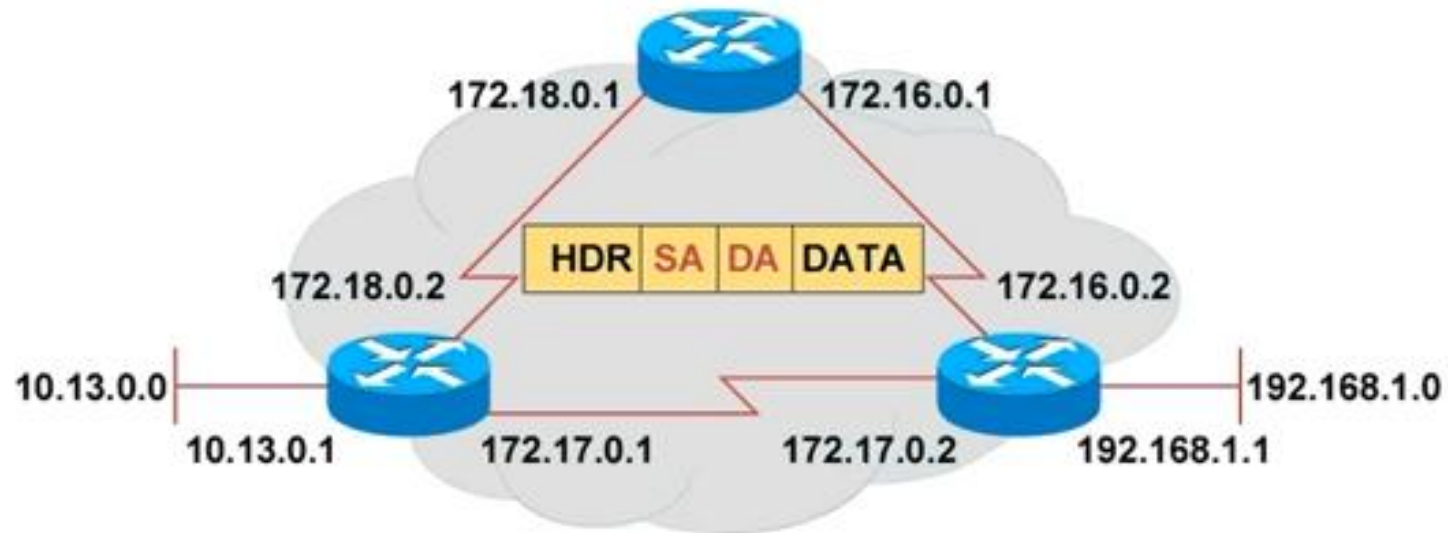


# IP Addressing & Subnetting

# What is Subnetting

- A subnet (short for subnetwork) may represent all the machines at one geographic location, in one building, or on the same LAN

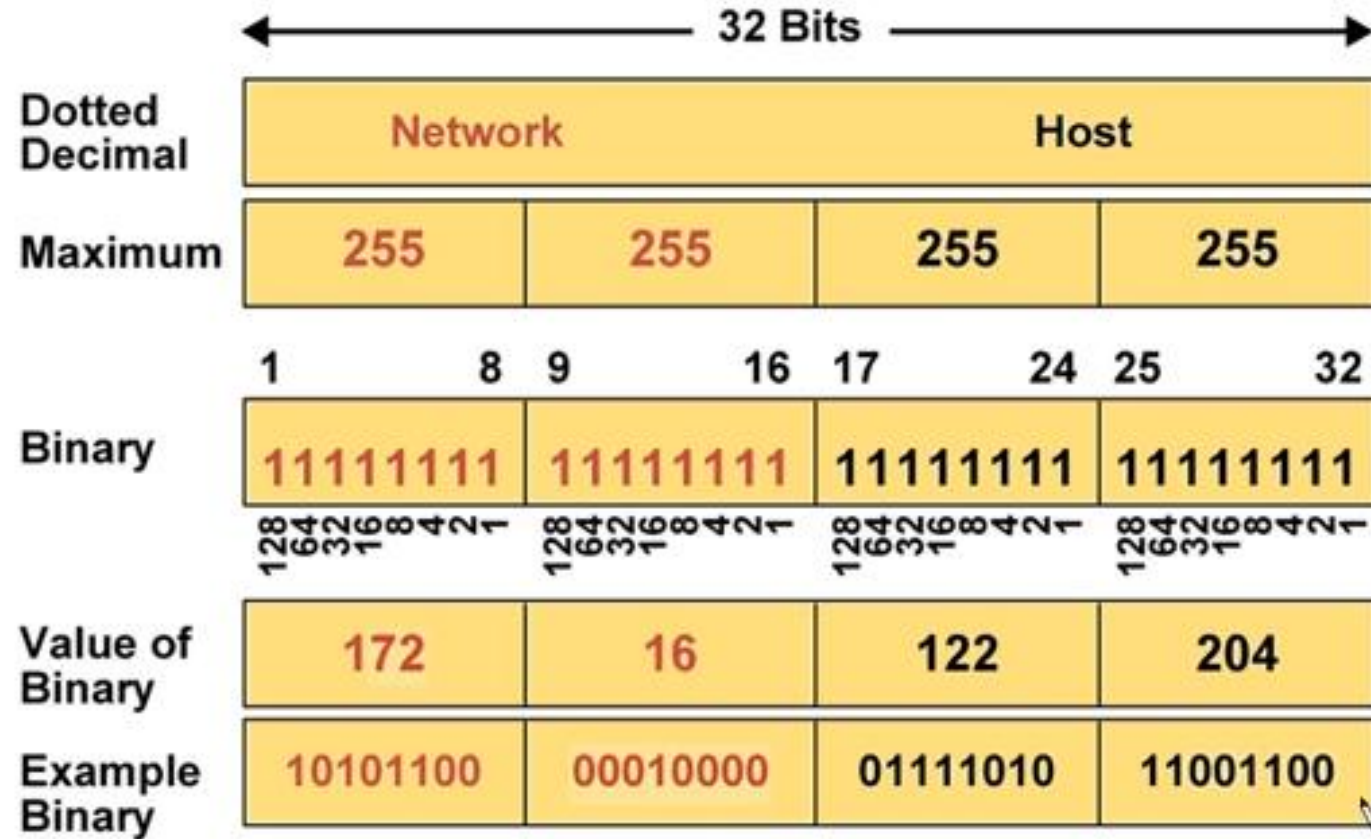
# Introducing IP Addresses



– Unique addressing allows communication between end stations.

Path choice is based on destination address.

# IP Addressing



# IP Address Classes

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

ICND009R\_22

## **Class A**

$$\text{No of network} = 2^7 - 2 = 126$$

$$\text{No of host} = 2^{24} - 2 = 16,777,214$$

## **Class B**

**No of network =  $2^{14}-2 = 16,382$**

**No of host =  $2^{16}-2 = 65,534$**

# Determining Available Host Addresses

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



## **Class C**

**No of network =  $2^{21}-2 = 2,097,152$**

**No of host =  $2^8-2 = 254$**

# 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		

**10.15.13.2 172.16.2.160 200.50.40.5**

X	Y	Z
0	0	0
0	1	0
1	0	0
1	1	1



$$1 * X = X$$

$$0 * X = 0$$

# Default subnet

	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>	172	16	0	0

10. 15.13.2  
255.0. 0. 0

-----

10. 0. 0. 0

172.16 . 2.160  
255.255.0 .0

-----

172.16.0.0

200. 50 . 40 .5  
255.255.255.0

-----

200.50. 40 . 0

# Subnet Mask with Subnets

	Network		Subnet	Host
172.16.2.160	10101100	00010000	00000010	10100000
255.255.255.0	11111111	11111111	11111111	00000000
	10101100	00010000	00000010	00000000
			128 192 224 240 248 252 254 255	
<b>Network Number</b>	172	16	2	0

Network number extended by eight bits •

10.15.13.2  
255.255.0.0  
-----  
10.15.0.0

172.16.2.160  
255.255.255.0  
-----  
172.16.2.0



# Subnet Mask with Subnets (Cont.)

	Network		Subnet	Host
172.16.2.160	10101100	00010000	00000010	10100000
255.255.255.192	11111111	11111111	11111111	11000000
	10101100	00010000	00000010	10000000
			128 192 224 240 248 252 254 255	128 192 224 240 248 252 254 255
<b>Network Number</b>	172	16	2	128

ICND20GR\_136

Network number extended by ten bits •

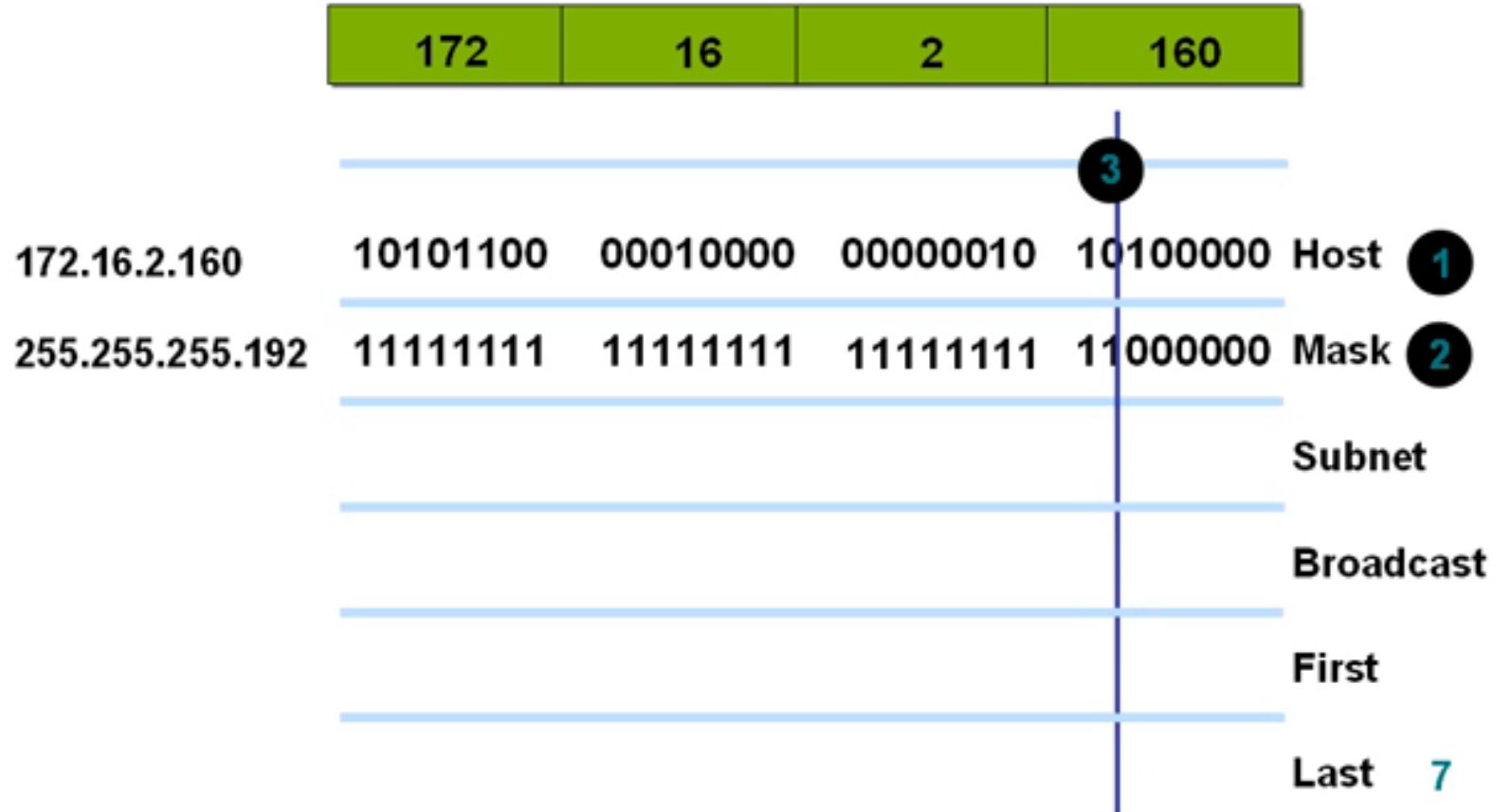
# Addressing Summary Example



172.16.2.160	10101100	00010000	00000010	10100000	Host <b>1</b>
255.255.255.192					Mask
					Subnet <b>4</b>
					Broadcast
					First
					Last



# Addressing Summary Example



# Addressing Summary Example

	172	16	2	160	
					3
172.16.2.160	10101100	00010000	00000010	10100000	Host 1
255.255.255.192	11111111	11111111	11111111	11000000	Mask 2
172.16.2.128	10101100	00010000	00000010	10000000	Subnet 4
172.16.2.191	10101100	00010000	00000010	10111111	Broadcast 5
172.16.2.129	10101100	00010000	00000010	10000001	First 6
172.16.2.190	10101100	00010000	00000010	10111110	Last 7

17: 17: 17: 17: 17: 17:

## Binary Example

LAN Properties

General | Authentication | Advanced

Connect using: Intel(R) Ethernet Controller

This connection has the following properties:

- QoS Flow Control
- Network Autotuning
- Internet Protocol Version 4

Description: Transmission wide area network across diverse media

Show icon in system tray

Notify me when the connection is disconnected

6

000 Host 1

000 Mask 2

000 Subnet 4

111 Broadcast 5

000 First 6

111 Last 7

Layer 9 of 9:

**Emphasize:** In layer 9, convert binary back to dotted decimal.

25: Addressing Quaternary Example  
 26: 101 1001 1000 1001 1000  
 Subnet mask 255.255.255.192  
 27: Class B Quaternary Example  
 28: Class C Quaternary Example  
 29: Example 1 Address in Binary  
 30: Example 1 Address in Binary Answer

75% Helvetica 18

شوبو جديد تصغير  
 ملف تحرير عرض إدراج تنسيق أدوات عرض الشرح إظهار تعليمات

شبكة Tc من IT  
 تصميم الخرائط  
 الإنكليزية (الولايات المتحدة الأمريكية)

كاتب مبرمج للتطبيقات

ملف تحرير عرض إدراج تنسيق أدوات عرض الشرح إظهار تعليمات

75% Helvetica 18

شبكة جديدة تعيين

# Binary Example

LAN Properties

General Authentication Advanced

Connect using: Intel(R) Ethernet Controller

This connection will use the following IP settings:

17: 192.168.1.100

25: 255.255.255.0

17: 192.168.1.1

17: 192.168.1.1

17: 192.168.1.1

17: 192.168.1.1

17: 192.168.1.1

Microsoft TCP/IP

The combination of IP address and subnet mask is invalid. All of the bits in the host address portion of the IP address are set to 0. Please enter a valid combination of IP address and subnet mask.

OK

Obtain DNS server address automatically

Use the following DNS server addresses:

Preferred DNS server: . . .

Alternate DNS server: . . .

Advanced...

OK Cancel

111 Broadcast

000 First 5

111 Last 6

7

Layer 9 of 9:

Emphasize: In layer 9, convert binary back to dotted decimal.

رسم

شبكة تفاعلية

شبكة 2c من IT

تصميم التبراشي

الإنجليزية (الولايات المتحدة الأمريكية)

25

26

27

28

29

30

# Addressing Summary

17	1	
----	---	--

172.16.2.16	1010110	0001000	0000000
255.255.255.19	1111111	1111111	1111111
172.16.2.12	1010110	0001000	0000100
172.16.2.19	1010110	0001000	0000101
172.16.2.12	1010110	0001000	0000100
172.16.2.19	1010110	0001000	0000101

Internet Protocol (TCP/IP) Properties

General

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

Obtain an IP address automatically

Use the following IP address:

IP address: 172 . 16 . 2 . 191

Subnet mask: 255 . 255 . 255 . 192

Default gateway: . . .

Obtain DNS server address automatically

Use the following DNS server addresses:

Preferred DNS server: . . .

Alternate DNS server: . . .

Advanced...

OK Cancel

Emphasize: In layer 9, convert binary back to dotted decimal.

Addressing Summary

17 1

172.16.2.16

255.255.255.1

172.16.2.12

172.16.2.19	1010110	0001000	00
172.16.2.12	1010110	0001000	00
172.16.2.19	1010110	0001000	00

Microsoft TCP/IP

The combination of IP address and subnet mask is invalid. All of the bits in the host address portion of the IP address are set to 1. Please enter a valid combination of IP address and subnet mask.

OK

Internet Protocol (TCP/IP) Properties

General

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

Obtain an IP address automatically

Use the following IP address:

IP address: 172 . 16 . 2 . 191

Alternate DNS server: . . . . .

Advanced...

OK Cancel

Layer 9 of 9:

Emphasize: In layer 9, convert binary back to dotted decimal.

شبكة الحاسوب

شبكة 20 من 22

تصميم البرنامج

الإنجليزية (الولايات المتحدة الأمريكية)



Addressing Summary

	17	1	
172.16.2.16	1010110	0001000	0000000
255.255.255.19	1111111	1111111	1000000
172.16.2.12	1010110	0001000	0000100
172.16.2.19	1010110	0001000	0001001
172.16.2.12	1010110	0001000	0000100
172.16.2.19	1010110	0001000	0001001

Internet Protocol (TCP/IP) Properties

General

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

Obtain an IP address automatically

Use the following IP address:

IP address: 172 . 16 . 2 . 130

Subnet mask: 255 . 255 . 255 . 192

Default gateway: . . .

Obtain DNS server address automatically

Use the following DNS server addresses:

Preferred DNS server: . . .

Alternate DNS server: . . .

Advanced...

OK Cancel

Layer 9 of 9: Emphasize: In layer 9, convert binary back to dotted decimal.

شبكة 2c من 11 تصميم الفهراسي الإنكليزية (الولايات المتحدة الأمريكية)

# Addressing Summary Example

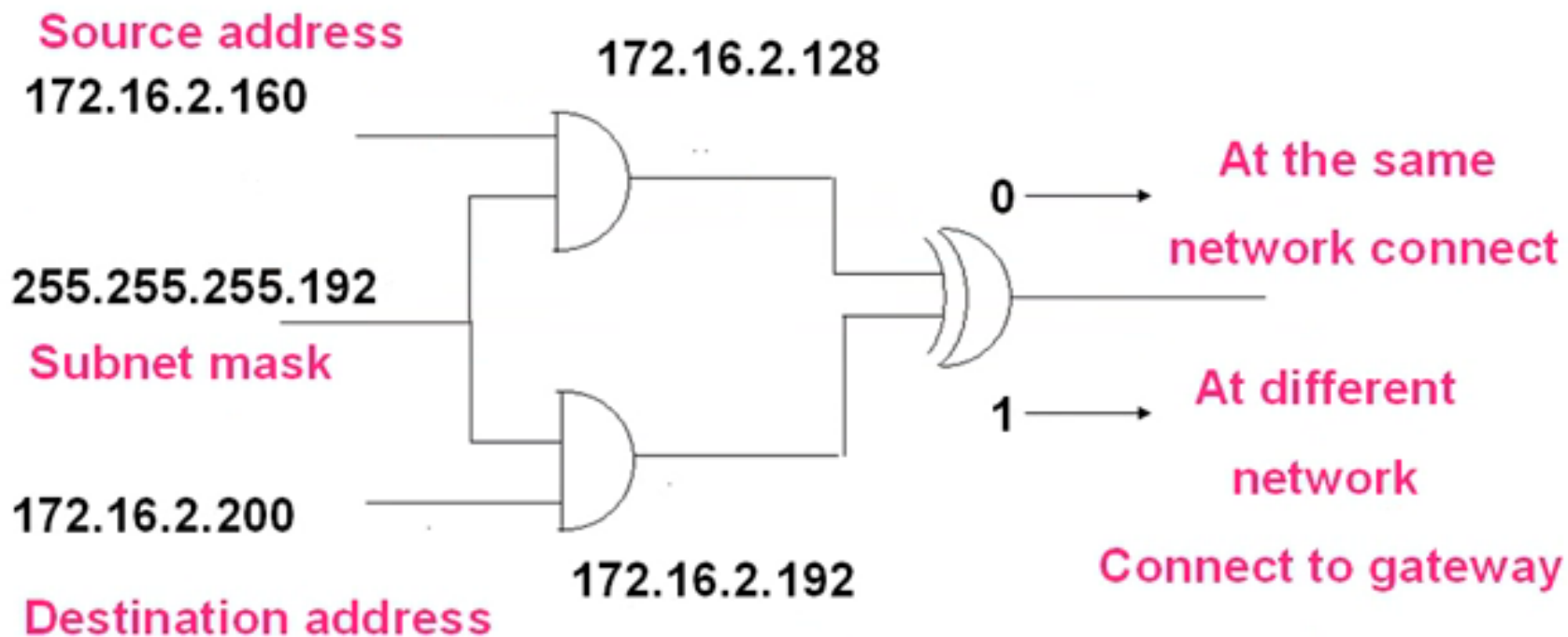
	172	16	2	160	
	----- ----- ----- -----				
	----- ----- ----- -----				3
172.16.2.160	10101100	00010000	00000010	10100000	Host 1
255.255.255.192	11111111	11111111	11111111	11000000	Mask 2
172.16.2.128	10101100	00010000	00000010	10000000	Subnet 4
172.16.2.191	10101100	00010000	00000010	10111111	Broadcast 5
172.16.2.129	10101100	00010000	00000010	10000001	First 6
172.16.2.190	10101100	00010000	00000010	10111110	Last 7

9

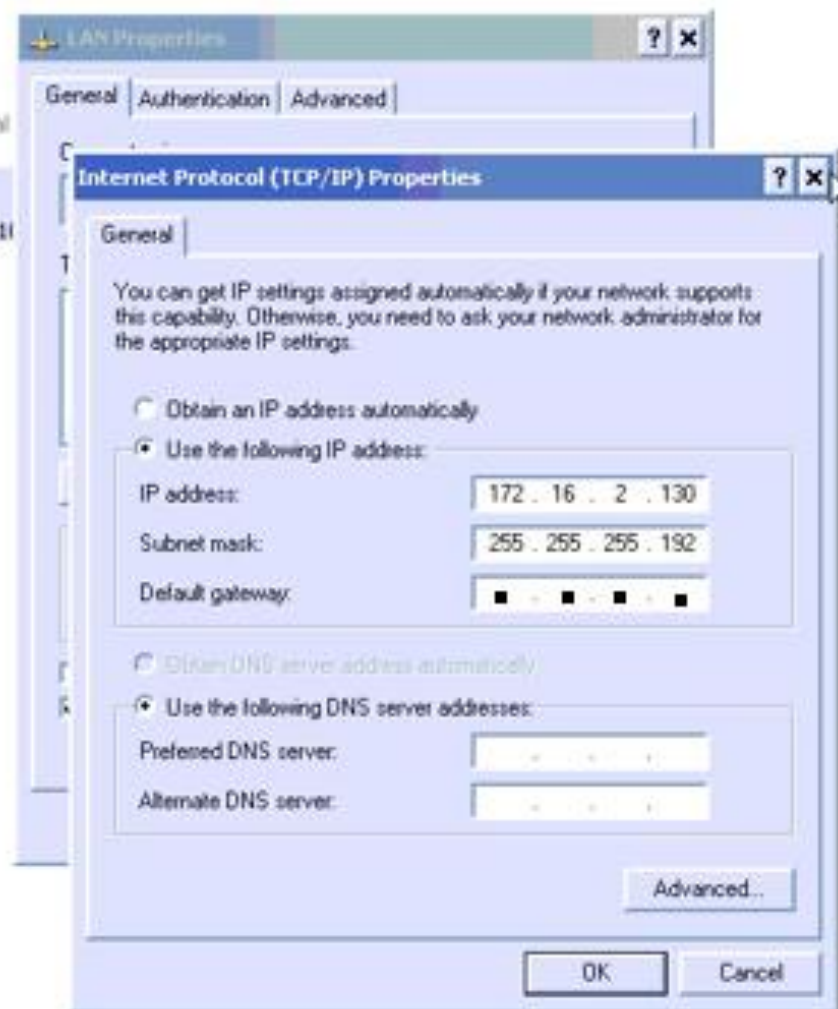
8

# 192.168.2.160 & 192.168.2.200

## Subnet mask 255.255.255.192



### LAN or High-Speed Internet



# Class B Subnet Example

IP Host Address:

Subnet Mask: 255.255.255.0

	Network	Network	Subnet	Host
172.16.2.121	1010110	0001000	0000001	01111001
255.255.255.0	1111111	1111111	1111111	0000000
Subnet:	1010110	0001000	0000001	0000000
Broadcast:	1010110	0001000	0000001	1111111

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•

# 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•

## 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

# design

- 192.168.10.0/24 5 Dept, 25 user
- First note 192.168.10.0 class c
- Default mask = 255.255.255.0

No of network =  $2^{n-2} \geq 5$  .....n=3

For check

No of host =  $2^5 - 2 = 30 > 25$

Ok

The subnet mask is 255.255.255.11100000  
255.255.255.224



192	168	5	0
-----	-----	---	---

192.168.5.32	192	168	5	00100000	Host
255.255.255.224	255	255	255	11100000	Mask
192.168.5.32	192	168	5	00100000	Subnet
192.168.5.63	192	168	5	00111111	Broadcast
192.168.5.64	192	168	5	01000000	Subnet
192.168.5.95	192	168	5	01011111	Broadcast
192.168.5.96	192	168	5	01100000	Subnet
192.168.5.127	192	168	5	01111111	Broadcast

192	168	5	0
-----	-----	---	---

192.168.5.0	192	168	5	00000000	Host
255.255.255.224	255	255	255	11100000	Mask

Factor =  $2^5 = 32$

- 192.168.5.0
- +32
- 192.168.5.32
- +32
- 192.168.5.64
- +32
- 192.168.5.96
- +23
- 192.168.5.128

# Subnetting Homework

- 1: A service provider has given you the Class C network range 209.50.1.0. Your company must break the network into 20 separate subnets.**
- 2: Your company would like to break the Class B private IP address range 172.16.0.0 into 60 different subnets**
- 3: A service provider has given you the Class C network range 209.50.1.0. Your company must break the network into as many subnets as possible as long as there are at least 50 clients per network.**
- 4: Your company would like to break the Class B private IP address range 172.16.0.0 into as many subnets as possible, provided that they can get at least 300 clients per subnet**
- 5: You are given the following IP address and subnet mask: 192.168.1.58 255.255.255.240  
Identify the original range of addresses (the subnet) that this IP address belongs to**