Media Access Control (Topologies)

The topology of a network is the arrangement or relationship of the network devices and the interconnections between them. LAN and WAN topologies can be viewed in two ways:

- **Physical topology**: Refers to the physical connections and identifies how end devices and infrastructure devices such as routers, switches, and wireless access points are interconnected. Physical topologies are usually point-to-point or star. See Figure 1.

- **Logical topology**: Refers to the way a network transfers frames from one node to the next. This arrangement consists of virtual connections between the nodes of a network. These logical signal paths are defined by data link layer protocols. The logical topology of point-to-point links is relatively simple while shared media offers deterministic and a non-deterministic media access control methods.

The data link layer "sees" the logical topology of a network when controlling data access to the media. It is the logical topology that influences the type of network framing and media access control used.

Media Access Control (WAN Topologies)

WANs are commonly interconnected using the following physical topologies:

- **Point-to-Point**: This is the simplest topology which consists of a permanent link between two endpoints. For this reason, this is a very popular WAN topology.

- **Hub and Spoke**: A WAN version of the star topology in which a central site interconnects branch sites using point-to-point links.

- **Mesh**: This topology provides high availability, but requires that every end system be interconnected to every other system. Therefore the administrative and physical costs can be significant. Each link is essentially a point-to-point link to the other node. Variations of this topology include a partial mesh where some but not all of end devices are interconnected.

In point-to-point networks, data can flow in one of two ways:

- **Half-duplex communication**: Both devices can both transmit and receive on the media but cannot do so simultaneously. Ethernet has established arbitration rules for resolving conflicts arising from instances when more than one station attempts to transmit at the same time. Figure 2 shows half-duplex communication.

- **Full-duplex communication**: Both devices can transmit and receive on the media at the same time. The data link layer assumes that the media is available for transmission for both nodes at any time. Therefore, there is no media arbitration necessary in the data link layer. Figure 3 shows full-duplex communication.

Media Access Control (LAN Topologies)

Physical topology defines how the end systems are physically interconnected. In shared media LANs, end devices can be interconnected using the following physical topologies:

- **Star**: End devices are connected to a central intermediate device. Early star topologies interconnected end devices using hubs. However, star topologies now use switches. The star topology is the most common physical LAN topology primarily because it is easy to install, very scalable (easy to add and remove end devices), and easy to troubleshoot.

- **Extended star or hybrid**: In an extended star topology, central intermediate devices interconnect other star topologies. In a hybrid topology, the star networks may interconnect using a bus topology.

- **Bus**: All end systems are chained to each other and terminated in some form on each end. Infrastructure devices such as switches are not required to interconnect the end devices. Bus topologies were used in legacy Ethernet networks because it was inexpensive to use and easy to set up.

- **Ring**: End systems are connected to their respective neighbor forming a ring. Unlike the bus topology, the ring does not need to be terminated. Ring topologies were used in legacy Fiber Distributed Data Interface (FDDI) networks. Specifically, FDDI networks employ a second ring for fault tolerance or performance enhancements.

Media Access Control (Contention Based Access)

When using a non-deterministic contention-based method, a network device can attempt to access the medium whenever it has data to send. To prevent complete chaos on the media, these methods use a Carrier Sense Multiple Access (CSMA) process to first detect if the media is carrying a signal.

If a carrier signal on the media from another node is detected, it means that another device is transmitting. When the device attempting to transmit sees that the media is busy, it will wait and try again after a short time period. If no carrier signal is detected, the device transmits its data. Ethernet and wireless networks use contention-based media access control.

It is possible that the CSMA process will fail and two devices will transmit at the same time creating a data collision. If this occurs, the data sent by both devices will be corrupted and will need to be resent.

Contention-based media access control methods do not have the overhead of controlled access methods. A mechanism for tracking whose turn it is to access the media is not required. However, the contention-based systems do not scale well under heavy media use. As use and the number of nodes increases, the probability of successful media access without a collision decreases. Additionally, the recovery mechanisms required to correct errors due to these collisions further diminishes the throughput.

CSMA is usually implemented in conjunction with a method for resolving the media contention. The two commonly used methods are:

- **Carrier sense multiple access with collision detection (CSMA/CD)**: The end device monitors the media for the presence of a data signal. If a data signal is absent and therefore the media is free, the device transmits the data. If signals are then detected that show another device was transmitting at the same time, all devices stop sending and try again later. Traditional forms of Ethernet use this method.

- **Carrier sense multiple access with collision avoidance (CSMA/CA)**: The end device examines the media for the presence of a data signal. If the media is free, the device sends a notification across the media of its intent to use it. Once it receives a clearance to transmit, the device then sends the data. This method is used by 802.11 wireless networking technologies.

Media Access Control (Controlled Access)

When using the controlled access method, network devices take turns, in sequence, to access the medium. If an end device does not need to access the medium, then the opportunity passes to the next end device. This process is facilitated by use of a token. An end device acquires the token and places a frame on the media, no other device can do so until the frame has arrived and been processed at the destination, releasing the token.

Note: This method is also known as scheduled access or deterministic.

Although controlled access is well-ordered and provides predictable throughput, deterministic methods can be inefficient because a device has to wait for its turn before it can use the medium.

Activity – Logical and Physical Topology Characteristics

This activity provides you with characteristics of data link layer media access control methods.

Classify each media access control method as a Physical or Logical Topology characteristic by clicking in the appropriate column.

	Physical Topology	Logical Topology
1. CSMA/CD		
2. Star		
3. Contention-based access		
4. Bus		
5. CSMA/CA		
6. Controlled access		
7. Point-to-Point		
8. Ring		
9. Hub and Spoke		