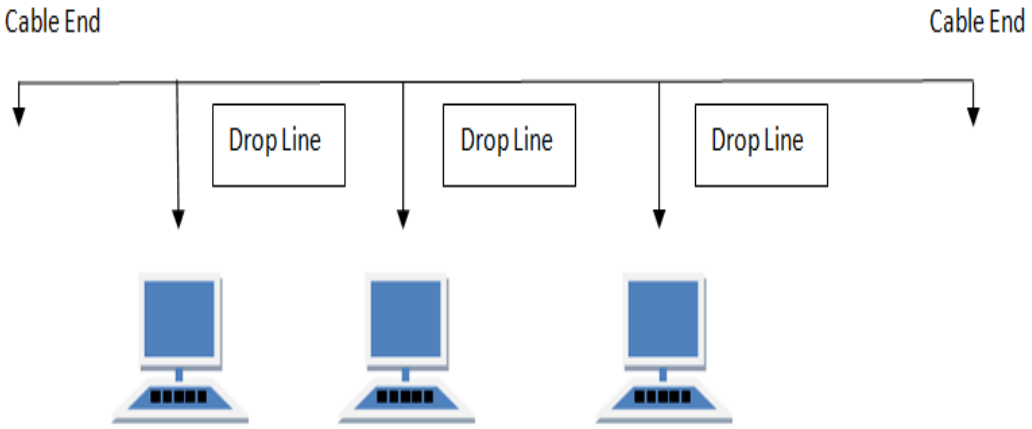
Types of Network Topology

Network Topology is the schematic description of a network arrangement, connecting various nodes (sender and receiver) through lines of connection.

BUS Topology

Bus topology is a network type in which every computer and network device is connected to single cable. When it has exactly two endpoints, then it is called **Linear Bus topology**.



Features of Bus Topology

1. It transmits data only in one direction.
2. Every device is connected to a single cable

Advantages of Bus Topology

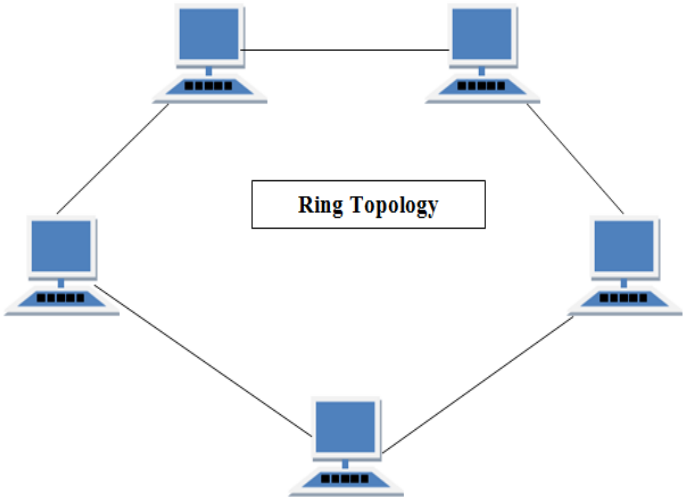
1. It is cost effective.
2. Cable required is least compared to other network topology.
3. Used in small networks.
4. It is easy to understand.
5. Easy to expand joining two cables together.

Disadvantages of Bus Topology

1. Cables fails then whole network fails.
2. If network traffic is heavy or nodes are more the performance of the network decreases.
3. Cable has a limited length.
4. It is slower than the ring topology.

RING Topology

It is called ring topology because it forms a ring as each computer is connected to another computer, with the last one connected to the first. Exactly two neighbors for each device.



Features of Ring Topology

1. A number of repeaters are used for Ring topology with large number of nodes, because if someone wants to send some data to the last node in the ring topology with 100 nodes, then the data will have to pass through 99 nodes to reach the 100th node. Hence to prevent data loss repeaters are used in the network.
2. The transmission is unidirectional, but it can be made bidirectional by having 2 connections between each Network Node, it is called **Dual Ring Topology**.
3. In Dual Ring Topology, two ring networks are formed, and data flow is in opposite direction in them. Also, if one ring fails, the second ring can act as a backup, to keep the network up.
4. Data is transferred in a sequential manner that is bit by bit. Data transmitted, has to pass through each node of the network, till the destination node.

Advantages of Ring Topology

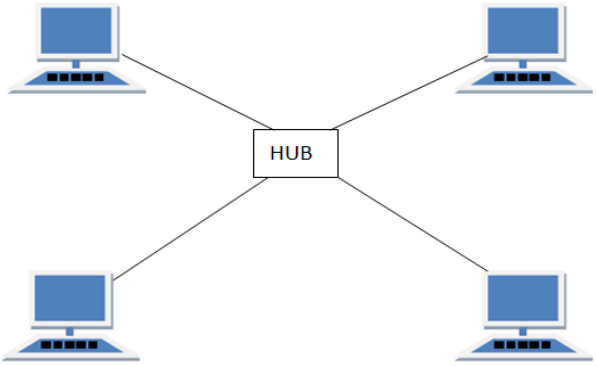
1. Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
2. Cheap to install and expand

Disadvantages of Ring Topology

1. Troubleshooting is difficult in ring topology.
2. Adding or deleting the computers disturbs the network activity.
3. Failure of one computer disturbs the whole network.

STAR Topology

In this type of topology all the computers are connected to a single hub through a cable. This hub is the central node and all others nodes are connected to the central node.



Features of Star Topology

1. Every node has its own dedicated connection to the hub.
2. Hub acts as a repeater for data flow.
3. Can be used with twisted pair, Optical Fiber or coaxial cable.

Advantages of Star Topology

1. Fast performance with few nodes and low network traffic.
2. Hub can be upgraded easily.
3. Easy to troubleshoot.
4. Easy to setup and modify.
5. Only that node is affected which has failed, rest of the nodes can work smoothly.

Disadvantages of Star Topology

1. Cost of installation is high.
2. Expensive to use.
3. If the hub fails then the whole network is stopped because all the nodes depend on the hub.
4. Performance is based on the hub that is it depends on its capacity

MESH Topology

It is a point-to-point connection to other nodes or devices. All the network nodes are connected to each other. Mesh has `n(n-1)/2` physical channels to link `n` devices.

There are two techniques to transmit data over the Mesh topology, they are :

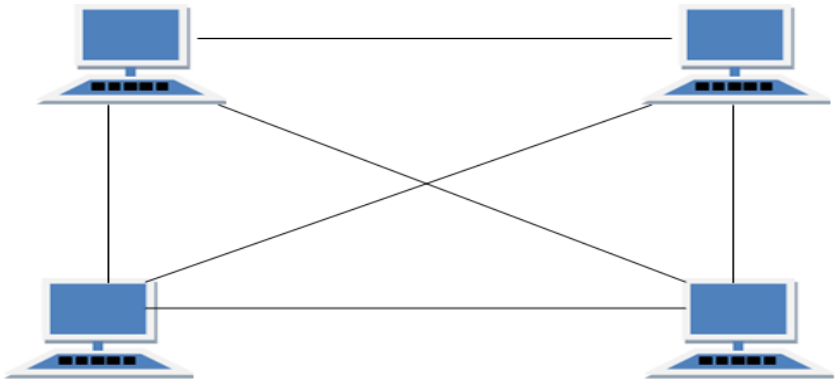
1. Routing
2. Flooding

MESH Topology: Routing

In routing, the nodes have a routing logic, as per the network requirements. Like routing logic to direct the data to reach the destination using the shortest distance. Or, routing logic which has information about the broken links, and it avoids those node etc. We can even have routing logic, to re-configure the failed nodes.

MESH Topology: Flooding

In flooding, the same data is transmitted to all the network nodes, hence no routing logic is required. The network is robust, and the its very unlikely to lose the data. But it leads to unwanted load over the network.



Types of Mesh Topology

1. **Partial Mesh Topology :** In this topology some of the systems are connected in the same fashion as mesh topology but some devices are only connected to two or three devices.
2. **Full Mesh Topology :** Each and every nodes or devices are connected to each other.

Features of Mesh Topology

1. Fully connected.
2. Robust.
3. Not flexible.

Advantages of Mesh Topology

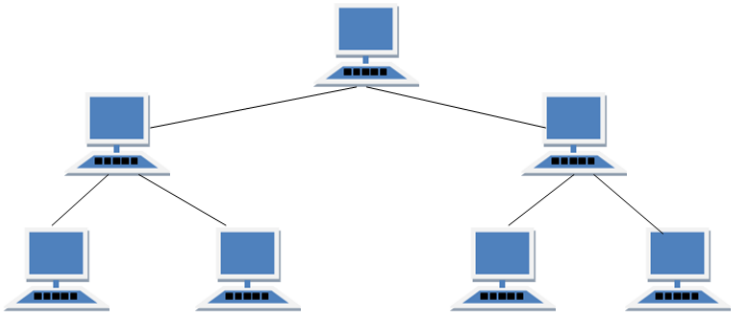
1. Each connection can carry its own data load.
2. It is robust.
3. Fault is diagnosed easily.
4. Provides security and privacy.

Disadvantages of Mesh Topology

1. Installation and configuration is difficult.
2. Cabling cost is more.
3. Bulk wiring is required.

TREE Topology

It has a root node and all other nodes are connected to it forming a hierarchy. It is also called hierarchical topology. It should at least have three levels to the hierarchy.



Features of Tree Topology

1. Ideal if workstations are located in groups.
2. Used in Wide Area Network.

Advantages of Tree Topology

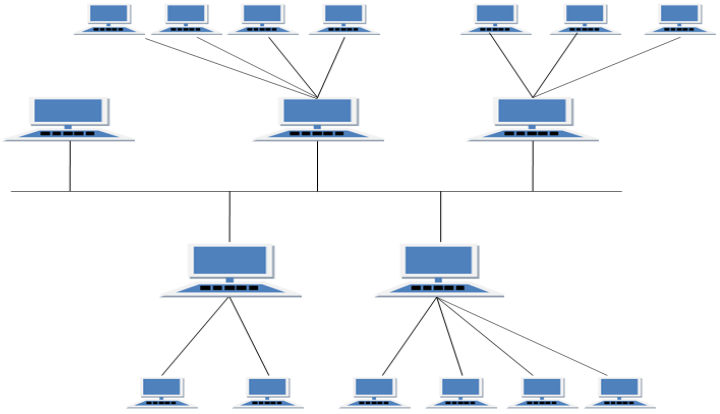
1. Extension of bus and star topologies.
2. Expansion of nodes is possible and easy.
3. Easily managed and maintained.
4. Error detection is easily done.

Disadvantages of Tree Topology

1. Heavily cabled.
2. Costly.
3. If more nodes are added maintenance is difficult.
4. Central hub fails, network fails.

HYBRID Topology

It is two different types of topologies which is a mixture of two or more topologies. For example if in an office in one department ring topology is used and in another star topology is used, connecting these topologies will result in Hybrid Topology (ring topology and star topology).



Features of Hybrid Topology

1. It is a combination of two or topologies
2. Inherits the advantages and disadvantages of the topologies included

Advantages of Hybrid Topology

1. Reliable as Error detecting and trouble shooting is easy.
2. Effective.
3. Scalable as size can be increased easily.
4. Flexible.

Disadvantages of Hybrid Topology

1. Complex in design.
2. Costly.

IEEE Networking Standards:

802 Standards. IEEE 802.2, 802.3, 802.5, 802.11

The Institute of Electrical and Electronics Engineers is a standards setting body. Each of their standards is numbered and a subset of the number is the actual standard. The 802 family of standards is ones developed for computer networking..

802.2 Logical Link Control

The technical definition for 802.2 is "the standard for the upper Data Link Layer sublayer also known as the Logical Link Control layer. It is used with the 802.3, 802.4, and 802.5 standards (lower DL sublayers)."

Basically, think of the 802.2 as the "translator" for the Data Link Layer. 802.2 is concerned with managing traffic over the physical network. It is responsible for flow and error control. The Data Link Layer wants to send some data over the network, 802.2 Logical Link Control helps make this possible

The LLC acts like a software bus allowing multiple higher layer protocols to access one or more lower layer networks. For example, if you have a server with multiple network interface cards, the LLC will forward packers from those upper layer protocols to the appropriate network interface. This allows the upper layer protocols to not need specific knowledge of the lower layer networks in use.

802.3 IEEE Standard

The IEEE 802.3 standard defines the characteristics for Ethernet networks. Ethernet networking is by far the most widely implemented form of local area networking. Several Ethernet LAN characteristics are identified in the 802.3 standard.

Since the development of the original 802.3 standards, there have also been several additions that have been assigned new designators. These standards are often referred to as the 802.3x standards. Some of the newer standards include 802.3u for Fast Ethernet, 802.3z for Gigabit Ethernet, and 802.3ae for 10-Gigabit Ethernet. The features for 802.3 are listed here:

- Speed The original IEEE 802.3 standard specified a network transfer rate of 10Mbps. There have been modifications to the standard, the result being Fast Ethernet (802.3u), which can transmit network data up to 100Mbps and higher, as well as Gigabit Ethernet (802.3z), which can transmit at speeds up to 1000Mbps. 802.3ae is a very fast 803.3 standard. Known as 10-Gigabit Ethernet, it offers speeds 10 times that of Gigabit Ethernet.
- Topology The original Ethernet networks used a bus or star topology because the original 802.3 standard included specifications for both twisted pair and coaxial cabling. The IEEE 802.3u and 802.3z specify twisted pair cabling and use a star topology. Remember that even when Ethernet uses a physical star topology, it uses a logical bus topology.
- Media The media refers to the physical cabling used to transmit the signal around the network. The original 802.3 specifications identified coaxial and twisted pair cabling to be used. The more modern standards specify twisted pair and fiber-optic cable. 802.3ae currently only supports fiber media.
- Access method The access method refers to the way that the network media is accessed. Ethernet networks use a system called Carrier Sense Multiple Access with Collision Detection (CSMA/CD). CSMA/CD works by monitoring the computers that are sending data on the network. If two computers transmit data at the same time, a data collision will occur. To prevent collisions, the systems sending the data will be required to wait a period of time and then retransmit the data to avoid the collision. 10-Gigbit Ethernet only operates in full-duplex mode and, as such, does not need to use the traditional Ethernet CSMA/CD access method.

802.5 Token Ring

The following is a list of the specific characteristics specified in the 802.5 standard:

- Speed The 802.5 Token Ring specifies network speeds of 4 and 16Mbps.
- Topology Token Ring networks use a logical ring topology and most often a physical star. The logical ring is often created in the multistation access unit (MSAU).
- Media Token Ring networks use unshielded twisted pair cabling or shielded twisted pair.
- Access method 802.5 specifies an access method known as token passing. On a Token Ring network, only one computer at a time can transmit data. When a computer has data to send, it must use a special type of packet known as a token. The token travels around the network looking for computers with data to send. The computer's data is passed along with the token until it gets to the destination computer at which point, the data is removed from the token and the empty token placed back on the ring.

802.11 Wireless Network Standards

The 802.11 standards specify the characteristics of wireless LAN Ethernet networks. Under the banner of 802.11, there are four common wireless standards. These include 802.11, 802.11a,

802.11b and 802.11g. Each of these wireless standards identifies several characteristics. Here is a review of the 802.11 wireless standards and characteristics:

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- Speed 802.11 standards are measured in Mbps and vary between network standards.
- Media the 802.11 standards use radio frequency (RF) as a transmission media. Depending on the standard, radio frequencies include 2.4GHz and 5GHz.
- Topology 802.11 wireless standards can be implemented in an ad-hoc or infrastructure topology.
- Access method 802.11 uses Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA). CSMA/CA is a variation on the CSMA/CD access method. CSMA/CA access method uses a "listen before talking" strategy. Any system wanting to transmit data must first verify that the channel is clear before transmitting, thereby avoiding potential collisions.

Spread Spectrum Spread spectrum refers to the manner in which data signals travel through a radio frequency. Spread spectrum requires that data signals either alternate between carrier frequencies or constantly change their data pattern. Spread spectrum is designed to trade off bandwidth efficiency for reliability, integrity, and security.

Range 802.11 wireless standards each specify a transmission range. The range is influenced by many factors such as obstacles or weather.

The following is a look at the various 802.11 standards and their characteristics.

- **IEEE 802.11 :** There were actually two variations on the initial 802.11 standard. Both offered 1 or 2Mbps transmission speeds and the same Radio Frequency (RF) of 2.4GHz. The difference between the two was in the way in which data traveled through the RF media. One used frequency hopping spread spectrum (FHSS), and the other, direct sequence spread spectrum (DSSS).
- **IEEE 802.11a :** In terms of speed, the 802.11a standard was far ahead of the original standards. 802.11a specified speeds of up to 54Mbps in the 5GHz band; but most commonly, communications takes place at 6Mbps, 12Mbps, or 24Mbps. 802.11a is not compatible with other wireless standards 802.11b and 802.11g. These standards are heavily favored to the 802.11a standard.
- **IEEE 802.11b :** The 802.11b standard provides for a maximum transmission speed of 11Mbps. However, devices are designed to be backward compatible with previous standards that provided for speeds of 1-, 2-, and 5.5Mbps. 802.11b uses a 2.4GHz RF range and is compatible with 802.11g.
- **IEEE 802.11g :** 802.11g is a popular wireless standard today. 802.11g offers wireless transmission over distances of 150 feet and speeds up to 54Mbps compared with the 11 megabits per second of the 802.11b standard. Like 802.11b, 802.11g operates in the 2.4GHz range, and is thus compatible with it.

FDDI Networking:

The American National Standards Institute (ANSI) developed the Fiber Distributed Data Interface (FDDI) standard in the mid-1980s to meet the growing need for a reliable and fast

networking system to accommodate distributed applications. FDDI uses a ring network design, but, unlike the traditional 802.5 standard, FDDI uses a dual ring technology for fault tolerance. Because of the dual ring design, FDDI is not susceptible to a single cable failure like the regular 802.5 IEEE standard. Figure 1.8 shows an FDDI network with a dual ring configuration.

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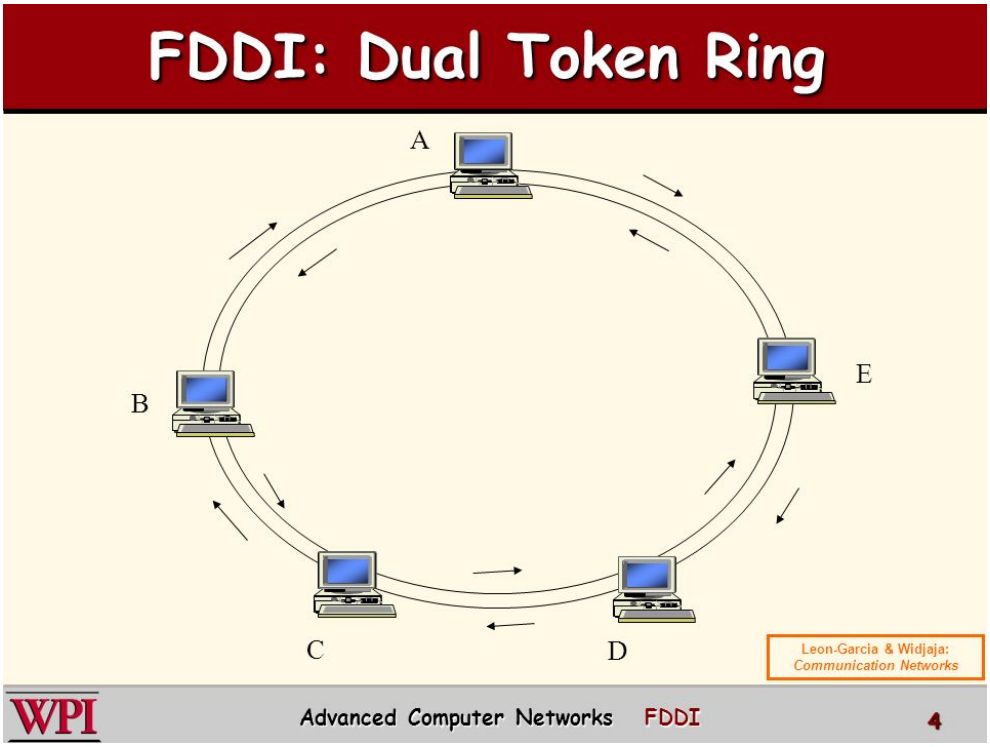
Figure 1 FDDI network.



As with any of the other standards, FDDI has specific characteristics:

- Speed FDDI transmits data at 100Mbps and higher.
- Topology FDDI uses a dual ring topology for fault-tolerant reasons.
- Media FDDI uses fiber-optic cable that enables data transmissions that exceed two kilometers. Additionally, it is possible to use FDDI protocols over copper wire known as the Copper Distributed Data Interface (CDDI).
- Access method Similar to 802.5, FDDI uses a token-passing access method.

Table 1. summarizes each of the wired standards discussed in the previous sections.

Table 1. IEEE 802 Network Standards

Standard	Speed	Physical Topology	Logical Topology	Media	Access Method
802.3	10Mbps		Bus and Star	Coaxial and	CSMA/CD

				twisted pair	
802.3u	100Mbps (Fast Ethernet)	Star	Bus	Twisted pair	CSMA/CD
802.3z	1000Mbps	Star	Bus	Twisted pair	CSMA/CD
802.3ae	10-Gigabit		Backbone connections	N/A	Fiber/Not Required
802.5	4Mbps and 16Mbps	Star	Ring	Twisted pair	Token passing
FDDI	100Mbps	Dual ring	Ring	Fiber-optic Twisted pair (CDDI).	Token passing

Table 2 IEEE 802 Wireless Network Standards

IEEE Standard	**Frequency/Media**	**Speed**	**Topology**	**Transmission Range**	**Access Method**	**Spread Spectrum**
802.11	2.4GHz RF	1 to 2Mbps	Ad-hoc/infra-structure		CSMA/CA	DSSS
802.11	2.4GHz RF	1 to 2Mbps	Ad-hoc/infra-structure		CSMA/CA	FHSS
802.11a	5GHz	Up to 54Mbps	Ad-hoc/infra-structure	25 to 75 feet indoors range can be affected by building materials	CSMA/CA	OFDM
802.11b	2.4GHz	Up to 11Mbps	Ad-hoc/infra-structure	Up to 150 feet indoors; range can be affected by building materials	CSMA/CA	DSSS
802.11g	2.4GHz	Up to 54Mbps	Ad-hoc/infra-structure	Up to 150 feet indoors; range can be affected by building materials	CSMA/CA	DSSS
IrDA	Infrared light beam	Up to 16Mbps	Ad-hoc	1 meter	N/A	N/A
Bluetooth	2.4GHz RF	720Kbps	Ad-hoc	10 meters	N/A	FHSS