MAC (Media Access Control) protocols are a set of rules and procedures that govern the access and utilization of the shared medium in a network. They define how devices in a network contend for the right to transmit data and handle collisions when multiple devices attempt to transmit simultaneously. MAC protocols are commonly used in wired and wireless networks to manage communication between devices.

There are several types of MAC protocols, each designed for specific network architectures and requirements. Here are some commonly used MAC protocols along with their properties and issues:

1. CSMA/CD (Carrier Sense Multiple Access with Collision Detection):
    - Properties: CSMA/CD is used in Ethernet LANs. It works by sensing the carrier (medium) before transmitting data and detecting collisions if they occur. If a collision is detected, the devices wait for a random period before attempting retransmission.
    - Issues: CSMA/CD is susceptible to collisions, especially in large networks with heavy traffic. As the network size grows, the chances of collision increase, reducing efficiency and throughput. Additionally, CSMA/CD does not scale well to high-speed networks due to the time it takes to detect collisions and retransmit data.

    Diagram:

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2. CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance):
    - Properties: CSMA/CA is commonly used in wireless networks, such as Wi-Fi. It operates similar to CSMA/CD but uses a different collision avoidance mechanism. Before transmitting, devices listen to the medium and wait for a clear channel. They also employ mechanisms like Request to Send (RTS) and Clear to Send (CTS) frames to further avoid collisions.
    - Issues: CSMA/CA is affected by the "hidden terminal" and "exposed terminal" problems. The hidden terminal problem occurs when two devices cannot sense each other but can interfere with the receiver. The exposed terminal problem happens when a device refrains from transmitting due to interference, even though it could have transmitted without causing a collision.

    Diagram:

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3. Token Passing:
    - Properties: Token passing protocols, like Token Ring, use a token that circulates through the network. Devices can transmit data only when they possess the token. After transmitting, the device releases the token, allowing other devices to utilize it. This ensures fair access to the network medium.
    - Issues: Token passing protocols require a well-defined order of device access and a mechanism for token recovery in case of token loss. Failure to recover lost

tokens can lead to network disruptions. Token passing also introduces a single point of failure since the loss of the token can halt the network.

Diagram:

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4. Polling:
    - Properties: In polling protocols, a central controlling device, known as the polling master, determines which device can transmit data. The master sequentially polls each device and grants permission to transmit. This provides controlled access to the medium and minimizes collisions.
    - Issues: Polling introduces additional overhead and delay due to the need for a centralized polling master. It can become a bottleneck in large networks with a high number of devices. If the polling master fails, the network communication may be disrupted.

Diagram:

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It's important to note that the above diagrams represent a simplified view of how devices access the medium and communicate. In reality, networks can be more complex, involving multiple devices and different topologies.

MAC Protocol Functionalities

The MAC (Media Access Control) protocol scheme refers to the set of rules and procedures used to control access to the shared communication medium in a network. Here are some key functionalities of the MAC protocol scheme:

1. Medium Access Control: The primary function of the MAC protocol is to ensure efficient and fair access to the communication medium. It defines how devices contend for access to transmit data without causing collisions or excessive delays.
2. Channel Allocation: The MAC protocol manages the allocation of the available communication channels to different devices. It determines which device can transmit data at a given time and on which channel.
3. Collision Avoidance: One of the major challenges in shared medium networks is avoiding collisions, where two or more devices try to transmit data simultaneously. The MAC protocol includes mechanisms to detect and avoid collisions, such as carrier sensing and random backoff algorithms.

4. Data Framing: The MAC protocol defines the format and structure of data frames used for transmission. It encapsulates the network layer data into frames and adds necessary control information, such as source and destination addresses, error checking codes, and sequence numbers.
5. Error Detection and Recovery: The MAC protocol incorporates error detection mechanisms to ensure data integrity during transmission. It typically uses techniques like cyclic redundancy check (CRC) to detect errors. In some cases, it may also include error recovery techniques, such as retransmission of lost or corrupted frames.
6. Flow Control: The MAC protocol manages the flow of data between the sender and receiver to avoid overwhelming the receiver with data. It includes mechanisms to regulate the rate of data transmission and handle situations where the receiver is unable to keep up with the incoming data.
7. Addressing and Identification: The MAC protocol assigns unique addresses to devices connected to the network, allowing them to be identified and addressed correctly. This enables data to be delivered to the intended recipient and facilitates communication between devices.
8. Priority and Quality of Service: Some MAC protocols support priority-based access, where certain types of traffic or devices are given higher priority over others. This feature is crucial for supporting applications with different quality of service requirements, such as real-time video or voice communication.

Overall, the MAC protocol scheme plays a crucial role in regulating access to the shared medium, managing data transmission, ensuring data integrity, and facilitating efficient communication in network environments.