WIRELESS MEDIUM ACCESS ISSUES

What is Wireless Medium Access?

Wireless medium access in IoT refers to how multiple devices communicate over shared wireless channels. Efficient Medium Access Control (MAC) ensures:

- Reliable data transmission
- Minimized collisions and interference
- Optimized wireless spectrum usage

Challenges in Wireless Medium Access

(a) Collisions

- Occur when multiple devices transmit simultaneously on the same frequency.
- Cause corrupted data packets and retransmissions, increasing network latency.
- **Solution:** CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance).

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(b) Hidden Node Problem

- Happens when two devices, out of each other's range, send data to a common receiver, leading to a collision.
- **Solution:** RTS/CTS (Request to Send/Clear to Send) protocol.

(c) Exposed Node Problem

- A device refrains from transmitting unnecessarily due to sensing another transmission, causing bandwidth underutilization.
- **Solution:** Improved MAC protocols to differentiate interference types.

(d) Interference

- Signal overlap from different devices degrades signal quality.
- **Solution:** Frequency hopping, advanced signal processing, and efficient channel allocation.

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(e) Bandwidth Allocation

- Inefficient bandwidth distribution causes congestion and unfair access.
- **Solution:** Dynamic bandwidth allocation and Quality of Service (QoS) mechanisms.

Medium Access Control (MAC) Protocols

MAC protocols manage data transmission over a shared wireless medium.

(a) Random Access Protocols

Devices transmit whenever needed without a fixed schedule.

- **ALOHA:**
  - **Pure ALOHA:** Devices send data anytime, leading to high collision chances.
  - **Slotted ALOHA:** Data is sent at specific time slots, reducing collisions.
- CSMA (Carrier Sense Multiple Access):

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- **CSMA/CD (Collision Detection):** Used in wired networks like Ethernet.
- **CSMA/CA (Collision Avoidance):** Used in wireless networks like Wi-Fi.

(b) Controlled Access Protocols

Devices follow a coordinated approach for communication.

- **Polling:** A master device sequentially polls each device to check if it has data to send (e.g., Bluetooth networks).
- **Token Passing:** A special token circulates in the network, and only the device holding the token can transmit data.

(c) Channelization Protocols

Divide the communication medium into distinct channels to avoid interference.

- **TDMA (Time Division Multiple Access):** Devices transmit in pre-assigned time slots.
- **FDMA (Frequency Division Multiple Access):** Each device is allocated a separate frequency band.

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Conclusion

Understanding wireless medium access challenges and MAC protocols helps in designing efficient IoT communication systems. Techniques like CSMA, ALOHA, TDMA, and FDMA improve reliability, reduce interference, and optimize bandwidth usage.

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