



Lecture (07)

* Ethernet Protocol & Network Hardware Components II

* ~~Internetwork Layer I~~

By:

Dr. Ahmed ElShafee

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Agenda

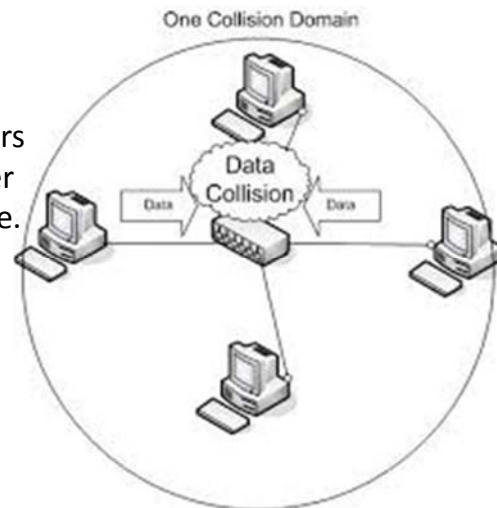
- Collision detection algorithm
- Data link layer devices
- other hardware components: servers
- other hardware components: Storage Area Network and Network Attached Storage
- other hardware components: Network Printers
- Internetwork Layer
- Internet
- IP Addresses
- Classifying IP Addresses

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Collision detection algorithm

- **CSMA/CD**
- As mentioned before a main function of data link layer make sure that two computers don't try to send packets over the network at the same time.
- If they do, the signals will collide with each other, and the transmission will fail.
- Ethernet networks use CSMA/CD, and Token Ring networks use token passing.



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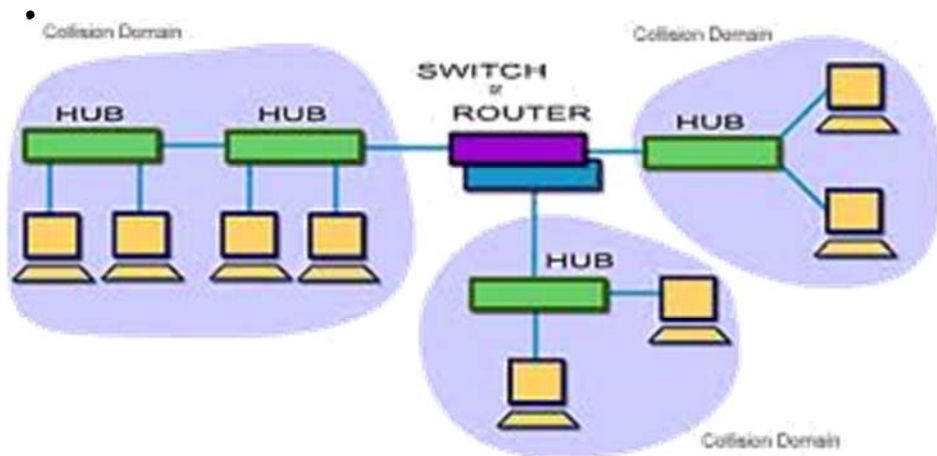
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- **CSMA/CD & collision domains**
- CSMA/CD works pretty well for smaller networks.
- After a network hits about 30 computers however, packets start to collide, and the network performance degrades radically.
- When that happens, the network should be divided into two or more separate sections that are sometimes called *collision domains*.

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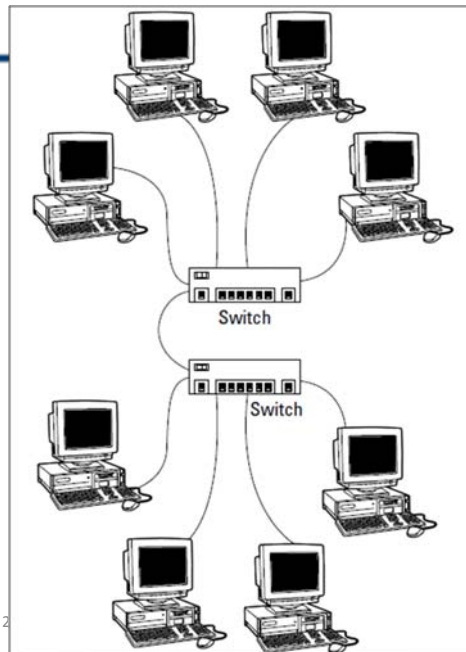
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Data link layer devices



- Switch
- Bridge

- **Switches**
- Both hubs and switches let you connect multiple computers to a twisted-pair network.
- Switches are more efficient than hubs,
- User can connect switches to one another; this is called *daisy chaining*
- some switches, have a special designated port for daisy chaining

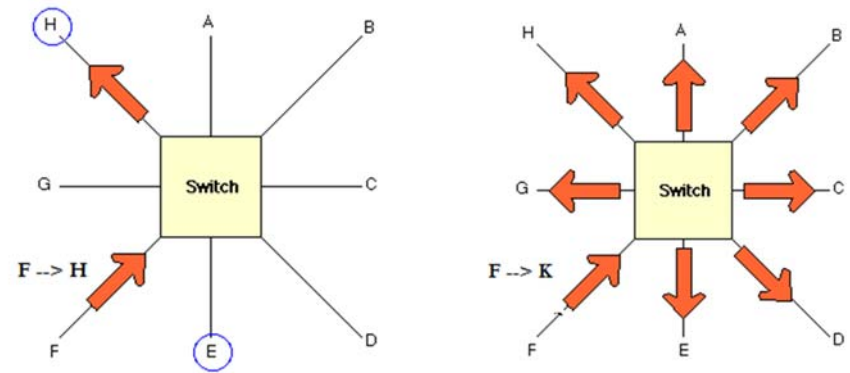


- daisy chain no more than three switches together.
- To solve this use stackable switches that have high-speed direct connections that enable two or more switches to be counted as a single switch.
- For large networks, *managed switch should be used*.
- A managed switch allows you to monitor and control various aspects of the switch's operation from a remote computer

- Switch recognize the MAC address of devices connected to its ports.
- When a packet is received by switch port, switch can recognize the destination of packet.
- Switch search its MAC address table, if the machine is connected to one of its port, it directed that packet to destination machine only. If not, it broadcast packet to all ports.
- So it's some time called switching hub.

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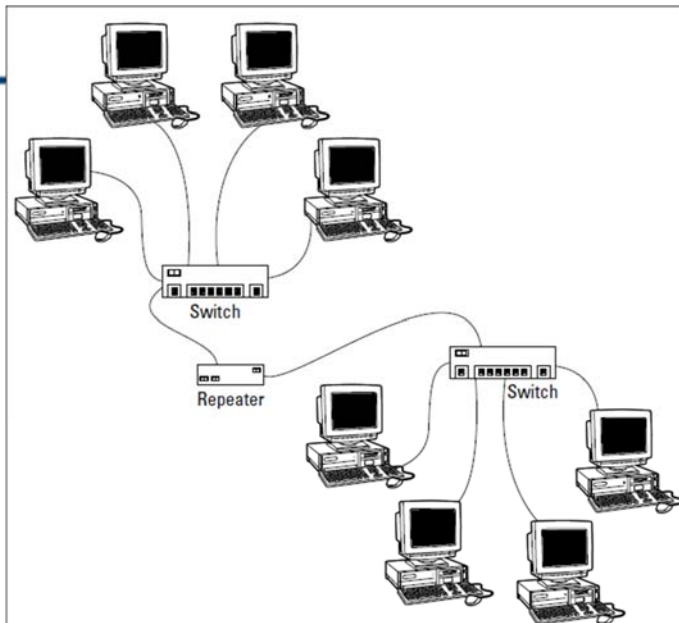
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- **Repeaters**
- Is a physical layer device, that gives the network signals a boost so that the signals can travel farther.



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- User can use a repeater to connect two groups of computers that are too far apart to be strung on a single segment
- Repeaters listen to signals coming down one network cable, amplify them, and send them down the other cable.
- A basic rule of Ethernet life is that a signal can't pass through more than three repeaters on its way from one node to another

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• Bridges

- Bridges are Data Link layer, that connects two networks so that they act as if they're one network.
- Bridges are used to partition one large network into two smaller networks for performance reasons
- bridge is a smart repeater.
- bridges listen to the network and automatically figure out the MAC address of each computer on both sides of the bridge.
- Then the bridge can inspect each message that comes from one side of the bridge and broadcast it on the other side of the bridge, but only if the message is intended for a computer that's on the other side.

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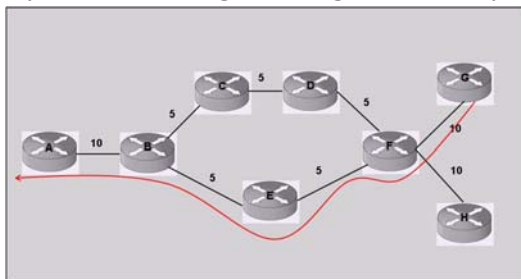
• Routers

- a router is a Network layer device, so it can work with the network packets at a higher level router can examine the IP address of the packets that pass through it.
- And because IP addresses have both a network and a host address, a router can determine what network a message is coming from and going to.
- a router is itself a node on the network, with its own MAC and IP addresses.
- This means that messages can be directed to a router, which can then examine the contents of the message to determine how it should handle the message.

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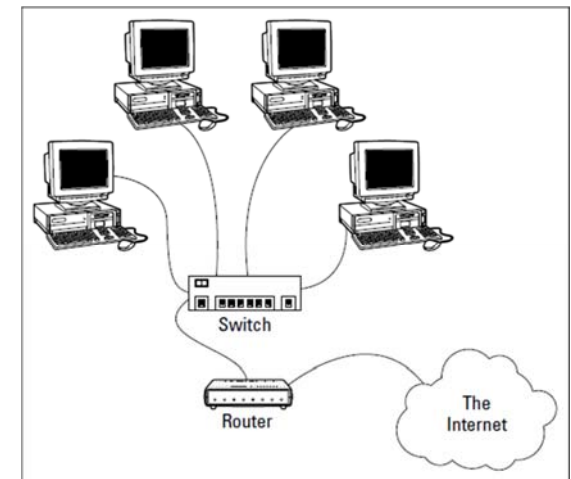
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- User can configure a network with several routers that can work cooperatively together.
 - For example, some routers are able to monitor the network to determine the most efficient path for sending a message to its ultimate destination.
 - If a part of the network is extremely busy, a router can automatically route messages along a less-busy route.



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- Routers can also connect networks that are geographically distant from each other via a phone line (using modems) or ISDN.
 - You can also use a router to join your LAN to the Internet.



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other hardware components:

servers

- Only the smallest networks can operate with out any dedicated server computer.
- Like home network or a small office network with only a few computers, you can get away with true *peer-to-peer networking*.
- That's where each client computer shares its resources such as file storage or printers, and a dedicated server computer isn't needed.
- Servers provide the shared resources that network users crave, such as file storage, databases, e-mail, Web services, and so on.

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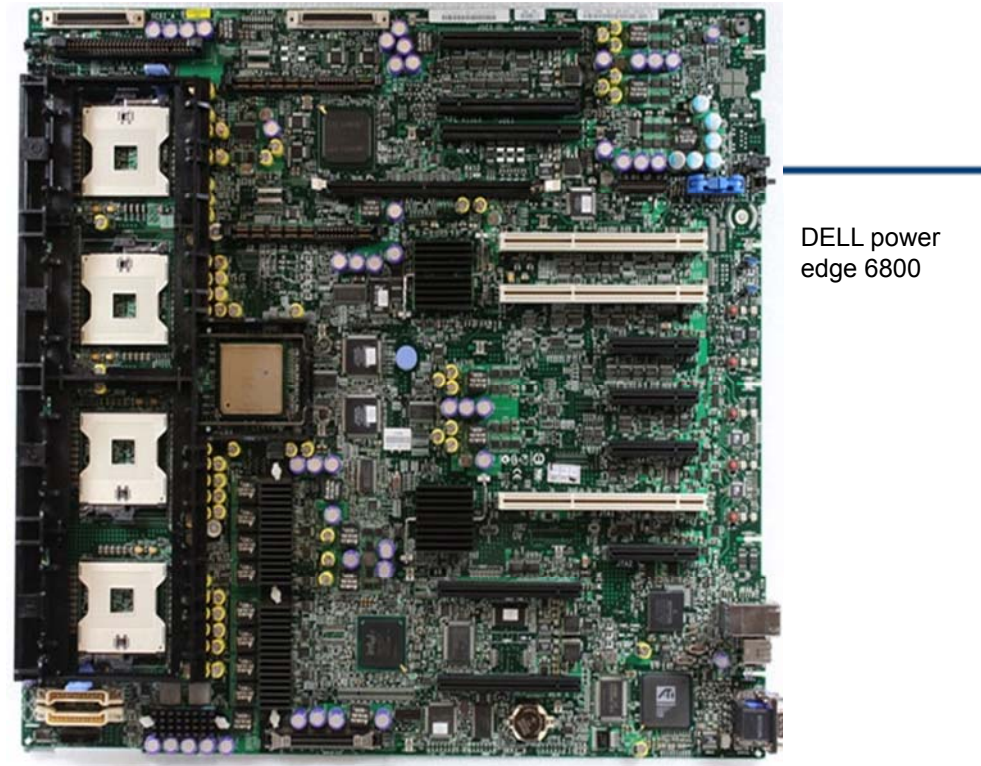
- server computer are similar to the components used in less expensive client computers

1. **Motherboard:**

- The major components on the motherboard include the processor (or CPU), supporting circuitry called the *chipset*, memory, expansion slots, a standard IDE hard drive controller, and I/O ports for devices such as keyboards, mice, and printers.
- Some motherboards also include additional built-in features such as a graphic adapter, SCSI disk controller, or network interface.

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- **Processor:** The processor, or CPU, is the brain of the computer.
- Intel had two processor models specifically designed for use in server computers.

Intel Processors

<i>Processor</i>	<i>Clock Speed</i>	<i>Processor Cores</i>
Itanium 9300	1.60–1.73GHz	4
Xeon	1.83–3.4GHz	2–6

- Itanium processors are faster than Xeon processors at the same clock speed

- **Memory:**
- The total memory capacity of the server depends on the motherboard.
- Most new servers can support at least 16GB of memory, and some can handle up to 256GB.
- **Hard drives:**
- Most desktop computers use inexpensive hard drives called *SATA* drives
- Servers use another type of drive known as *SCSI*
- For the best performance, use the SCSI drives along with a high-performance SCSI controller card.
- **SATA drives are often used in inexpensive servers.**

- **Network connection**
- Gigabit Ethernet builtin card
- **Video:**
- servers equipped with inexpensive generic video cards and monitors without affecting network performance.
- **Power supply:**
- larger power supply (typically 300 watts).
- If the server houses a large number of hard drives, it may require an even larger power supply.

- **Server form factors**
- 1. **Tower case:**
- Most servers are housed in a traditional tower case, similar to the tower cases used for desktop computers.
- A typical server tower case is 18-inches high, 20-inches deep, and 9-inches wide and has room inside for a motherboard, five or more hard drives, and other components.
- Tower cases also come with built-in power supplies.



- Other features
 - redundant power supplies
 - hot-swappable fans
 - hot-swappable disk drive bays.
- **Rack mount**
- Rack-mount servers are designed to save space when you need more than a few servers in a confined area.
- A rack-mount server is housed in a small chassis that's designed to fit into a standard 19-inch equipment rack.



- **Blade servers**
- is a server on a single card that can be mounted alongside other blade servers in a blade chassis, which itself fits into a standard 19-inch equipment rack.
- the blade enclosure provides power for all its blade servers.
- blade enclosure provides KVM switch, so users can control any of the servers in a blade server network from a single keyboard, monitor, and mouse

Figure 2. Blade server chassis (rear)

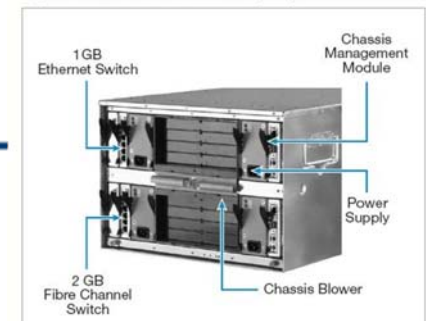


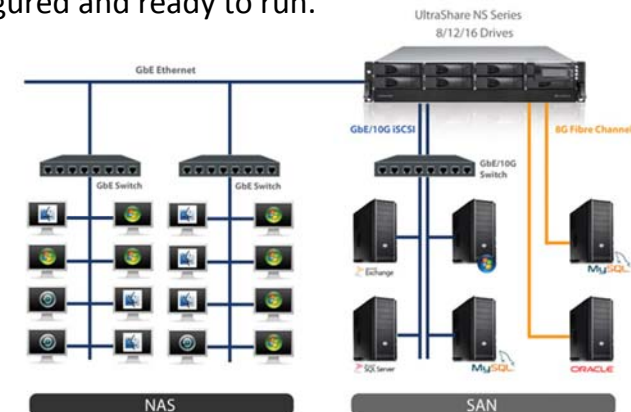
Figure 1. Blade server chassis (front)



other hardware components: Storage Area Network and Network Attached Storage

- SAN is a complicated and expensive technology that provides huge quantities of data storage for large networks
- A SAN consists of three components:
 - storage devices (perhaps hundreds of them),
 - a separate high speed network (usually fiber-optic) that directly connects the storage devices to each other,
 - one or more SAN servers that connect the SAN to the local area network.
- The SAN server manages the storage devices attached to the SAN and allows users of the LAN to access the storage.

- *Network attached storage*, also known as NAS is a network server that provides a disk space to network users.
- A *NAS device* is a self-contained file server that's preconfigured and ready to run.



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- Example of NAS, Dell PowerVault NX300.
 - A self-contained file server built into a small rack-mount chassis.
 - It supports up to four hard drives with a total capacity up to four terabyte (or 4,000GB).
 - The NX300 uses a Xeon processor and two built-in gigabit network ports.



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- Note that some NAS devices use customized versions of Linux rather than Windows Storage Server.
 - Also, in some systems, the operating system resides on a separate hard drive that's isolated from the shared disks.
 - This prevents the user from inadvertently damaging the operating system



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other hardware components: Network Printers

- Although you can share a printer on a network by attaching the printer to a server computer, many printers have network interfaces built in.

Internetwork Layer

Internet

- the Internet links hundreds of millions of computer users throughout the world.
- Strictly speaking, the Internet is a network of networks.
- It consists of tens of thousands of separate computer networks, all interlinked, so that a user on any of those networks can reach out and potentially touch a user on any of the other networks.

- The father of the internet is the ARPANET, which was built by the US Department of Defense in 1969 to link defense installations.
- In the 1970s, ARPANET was split into two networks: one for military use (renamed MILNET) and the original ARPANET
- The two networks were connected by a networking link called IP — the *Internet protocol*
- *Early IP was designed to allow 10 thousands of networks to be connected.*
- By the mid-1980s, ARPANET was beginning to reach the limits of what it could do.

- National Science Foundation (NSF), set up a nationwide network designed to connect huge *supercomputers*, used to discover new prime numbers and calculate the orbits of distant galaxies, In fact, NSFNET replaced ARPANET as the new backbone for the Internet.
- The Net began to grow so fast that even NSFNET couldn't keep up, so private commercial networks got into the game.
- The size of the Internet nearly doubled every year for most of the 1990s.
- After millennium, the growth rate slowed a bit.
- However, the Internet still seems to be growing at the phenomenal rate of about 30 to 50 percent per year,

IP Addresses

- **Introduction**
- An *IP address* is a number that uniquely identifies every host on an IP network.
- IP addresses operate at the interNetwork layer of the TCP/IP protocol stack, so they are independent of lower-level Data Link layer MAC addresses, such as Ethernet MAC addresses.
- IP addresses are 32-bit binary numbers, which means that theoretically, a maximum number of available hosts is about 4 billion unique host addresses can exist throughout the Internet ($2^{32} = 4.3 \text{ E9}$)
- Many experts predict that we will run out of IP addresses soon.

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- a standard for 128-bit IP addresses has been adopted, to overcome that problem

Networks and hosts

- a 32-bit IP address actually consists of two parts:
- **The network ID (or network address):** Identifies the network on which a host computer can be found
- **The host ID (or host address):** Identifies a specific device on the network indicated by the network ID

The dotted-decimal notation

- In dotted-decimal notation, each group of eight bits — an *octet* — is represented by its decimal equivalent. For example, consider the following binary IP address:

110000001010100010001000100000011100

- To convert this value to dotted-decimal notation, first divide it into four octets, as follows:

11000000	10101000	10001000	10001000
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- Then, convert each of the octets to its decimal equivalent:

11000000	10101000	10001000	10001000
192	168	136	28

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- Then, use periods or dots to separate the four decimal numbers, like this:

192.168.136.28

Classifying IP Addresses

- In IP addressing scheme, some arbitrary number of bits for it is assigned an for network ID, The remaining bits then be used for the host ID.
- suppose that half of the address (16 bits) would be used for the network, the remaining 16 bits used for the host ID. result of that scheme would be 65,536 networks, each of those networks could have 65,536 hosts.
- Suppose that a network of 1,000 computers joins the Internet and is assigned one of these hypothetical network IDs, that network then wast 64,000 IP addresses for hosts.

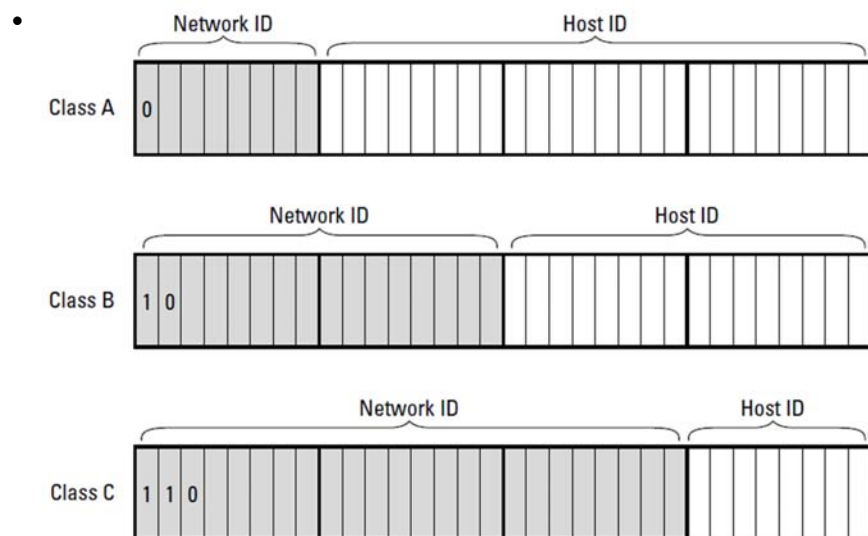
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- Solution, is IP address classes
- The IP protocol defines five different address classes: A, B, C, D, and E.
- of the first three classes, A–C, uses a different size for the network ID and host ID portion of the address.
- Class D is for a special type of address called a *multicast address*.
- Class E is an experimental address class that isn't used.

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- The first four bits of the IP address are used to determine into which class a particular address fits, as follows:
- **If the first bit is zero**, the address is a Class A address “0xxx”
- **If the first bit is one and if the second bit is zero**, the address is a Class B address. “10xx”
- **If the first two bits are both one and if the third bit is zero**, the address is a Class C address. “110x”
- **If the first three bits are all one and if the fourth bit is zero**, the address is a Class D address “1100”
- **If the first four bits are all one**, the address is a Class E address. “1111”

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IP Address Classes

Class	Address Number Range	Starting Bits	Length of Network ID	Number of Networks	Hosts
A	1-126 . x . y . z	0	8	126	16,777,214
B	128-191 . x . y . z	10	16	16,384	65,534
C	192-223 . x . y . z	110	24	2,097,152	254

Class A addresses

- Class A addresses are designed for very large networks, as only eight bits are allocated to the network, first of these bits is used to indicate that the address is a Class A, only 126 Class A networks can exist in the entire Internet.
- The last 3 octets are used for hosts, so each network can

IP Address Classes

Class	Address Number Range	Starting Bits	Length of Network ID	Number of Networks	Hosts
A	1-126 . x . y . z	0	8	126	16,777,214

- Only about 40 Class A addresses are actually assigned to companies or organizations, The rest are either reserved by Internet Assigned Numbers Authority (IANA)

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Some Well-Known Class A Networks

Net	Description	Net	Description
3	General Electric Company	32	Norsk Informasjonsteknologi
4	Bolt Beranek and Newman Inc.	33	DLA Systems Automation Center
6	Army Information Systems Center	35	MERIT Computer Network
8	Bolt Beranek and Newman Inc.	38	Performance Systems International
9	IBM	40	Eli Lilly and Company
11	DoD Intel Information Systems	43	Japan Inet
12	AT&T Bell Laboratories	44	Amateur Radio Digital Communications
13	Xerox Corporation	45	Interop Show Network
15	Hewlett-Packard Company	46	Bolt Beranek and Newman Inc.
16	Digital Equipment Corporation	47	Bell-Northern Research

Some Well-Known Class A Networks

Net	Description	Net	Description
17	Apple Computer Inc.	48	Prudential Securities Inc.
18	MIT	51	Department of Social Security of UK
19	Ford Motor Company	52	E.I. duPont de Nemours and Co., Inc.
20	Computer Sciences Corporation	53	Cap Debis CCS (Germany)
22	Defense Information Systems Agency	54	Merck and Co., Inc.
25	Royal Signals and Radar Establishment	55	Boeing Computer Services
26	Defense Information Systems Agency	56	U.S. Postal Service
28	Decision Sciences Institute (North)	57	SITA
29-30	Defense Information Systems Agency		

- **Class B addresses**
- the first two octets of the IP address are used as the network ID, and the second two octets are used as the host ID.
- in order to indicate that the address is Class B the first two bits of the first octet are required to be 10, As a result, a total of 16,384 Class B networks can exist.

IP Address Classes

<i>Class</i>	<i>Address Number Range</i>	<i>Starting Bits</i>	<i>Length of Network ID</i>	<i>Number of Networks</i>	<i>Hosts</i>
B	128–191 .x.y.z	10	16	16,384	65,534

- Each Class B network can accommodate more than 65,000 hosts.

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- The problem with Class B networks is that even though they are much smaller than Class A networks, they still allocate far too many host IDs.

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- **Note:**
- Class A addresses end with 126.x.y.z, and Class B addresses begin with 128.x.y.z.
- What happened to 127.x.y.z? This special range of addresses is reserved for loopback testing, so these addresses aren't assigned to public networks.

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Class C addresses

- the first three octets are used for the network ID, and the fourth octet is used for the host ID.
- with 24 network ID bits, Class C addresses allow for more than 2 million networks, each Class C network can accommodate only 254 hosts


IP Address Classes

<i>Class</i>	<i>Address Number Range</i>	<i>Starting Bits</i>	<i>Length of Network ID</i>	<i>Number of Networks</i>	<i>Hosts</i>
C	192–223 .x.y.z	110	24	2,097,152	254

- The problem with Class C networks is that they're too small.

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**Thanks,..
See you next week (ISA),...**

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