Computer networks

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Computer Networking

- Computer Networking is the practice of connecting computers together to enable communication and data exchange between them.

- Computer Network is a collection of two or more computers.

- It helps users to communicate more easily.

How Does a Computer Network Work?

- Basics building blocks of a Computer network are Nodes and Links.

- A Network Node can be illustrated as Equipment for Data Communication like a Modem, Router, etc., or Equipment of a Data Terminal like connecting two computers or more.

- Link in Computer Networks can be defined as wires or cables or free space of wireless networks.

Basic Terminologies of Computer Networks

- **Network** – collection of computers and devices that are connected together to enable communication and data exchange.

- **Nodes** – devices that are connected to a network. These can include computers, Servers, Printers, Routers, Switches, and other devices.

- **Protocol** – set of rules and standards that govern how data is transmitted over a network. Examples of protocols include TCP/IP, HTTP, and FTP.

Basic Terminologies of Computer Networks

▶ **Topology** – refers to the physical and logical arrangement of nodes on a network.

▶ **Service Provider Networks** - these types of Networks give permission to take Network Capacity and Functionality on lease from the Provider.

▶ **IP Address** - unique numerical identifier that is assigned to every device on a network. IP addresses are used to identify devices and enable communication between them.

Basic Terminologies of Computer Networks

➤ **DNS** - protocol that is used to translate human-readable domain names (such as www.google.com) into IP addresses that computers can understand.

➤ **Firewall** - security device that is used to monitor and control incoming and outgoing network traffic. Firewalls are used to protect networks from unauthorized access and other security threats.

Types of Enterprise Computer Networks

- **LAN** - Local Area Network is a network that covers a small area, such as an office or a home. LANs are typically used to connect computers and other devices within a building or a campus.

- **WAN** - Wide Area Network is a network that covers a large geographic area, such as a city, country, or even the entire world. WANs are used to connect LANs together and are typically used for long-distance communication.

- **Cloud Networks** - can be visualized with a Wide Area Network as they can be hosted on public or private cloud service providers and cloud networks are available if there is a demand. Cloud Networks consist of Virtual Routers, Firewalls, etc.

Types of Computer Network Architecture

- **Client-Server Architecture** - type of Computer Network Architecture in which Nodes can be Servers or Clients. Here, the server node can manage the Client Node Behaviour.

- **Peer-to-Peer Architecture** - In P2P (Peer-to-Peer) - there is not any concept of a Central Server. Each device is free for working as either client or server.
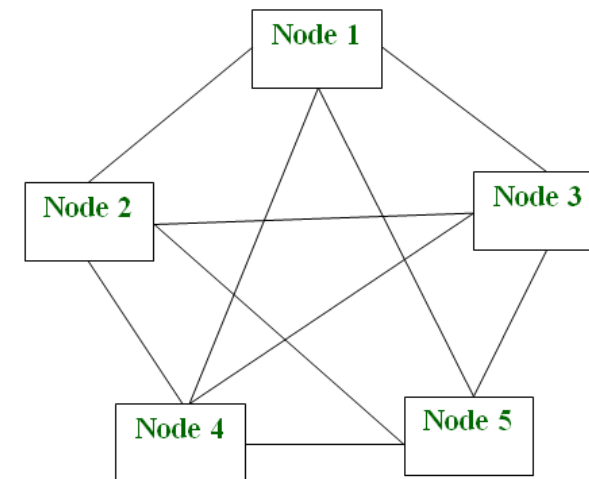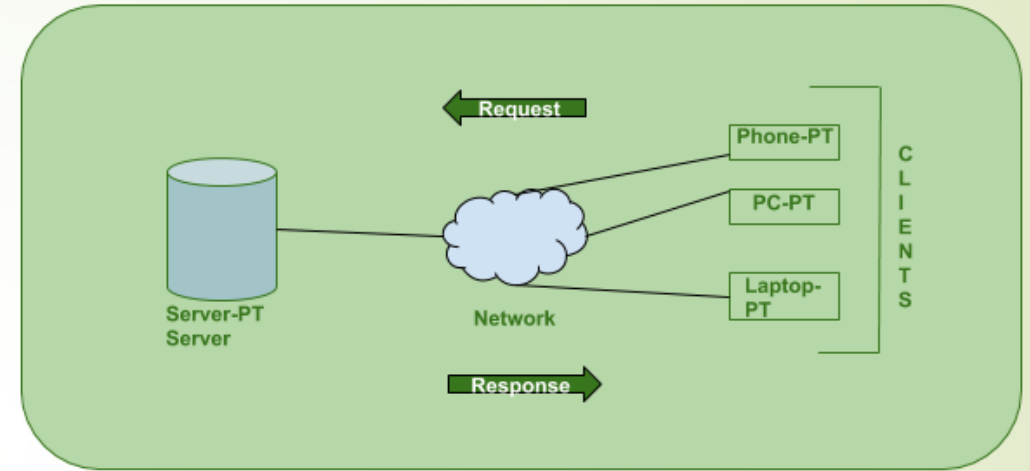
P2P Architecture

Network Devices

- An interconnection of multiple devices, also known as hosts, that are connected using multiple paths for the purpose of sending/receiving data or media.

- Computer networks can also include multiple devices/mediums which help in the communication between two different devices; these are known as Network devices and include things such as routers, switches, hubs, and bridges.

Router   Hub   Bridge

Wireless Router   Switch   Wireless Bridge

Physical Components of Computer Network

- **NIC(Network Interface Card)** – network adapter that is used to connect the computer to the network. It is installed in the computer to establish a LAN. It has a unique id that is written on the chip, and it has a connector to connect the cable to it. The cable acts as an interface between the computer and the router or modem. There are two types of NIC:

  - Wired NIC: Cables and Connectors use Wired NIC to transfer data.

  - Wireless NIC: These connect to a wireless network such as Wifi, Bluetooth, etc.

Physical Components of Computer Network

▶ **HUB** - is a basically multi-port repeater. A hub connects multiple wires coming from different branches, for example, the connector in star topology which connects different stations. Hubs cannot filter data, so data packets are sent to all connected devices. In other words, the collision domain of all hosts connected through Hub remains one.
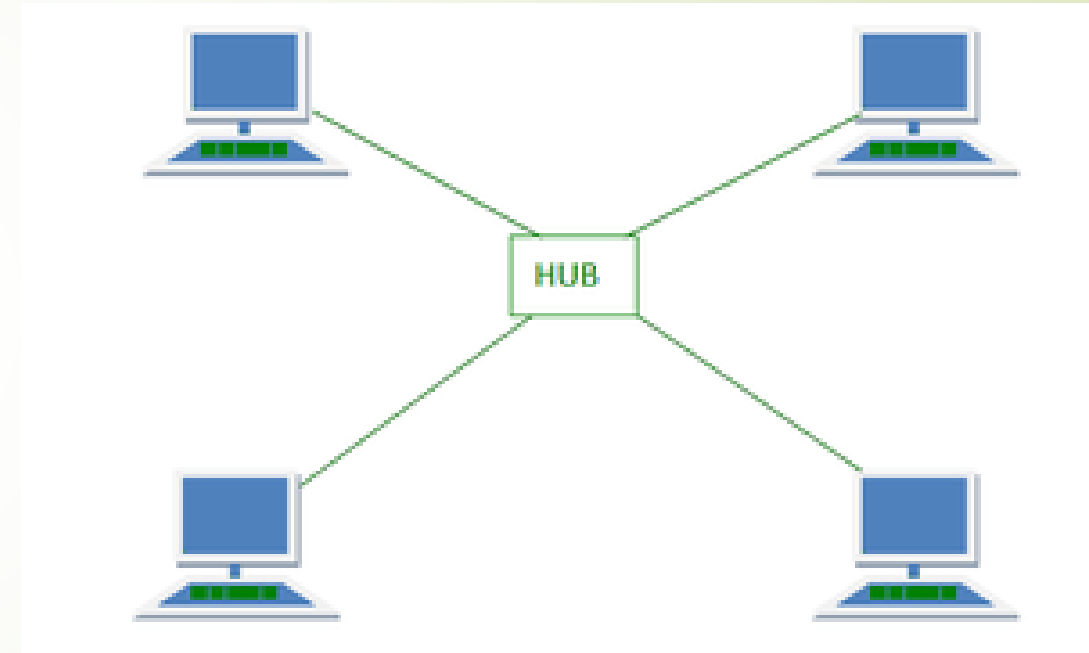
Physical Components of Computer Network

▶ **Router -** device like a switch that routes data packets based on their IP addresses. The router is mainly a Network Layer device. Routers normally connect LANs and WANs and have a dynamically updating routing table based on which they make decisions on routing the data packets. The router divides the broadcast domains of hosts connected through it.


Router

Physical Components of Computer Network

▶ **Modem** – short form of Modulator/Demodulator. The Modem is a hardware component/device which can connect computers and other devices such as routers and switches to the internet. Modems convert or modulate the analog signals coming from telephone wire into a digital form that is in form of 0s and 1s.

Physical Components of Computer Network

- Switch – multiport bridge with a buffer and a design that can boost its efficiency(a large number of ports imply less traffic) and performance.

- A switch is a data link layer device. The switch can perform error checking before forwarding data, which makes it very efficient as it does not forward packets that have errors and forward good packets selectively to the correct port only.

How Does a Network Switch Works?

Router

Network Switch

Phone

Printer

Server

Gaming Console

Desktop Computer

Laptop
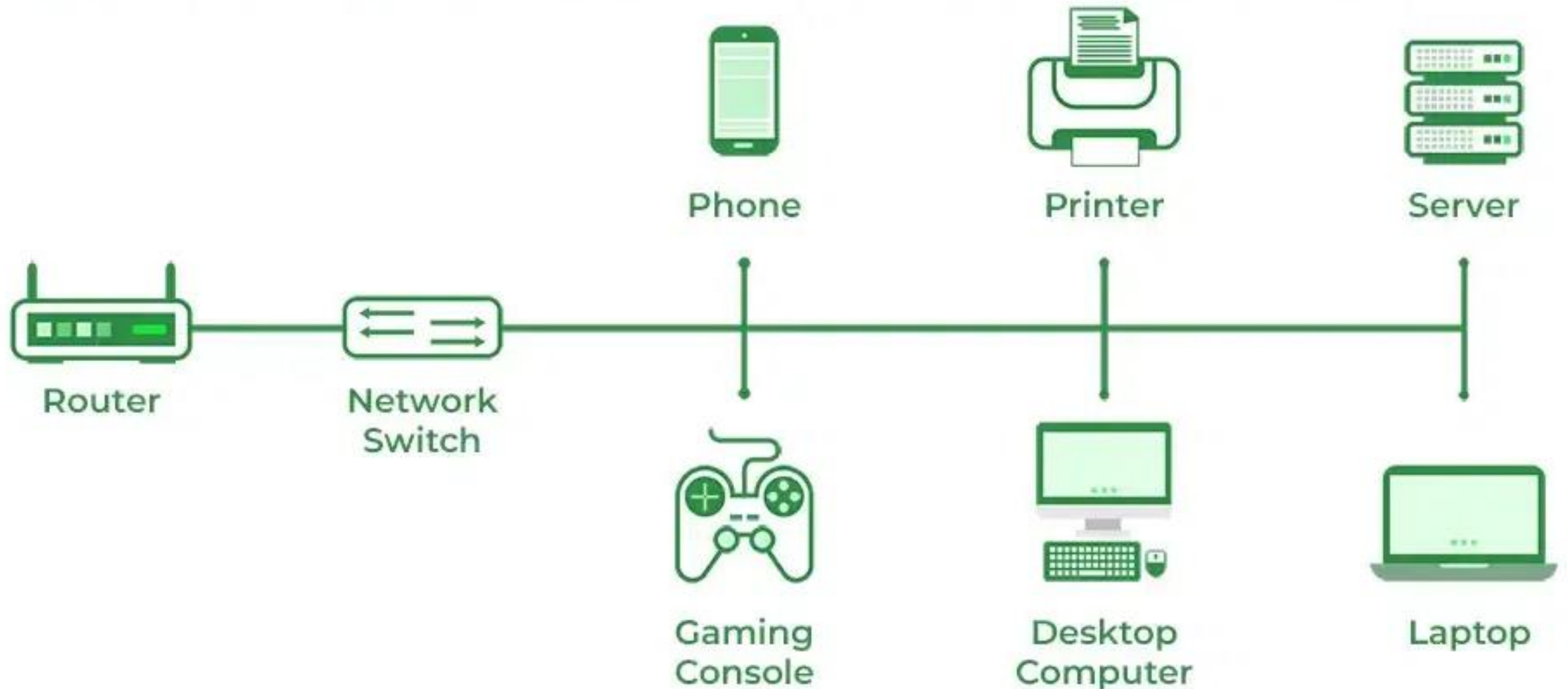
Physical Components of Computer Network

- **Nodes(node)** – term used to refer to any computing devices such as computers that send and receive network packets across the network. Two Types of nodes are:
  - **End Nodes** – these type of nodes is going to be the starting point or the end point of communication. e.g., computers, security cameras, network printers, etc.
  - **Intermediary Nodes** - these nodes are going to be in between starting point or end point of the end nodes. E.g., Switches, Bridges, Routers, cell towers, etc.

▶**Media** - also known as Link which is going to carry data from one side to another side. This link can be Wired Medium (Guided Medium) and Wireless Medium (Unguided Medium). It is of two types:

▶Wired Media

▶Wireless Media

Examples of Wired media

▶ **Ethernet -** the most widely used LAN technology, which is defined under IEEE standards 802.3.

▶ **Fibre Optic Cable** - in this data is transferred in the form of light waves.
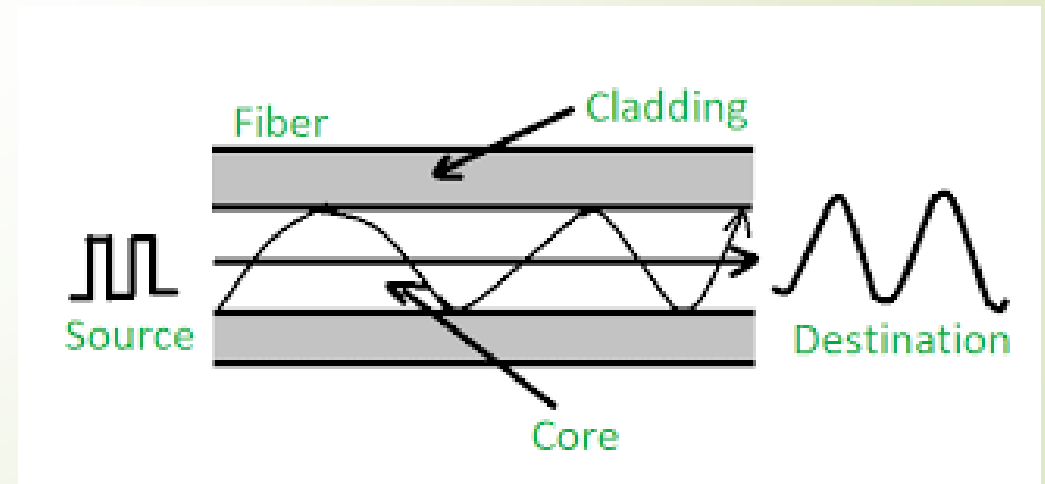
Examples of Wired media

- **Coaxial Cable:** Mainly used for audio and video communications.

- **USB Cable:** USB Stands for Universal Serial Bus. Mainly used to connect PC and smartphones.
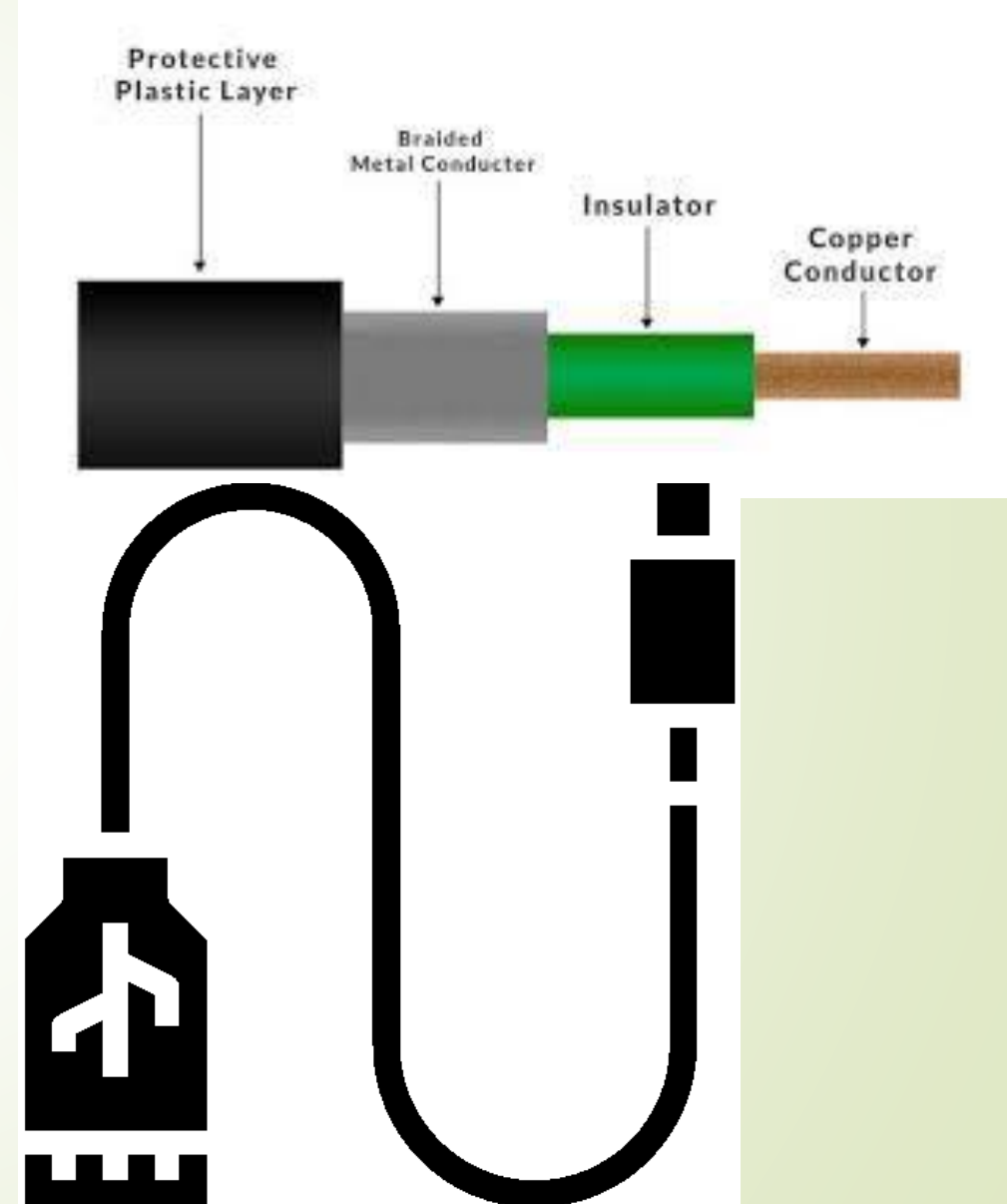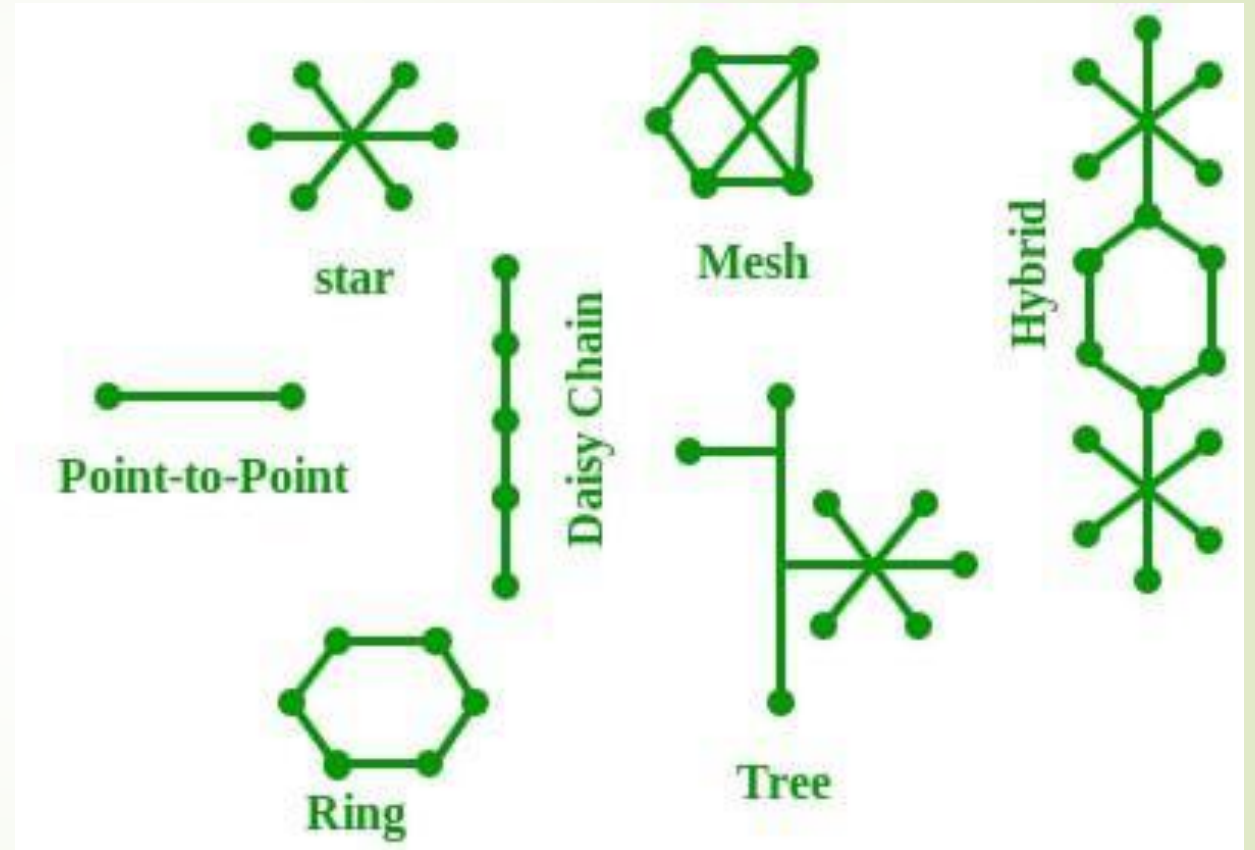
Examples of Wireless media

- **Infrared** (e.g. short-range communication – TV remote control).

- **Radio** (e.g. Bluetooth, Wi-Fi).

- **Microwaves** (e.g. Cellular system).

- **Satellite** (e.g. Long range communications – GPS).

Network Topology

The Network Topology is the layout arrangement of the different devices in a network. Common examples include Bus, Star, Mesh, Ring, and Daisy chain.

Protocol

- A protocol is a set of rules or algorithms which define the way how two entities can communicate across the network and there exists a different protocol defined at each layer of the OSI model.

- A few such protocols are TCP, IP, UDP, ARP, DHCP, FTP, and so on.

Types of Protocol

- **Network Layer Protocols** - operate in the network layer which is also known as the Layer 3 of the network architecture. Network layer protocols are responsible for packet routing, forwarding and addressing of data packets throughout the network . IP and ICMP are the network layer protocols.

- **Transport layer Protocols** - works in transport layer which provides end-to-end service ensuring data transfer across apps on different devices. TCP and UDP are the most popular transport layer protocols.
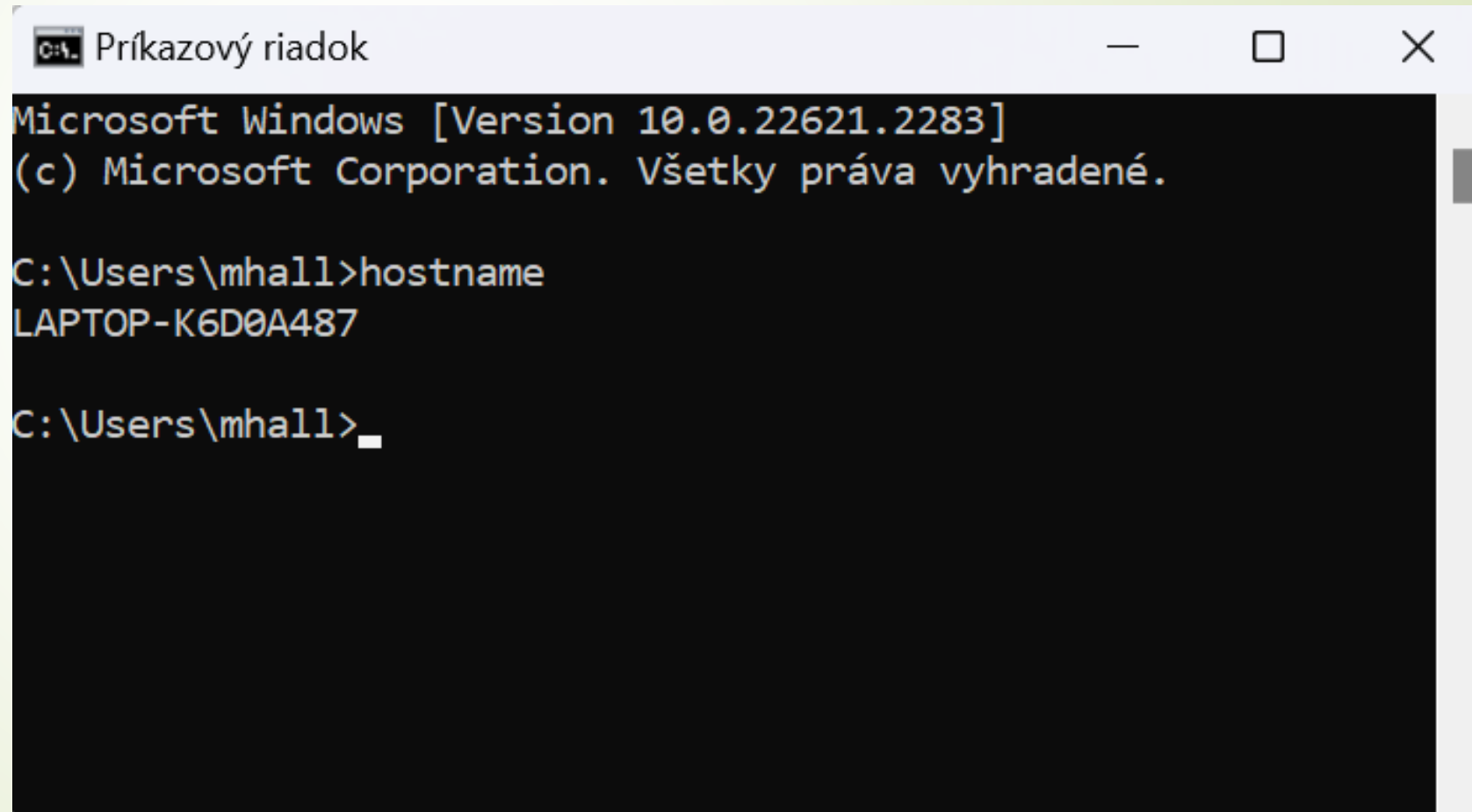
Types of Protocol

- **Application Layer Protocol** - working in the application layer of the network architecture provides communication between applications running on different devices. The application layer protocols enable cross-device communication. They format, exchange, and interpret application data. HTTP, FTP, and SMTP are examples.

- **Wireless Protocols** - basically used in wireless communication which enables data transfer through wireless networks. Bluetooth, Wi-Fi, and LTE protocols are examples.

Types of Protocol

- **Routing Protocols** - establishes the best/optimal network pathways throughout the network for fastest data transmission. Routers share information to develop and maintain routing tables. RIP, OSPF, and BGP are examples.

- **Security Protocols** - protects data confidentiality, integrity, and authenticity while transmission of data over the network. They include SSL and TLS, encryption methods, and authentication protocols for providing data security.

- **Internet Protocols** - identifies devices uniquely. Internet protocol provides data communication through routing and forwarding data packets from one device to another by unique addressing scheme.

Unique Identifiers of Network

▶ **Hostname:** Each device in the network is associated with a unique device name known as Hostname.

Unique Identifiers of Network

- **IP Address (Internet Protocol address):** Also known as the Logical Address, the IP Address is the network address of the system across the network.

- To identify each device in the world-wide-web, the Internet Assigned Numbers Authority (IANA) assigns an IPV4 (Version 4) address as a unique identifier to each device on the Internet.

- The length of an IPv4 address is 32 bits, hence, we have 232 IP addresses available. The length of an IPv6 address is 128 bits.

Unique Identifiers of Network

- **MAC Address (Media Access Control address):** Also known as physical address, the MAC Address is the unique identifier of each host and is associated with its NIC (Network Interface Card).

- A MAC address is assigned to the NIC at the time of manufacturing. The length of the MAC address is: 12-nibble/ 6 bytes/ 48 bits.

Unique Identifiers of Network

▶ Port - can be referred to as a logical channel through which data can be sent/received to an application.

▶ Any host may have multiple applications running, and each of these applications is identified using the port number on which they are running.

▶ A port number is a 16-bit integer, hence, we have 2^{16} ports available which are categorized:

Port Types	Range
Well known Ports	0 – 1023
Registered Ports	1024 – 49151
Ephemeral Ports	49152 – 65535

Other Related Concepts

➡ **DNS Server -** Domain Name System.

➡ DNS is basically a server that translates web addresses or URLs (ex: www.google.com) into their corresponding IP addresses.

➡ We don't have to remember all the IP addresses of each and every website.

How do I connect to the Internet? – Type of internet service

- **Dial-up** - this is generally the slowest type of Internet connection, and we should probably avoid it unless it is the only service available in our area. Dial-up Internet uses our phone line, so unless you have multiple phone lines you will not be able to use landline and the Internet at the same time.

- **DSL** - uses a broadband connection, which makes it much faster than dial-up. DSL connects to the Internet via a phone line but does not require to have a landline at home. And unlike dial-up, we'll be able to use the Internet and your phone line at the same time.

How do I connect to the Internet? – Type of internet service

- **Cable** - connects to the Internet via cable TV, although we do not necessarily need to have cable TV in order to get it. It uses a broadband connection and can be faster than both dial-up and DSL service; however, it is only available where cable TV is available.

- **Satellite** - uses broadband but does not require cable or phone lines; it connects to the Internet through satellites orbiting the Earth. As a result, it can be used almost anywhere in the world, but the connection may be affected by weather patterns. Satellite connections are also usually slower than DSL or cable.

How do I connect to the Internet? – Type of internet service

- **3G and 4G -** most commonly used with mobile phones, and it connects wirelessly through our ISP's network. However, these types of connections aren't always as fast as DSL or cable. They will also limit the amount of data we can use each month, which isn't the case with most broadband plans.

- **5G** - the 5th generation mobile network. It is a new global wireless standard after 1G, 2G, 3G, and 4G networks. 5G enables a new kind of network that is designed to connect virtually everyone and everything together including machines, objects, and devices.

How do I connect to the Internet? – Choosing an Internet service provider

- Internet speed is measured in bits (a single binary 1 or 0) per second.

- Internet connections can handle a lot of this data, so we usually talk about speeds in megabits per second (Mbps), which is a million bits per second.

- When speeds get really fast (1,000 Mbps or faster), we talk about them in gigabits per second (Gbps), which is a billion bits per second (1,000 Mbps = 1 Gbps).

- The fastest residential speeds currently available are in the multigigabit range, reaching as high as 5 Gbps (according to advertised speeds).

How do I connect to the Internet? – Choosing an Internet service provider

- **Download speed** - is the speed most often advertised on internet plans. It measures how fast information from the internet gets to our device (for example, how fast your Netflix show loads). It's usually measured in megabits per second (Mbps), although really fast connections are measured in gigabits per second (Gbps).

- **Upload speed** - refers to how fast information on our device can be sent to some other destination on the internet. It's simply the bandwidth available on our connection going the opposite direction.

Home networking
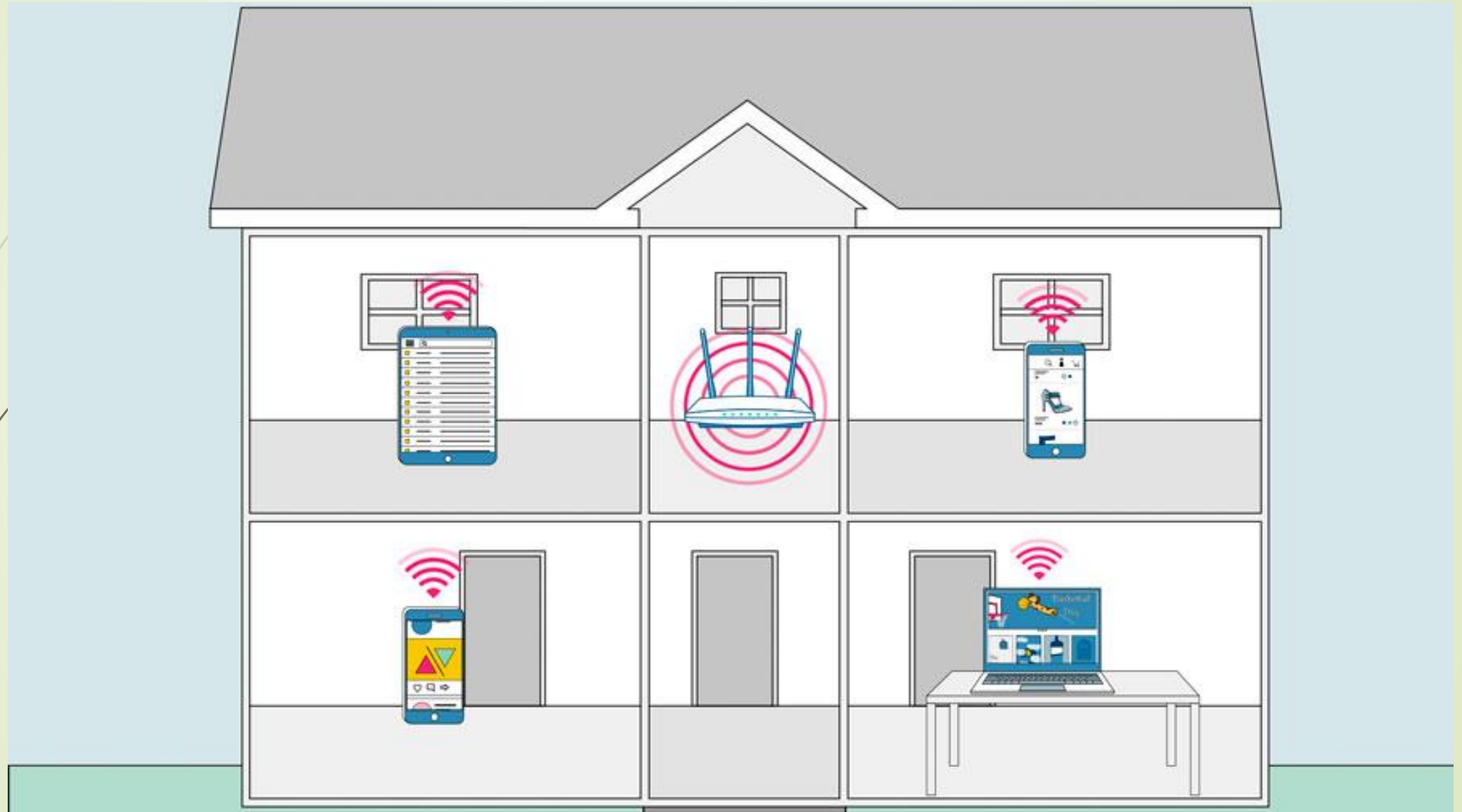
Browsing the web

- Most information on the Internet is on websites.

- A **website** is a collection of related text, images, and other resources. Websites can resemble other forms of media - like newspaper articles or television program or they can be interactive in a way that's unique to computers.

- A **web browser** allows us to connect to and view websites. The web browser itself is not the Internet, but it displays pages on the Internet. Each website has a unique address. By typing this address into our web browser, we can connect to that website and our web browser will display it.

Navigating websites

- Websites often have **links** to other sites, also called **hyperlinks**. These are often parts of the text on the website.

- Each website has a unique address, called a URL. We'll notice that when we click a link, the URL changes as our browser loads a new page. If we type a URL in the address bar in our browser, our browser will load the page associated with that URL. It's like a street address, telling our browser where to go on the Internet.

- When we're looking for specific information on the Internet, a search engine can help. A search engine is a specialized website that's designed to help us find other websites.

Thank you for your attention!