University of Technology

Biomedical Engineering Department

First year

2nd lecture

Of

Principles of computer engineering and Programming methodology

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Data Communication & Computer Network

Data communications refers to the transmission of data between two or more computers. A computer network is a telecommunications network that allows computers to exchange data. The physical connection between networked computing devices is established using either cable media or wireless media. The best-known computer network is the Internet.

1. Computer Network Types

Generally, networks are distinguished based on their geographical span. A network can be as small as distance between your mobile phone and its Bluetooth headphone and as large as the internet itself, covering the whole geographical world.

1) Personal Area Network

A Personal Area Network (PAN) is smallest network which is very personal to a user. PAN has connectivity range up to 10 meters. PAN may include wireless computer keyboard and mouse, Bluetooth enabled headphones and wireless printers.

2) Local Area Network

Local Access Network (LAN) is a short-distance network. It connects computers that are close together, usually within a room or a building. Very rarely, a LAN network will span a couple of buildings. An example of a LAN network is the network in a school or an office building. A LAN network doesn’t need a router to operate.

3) Wide Area Network

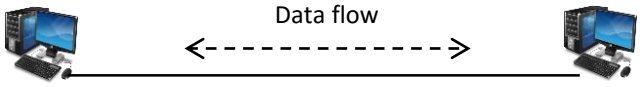
Wide Area Network (WAN) cover a huge geographical area. A WAN is a collection of LAN networks. LANs connect to other LANs with the help of a router to create WAN.

2. Computer Network Topologies

A Network Topology is the arrangement with which computer systems or network devices are connected to each other.

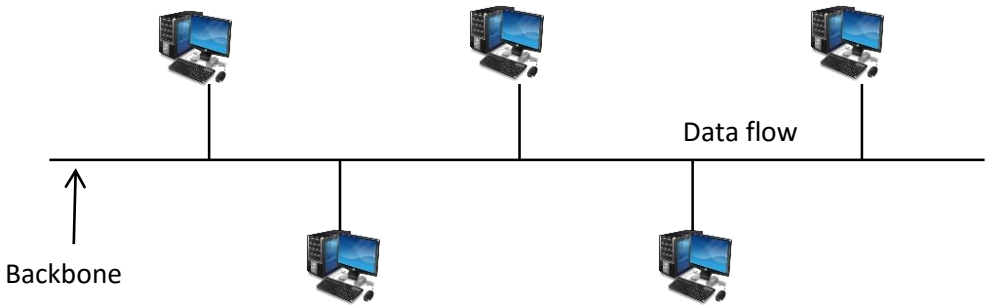
1) Point-to-Point

Point-to-point networks contain exactly two computers.



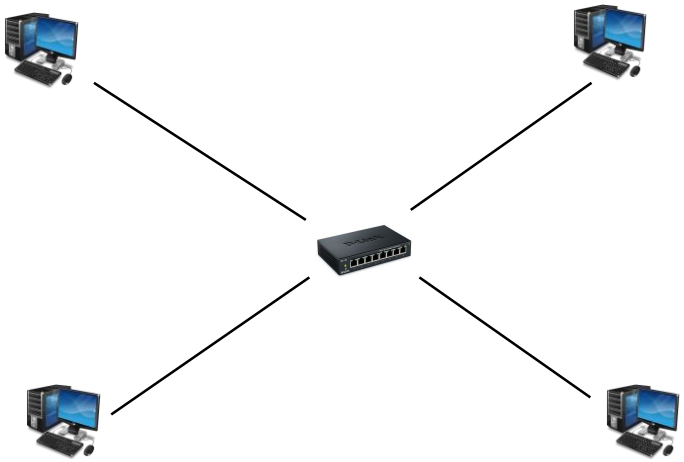
2) Bus Topology

In case of Bus topology, all devices share single communication line or cable called backbone.



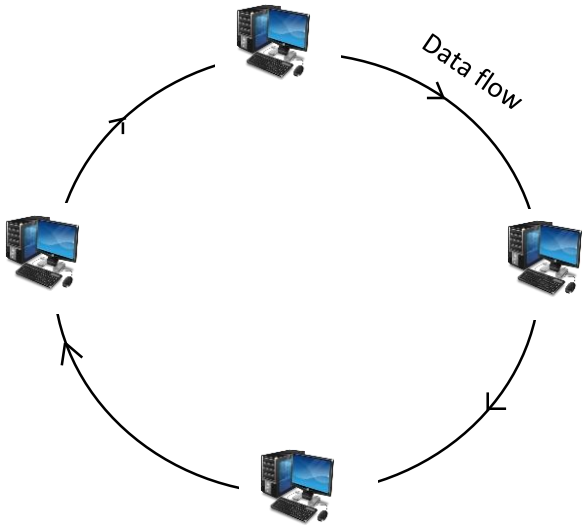
3) Star Topology

All hosts in Star topology are connected to a central device, known as hub or switch device.



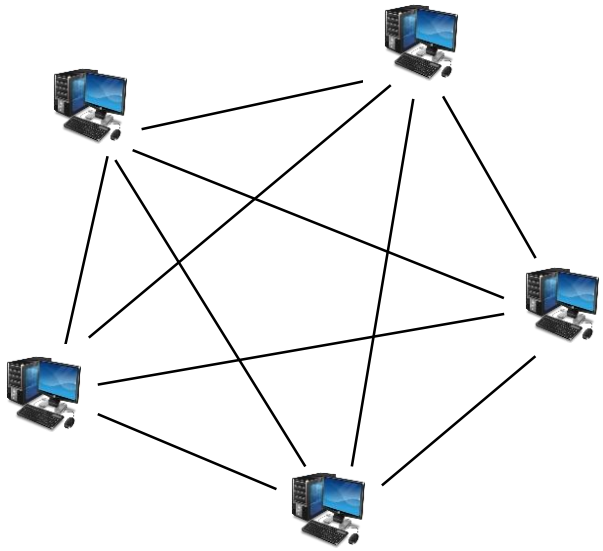
4) Ring Topology

In ring topology, each host machine connects to exactly two other machines, creating a circular network structure. When one host tries to communicate or send message to a host which is not adjacent to it, the data travels through all intermediate hosts.



5) Mesh Topology

In this type of topology, a host is connected to one or multiple hosts. This topology has hosts in point-to-point connection with every other host.



3. Transmission Media

The media over which the information between two computer systems is sent called transmission media. Transmission media comes in two forms.

First: - Guided Media

All communication wires/cables are guided media, such as Twisted Pair Cable, coaxial cables, and fiber Optics. In this media, the sender and receiver are directly connected and the information is send (guided) through it.

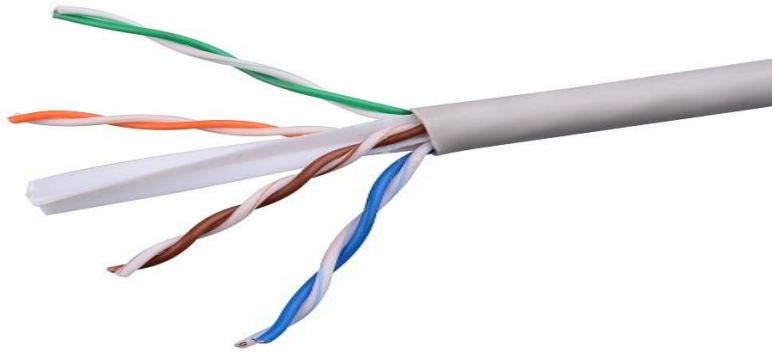
1) Twisted Pair Cable:

Twisted pair cabling is a type of wiring. There are two types Shielded Twisted Pair (STP) and unshielded Twisted pair (UTP). The UDP is used in Cat.6 cables.

Cat 6 cable: Category 6 cable, commonly referred to as Cat 6, is a standardized cable for Ethernet, Fast Ethernet and Gigabit Ethernet.

Cat 6 cables consist of four unshielded twisted pairs (UTP) of copper wire terminated by *RJ45* connectors.

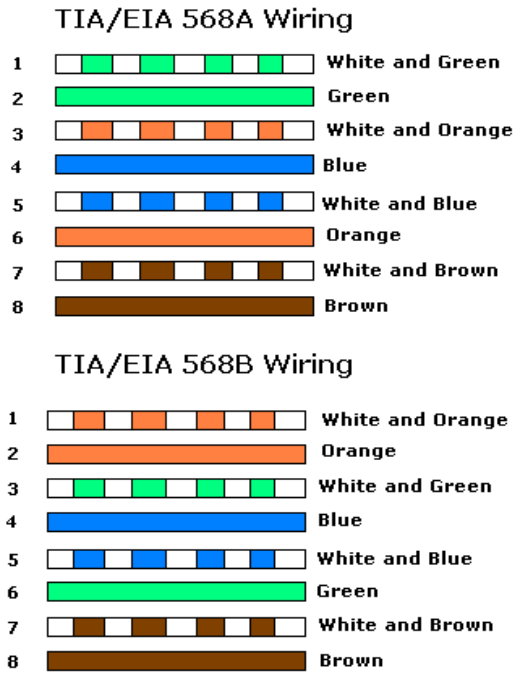
Where RJ45 refer to Registered Jack 45, an eight-wire connector used commonly to connect computers to local area networks (LAN), especially **Ethernets**.



Cat 6 cable

RJ45 connector

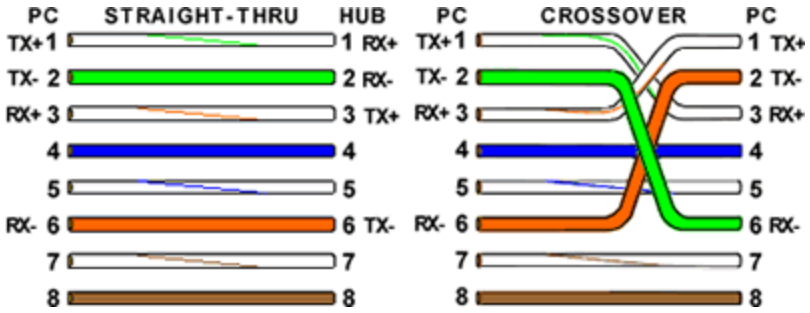
There are two standards for Cat6 wiring arrange in RJ45, they are T-568A and T-568B



Crossover and **straight through cable**

An Ethernet *crossover cable* is a type of Ethernet cable used to connect computing devices together directly. It is most often used to connect two devices of the *same type*, such as two computers or two switches connect to each other. By contrast *straight through* cables are used to connect devices of *different types*, such as a computer or router to switch or hub.

The RJ45 termination use T568A or T568B for straight cable, while for crossover cable, use T-568A at one end and T-568B at the other end of cat6 cable.



2) Coaxial Cable

A type of wire that consists of a center wire surrounded by insulation and then a grounded shield of braided wire. The shield minimizes electrical and radio frequency interference.

Coaxial cabling is the primary type of cabling used by the cable television industry and is also widely used for computer networks, such as Ethernet.

3) Fiber Optics

An optical fiber cable is a cable containing one or more optical fibers that are used to carry light. This cable is used for long distance telecommunication or providing a high-speed data connection between different parts of a building.

<u>Second</u>: - Unguided Media

Wireless is said to be unguided media, because there is no connectivity between the sender and receiver. Information is spread over the air, and anyone within wireless signals range may collect the information e.g. radio transmission.

4. Networking hardware

1) **Hub** is a network hardware device for connecting multiple devices together and making them act as a single network segment. It has multiple input/output (I/O) ports, in which a signal introduced at the input of any port appears at the output of every port except the original incoming. The hub broadcast the data to all devices connected to its ports.

2) **Switch** is a computer networking device that connects devices together in *single network*, by using packet switching to receive, process and forward data to the destination device(s) that locate in same LAN. Unlike hubs, a network switch forwards data only to one or multiple devices that need to receive it, rather than broadcasting the same data out to all its ports.

3) **Router** is a device that forwards data packets along networks. A router is connected to at least two networks, commonly two LANs or WANs or a LAN and its ISP's network. Routers are located at gateways, the places where two or more networks connect.

   To forward the data packet to specific destination the *routing table* used for data packet journey through network.

4) **Wireless access point (WAP)** is a networking hardware device that allows wireless devices to connect to a wired network using Wi-Fi, or related standards. The WAP can be integral component of the router.

5. Open System Interconnection (OSI)

The ***O**pen **S**ystem **I**nterconnection (OSI*) model defines *a networking framework to implement protocols in seven layers*. In the OSI model, control is passed from one layer to the next, starting at the application layer in one station (e.g. computer), and proceeding to the bottom layer, over the channel to the next station and back up the hierarchy.

The OSI Model is *not tangible* there is really nothing to the OSI model. The OSI model doesn't perform any functions in the networking process. It is a *conceptual framework* so we can better understand complex interactions that are happening.

Application (Layer 7)

OSI Model, Layer 7, supports application and end-user processes. This layer provides application services for file transfers, e-mail, and other network software services.

Presentation (Layer 6)

This layer provides independence from differences in data representation by translating from application to network format, and vice versa.

Session (Layer 5)

This layer establishes, manages and terminates connections between applications. The session layer sets up, coordinates, and terminates conversations, exchanges, and dialogues between the applications at each end.

Transport (Layer 4)

OSI Model, Layer 4, provides transparent transfer of data between end systems, or hosts, and is responsible for end-to-end error recovery and flow control. It ensures complete data transfer.

The best-known transport protocol is Transmission Control Protocol (TCP), and User Datagram Protocol UDP.

TCP is a connection-oriented protocol, The TCP consider **Reliable** connection due to TCP follow the *acknowledgment*, *retransmission* and *timeout* for messages during transmission.

UDP is a simpler message-based connectionless protocol. The UDP is **Unreliable** because when a UDP message is sent, it cannot be known if it will reach its destination, which means there is no acknowledgment or retransmission message.

Network (Layer 3)

Layer 3 provides switching and routing technologies, creating logical paths, known as virtual circuits, for transmitting data from node to node. Routing and forwarding are functions of this layer, as well as addressing, error handling, congestion control and packet sequencing. The Internet Protocol (IP) as an example for this layer.

IP address

An Internet Protocol address (IP address) is a numerical label assigned to each device (e.g. computer, printer). IP address represent as a unique ID to that device.

IP versions

Two versions of the Internet Protocol (IP) are in use: IP Version 4 (IP_{V4}) and IP Version 6 (IP_{V6}).

Each version defines an IP address differently.

IP_{V4} addresses

1) The IP contain 32 bits divided to 4 section (eight-digit binary “8 bits” in each section) separated by dot (.)
2) Each section can be any number between 0 – 255 (e.g. 192.16.0.2)

IPV6 addresses

3) The IP contain 128 bits divided to 8 section (four hexadecimal digits “16 bits” in each section) separated by colons (:)
4) example, 2001:0db8:85a3:0000:0000:8a2e:0370:7334

Data Link (Layer 2)

At OSI Model, Layer 2, data packets are encoded and decoded into bits. It furnishes transmission management and handles errors in the physical layer, flow control and frame synchronization.

The data link layer is divided into two sub layers: The Media Access Control (MAC) layer and the Logical Link Control (LLC) layer.

Physical layer (Layer 1)

Physical layer is the only layer of OSI network model which actually deals with the physical connectivity of two different stations. This layer defines the hardware equipment, cabling, wiring, frequencies, pulses used to represent binary signals etc. Physical layer provides its services to Data-link layer.