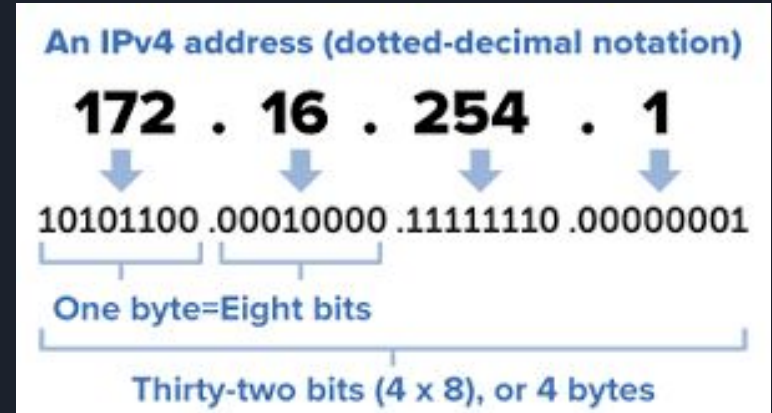# IP Network Addressing

What are IP Addresses?

- IP Addresses are assigned to devices so routers know where to forward packets
- IP Addressing is a Layer 3 (Network Layer) protocol
- Most IP Addresses correspond to one specific device.
 - Depends on public or private IP addresses

How do IPv4 Addresses Work

- IPv4 Addresses are stored as 4 octets of 8 bits each (32 bits total).
- They are displayed as 4 numbers, each between 0 and 255 (i.e. 172.217.4.174)
- IPv6 addresses also exist, but you will not be tested on them in Cyberpatriot this year.

An IPv4 address (dotted-decimal notation)

172 . 16 . 254 . 1

10101100 .00010000 .11111110 .00000001

One byte=Eight bits

Thirty-two bits (4 x 8), or 4 bytes

IP Address Structure

- An IP Address is broken into two parts, the subnet portion and the host portion.
    - The subnet mask tells you how large each part is
- The subnet portion is based on what network the device is on, while the host portion is unique to each host in the network.
- In any network, the last address is the broadcast address.
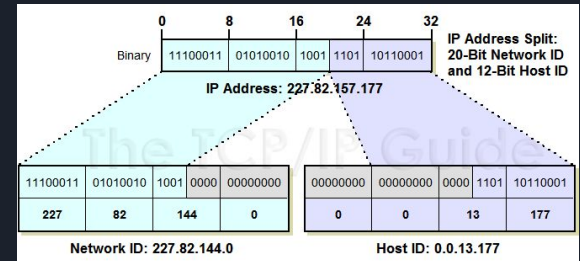
Subnet Mask

- Subnet Masks are used to determine the size of the network and host portions of the IP Address
- The network portion is first, then the host portion is second.
- CIDR Notation (i.e. /24) The number after the slash is the number of bits in the network portion
- Calculators exist to do some of this for you: http://www.ip-calc.com/

	Network Portion			Host Portion
IPv4 Address	192 .	168 .	10	10
	11000000 10101000 00001010			00001010
Subnet Mask	255 .	255 .	255	0
	11111111 11111111 11111111			00000000

Types of Addresses in a Network 192.168.0.0 /24

- Network Address: All hosts share the same network address (contains host and broadcast address)
- Host Address: IP addresses assigned to hosts and devices
  - First Host Address: First available host IP address in the network
  - Last Host Address: Last available host IP address in the network
- Broadcast Address: An address that communicates with all hosts in the network

IPv4 Communication

- Unicast: sending a packet from one host to another host
  - Ex. Peer-to-peer, client-server
- Broadcast: sending a packet from one host to all hosts in the network
  - Ex. DHCP
- Multicast: sending a packet from one host to a group of hosts (not all!)
  - Ex. Routing Protocols

Special IP Addresses

- There are three blocks of private IP Addresses:
    - 10.0.0.0/8 (10.0.0.0 to 10.255.255.255)
    - 172.16.0.0/12 (172.16.0.0 to 172.31.255.255)
    - 192.168.0.0/16 (192.168.0.0 to 192.168.255.255)
- Private IP Addresses are reserved for local use (for internal hosts), so they are not routed over the Internet
- There are other IP address blocks reserved for special uses. Use Google to search them up if you need to know them.

Classful Addressing

- A legacy subnetting scheme
  - No longer used because it wastes a lot of addresses
- Unlikely to be seen, but here for reference.

Class C Specifics	
Address block	192.0.0.0 - 223.255.255.0
Default Subnet Mask	/24 (255.255.255.0)
Maximum Number of Networks	2,097,152
Number of Host per Network	254
High order bit	110xxxxx.___.___.___

| Class B Specifics	
Address block	128.0.0.0 - 191.255.0.0
Default Subnet Mask	/16 (255.255.0.0)
Maximum Number of Networks	16,384
Number of Host per Network	65,534
High order bit	10xxxxxx.___.___.___

| Class A Specifics	
Address block	0.0.0.0 – 127.0.0.0*
Default Subnet Mask	/8 (255.0.0.0)
Maximum Number of Networks	128
Number of Host per Network	16,777,214
High order bit	0xxxxxxx.___.___.___

Subnetting Networks

What is Subnetting?

- Subnetting is breaking apart a network into smaller portions of the network, called subnets.
- Subnets are usually split by routers, which are responsible for routing traffic between different subnets.
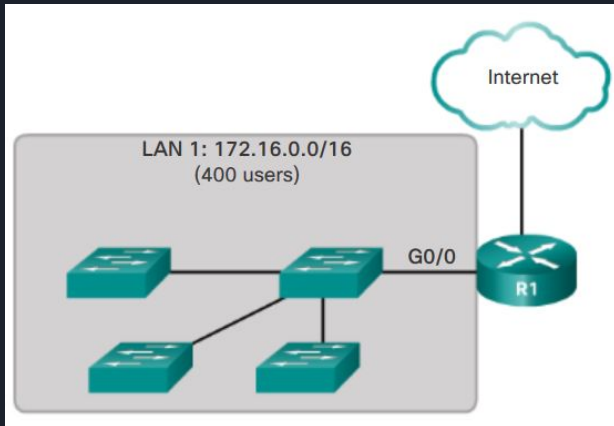
VS.
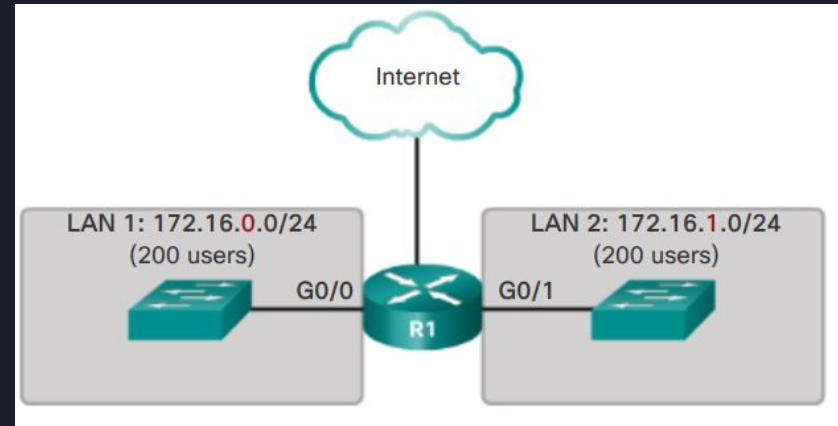
Why use subnetting?

- Easier to manage smaller networks than larger ones.
- Reduces network traffic and improves network performance
- Network latency caused by broadcast packets being sent to many more devices than are necessary.
- Manage related devices together by splitting into subnets based on function
- Save addresses by only using the needed number of IP addresses.

Subnetting considerations

Things to keep in mind while planning how to subnet a network:
- Leave enough host addresses so there's room for expansion
- Don't waste addresses unnecessarily
- Divide network logically and consistently
- Don't duplicate ip addresses

How to assign addresses within a subnet

- Have a consistent set of rules for assigning IP addresses
  - These rules should follow the same guidelines as subnetting networks
- Possible methods of grouping devices:
  - Device Type
  - Geographic Location
  - Personnel Type/Role