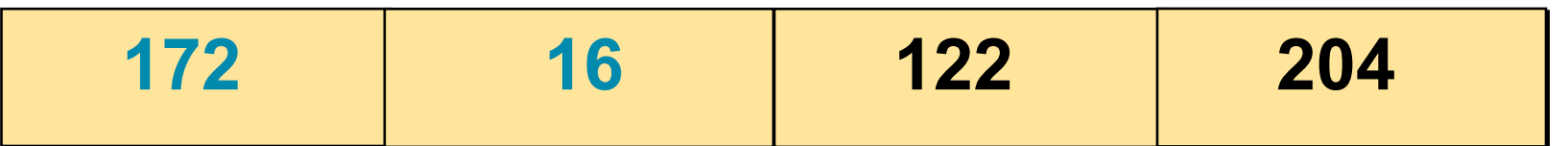
**Maximum**



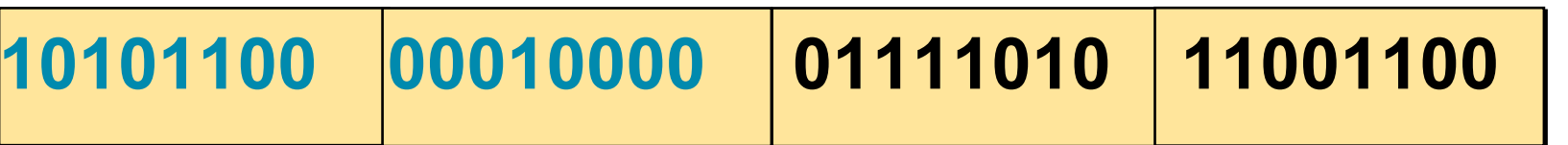
**Binary**



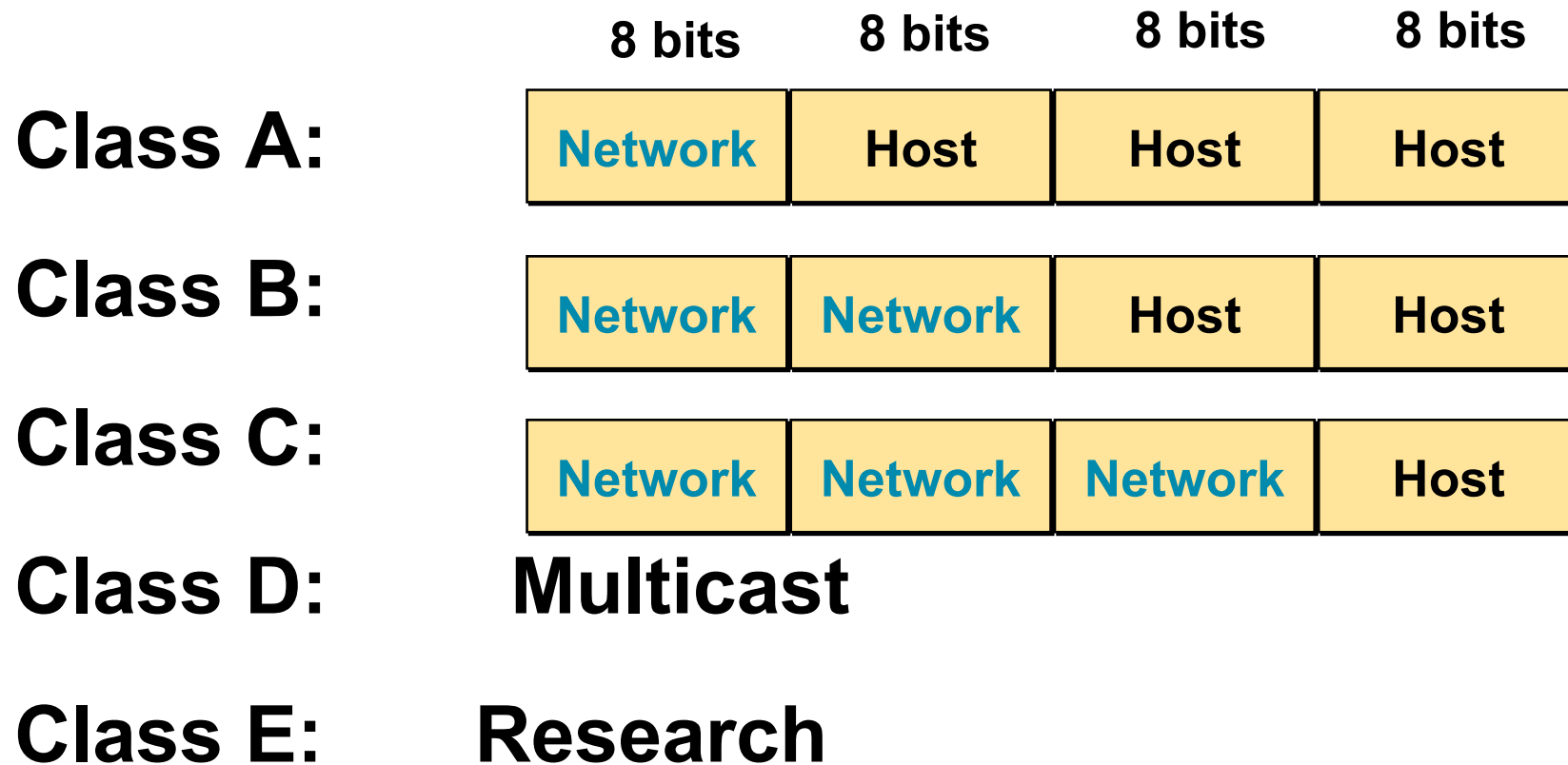
**Example  
Decimal**



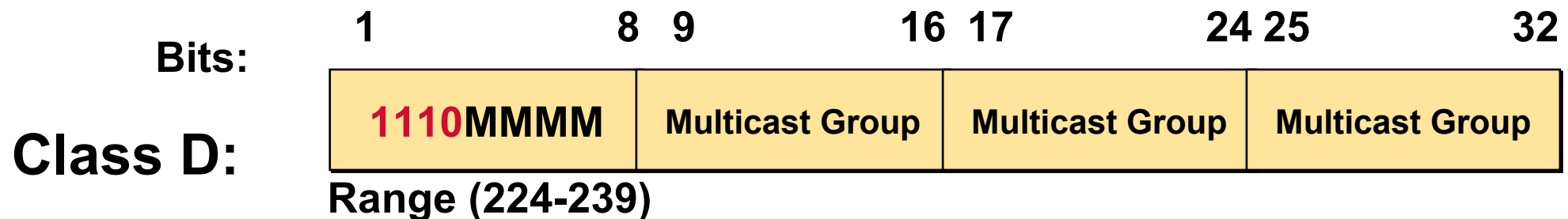
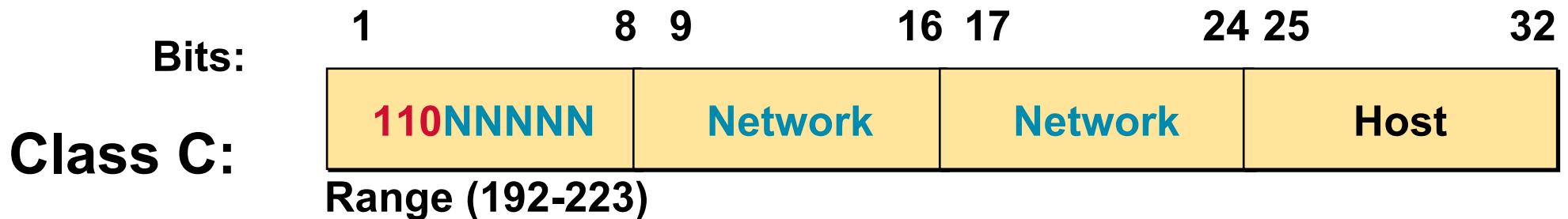
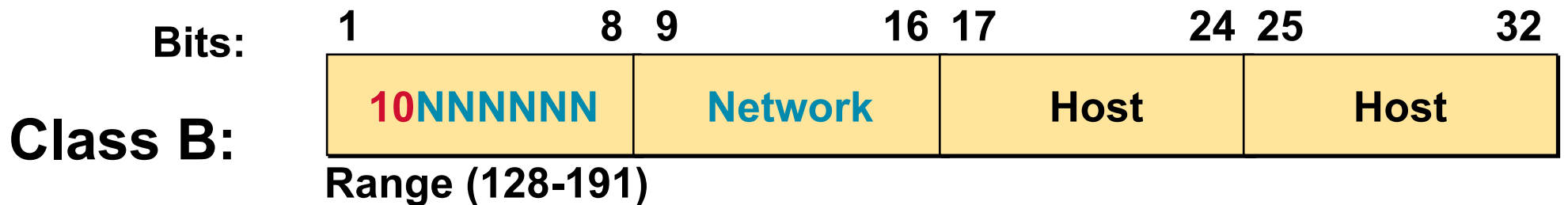
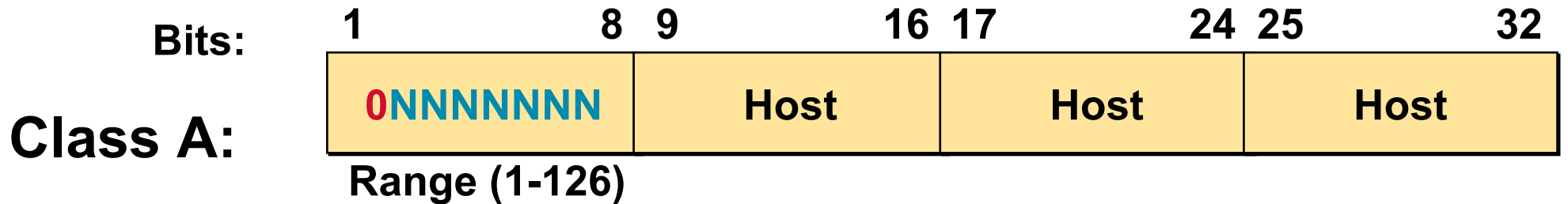
**Example  
Binary**



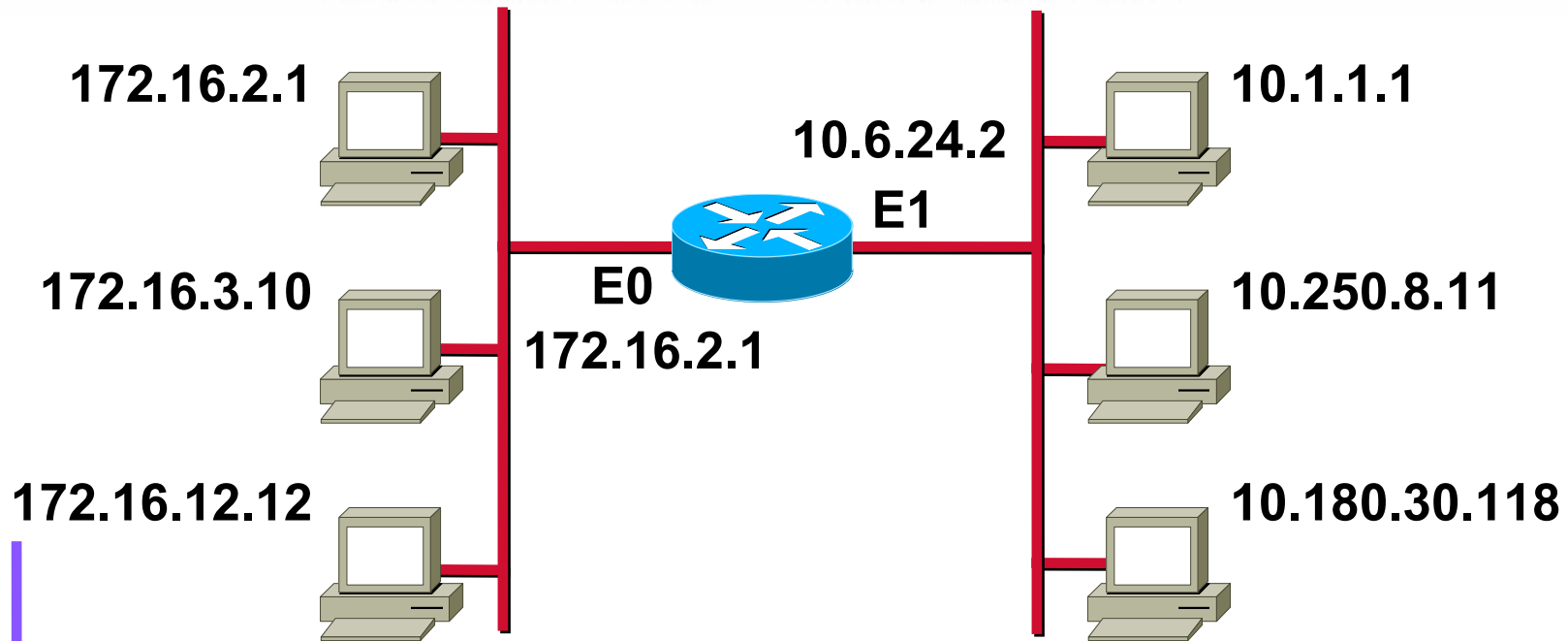
# IP Address Classes



# 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

Network

Host

<b>172</b>	<b>16</b>	<b>0</b>	<b>0</b>
------------	-----------	----------	----------

		<b>16</b>	<b>15</b>	<b>14</b>	<b>13</b>	<b>12</b>	<b>11</b>	<b>10</b>	<b>9</b>	<b>8</b>	<b>7</b>	<b>6</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>N</b>
<b>10101100</b>	<b>00010000</b>																
																<b>1</b>	
																<b>2</b>	
																<b>3</b>	
																⋮	
																<b>65534</b>	
																<b>65535</b>	
																<b>65536</b>	

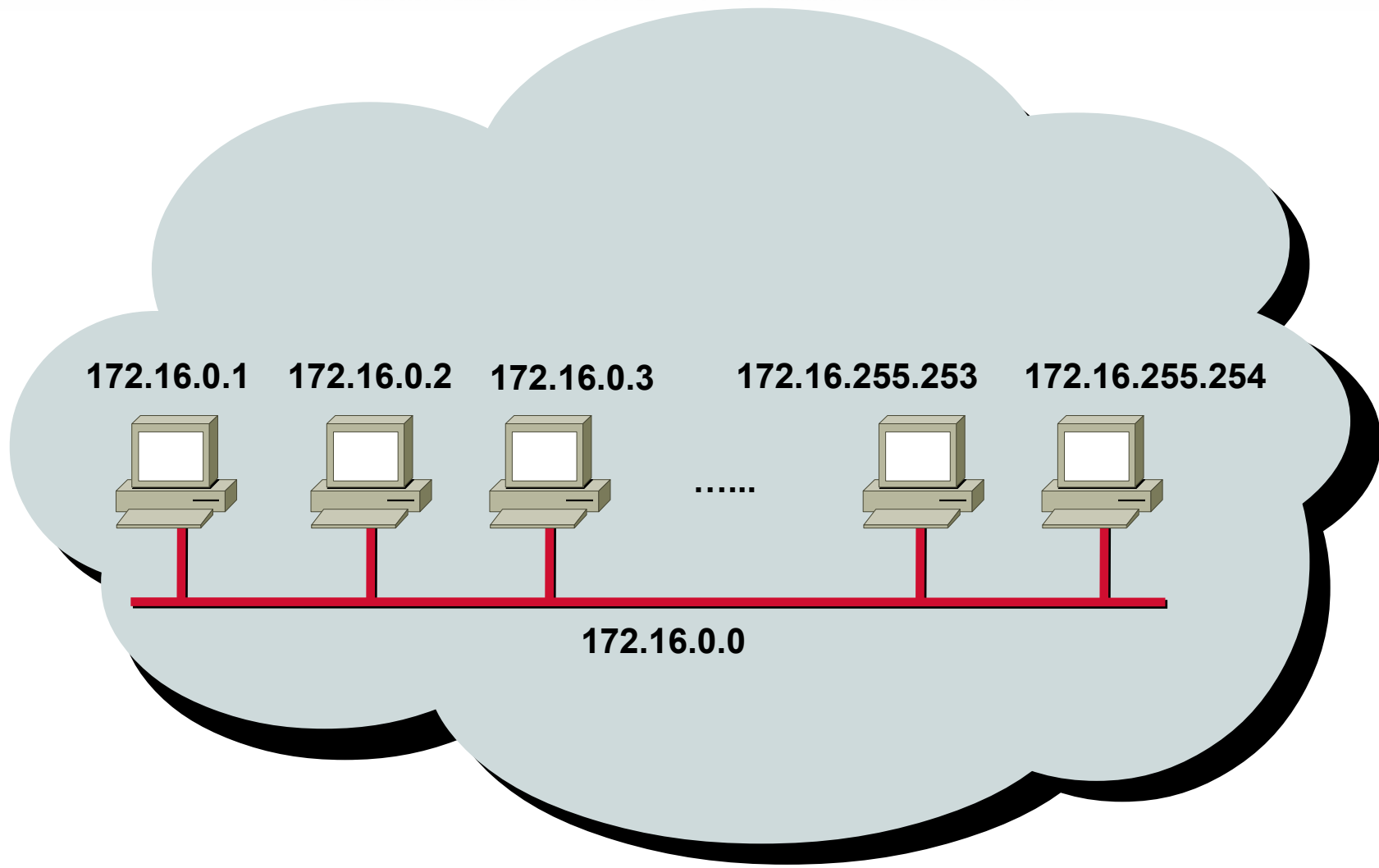
$$2^N - 2 = 2^{16} - 2 = 65534$$

<b>65536</b>		<b>2</b>
-		<b>2</b>
<b>65534</b>		

# IP Address Classes Exercise Answers

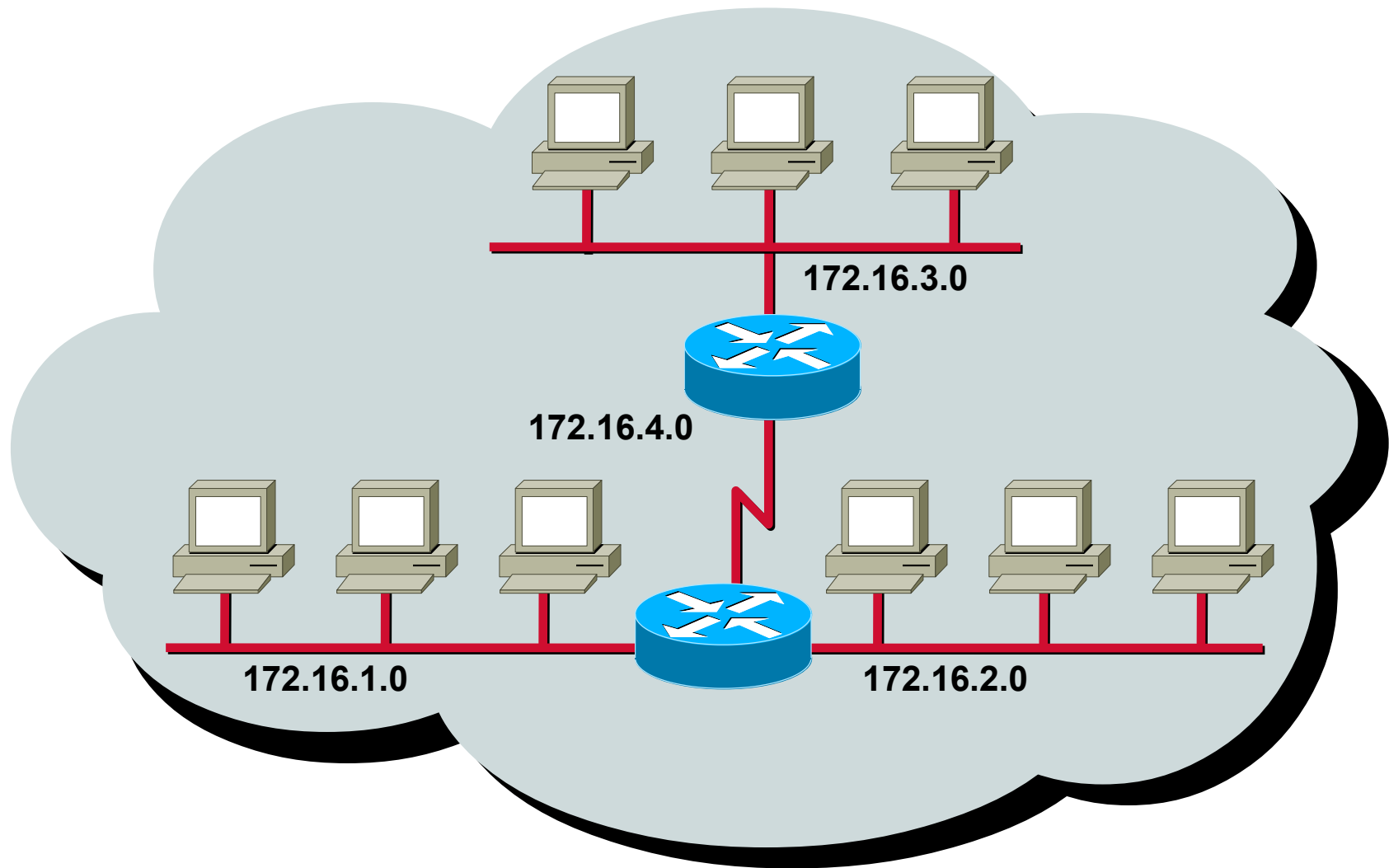
Address	Class	Network	Host
10.2.1.1	A	10.0.0.0	0.2.1.1
128.63.2.100	B	128.63.0.0	0.0.2.100
201.222.5.64	C	201.222.5.0	0.0.0.64
192.6.141.2	C	192.6.141.0	0.0.0.2
130.113.64.16	B	130.113.0.0	0.0.64.16
241.256.201.10	Nonexistent		

# Addressing without Subnets



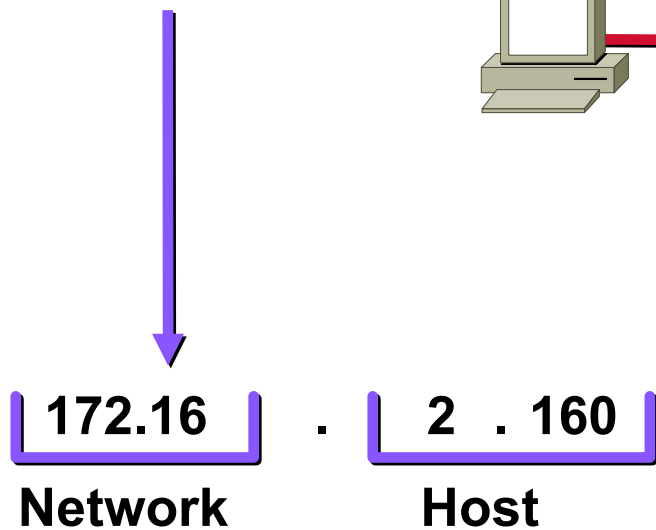
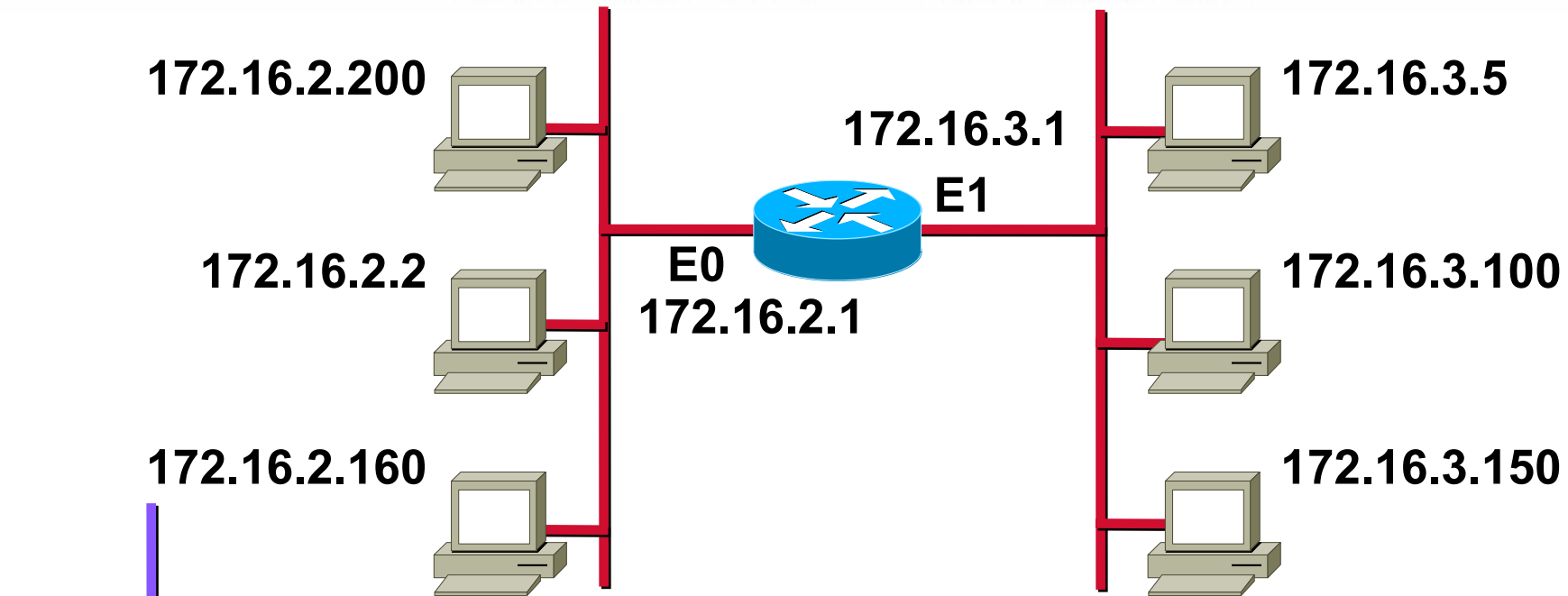
**Network 172.16.0.0**

# Addressing with Subnets



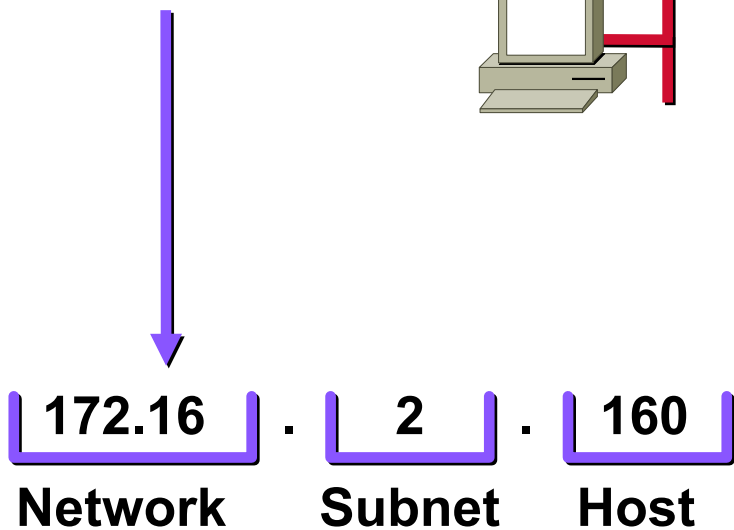
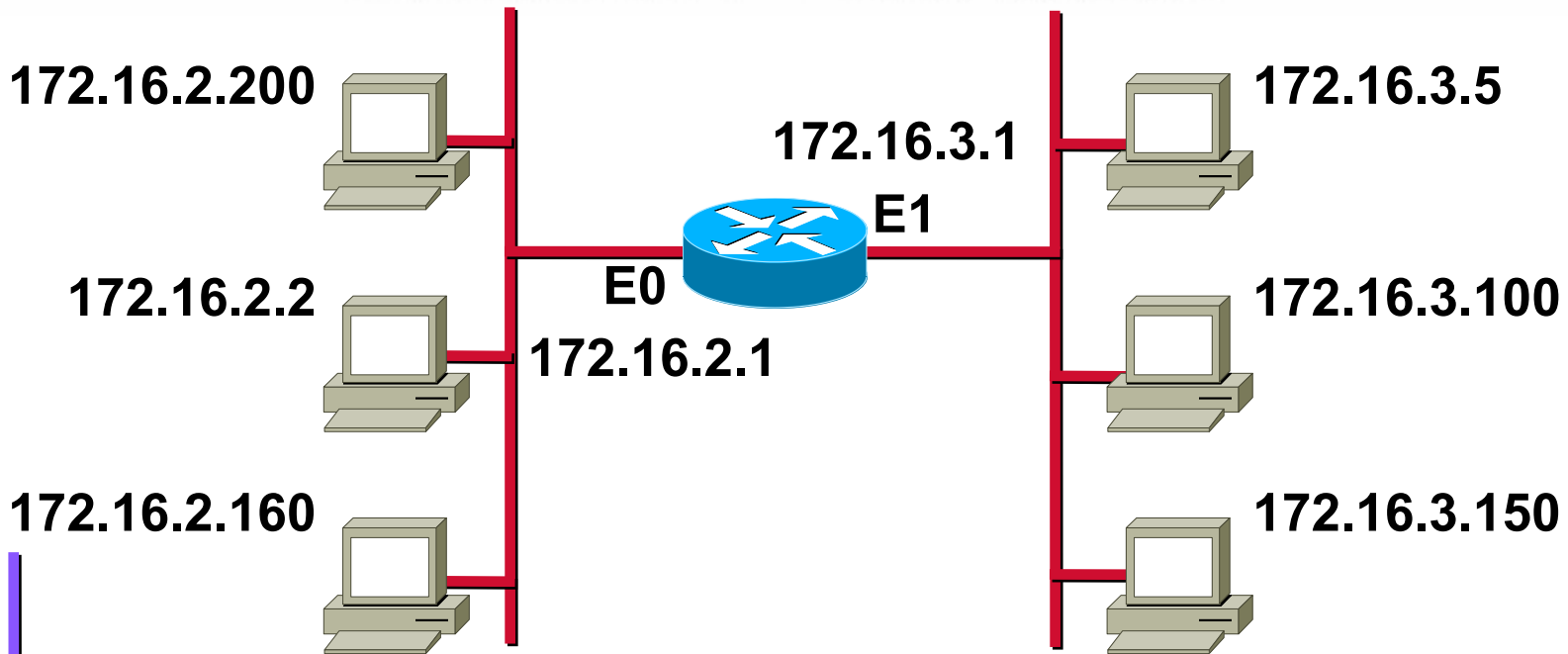
**Network 172.16.0.0**

# Subnet Addressing



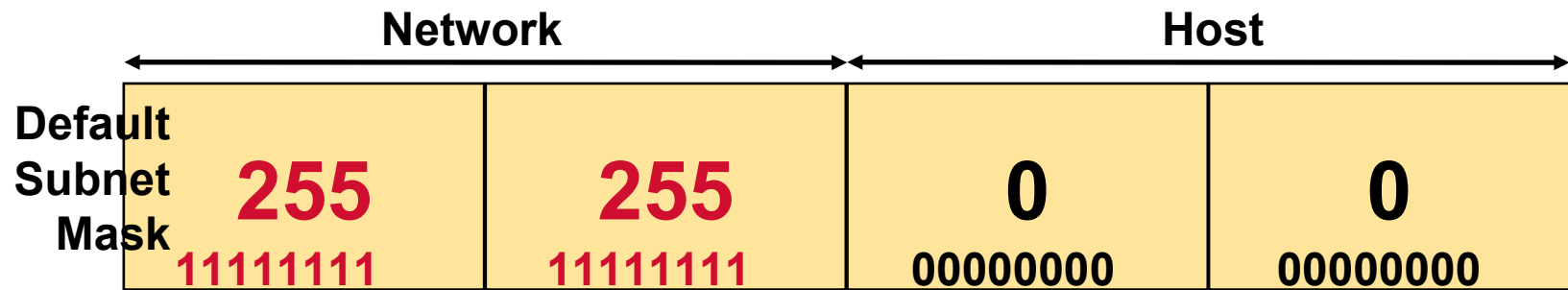
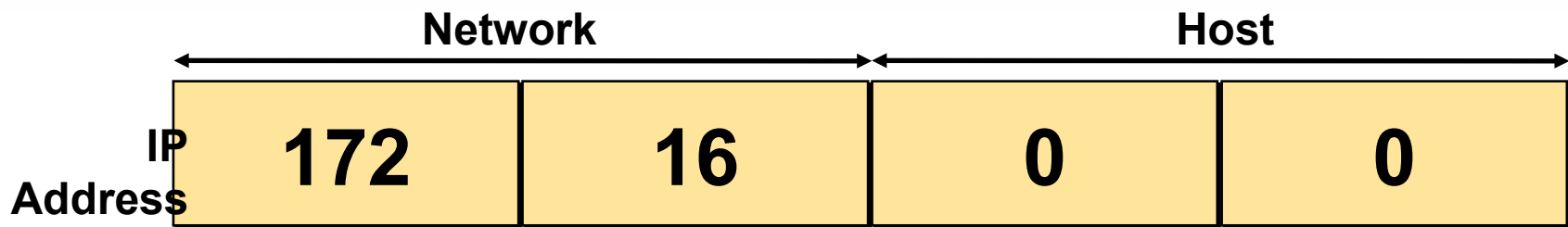
New Routing Table	
Network	Interface
172.16.0.0	E0
172.16.0.0	E1

# Subnet Addressing

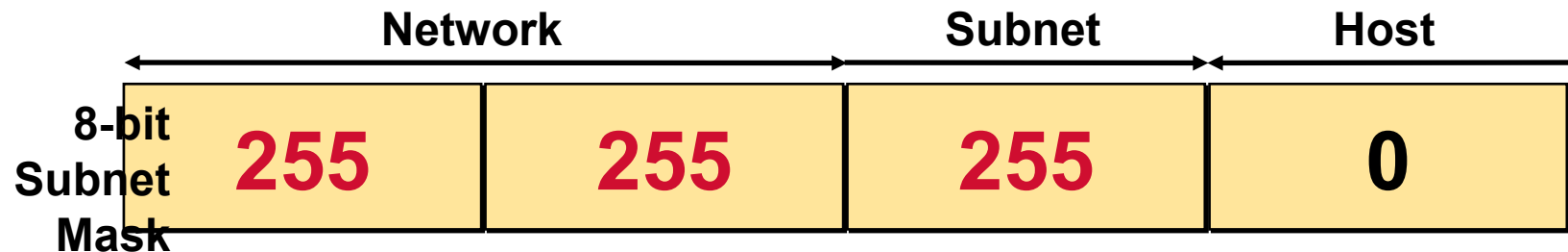


New Routing Table	
Network	Interface
172.16.2.0	E0
172.16.3.0	E1

# 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		
↓	↓	↓	↓	↓	↓	↓	↓	↓	
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

	Network		Host	
<b>172.16.2.160</b>	10101100	00010000	00000010	10100000
<b>255.255.0.0</b>	11111111	11111111	00000000	00000000
	10101100	00010000	00000000	00000000
<b>Network Number</b>	<b>172</b>	<b>16</b>	<b>0</b>	<b>0</b>

**Subnets not in use—the default**

# Subnet Mask with Subnets

	Network	Subnet	Host
172.16.2.160	10101100	00010000	00000010
255.255.255.0	11111111	11111111	11111111
	10101100	00010000	00000010
			00000000

128	192	224	240	248	252	254	255
-----	-----	-----	-----	-----	-----	-----	-----

Network Number	172	16	2	0
----------------	-----	----	---	---

Network number extended by eight bits

# Subnet Mask with Subnets (cont.)

172.16.2.160

255.255.255.192

Network	Subnet	Host
10101100	00010000	00000010 10100000
11111111	11111111	11111111 11000000
10101100	00010000	00000010 10000000

128 192 224 240 248 252 254  
 255 128 192 224 240 248 252 254 255

Network Number

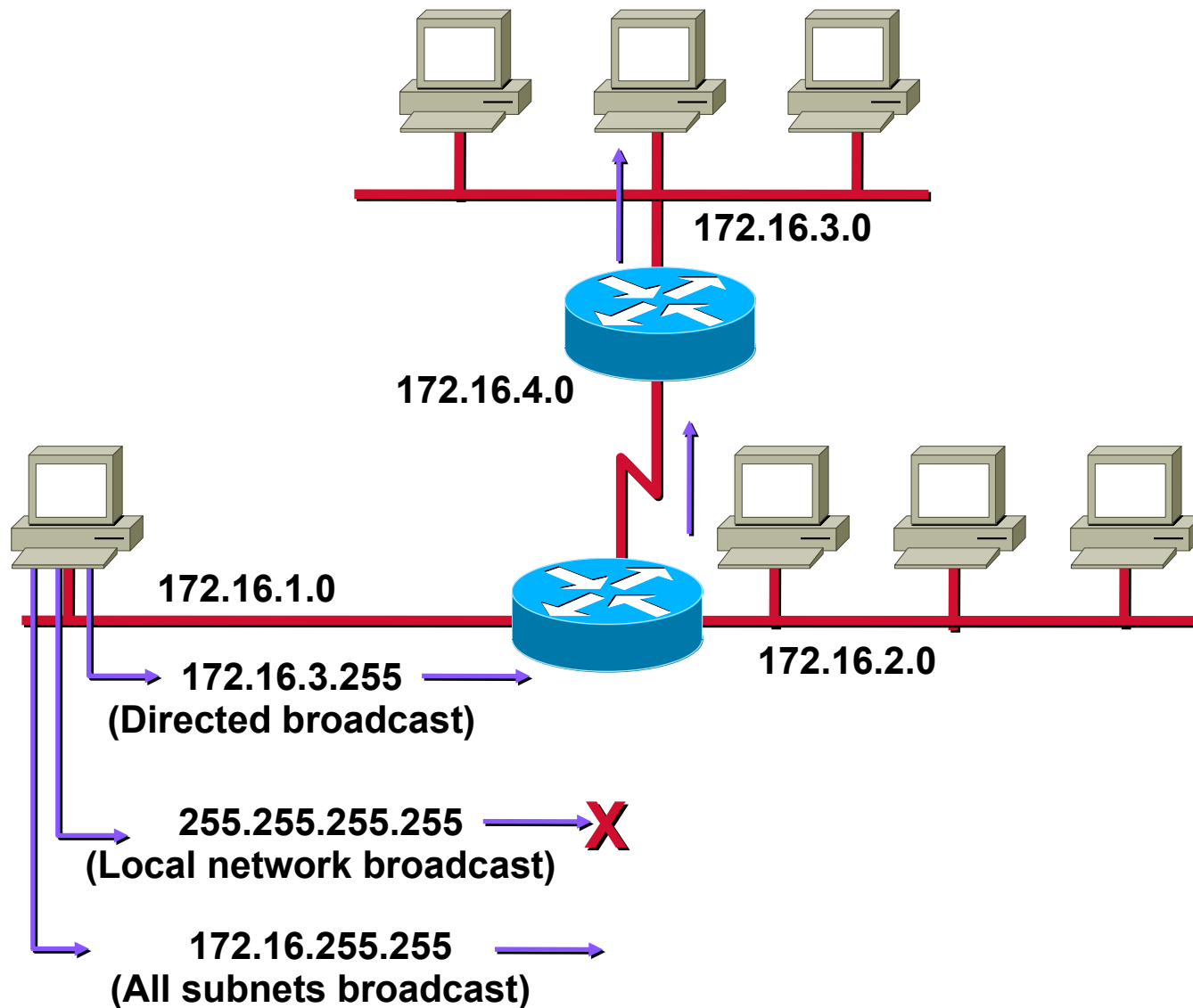
172	16	2	128
-----	----	---	-----

Network number extended by ten bits

# 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

172	16	2	160
-----	----	---	-----

3

172.16.2.160	10101100	00010000	00000010	10 100000	Host	1
255.255.255.192	11111111	11111111	11111111	11 000000	Mask	2
172.16.2.128	10101100	00010000	00000010	10 000000	Subnet	4
172.16.2.191	10101100	00010000	00000010	10 111111	Broadcast	5
172.16.2.129	10101100	00010000	00000010	10 000001	First	6
172.16.2.190	10101100	00010000	00000010	10 111110	Last	7

# 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

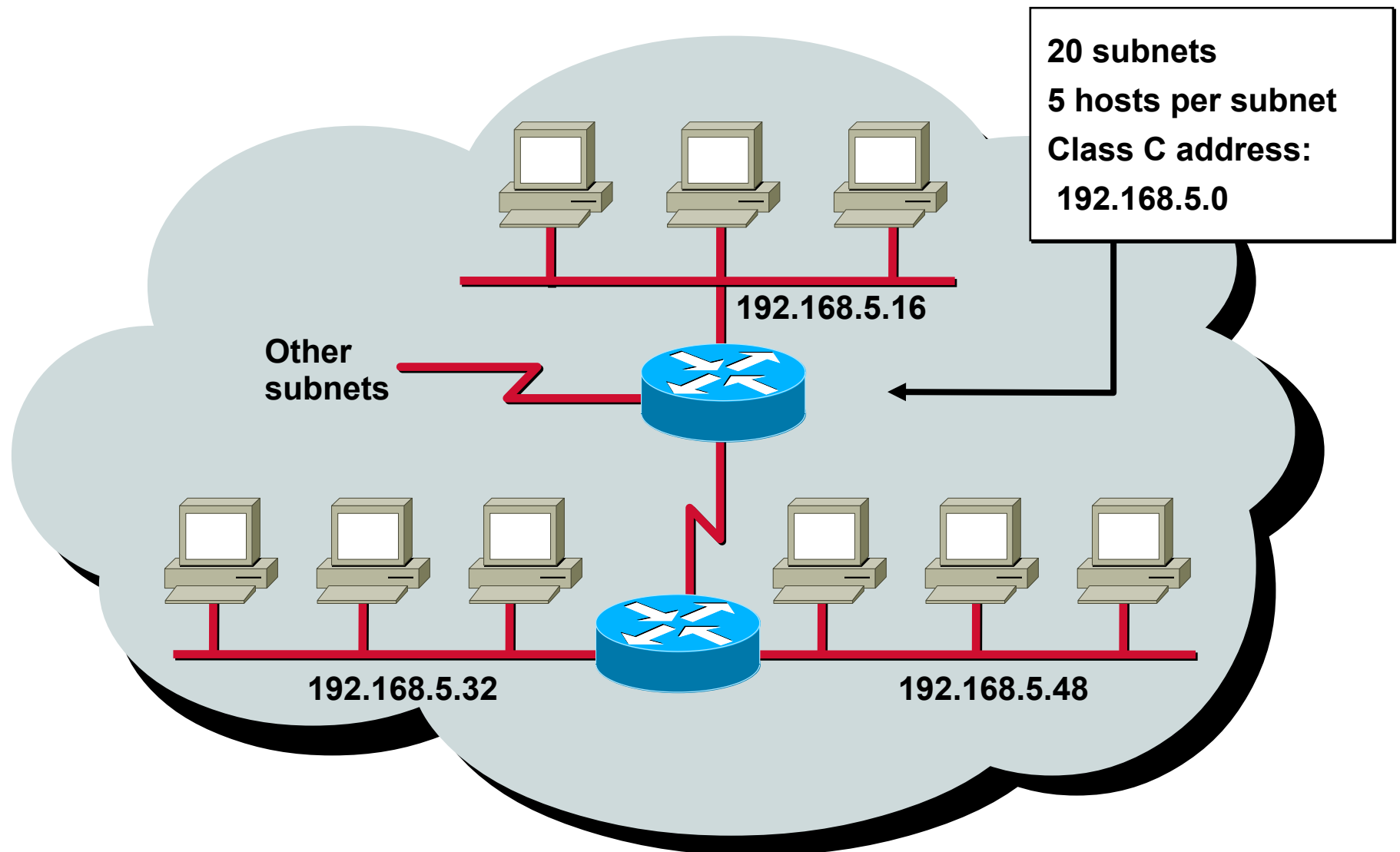
**Subnet Address = 172.16.2.0**

**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	01111001	
255.255.255.248:	11111111	11111111	11111111	11111000	
Subnet:	11000000	10101000	00000101	01111000	
Broadcast:	11000000	10101000	00000101	01111111	

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

# B

# 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