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* Medium Access Control (MAC):

The Medium Access Control (MAC) defines rules for how nodes communicate in a wireless network.

MAC is used to avoid collisions and optimize performance.

Used to minimizing energy consumption by reducing unnecessary transmissions.

Used to manage access to the shared medium efficiently to ensure smooth communication.

=) Types of MAC:

1 Contention Based MAC:

It is also known as Random Access MAC.

Nodes compete with each other to access the wireless medium.

No Predefined schedule: Nodes transmit whenever the channle is free.

High chance of collisions when multiple nodes transmit at the same time.

2 Scheduled-Based MAC:

Also known as Deterministic MAC.

Nodes follow a fixed schedule for data transmission.

Each node gets a dedicated time slot - no competition and no collisions.

More energy-efficient than contention based MAC, but less flexible.

3 Hybrid MAC:

Combines features of both contention-based and scheduled based MAC.

Adapts to changing network conditions for better efficiency.

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Uses CSMA/CA when traffic is low and TDMA where traffic is high.

Minimizes collisions while optimizing energy usage and latency.

4 Cross-Layer MAC:

Allows multiple Layers (MAC, Network and Physical layers) to exchange information.

Improves network efficiency by dynamically adjusting parameter.

* Sensor Deployment and Node Discovery in IoT.

=> Sensor Deployment:

Sensor Deployment is the process of placing nodes in IoT network to achieve optimal coverage, connectivity and efficiency.

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-> Deployment Methods:

A Predetermined Deployment: Sensors are placed at fixed, predefined locations.

B Random Deployment: Sensors are distributed randomly.

-> Deployment strategies:

A Random Deployment: Sensors are scattered randomly.

B Delaunay Triangulation: Uses geometric algorithms to optimize sensors placement.

C Expectation-Maximization Algorithm: Probabilistic Approach to optimize sensor position.

D Grid-Based Deployment: Sensors are placed in a structured grid.

E Clustering-Based Deployment: Sensors are grouped into clusters.

-> Deployment Goals:

A. Maximizing Coverage
B. Enhancing Connectivity
C. Energy efficiency
D. Scalability
E. Robustness.

=> Node Discovery:

Node Discovery is a process in IoT networks that enables nodes to identify and communicate with each other.

-> Node Discovery Techniques:

A Active Discovery: Nodes send periodic messages to detect nearby nodes.

B Passive Discovery: Nodes listen for discovery messages from other devices.

C Centralize Discovery: A central controller manages node detection

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D. Distributed Discovery : Nodes autonomously discover each other without a central system.

-> Node Discovery Mechanism :

Steps :

1) Broadcasting a Discovery Command : A request is sent to all nodes in the networks.

2) Receiving Response : Each node acknowledges and shares its details.

* Data Dissemination and Data Aggregation.

=> Data Dissemination :

It refers to the process of transfering and updating data from a server or source node to other nodes.

-> Process :

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1) Nodes interested in certain events broadcast their interests periodically.

2) Interests propagate through the entire sensor network.

3) When events occurs, the source node sends data to the sink.

4) Intermediate nodes store and forward the data, maintaining a cycle.

-) Methods :

1 Flooding :

Each node receiving data rebroadcast it to all neighboring nodes until a hop limit is reached.

2 Gossiping :

When a node received data, it randomly selects a neighbor and forwards the data to it.

=> Data Aggregation:

It is process of combining data from multiple sources to reduce redundancy and optimize energy consumption.

It reduces network traffic and energy consumption.

It improves data accuracy by eliminating redundant information

-> Methods:

1. Cluster-Based Aggregation:

Data is aggregated at cluster heads before being sent to the sink.

2. Tree-Based Aggregation:

Data is collected in a hierarchical structure and reduce the duplicate transmissions.

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* Difference b/w Unicast, Multicast and Broadcast.

=>

	Unicast	Multicast	Broadcast
1	Data is sent From a single sender to a receiver.	Data is sent From single sender to group of receiver.	Data is sent from one sender to all device in network segment.
2	One-to-One Communication.	One-to-Many Communication.	One-to-All Communication
3	Uses a unique MAC address For receiver.	Uses a special multicast IP address.	Uses a Broadcast address.
4	Secure and Private Communication.	More Secure than Broadcast.	Least Secure.
5	Not Scalable For Group of Receiver.	Scalable	Not Scalable
6.	Inefficient For Group Communication.	More efficient than Unicast	Least efficient.

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* RTS / CTS Flow Control :

=> RTS / CTS stands for Request to send / Clear to send.

RTS/CTS handshake mechanism used in wireless communication to prevent data collisions.

It ensure efficient data transfer b/w devices.

=> Working Mechanism :

1 Request to Send :

When a node wants to send data, it first transmits a short RTS Frame to the receiving Node.

The RTS frame is a request asking for permission to send data.

2 Clear to Send :

If Node is available and the channle is free, it responds with CTS Frame

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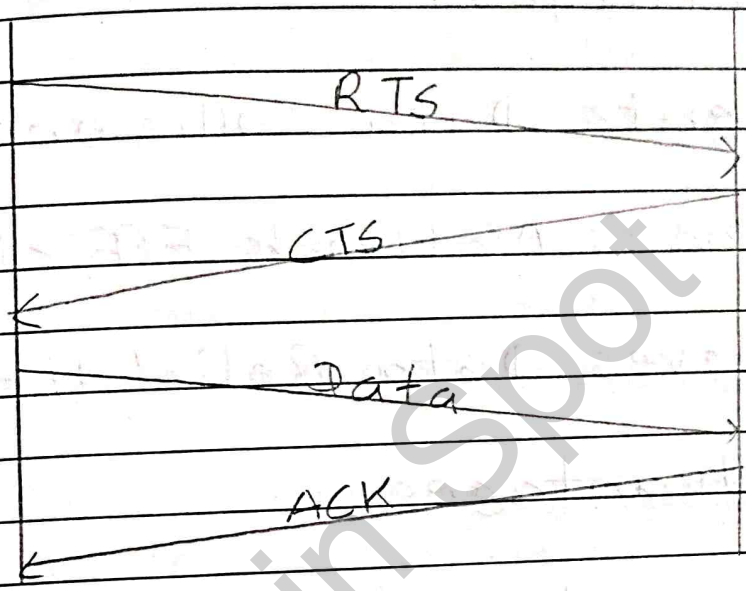
The CTS frame grants permission for Node to start data transmission



3 Data Transmission:

After receiving the CTS frame, Node begins transmitting the actual data packet.

4 Collision Avoidance:

IF Receiver is busy or the channel is not clear, it does not send a CTS Frame.

Transmitter, upon not receiving a CTS Frame within a certain

time, assumes that the channel is occupied and postpones transmission.

-> Advantages:

1. Prevents Data Collisions
2. Enhances Network Efficiency
3. Improves Data Reliability.

-> Disadvantages:

1. Increased Communication Overhead.
2. Latency Issues
3. Not suitable for short Data Transfers.

11 Explain how wireless communication might affect the development of the IoT?

=> The IoT is a system of interconnect devices that communicate and exchange data using the internet often through wireless network.

Wireless communication allowes seamless data transfer without

physical constraints.

=> Issues :

A. Interference and Congestion :

Wireless IoT devices share Frequency bands, leading to signal interference.

Overlapping Wi-Fi, Bluetooth can cause network congestion, reducing performance.

B. Half - Duplex Communication :

Many IoT devices operates in half-duplex mode, meaning they can either send or receive data at a time, Not both simultaneously.

This can lead to latency and collisions in networks with high traffic.

C. Time - Varying Channels and Signal Propagation Issues :

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Wireless signals are affected by environmental conditions, including,
Reflection, Diffraction and Scattering.

D. Burst Channel Errors:

In wireless communication, Burst errors occur when signal strength fluctuates due to obstacles, interference or distance variations.

This can lead to data loss, requiring retransmission and increasing power consumption.

E. Security Risks:

Wireless networks are susceptible to cyber threats like hacking, eavesdropping etc.

F. Limited Bandwidth:

Wireless network have limitation of bandwidth, as the number of IoT devices increase, it can lead to network congestion.

G. Energy Constraints:

IoT devices, especially those powered by batteries, require energy-efficient wireless protocols.