

CHAPTER 1

Networking Theory

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OUTLINE

- ❑ What is a data communication?
- ❑ How do networks communicate?
- ❑ Data Flow
- ❑ Internetworking device
- ❑ Addressing
- ❑ Network layers

What is a data communication?

- Data communication is the **transfer of data** from one device to another via some form of transmission **medium**.
- There are **two types of data transmission medium** to make a connection between devices in computer **networks**
 - Conducted medium
 - Wireless medium



NOTE

A **network** is a collection of computers, servers, mainframes, network devices, or other devices connected together to allow the sharing of data.

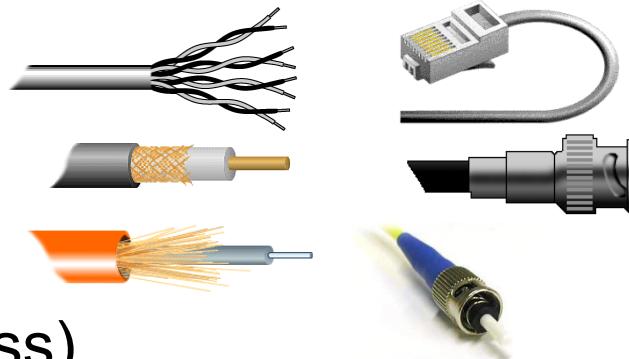
How do networks communicate?

- Connection between computers and devices: signal transmitted
Passing through one of the following medium:

- Wires and cables (conducted)

EX.

- Twisted pair wire
- Coaxial cable
- Fiber optic cable



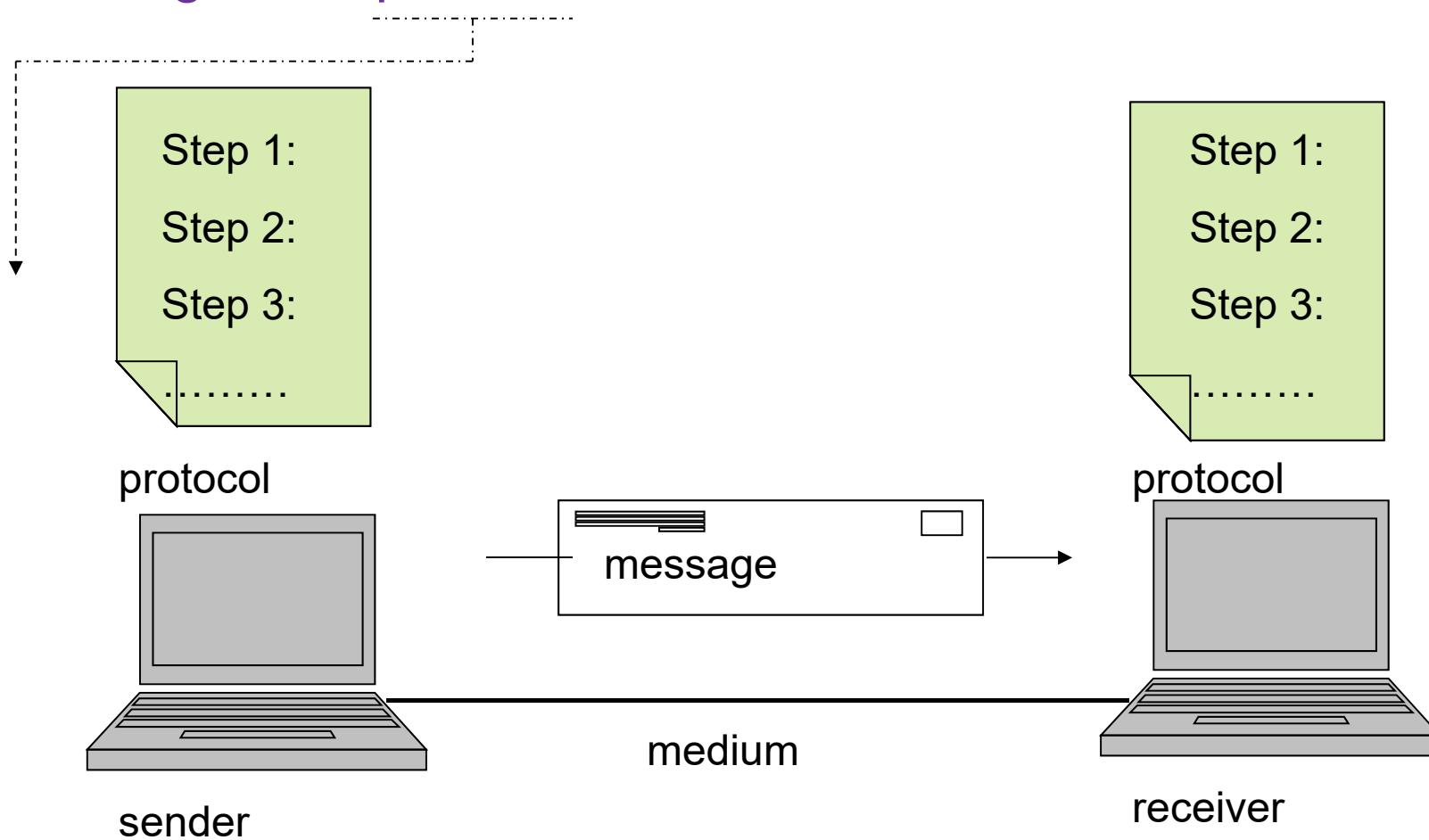
- Or through space (wireless)

EX.

- Microwave Transmission
- Satellite Transmission
- Cellular Telephone Systems
- Infrared Transmissions
- Wimax
- Bluetooth , Wi Fi

How do networks communicate?

The required Components to establish a communication link between two or more devices : sender, receiver, medium, message, and protocol



How do networks communicate?

Note:

- ❑ A **protocol** is a precise set of rules defining how computers communicate(the format of addresses, how data is split into packets, and so on).
- ❑ There are many different protocols defining different aspects of network communication.

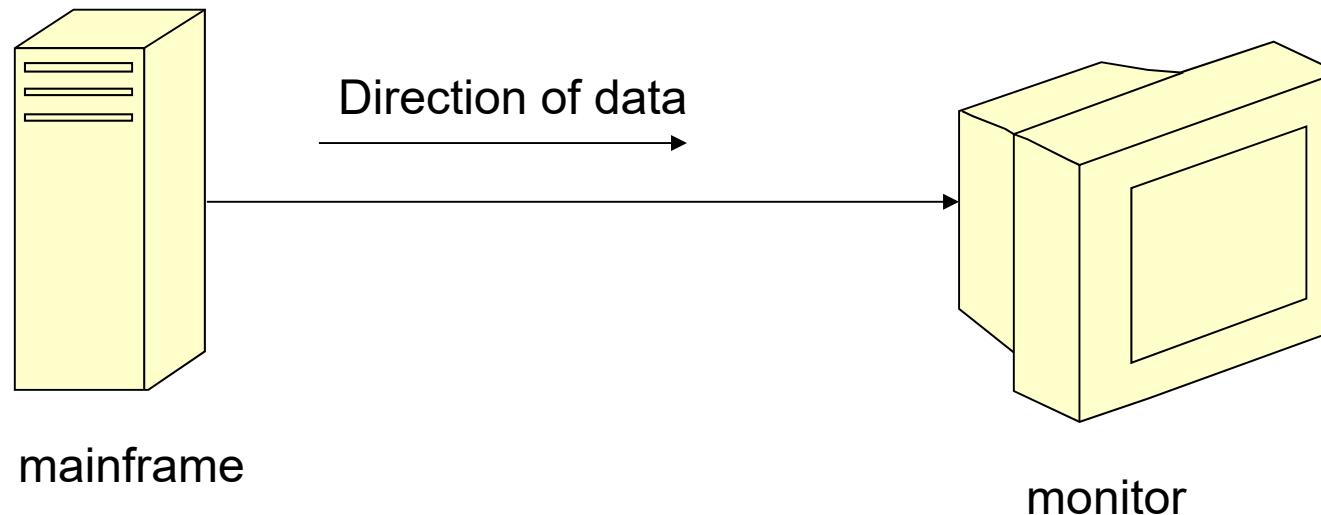
Data Flow

Data flow: transmission the data between two devices can occur in one of **three ways**:

- Simplex connection
- Half-duplex connection
- Full- duplex connection

Data Flow

Simplex



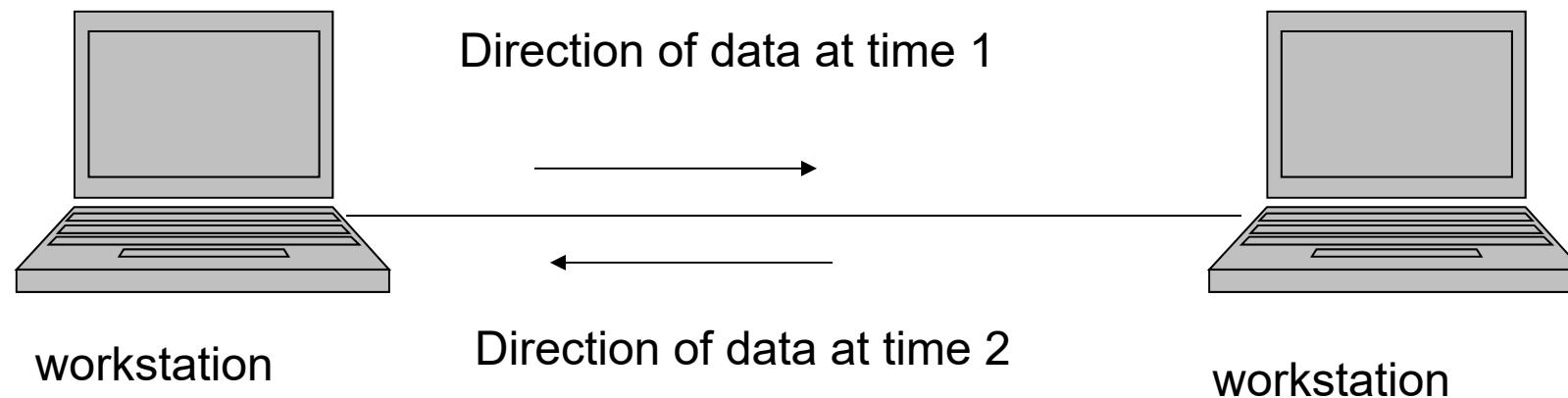
Data Flow

Simplex

- Simplex connection is established in **one** direction only.
- A good **example**: the data transmitted from your **keyboard** to your **CPU**.
- The CPU never needs to send characters to the keyboards but the **keyboards always sends** characters to the CPU.
- In many cases, **computers** almost send characters to **printers**, but printers usually not send characters to computers.
- e.g. **TV** or radio broadcasts

Data Flow

Half-Duplex



Data Flow

Half-Duplex

- In a half-duplex connection, each device can communicate to the other, but **not simultaneously**; this means the communication is in one direction at a time.
- a **walkie-talkie** is an example of a half-duplex device (two-way radio) that has a “**push-to-talk**” button ;
- when the local users want to **speak** to the remote person they **push the button**, which **turns on the transmitter but turns off the receiver** (local user cannot hear the remote person).

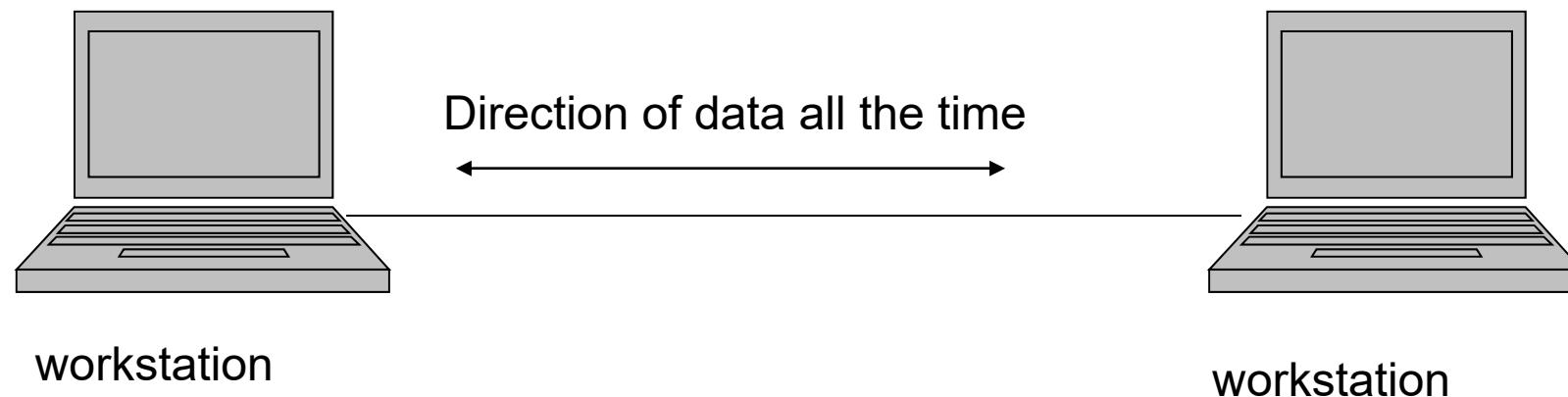
Data Flow

Half-Duplex cont.

- To listen to the remote person you need to release the button , which turns on the receiver but turns off the transmitter.
- Provide communication in both directions, but only one direction at a time (not simultaneously).

Data Flow

Full-Duplex



Data Flow

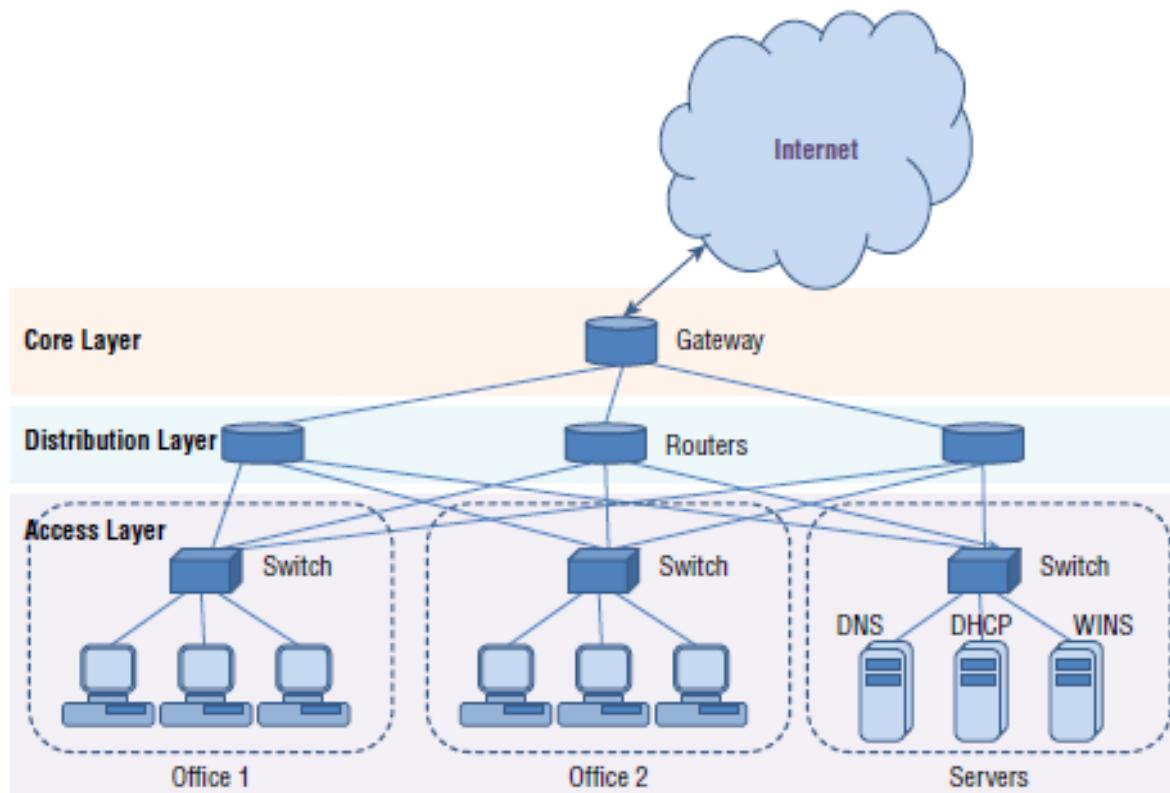
Full-Duplex

- A full duplex system, both devices can communicate to the other simultaneously (ie. communication in both directions).
- An example of a full duplex device is a telephone; the devices at both ends of a call can speak and be heard by the other device simultaneously.
- The earphone reproduces the speech of the remote device at the same time the microphone produces the speech of the local device, because there is a two-way communication channel between them.

Internetworking devices

Enterprise Network Architecture

Large organizations with huge computer networks can be classified into three layers (from top to bottom), the **Core**, **Distribution**, and **Access**.



Internetworking devices

The Access layer

- provides the network access to **end-user devices**, such as computers, printers, or servers.
- The typical networking devices are **switches**, which connect all the devices in either a **star network** topology or a **tree network** topology.

Internetworking devices

The Distribution layer

- bridges the gap between the Access layer and the Core layer.
- The typical networking devices are routers, which connect all the switches in the Access layer to the Core layer.
- The Distribution layer also provides the network connection by using mesh network topology.

Internetworking devices

The Core layer

- connects all the distribution routers together and provides the Internet access.
- The core layer is also known as the *backbone*.
- The typical networking device is a gateway router, also called the default gateway.
- Large organizations may have more than one gateway router to provide the Internet connection with more bandwidth.
- The gateway is also the place where the network proxy server.

Internetworking devices

Servers 'Key Network Components

various servers such as **DNS** (Domain Name System) and **DHCP** (Dynamic Host Configuration Protocol) servers.

- The **DNS** is another key component. The computers work based on IP addresses, but we humans are not good at remembering numbers, so we prefer names. DNS servers **translate the human-understandable domain names into machine-understandable IP addresses**, and vice versa.

Internetworking devices

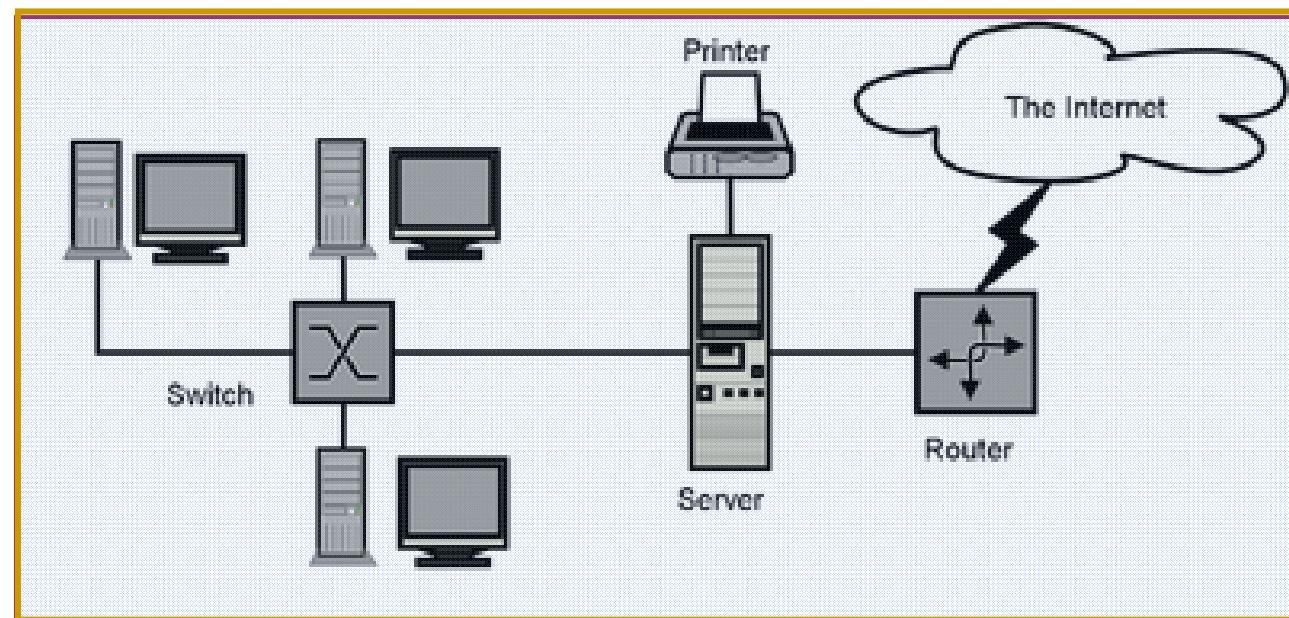
Servers 'Key Network Components

various servers such as **DNS (Domain Name System)** and **DHCP (Dynamic Host Configuration Protocol)** servers.

- The **DHCP** server automatically **provides the network configuration information for your computer**. The following **are four minimum pieces of information** you need to configure your computer to access the Internet:
 - **IP address:** **To identify the device**
 - **Subnet mask:** **To identify the subnet of the device**
 - **DNS server:** **To know where the DNS server is**
 - **Default gateway:** **To know where the gateway router is**

Internetworking devices

- An excellent example of a network is the Internet, which connects millions of people all over the world.
- Below is an example image of a home network with multiple computers and other **network devices** that are connected to each other and to the Internet.



Internetworking devices

- The different types of computers (clients and servers) can be communicated using the following **interconnected devices** (network device)

Internetworking devices	
● Hubs	● Gateways
● Repeaters	● Wireless access points (WAPs)
● Bridges	● Modems
● Switches	● Firewalls
● Routers	
●	

Types of network devices



Access point

An AP is a device that sends and receives data wirelessly over radio frequencies.



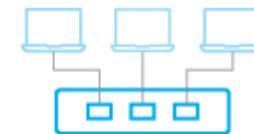
Bridge

A network bridge acts as an interconnection between two LANs, creating a single network from separate LANs.



Gateway

A gateway connects discrete networks and translates packet data so it can travel between the systems.



Hub

A hub joins multiple devices on the same LAN, broadcasting messages to all ports without examining frames.



Modem

A modem modulates and demodulates signals between devices, such as analog to digital.



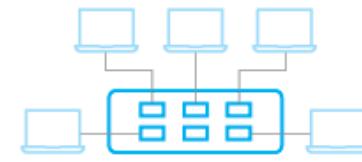
Repeater

A repeater strengthens a signal and retransmits it along to its destination.



Router

A router directs data requests from one network to another, using a packet's IP address to forward it to its destination.

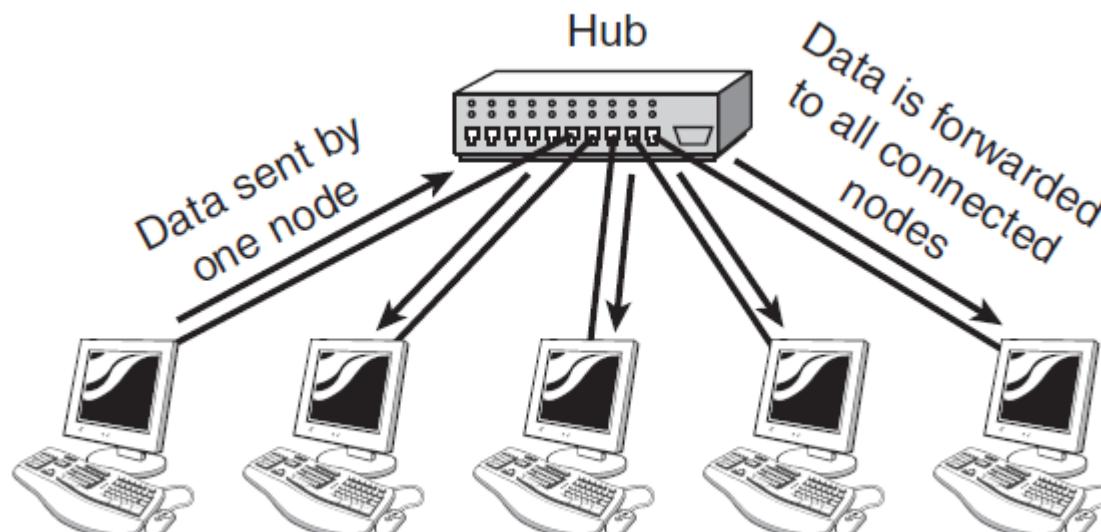


Switch

A network switch forwards data to its proper destination, examining a packet's MAC address info to determine the intended device.

Hub

- A hub works in the **physical layer** of the OSI model.
- It is basically a **non-intelligent device** (has no decision making capability).
- Example to explain what is the function of the hub
 - it takes the input data from one of the ports and **broadcast the information to all the other ports** connected to the networks
 -



Hub

- **Example:** assume we have **4 computers** connected to the **4** ports of the **hub**. Suppose, if computer **A** want to send data to computer **B**, then computer **A** broadcasts the data on the network, and computer **B** being connected to the network has access to the data.
 - But in this case, all the other ports connected to the network has access to the data that is being transmitted by computer **A**

Hub

- Hubs cannot filter data, so data packets are sent to all connected devices.
- Hubs do not have intelligence to find out best path for data packets which leads to inefficiencies.



Repeater

- A repeater is a device **similar to the hub** (has all the features of a hub), but has additional features.
- It also works in the **physical layer**.
- The repeaters are used in places where **regeneration of input signal** is necessary.
- To understand, why The repeaters are necessary???, during the transmission of the signals over a long distances, **the signal may be attenuated, (delayed or received with distortions and noise)** which lead to losing of data.
- Hence, the repeater **regenerates the weak signal** in order to prevent attenuation.

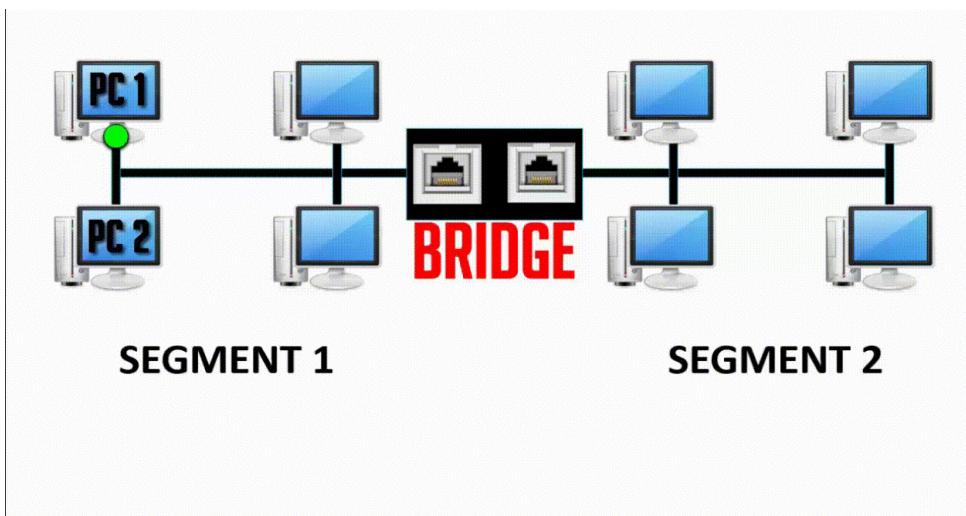
Repeater

- An important point to be noted about repeaters is that they **do not amplify** the signal.
- When the signal becomes weak, they **copy the signal bit by bit** and **regenerate** it at the original strength.
- It is a **two port** device.



Bridge

- A device that **connects two local-area networks (LANs)**, or two segments of the same LAN .
- The two LANs being connected can be **similar or dissimilar**
- the bridge connects the two subnets and **manages the traffic flow between them.**
- A bridge operates at **data link layer**.

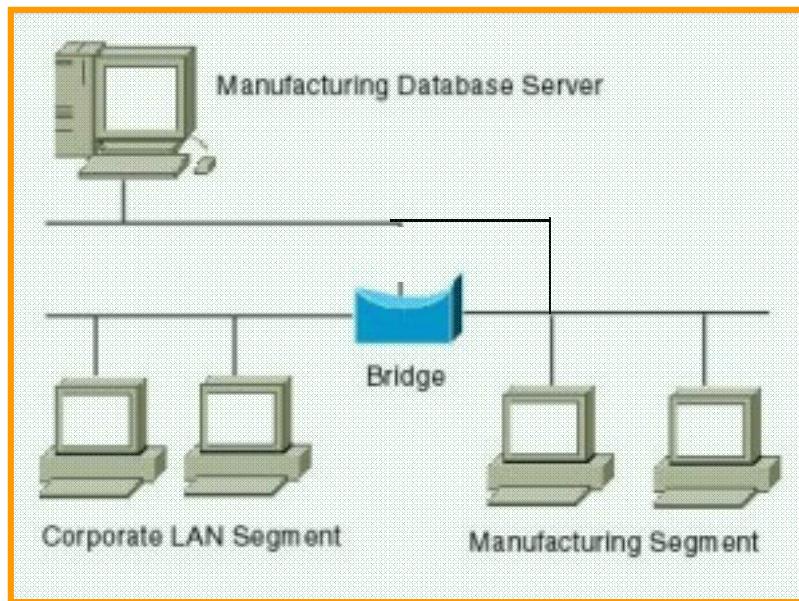


How Bridge works in Network

example, Here PC 1 tries to send data to PC 2. Data will first travel to the bridge. The bridge will read its **MAC address** and decide whether to send the data to segment 1 or segment 2. Hence, the PC 2 is available in segment 1 means bridge will broadcast the data only in segment 1 and excludes all the PCs connected in segment 2. Like this **bridge reduce the traffic on a computer network.**

Bridge

- A bridge is a repeater, with add on functionality by reading the **MAC addresses** of source and destination.
- It has a single input and single output port, thus making it a two port device.



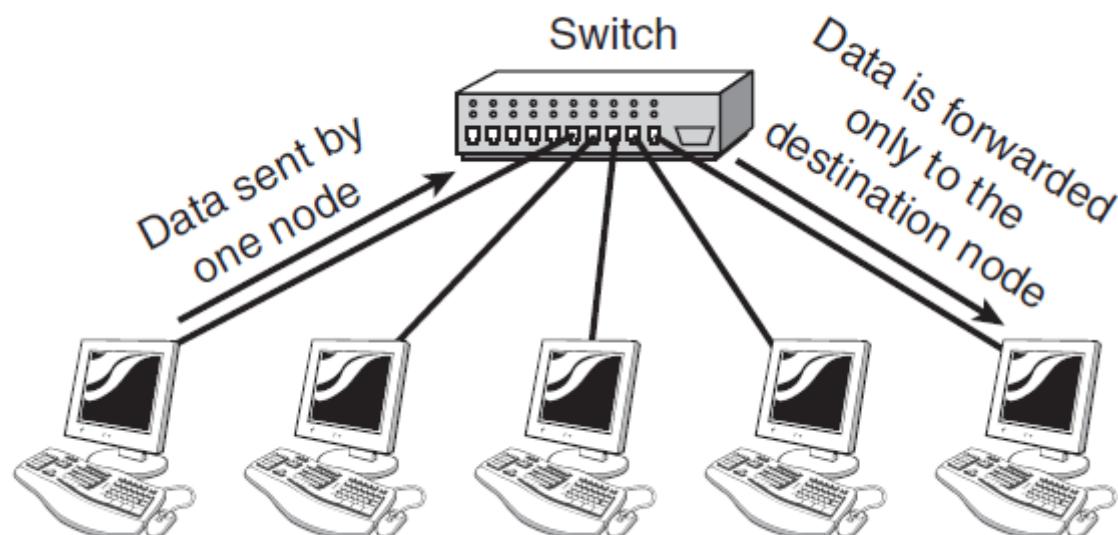
Switch

- A switch is an **intelligent device** that works in the **data link layer**.
- The **term intelligent** refers to the **decision making** capacity of the switch.
- It has knowledge of the **MAC addresses** of the ports in the network.

Switch

❑ **Example**, if data has to be **sent** from computer **A** to computer **B**, then, the data is transferred **to** the computer **B** only, and **not to any other computers** connected on the network.

- Hence, it establishes a link between the sender and the receiver based on the **MAC addresses**



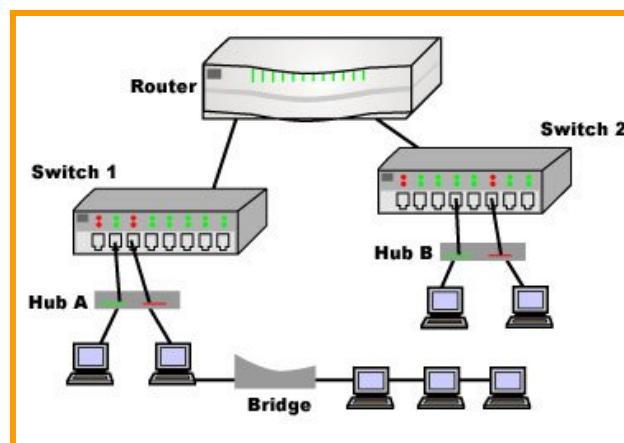
Switch

- A switch is a **multi port bridge with a buffer** (large number of ports imply less traffic).
- Switch can perform **error checking** before forwarding data (i.e. it does not forward **packets** that have errors and forward the good selected packets to correct port only).



Router

- A device that connects *different networks* (any number of LANs with WANs).
- Routers use **headers** and a forwarding table to determine where packets go.
- Routers perform routing functions to find **the best route** between any two hosts.
- routers use the **software-configured network address** to make decisions (Unlike bridges and switches, which use the **hardware-configured MAC address** to determine the destination of the data).



Router

- Router is working in a Network Layer.
- Routers have a dynamically updating routing table based on making decisions of routing the data packets.

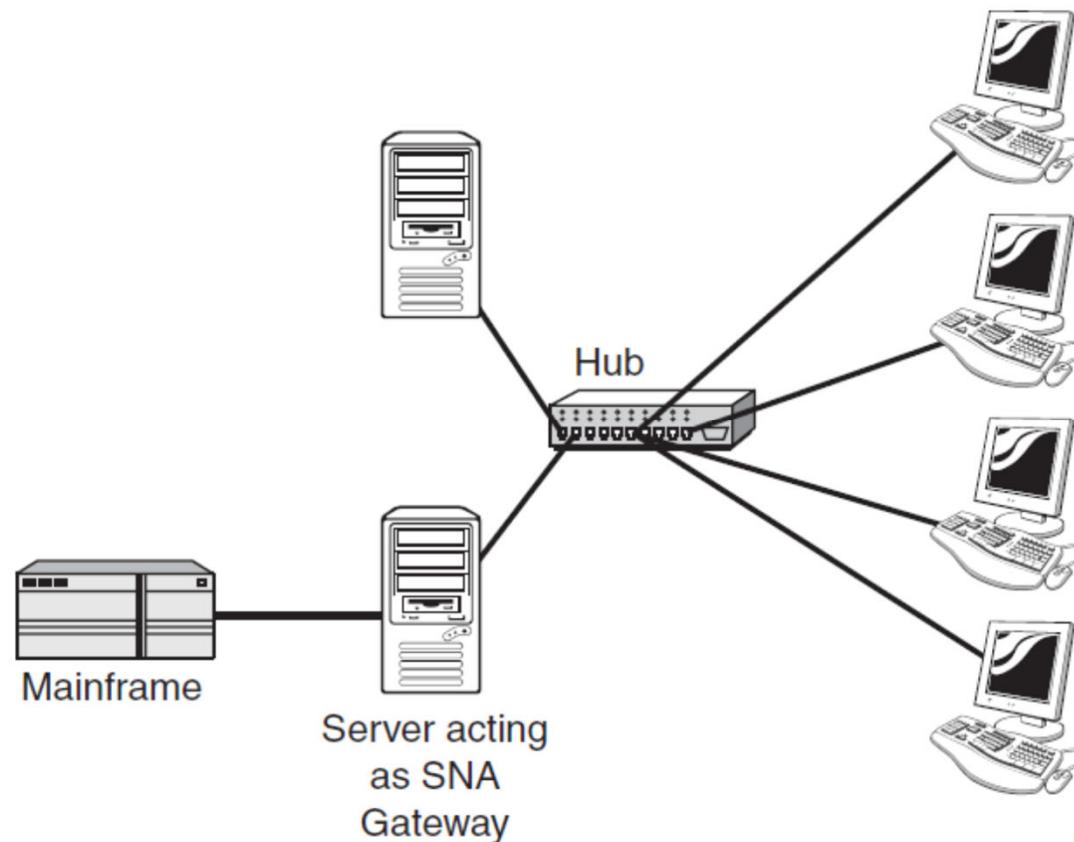


Gateways

- The term gateway is applied to any device, or software application that can perform the function of translating data from one format to another.
- The key feature of a gateway is that it converts the format of the data, not the data itself.
- good example of a gateway involves the Systems Network Architecture (SNA) gateway, which converts the data format used on a PC to that used on an IBM mainframe or minicomputer.

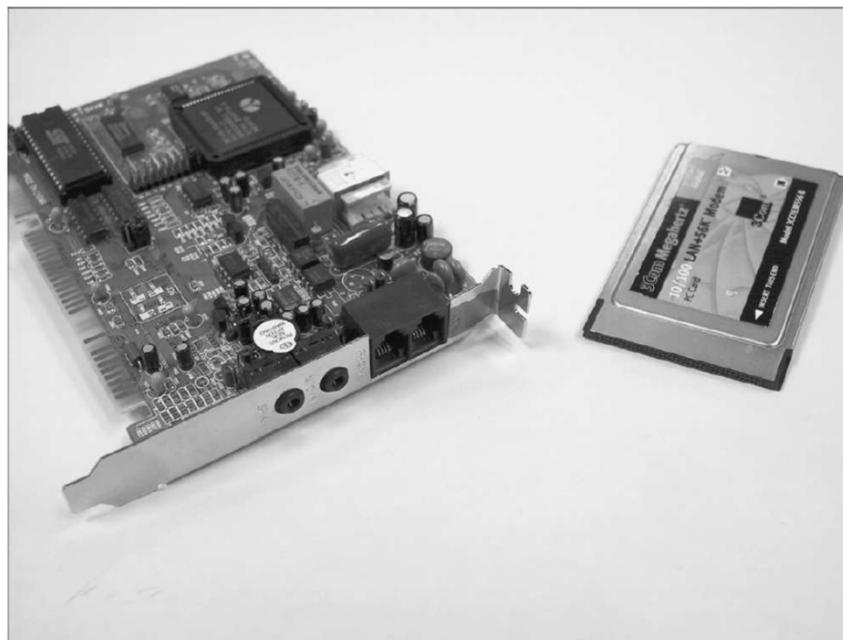
Gateways

- A system that acts as an SNA gateway sits **between** the client PC and the mainframe and translates requests and replies from both directions.



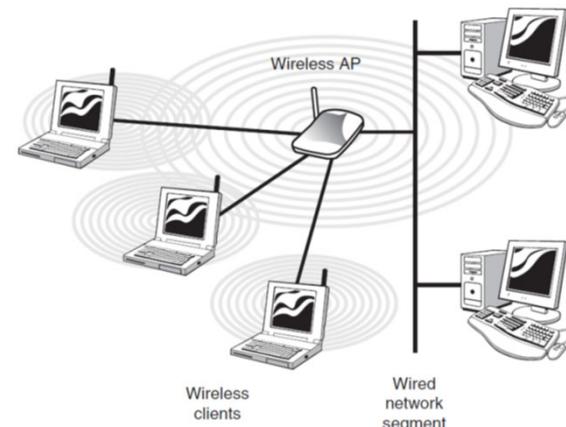
Modems

- Modem is a contraction of the terms **modulator** and **demodulator**.
- Modems perform a simple function: They translate digital signals from a computer into analog signals that can travel across conventional phone lines.
- The modem **modulates** the signal at the **sending end** and **demodulates** at the receiving end.



Wireless Access Point (WAP)

- Wireless access points, referred to as WAPs are a transmitter and receiver (transceiver) device used for wireless LAN (WLAN) radio signals.
- A WAP is typically a separate network device with a built-in antenna, transmitter, and adapter and works on data link layer
- WAPs use the wireless network mode to provide a connection point between WLANs and a wired Ethernet LAN.
- WAPs also typically have several ports allowing a way to expand the network to support additional clients.

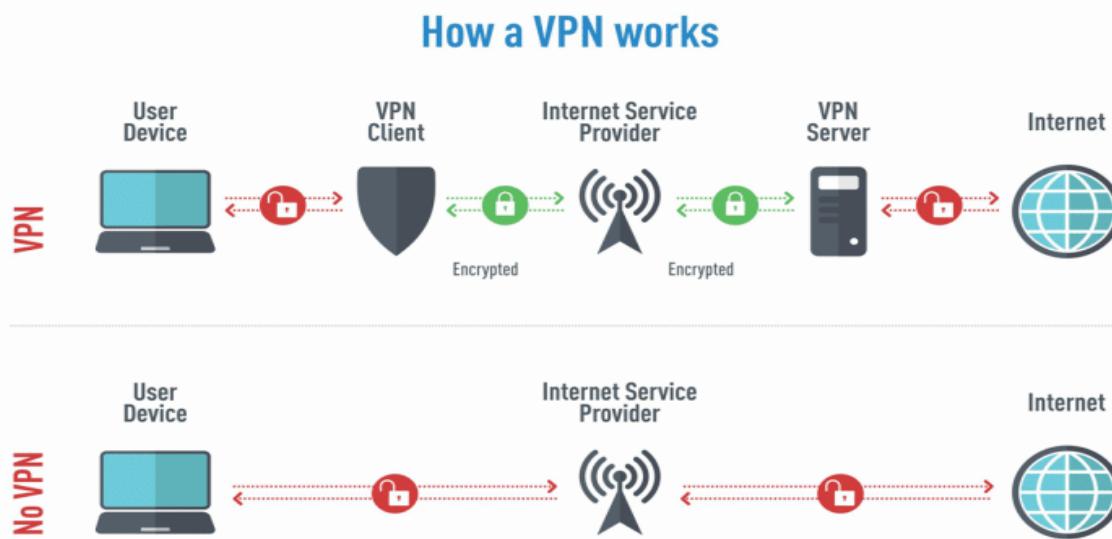


Firewalls

- A firewall is a **networking device**, either hardware or software program.
- Firewall **prevents unauthorized access** to a private network.
- All traffic must pass through the firewall and **only authorized traffic** must pass.
- It is a system **located between two networks** where it implements **an access control policy** between those networks.
- It works on **network layer** and uses encryption to encrypt the data before transmission such as **VPN Firewall Router**.

VPN

- VPN stands for "**Virtual Private Network**" and is used to establish a **protected network connection** when using public networks (external network).
- VPNs **encrypt** your internet traffic (The **encryption** takes place in **real time**) and **mask or hide** your online identity.
- This makes it more difficult for third parties (**hackers**) to track your activities online and steal data.



THE END

END

