Internet! How it Works?

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Internet

- It is the largest network in the world that connects hundreds of thousands of individual networks all over the world.
- The popular term for the Internet is the "information highway".
- Rather than moving through geographical space, it moves your ideas and information through cyberspace – the space of electronic movement of ideas and information.

The uses of the Internet

- Send e-mail messages, surfing the web.
- Send (upload) or receive (down load) files between computers.
- Interconnect between two electronic device through TCP/IP (Transmission Control Protocol/Internet Protocol)

Common Network Types

- Local Area Network (LAN)
- Personal Area Network (PAN)
- Metropolitan Area Network (MAN)
- Wide Area Networks (WAN)

Personal Area Network (PAN)

- A personal area network, or PAN, is a computer network organized around an individual person within a single building. This could be inside a small office or residence. A typical PAN would include one or more computers, telephones, peripheral devices, video game consoles and other personal entertainment devices.
- Send a document to the printer in the office upstairs while you are sitting on the couch with your laptop.
- Upload the photo from your cell phone to your desktop computer.

Local Area Network (LAN)

- A local area network, or LAN, consists of a computer network at a single site, typically an individual office building. A LAN is very useful for sharing resources, such as data storage and printers.
- The smallest LAN may only use two computers, while larger LANs can accommodate thousands of computers. A LAN typically relies mostly on wired connections for increased speed and security, but wireless connections can also be part of a LAN.
- Organizations often have several LANS

Metropolitan Area Network (MAN)

- A metropolitan area network, or MAN, consists of a computer network across an entire city, college campus or small region.
- A MAN is larger than a LAN, which is typically limited to a single building or site.
- Depending on the configuration, this type of network can cover an area from several miles to tens of miles.
- A MAN is often used to connect several LANs together to form a bigger network.

Wide Area Networks (WAN)

- A wide area network, or WAN, occupies a very large area, such as an entire country or the entire world. A WAN can contain multiple smaller networks, such as LANs or MANs. The Internet is the best-known example of a public WAN.
- Two or more LANs connected
- Over a large geographic area
- Typically use public or leased lines
 - Phone lines
 - Satellite
- The Internet is a WAN

Client/Server network

Client/Server network

- Nodes and servers share data roles
- Nodes are called clients
- Servers are used to control access
- Database software
 - Access to data controlled by server
- Server is the most important computer

Client/Server Structure of the Web

- Web is a collection of files that reside on computers, called Web servers, that are located all over the world and are connected to each other through the Internet.
- When you use your Internet connection to become part of the Web, your computer becomes a **Web client** in a worldwide client/server network.
- A Web browser is the software that you run on your computer to make it work as a web client.



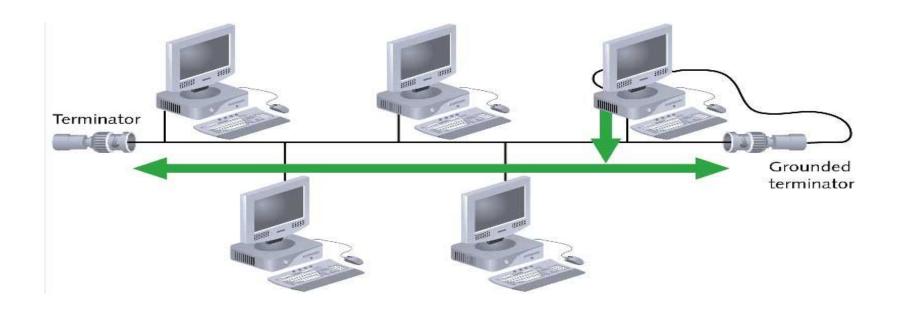
Physical Topologies

- Physical topology: physical layout of nodes on a network
- ▶ Three fundamental shapes:
 - Bus
 - Ring
 - Star
- May create hybrid topologies
- Topology integral to type of network, cabling infrastructure, and transmission media used

Bus

- Single cable connects all network nodes without intervening connectivity devices
- Devices share responsibility for getting data from one point to another
- Terminators stop signals after reaching end of wire
 - Prevent signal bounce
- Inexpensive, not very scalable
- Difficult to troubleshoot, not fault-tolerant

Bus (continued)



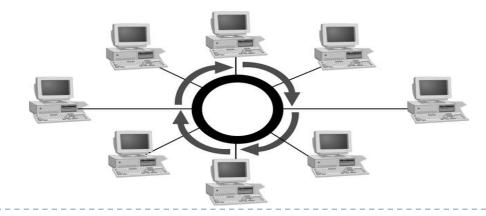
Advantages and Disadvantages

- Works well for small networks
- Relatively inexpensive to implement
- Easy to add to it

- Management costs can be high
- Potential for congestion with network traffic

Ring Topologies

- Each node is connected to the two nearest nodes so the entire network forms a circle
- One method for passing data on ring networks is token passing
- ▶ Each workstation transmits data



Advantages of Ring Topology

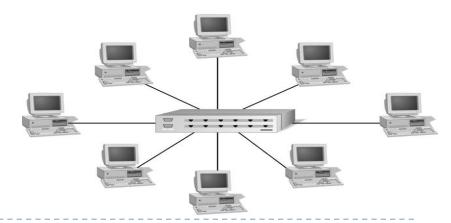
- Easier to manage; easier to locate a defective node or cable problem
- Well-suited for transmitting signals over long distances on a LAN
- Handles high-volume network traffic
- Enables reliable communication

Disadvantages of Ring Topology

- Expensive
- Requires more cable and network equipment at the start
- Not used as widely as bus topology
 - Fewer equipment options
 - Fewer options for expansion to high-speed communication

Star Topologies

- Every node on the network is connected through a central device
- Any single cable connects only two devices
 - Cabling problems affect two nodes at most
- Requires more cabling than ring or bus networks
 - More fault-tolerant
 - Scalable



Advantages and Disadvantages of Star

- Low startup costs
- ▶ Easy to manage
- Offers opportunities for expansion
- Most popular topology in use; wide variety of equipment available

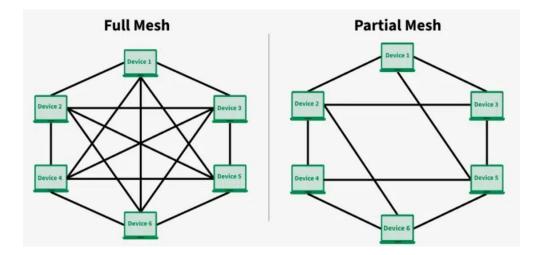
- Center Point is a single point of failure
- Requires more cable than the bus

Mesh Topology

every device is interconnected with every other device, providing multiple route for data to travel.

If a mesh network has N nodes, then there are N(N-1)/2

links.



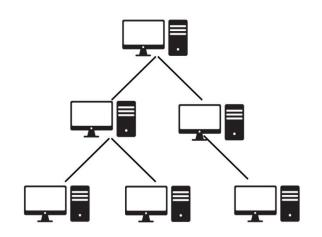
Advantages and Disadvantages of Star

- No center point failure
- Highly reliable

- High startup and maintain costs
- Requires more cable than the bus

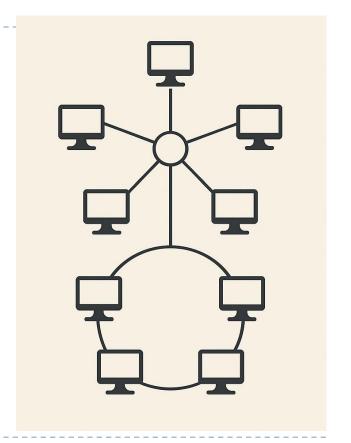
Tree topology

- Tree topology combines characteristics of star and bus topologies, organizing devices in a parent-child hierarchy resembling a tree.
- ▶ The root node acts as a central hub.
- Issues in one branch typically don't affect the entire network

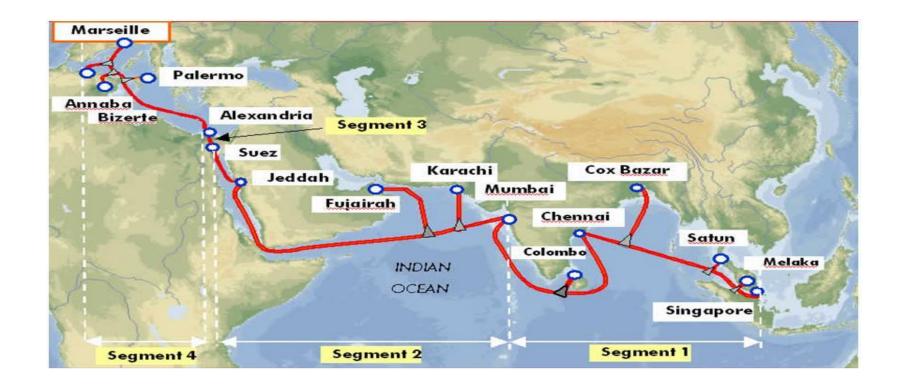


Hybrid topology

network configuration that combines two or more different types of topologies, such as star, bus, ring, or mesh, into a single cohesive structure.



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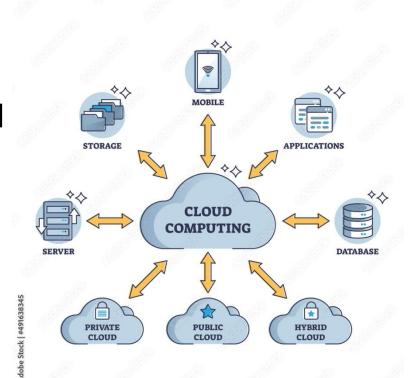


Cloud Computing

- Delivery of computing services (servers, storage, databases, networking, software) over the internet ("the cloud").
 - On-demand self-service
 - Broad network access
 - Resource pooling
 - Rapid elasticity
- Examples: AWS, Microsoft Azure, Google Cloud Platform

Cloud Computing

- From Netflix and Spotify to Google Docs and Instagram,
- Companies moving to the cloud can significantly reduce their carbon footprint.
- accelerating breakthroughs in fields like Al, healthcare, and finance



Cloud Service Models

- ▶ laaS (Infrastructure as a Service):
 - Provides virtualized computing resources
 - Example: Amazon EC2, Google drive, classroom
- PaaS (Platform as a Service):
 - Offers hardware and software tools over the internet
 - **▶ Example: Google App Engine, Kaggle**
- SaaS (Software as a Service):
 - Delivers software applications via the web
 - **Example: Microsoft 365**



How cloud computing works?

- **Front-End**: The user interface (e.g., web browser or app) that interacts with the cloud.
- ▶ **Back-End**: Comprises servers, storage, databases, and applications managed by the cloud provider.
- Network Layer: Connects front-end and back-end via the internet or private networks.
- Virtualization: Enables multiple virtual machines to run on a single physical server, optimizing resource use.

Network Devices



Router



Hub



Hub

- In general, hub is the central part of a wheel where the spokes come together.
- It cannot filter data. Data packets are sent to all connected devices, and there is no intelligence to find out the best path for data packet which then leads to inefficiencies and wastage.
- Hubs are used on a small networks where data transmission is not very high.

Switch

- Switches can perform error checking before forwarding data, which are very efficient by not forwarding packets that errorend out or forwarding good packets selectively to correct devices only.
- Switches can support both layer 2 (based on MAC address) and layer 3 (based on IP address) depending on the type of switch.
- Usually, large networks use switches instead of hubs to connect computers within the same subset

Router

- Router forwards packets based on address just like a switch.
- * Routers usually use the IP address to forward packets, which allow the network to go across different protocols.
- * Routers forward packets based on software while a switch forwards using hardware.
 - Eg: Layer 3 uses a hardware called ASIC (Application Specific Integrated Circuits)

Router

- Routers support different Wide Area Network (WAN) technologies but switches do not.
- Wireless routers have access point built in. The most common home use for routers is to share a broadband internet connection.
- As the router has a public IP address which is shared with the network, when data comes through the router, it is forwarded to the correct computer.

How to access the Internet?

- Many schools and businesses have direct access to the Internet using special high-speed communication lines and equipment.
- Students and employees can access through the organization's local area networks (LAN) or through their own personal computers.
- Another way to access the Internet is through Internet Service Provider (ISP).



Internet Service Provider (ISP)

- A commercial organization with permanent connection to the Internet that sells temporary connections to subscribers.
- Examples:
- Prodigy, America Online, Microsoft network, AT&T Networks.



How to access the Web?

- Once you have your Internet connection, then you need special software called a browser to access the Web.
- ▶ The Web (World Wide Web) consists of information organized into Web pages containing text and graphic images.
- Web browsers are used to connect you to remote computers, open and transfer files, display text and images.
- Web browsers are specialized programs.
- Examples of Web browser: Safari, Google Chrome



Hypertext Markup Language (HTML)

- HTML uses codes, or tags, to tell the Web browser software how to display the text contained in the document
- To allow Web browser software to read them, the text must be formatted according to a generally accepted standard.
- The standard used on the web is Hypertext markup language (HTML).
- ▶ For example: <I> and </I> tags, and tags

Addresses on the Web:IP Addressing

- Each computer on the internet does have a unique identification number, called an IP (Internet Protocol) address.
- The IP addressing system currently in use on the Internet uses a four-part number.
- Each part of the address is a number ranging from 0 to 255, and each part is separated from the previous part by period,
- For example, 106.29.242.17



IP Addressing

- The combination of the four IP address parts provides 4.2 billion possible addresses ($256 \times 256 \times 256 \times 256$).
- ▶ This number seemed adequate until 1998.
- Members of various Internet task forces are working to develop an alternate addressing system that will accommodate the projected growth.
- However, all of their working solutions require extensive hardware and software changes throughout the Internet.





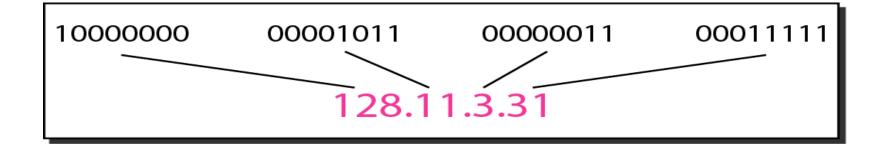
The IPv4 addresses are unique and universal.

An IPv4 address is 32 bits long.



The address space of IPv4 is 2³² or 4,294,967,296.

Dotted-decimal notation and binary notation for an IPv4 address



Note

In classful addressing, the address space is divided into five classes:

A, B, C, D, and E.

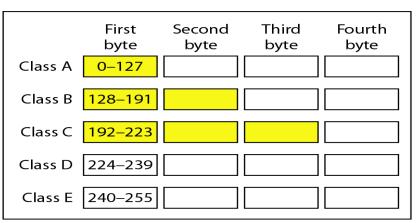
usage of each IP address class

IP Class	Usage Description		
Α	Very large networks (e.g., large corporations, ISPs)		
В	Medium-sized networks (e.g., universities, big businesses)		
С	Small networks (e.g., small businesses, home networks)		
D	Multicasting (used for group communications)		
E	Experimental and research purposes		

Finding the classes in binary and dotted-decimal notation

	First byte	Second byte	Third byte	Fourth byte
Class A	0			
Class B	10			
Class C	110			
Class D	1110			
Class E	1111			

a. Binary notation



b. Dotted-decimal notation



Change the following IPv4 addresses from binary notation to dotted-decimal notation.

- a. 10000001 00001011 00001011 11101111
- **b.** 11000001 10000011 00011011 11111111



Change the following IPv4 addresses from binary notation to dotted-decimal notation.

- a. 10000001 00001011 00001011 11101111
- **b.** 11000001 10000011 00011011 11111111

Solution

We replace each group of 8 bits with its equivalent decimal number (see Appendix B) and add dots for separation.

- a. 129.11.11.239
- **b.** 193.131.27.255



Change the following IPv4 addresses from dotted-decimal notation to binary notation.

- **a.** 111.56.45.78
- **b.** 221.34.7.82



Change the following IPv4 addresses from dotted-decimal notation to binary notation.

- **a.** 111.56.45.78
- **b.** 221.34.7.82

Solution

We replace each decimal number with its binary equivalent

- a. 01101111 00111000 00101101 01001110
- **b.** 11011101 00100010 00000111 01010010

Find the error if any in the following IPv4 addresses.
a. 111.56.045.78

a. 111.56.045.78 b. 221.34.7.8.20

d. 11100010.23.14.67

c. 75.45.301.14

Solution
a. There must be no leading zero (045).

b. There can be no more than four numbers.
c. Each number needs to be less than or equal to 255.

d. A mixture of binary notation and dotted-decimal



Find the class of each address.

- *a.* <u>0</u>00000001 00001011 00001011 11101111
- b. <u>110</u>000001 100000011 00011011 111111111
- *c.* <u>14</u>.23.120.8
- *d.* 252.5.15.111

Domain Name Addressing

- Most web browsers do not use the IP address t locate Web sites and individual pages.
- They use domain name addressing.
- A domain name is a unique name associated with a specific IP address by a program that runs on an Internet host computer.
- This program, which coordinates the IP addresses and domain names for all computers attached to it, is called **DNS (Domain Name System) software**.
- The host computer that runs this software is called a domain name server.



Domain Name Addressing

- Domain names can include any number of parts separated by periods, however most domain names currently in use have only three or four parts.
- Domain names follow hierarchical model that you can follow from top to bottom if you read the name from the right to the left.
- For example, the domain name gsb.uchicago.edu is the computer connected to the Internet at the Graduate School of Business (gsb), which is an academic unit of the University of Chicago (uchicago), which is an educational institution (edu).
- No other computer on the Internet has the same domain name.

Uniform Resource Locators

- The IP address and the domain name each identify a particular computer on the Internet.
- However, they do not indicate where a Web page's HTML document resides on that computer.
- To identify a Web pages exact location, Web browsers rely on Uniform Resource Locator (URL).
- ▶ URL is a four-part addressing scheme that tells the Web browser:
- > What transfer protocol to use for transporting the file
- > The domain name of the computer on which the file resides
- The pathname of the folder or directory on the computer on which the file resides
- > The name of the file

Structure of a Uniform Resource Locators

protocol pathname

http://www.du.ac.bd/academic/department_item/ILET

Domain name filename

http => Hypertext Transfer Protocol



HTTP

- The transfer protocol is the set of rules that the computers use to move files from one computer to another on the Internet.
- The most common transfer protocol used on the Internet is the Hypertext Transfer Protocol (HTTP).
- Two other protocols that you can use on the Internet are the File Transfer Protocol (FTP) and the Telnet Protocol

How to find information on the Web?

- A number of search tools have been developed and available to you on certain Web sites that provide search services to help you find information.
- Examples:
- Yahoo → www.yahoo.com
- ➤ Google → www.google.com
- ➤ Dhaka University → www.du.ac.bd/
- > MSN WebSearch → www.search.msn.com

Thank you.