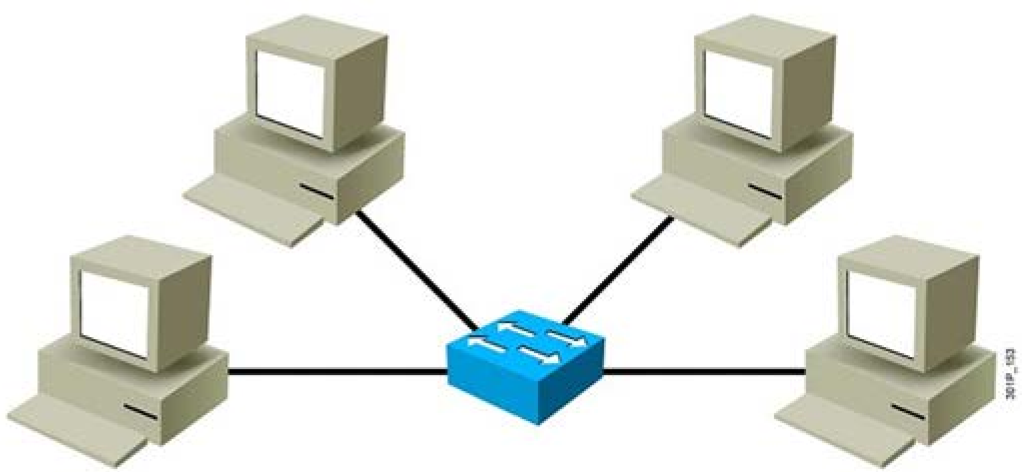
LAN Connections

Constructing a Network Addressing Scheme

Flat Topology

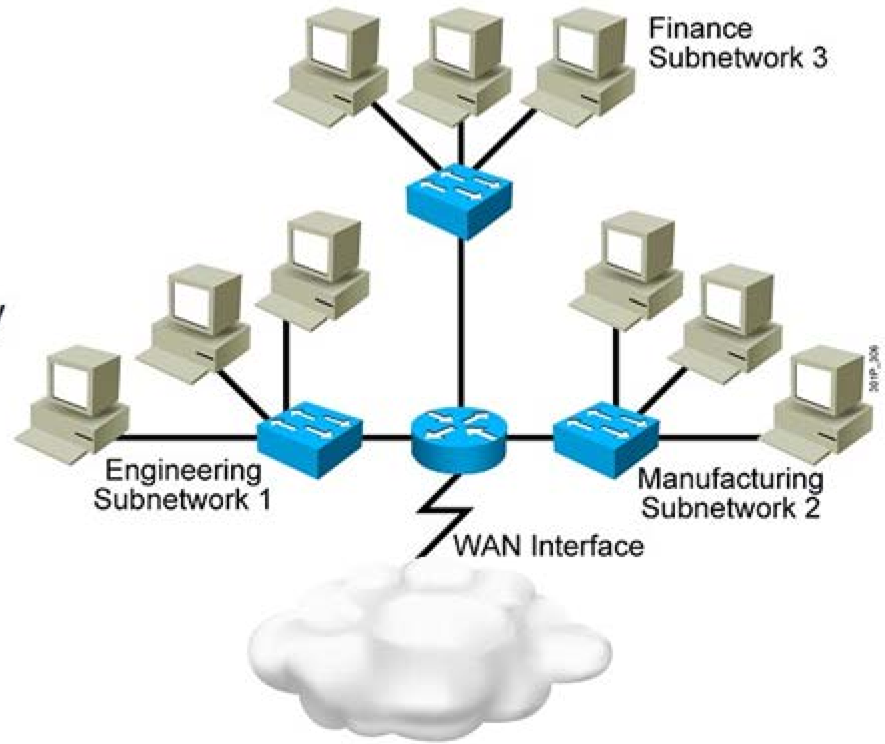
The problems with a flat topology are as follows:

- All devices share the same bandwidth.
- All devices share the same Layer 2 broadcast domain.
- It is difficult to apply a security policy.



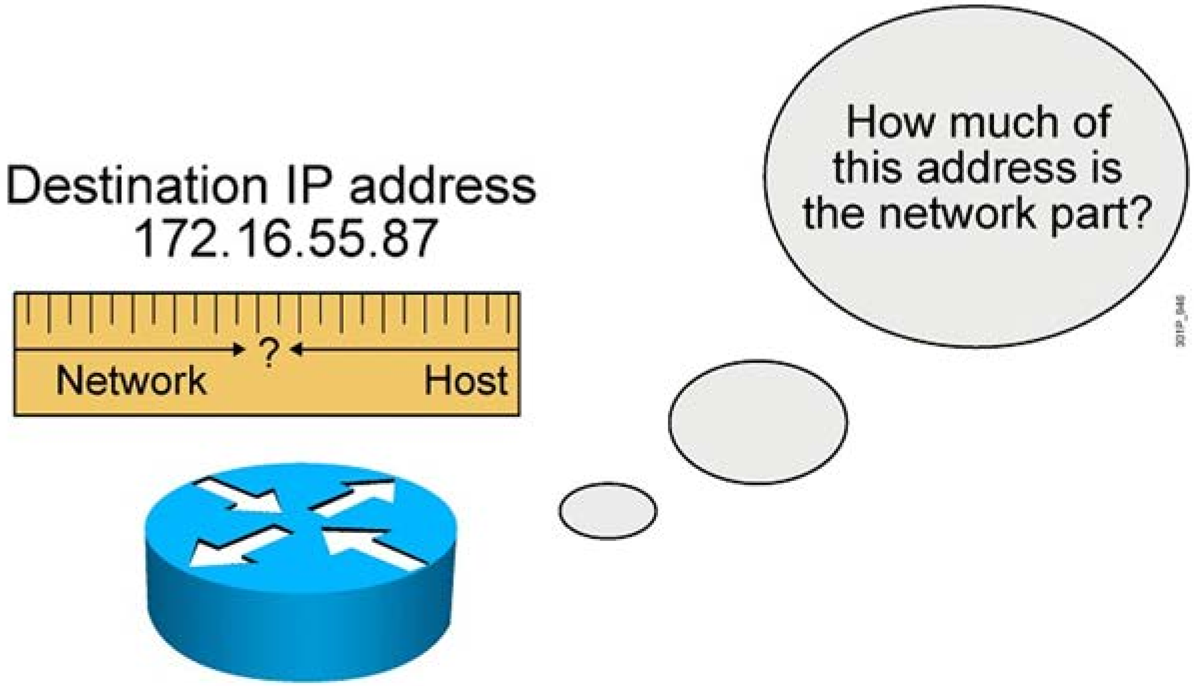
Subnetworks

- Smaller networks are easier to manage.
- Overall traffic is reduced.
- You can more easily apply network security policies.

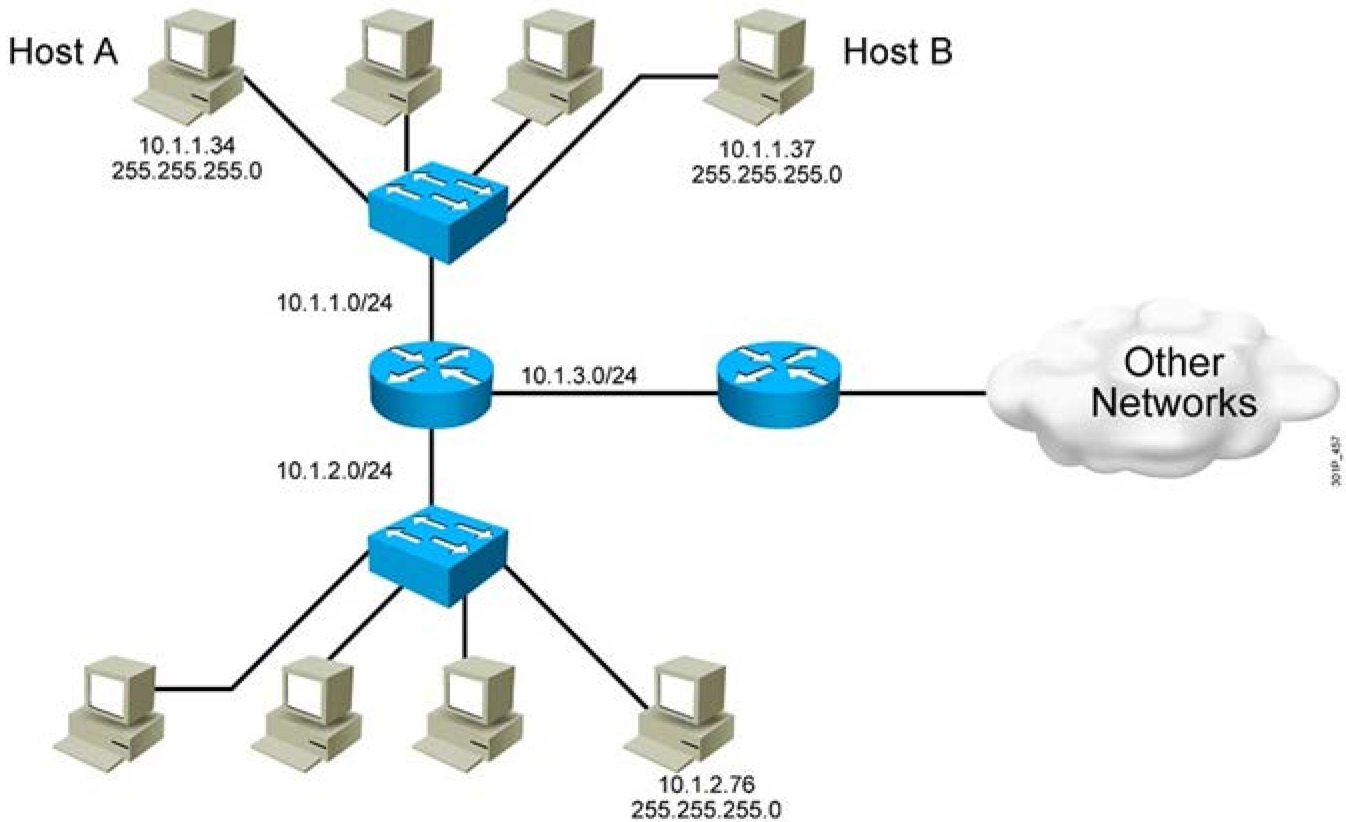


What a Subnet Mask Does

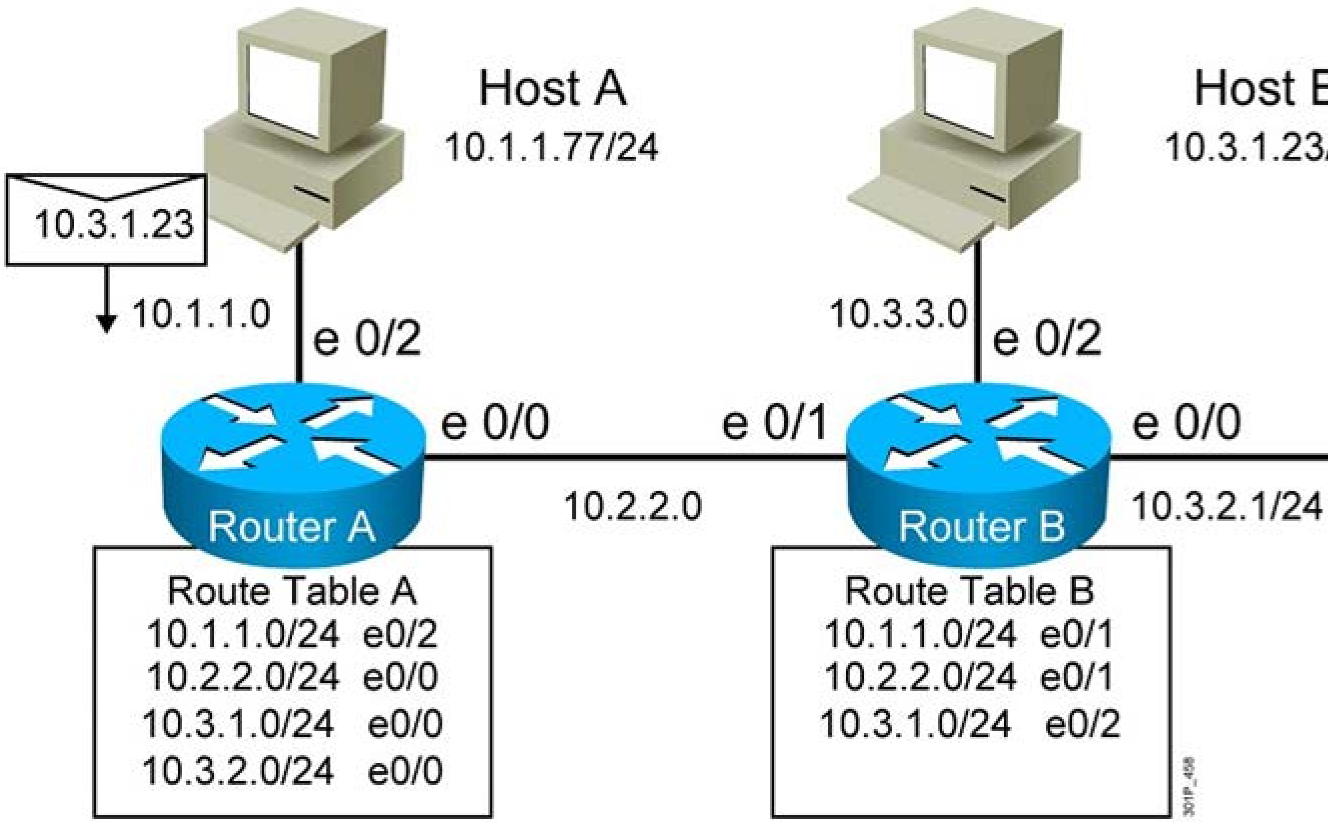
- Tells the router the number of bits to look at when routing
- Defines the number of bits that represent the network part



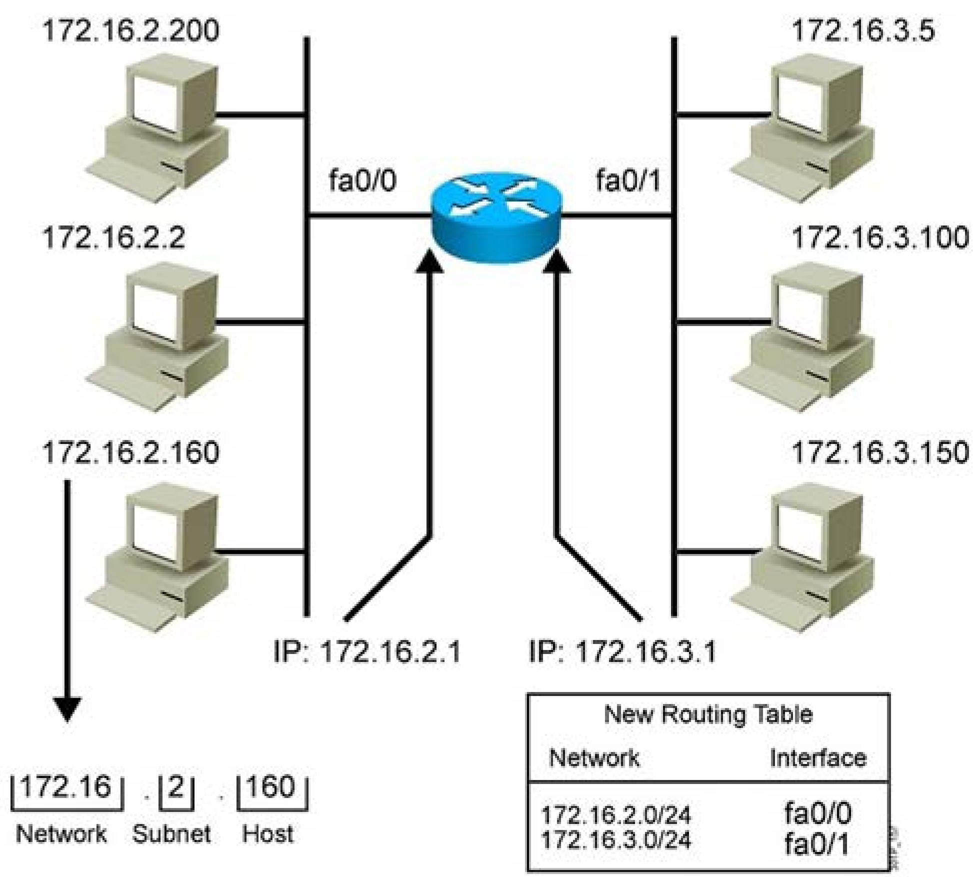
End System Subnet Mask Operation



How Routers Use Subnet Masks



Applying the Subnet Address Scheme



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Octet Values of a Subnet Mask

- Subnet masks, like IP addresses, are represented in the dotted decimal format, such as 255.255.255.0.
- The number 1 reflects the network part of the IP address.

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

Default Subnet Masks

Example Class A address (decimal):	10.0.0.0
Example Class A address (binary):	00001010.00000000.00000000.00000000
Default Class A mask (binary):	11111111.00000000.00000000.00000000
Default Class A mask (decimal):	255.0.0.0
Default classful prefix length:	/8

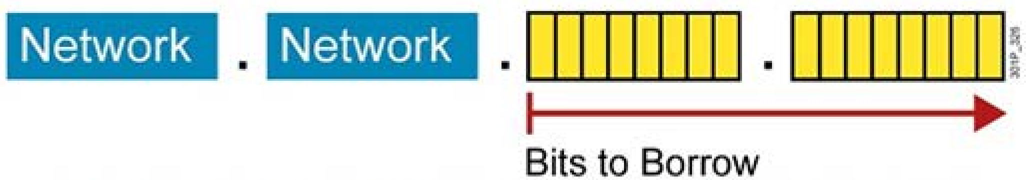
Example Class B address (decimal):	172.16.0.0
Example Class B address (binary):	10101100.10101000.00000000.00000000
Default Class B mask (binary):	11111111.11111111.00000000.00000000
Default Class B mask (decimal):	255.255.0.0
Default classful prefix length:	/16

Example Class C address (decimal):	192.168.42.0
Example Class C address (binary):	11000000.10101000.00101010.00000000
Default Class C mask (binary):	11111111.11111111.11111111.00000000
Default Class C mask (decimal):	255.255.255.0
Default classful prefix length:	/24

Possible Subnets and Hosts for a Class C Network

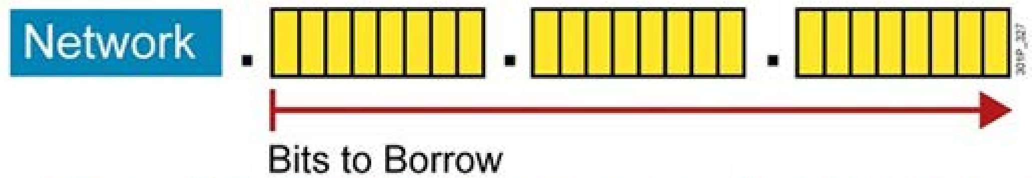
Number of Bits Borrowed (s)	Number of Subnets Possible (2^s)	Number of Bits Remaining in Host ID ($8 - s = h$)	Number of Hosts Possible Per Subnet ($2^h - 2$)
1	2	7	126
2	4	6	62
3	8	5	30
4	16	4	14
5	32	3	6
6	64	2	2
7	128	1	0
8	256	0	0

Possible Subnets and Hosts for a Class B Network



Number of Bits Borrowed (s)	Number of Subnets Possible (2^s)	Number of Bits Remaining in Host ID ($16 - s = h$)	Number of Hosts Possible per Subnet ($2^h - 2$)
1	2	15	32,766
2	4	14	16,382
3	8	13	8,190
...	...	...	...
13	8192	3	6
14	16384	2	2
15	32768	1	0
16	65536	0	0

Possible Subnets and Hosts for a Class A Network



Number of Bits Borrowed (s)	Number of Subnets Possible (2^s)	Number of Bits Remaining in Host ID ($24 - s = h$)	Number of Hosts Possible per Subnet ($2^h - 2$)
1	2	23	8,388,606
2	4	22	4,194,302
3	8	21	2,097,150
...	...	...	...
21	2097152	3	6
22	4194304	2	2
23	8388608	1	0
24	16777216	0	0

Procedure for Implementing Subnets

1. Determine the IP address that is assigned by the registry authority.
2. Based on the organizational and administrative structure, determine the number of subnets that are required.
3. Based on the address class and required number of subnets, determine the number of bits that you need to borrow from the host ID.
4. Determine the binary and decimal value of the subnet mask.
5. Apply the subnet mask to the network IP address to determine the subnet and host addresses.
6. Assign subnet addresses to specific interfaces for all devices that are connected to the network.

Eight Easy Steps for Determining Subnet Addresses – Example

IP Address: 192.168.221.37 Subnet Mask /29

Step	Description	Example
1.	Write the octet that is being split in binary.	Host octet: 37 Host octet in binary: 00100101
2.	Write the mask or classful prefix length in binary.	Assigned mask: 255.255.255.248 (/29) Host octet in binary: 11111000
3.	Draw a line to delineate the significant bits in the assigned IP address. Cross out the mask so you can view the significant bits in the IP address.	Split octet (binary): 00100 | 101 Split mask (binary): 11111 | 000

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Eight Easy Steps for Determining Subnet Addresses – Example (Cont.)

Step	Description	Example
4.	Copy the significant bits four times.	00100 000 (network address) 00100 001 (first address in subnet) 00100 110 (last address in subnet) 00100 111 (broadcast address)?
5.	In the first line, define the network address by placing all zeros in the nonsignificant bits.	
6.	In the last line, define the broadcast address by placing all ones in the nonsignificant bits.	
7.	In the middle lines, define the first and last host number.	
8.	Increment the subnet bits by one.	00101 000 (next subnet)

Completed Subnet Addresses

Network address: 192.168.221.32
Subnet mask: 255.255.255.248
First subnet: 192.168.221.32
First host address: 192.168.221.33
Last host address: 192.168.221.38
Broadcast address: 192.168.221.39
Next subnet: 192.168.221.40

Example: Applying a Subnet Mask for a Class C Address

IP Address 192.168.5.139   Subnet Mask /27

IP Address	192	168	5	139	
IP Address	11000000	10101000	00000101	10001011	
Subnet Mask	11111111	11111111	11111111	11100000	/27
Network (2)	11000000	10101000	00000101	10000000	
Network (10)	192	168	5	128	
First Host	192	168	5	10000001=129	
Last Host	192	168	5	10011110=158	
Directed Broadcast	192	168	5	10011111=159	
Next Network	192	168	5	10100000=160	

Example: Applying a Subnet Mask for a Class B Address

IP Address 172.16.139.46 Subnet Mask /20

IP Address	172	16	139	46	
IP Address	10101100	00010000	10001011	00101110	
Subnet Mask	11111111	11111111	11110000	00000000	/20
Network (2)	10101100	00010000	10000000	00000000	
Network (10)	172	16	128	0	
First Host	172	16	10000000	00000001=128.1	
Last Host	172	16	10001111	11111110=143.254	
Directed Broadcast	172	16	10001111	11111111=143.255	
Next Network	172	16	10010000	00000000=144.0	

Example: Applying a Subnet Mask for a Class A Address

IP Address 10.172.16.211   Subnet Mask /18

IP Address	10	172	16	211	
IP Address	00001010	10101100	00010000	11010011	
Subnet Mask	11111111	11111111	11000000	00000000	/18
Network (2)	00001010	10101100	00000000	00000000	
Network (10)	10	172	0	0	
First Host	10	172	00000000	00000001=0.1	
Last Host	10	172	00111111	11111110=63.254	
Directed Broadcast	10	172	00111111	11111111=63.255	
Next Network	10	172	01000000	00000000=64.0	

Summary

- Networks, particularly large networks, are often divided into smaller subnetworks, or subnets. Subnets can improve network performance and control.
- A subnet address extends the network portion. A subnet address is created by borrowing bits from the original host portion and designating them as the subnet field. Determining the optimal number of subnets and hosts depends on the type of network and the number of host addresses that are required.
- End systems use subnet masks to compare the network portion of the local network addresses with the destination addresses of the packets to be sent.

Summary (Cont.)

- Routers use subnet masks to determine if the network portion of an IP address is in the corresponding routing table or if the packet needs to be sent to the next router.
- Subnet masks are usually represented in the dotted decimal notation like IP addresses. In their binary representation, subnet masks have all 1s in the network and subnetwork portions and all 0s in the host portion.

Summary (Cont.)

- Follow these steps to determine the subnetwork and host addresses using a subnet mask:

1. Write the octet being split in binary.
2. Write the mask in binary and draw a line to delineate the significant bits.
3. Cross out the mask so you can view the significant bits.
4. Copy the subnet bits four times.
5. Define the network address by placing all zeroes in the host bits.
6. Define the broadcast address by placing all ones in the host bits.
7. Define the first and last host numbers.
8. Increment the subnet bits by one.