

IP Addressing and Subnetting

Objectives

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Upon completion, you will be able to:

- Discuss the **Types** of Network Addressing
- Explain the **Form** of an IP Address
 - Network ID
 - Host ID
- Discuss the **Classes** of IP Addresses
- Understand the Function of the **Mask**

Let's Talk About Addressing!

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- **Types of Addressing:**
 - Layer 2 – MAC Addresses (**Media Access Control**)
0134.2345.12AB A **MAC** Address
0134.23 Vendor Code
45.12AB Serial Number
 - Layer 3 – Logical Addresses (**IPv4 or IPX**)
- **Assignment of IP Addresses:**
 - Static Addresses – assigned by an Administrator
 - Dynamic Addresses – DHCP
 - “Hierarchical” vs. “Flat” Addressing Schemes

Can You Count in Binary?

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We are Very Familiar with our
Decimal System...

0 1 2 3 4 5 6 7 8 9...10 11 12 13...

But,

We Need to Become Familiar with the
Binary System...only 0' s and 1' s

0000 1 10 11 100 101 110 111 1000 1001...
0 1 2 3 4 5 6 7 8 9

Basics of An IPv4 Address

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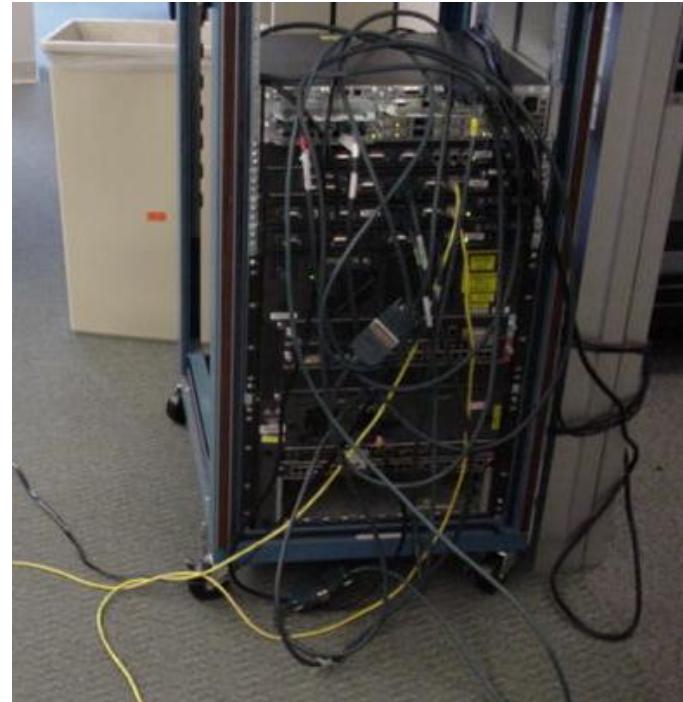
- Layer 3 (L3) Logical IP Addresses are comprised of 4 Octets, separated by a .
- The **Decimal** form looks like this:

176.223.14.127

- The **Binary** form looks like:

128 64 32 16 8 4 2 1

10110000.11011111.00001110.01111111



Basics of An IPv4 Address

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- Each of the 4 Octets has **8 Bits**
- Each of these Bits has a “Binary Value”
- Each Bit can only be a **One** or a **Zero**
- Let’s Look at One of the Octets – **8 Bits**



Each of these 8 bits has a distinct value, that starts at “1” from the right side and moving to the left, doubles each time to 2, 4, 8, 16, 32, 64, and finally 128, as shown above.

IPv4 Addressing

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		32 bits							
Dotted Decimal	Network	Host							
Maximum	255				255				255
	1	8	9	16	17	24	25	32	
Binary	11111111	11111111	11111111	11111111	11111111	11111111	11111111	11111111	
	128 64 32 16 8 4 2 1								
Example Decimal	172	16	122	204					
Example Binary	10101100	00010000	01111010	11001100					

IPv4 Address Classes

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- | | 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 | | | |

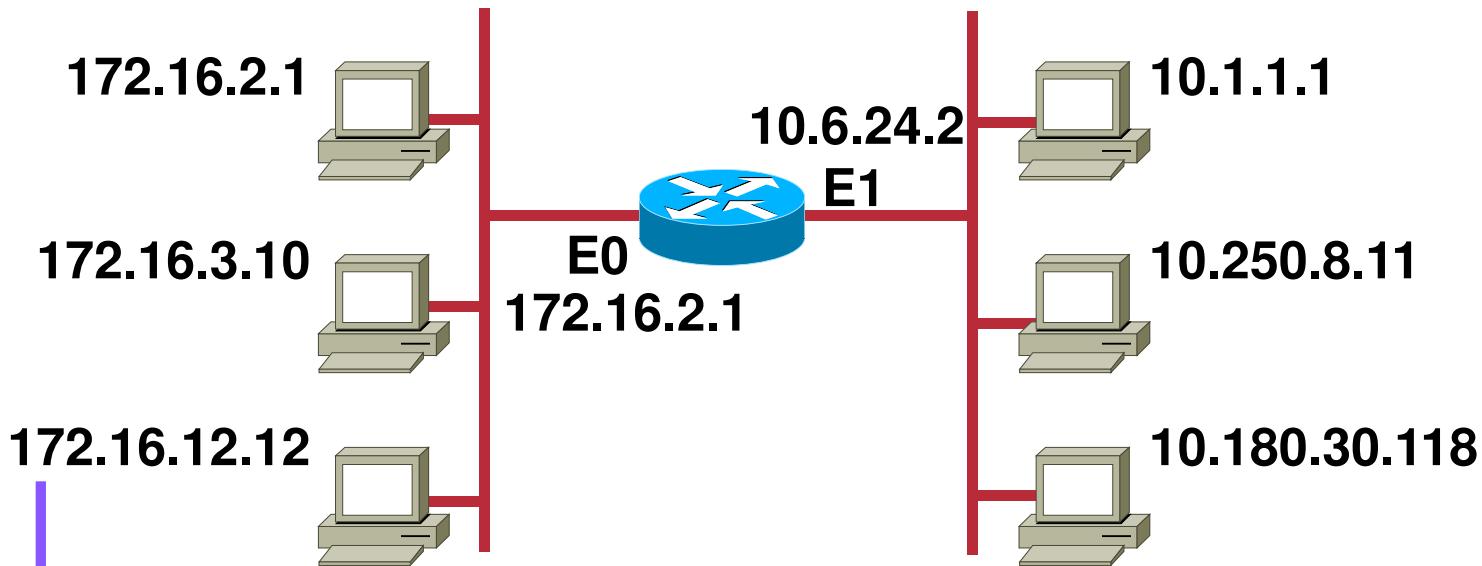
IPv4 Address Classes

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Bits:	1	8 9	16 17	24 25	32
Class A:	0NNNNNNN	Host	Host	Host	
	Range (1-127) – 16,777,214 hosts				
Class B:	10NNNNNN	Network	Host	Host	
	Range (128-191) – 65,534 hosts				
Class C:	110NNNNN	Network	Network	Host	
	Range (192-223) – 254 hosts				
Class D:	1110MMMM	Multicast Group	Multicast Group	Multicast Group	
	Range (224-239)				

Host Addresses

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172.16 . 12 . 12
Network Host

Network	Interface
172.16.0.0	E0
10.0.0.0	E1

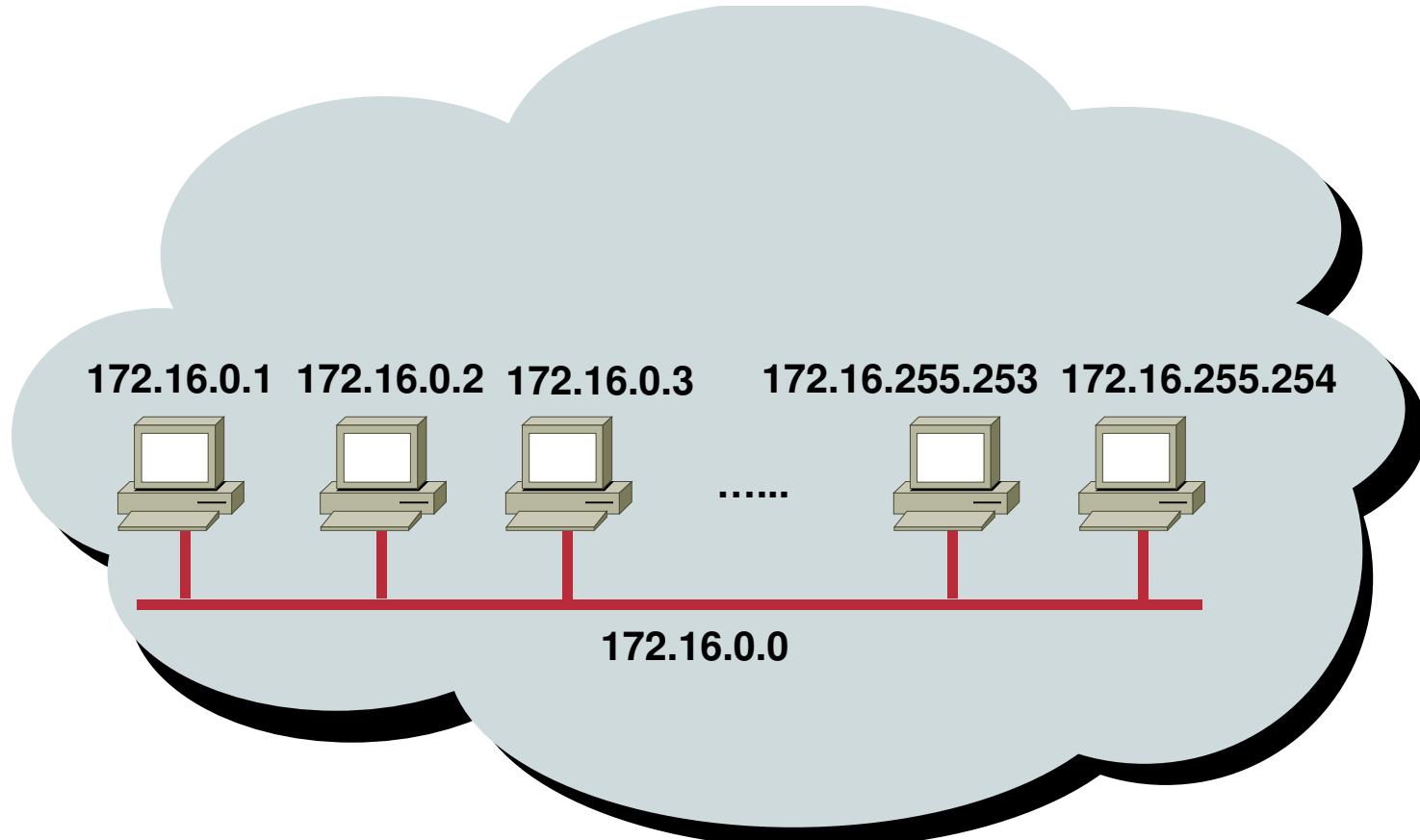
Determining Available Host Addresses

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Network	Host	
172	16	0 0
10101100 00010000	00000000 00000000 00000000 00000001 00000000 00000011 ⋮ ⋮ 11111111 11111101 11111111 11111110 11111111 11111111	N 1 2 3 ⋮ 65534 65535 65536 - 2 <hr/> 65534
Remember 2^N-2 (where N is the number of host bits)		
$2^N-2 = 2^{16}-2 = 65534$		

Addressing without Subnets

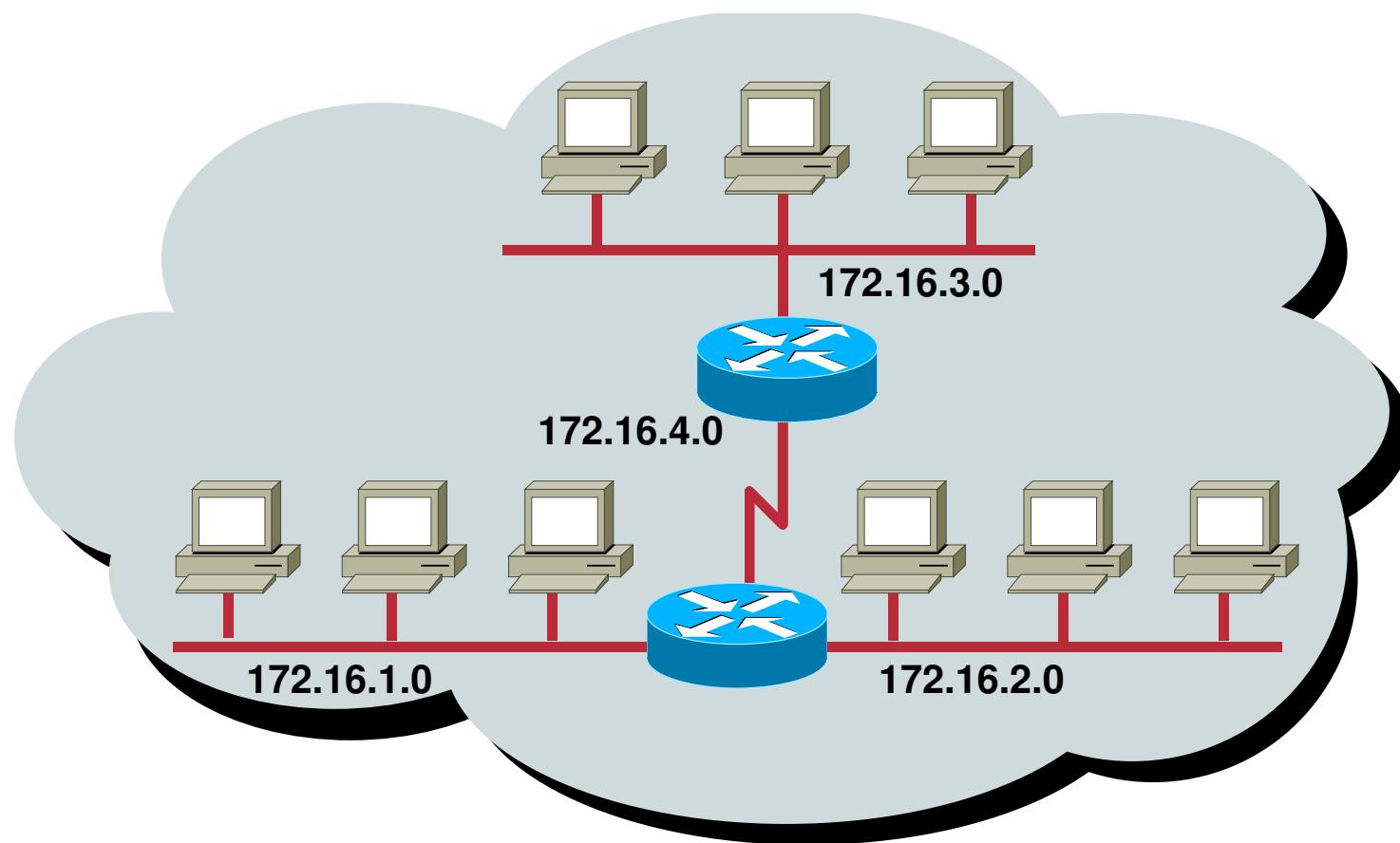
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- Network 172.16.0.0

Addressing with Subnets

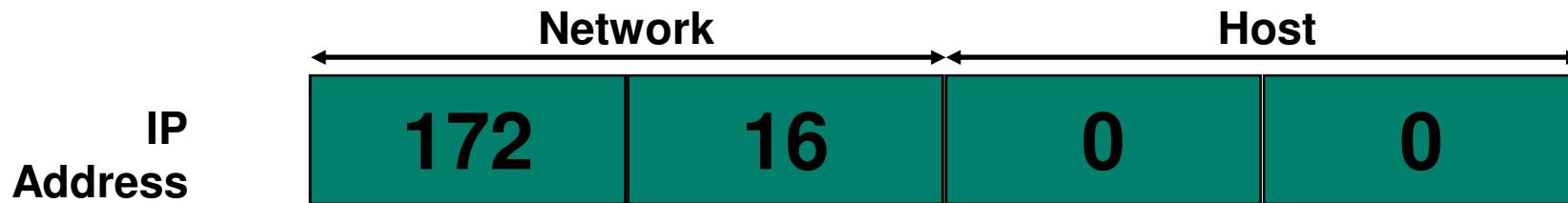
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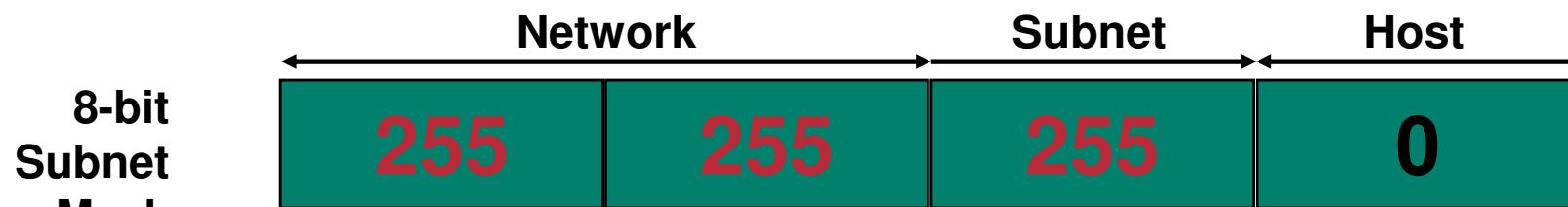
- Network 172.16.0.0

Subnet Mask

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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

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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

Know your two's

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- $2^1 = 2$
- $2^2 = 4$
- $2^3 = 8$
- $2^4 = 16$
- $2^5 = 32$
- $2^6 = 64$
- $2^7 = 128$
- $2^8 = 256$
- $2^9 = 512$
- $2^{10} = 1024$
- $2^{11} = 2048$
- $2^{12} = 4096$
- $2^{13} = 8192$
- $2^{14} = 16384$
- $2^{15} = 32768$
- $2^{16} = 65536$

Know Your CIDR Values

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- | | | | |
|-----------------|-----|-------------------|-----|
| • 255.0.0.0 | /8 | • 255.255.224.0 | /19 |
| • 255.128.0.0 | /9 | • 255.255.240.0 | /20 |
| • 255.192.0.0 | /10 | • 255.255.248.0 | /21 |
| • 255.224.0.0 | /11 | • 255.255.252.0 | /22 |
| • 255.240.0.0 | /12 | • 255.255.254.0 | /23 |
| • 255.248.0.0 | /13 | • 255.255.255.0 | /24 |
| • 255.252.0.0 | /14 | • 255.255.255.128 | /25 |
| • 255.254.0.0 | /15 | • 255.255.255.192 | /26 |
| • 255.255.0.0 | /16 | • 255.255.255.224 | /27 |
| • 255.255.128.0 | /17 | • 255.255.255.240 | /28 |
| • 255.255.192.0 | /18 | • 255.255.255.248 | /29 |
| | | • 255.255.255.252 | /30 |

Subnet Mask with Subnets

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	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

Network
Number

172	16	2	0
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- Network number extended by eight bits
- Without a subnet mask you cannot tell the host address nor the network it resides on!

Subnet Mask with Subnets (cont.)

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	Network	Subnet	Host	
172.16.2.160	10101100	00010000	00000010	10100000
255.255.255.192	11111111	11111111	11111111	11000000
	10101100	00010000	00000010	10000000

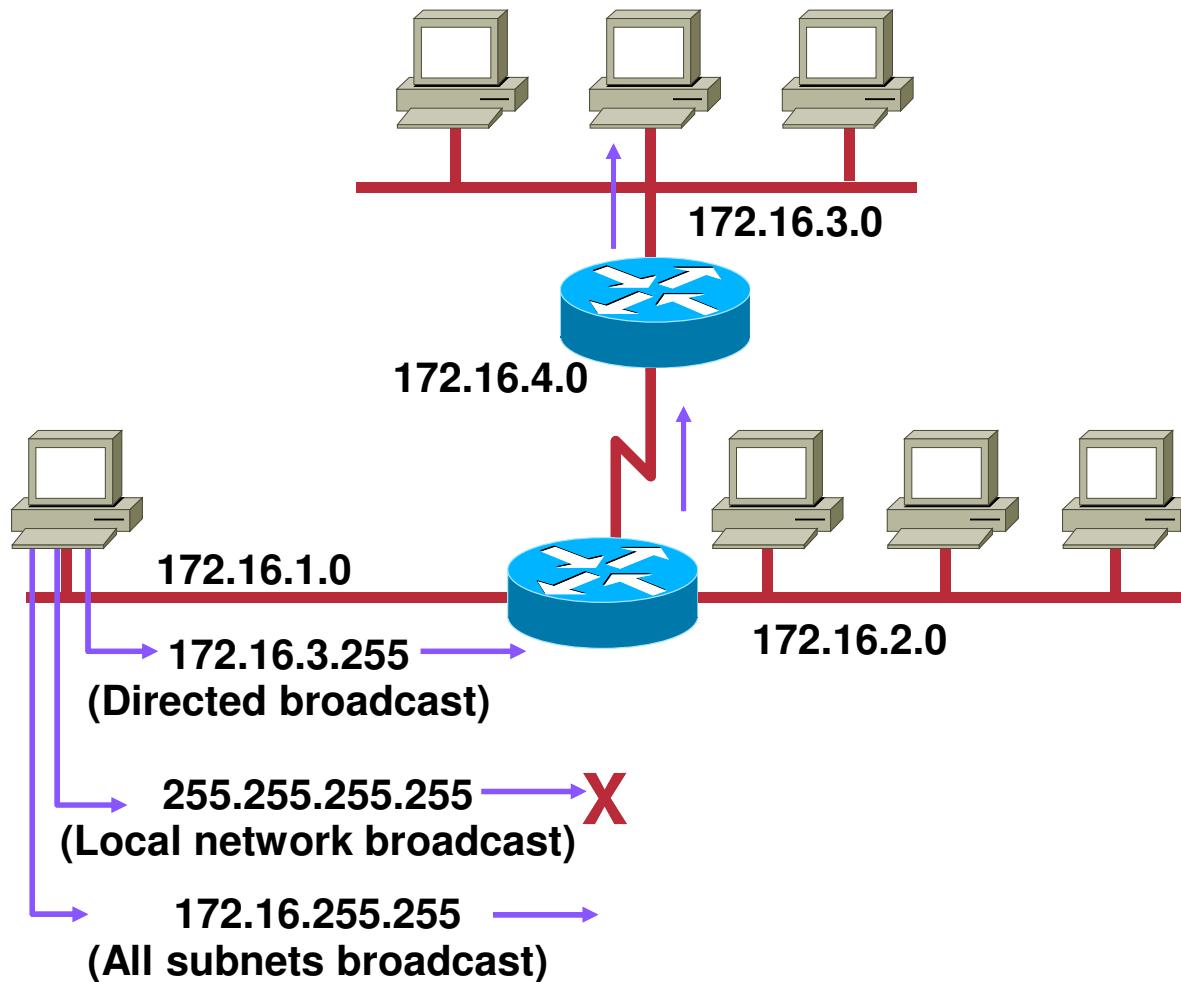
128 192 224 240 248 252 254 255
128 192 224 240 248 252 254 255

Network Number	172	16	2	128
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- Network number extended by ten bits

Broadcast Addresses

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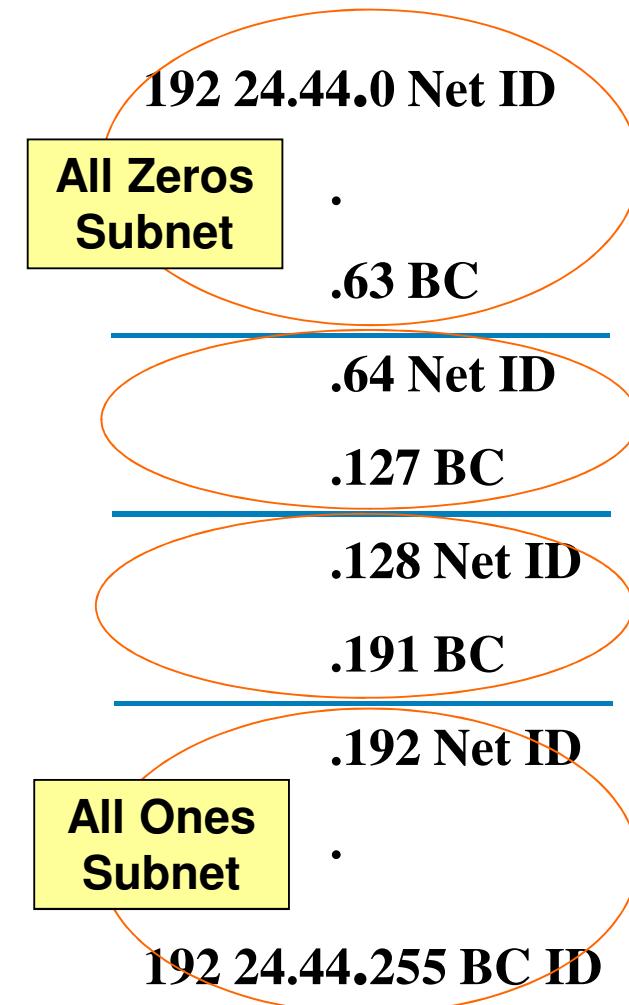
All Zeros and All Ones Subnets

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RFC 1878 states:

"This practice of excluding the “all-zeros subnet” and the “all-ones subnet” is obsolete! Modern software will be able to utilize all definable sub-networks."

Today, the use of subnet zero and the all-ones subnet is generally accepted and most vendors support their use, though, on certain networks (and the CCNA Exam**), particularly the ones using legacy software, the use of subnet zero and the all-ones subnet can lead to problems.**



VLSM - Variable Length Subnet Mask

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