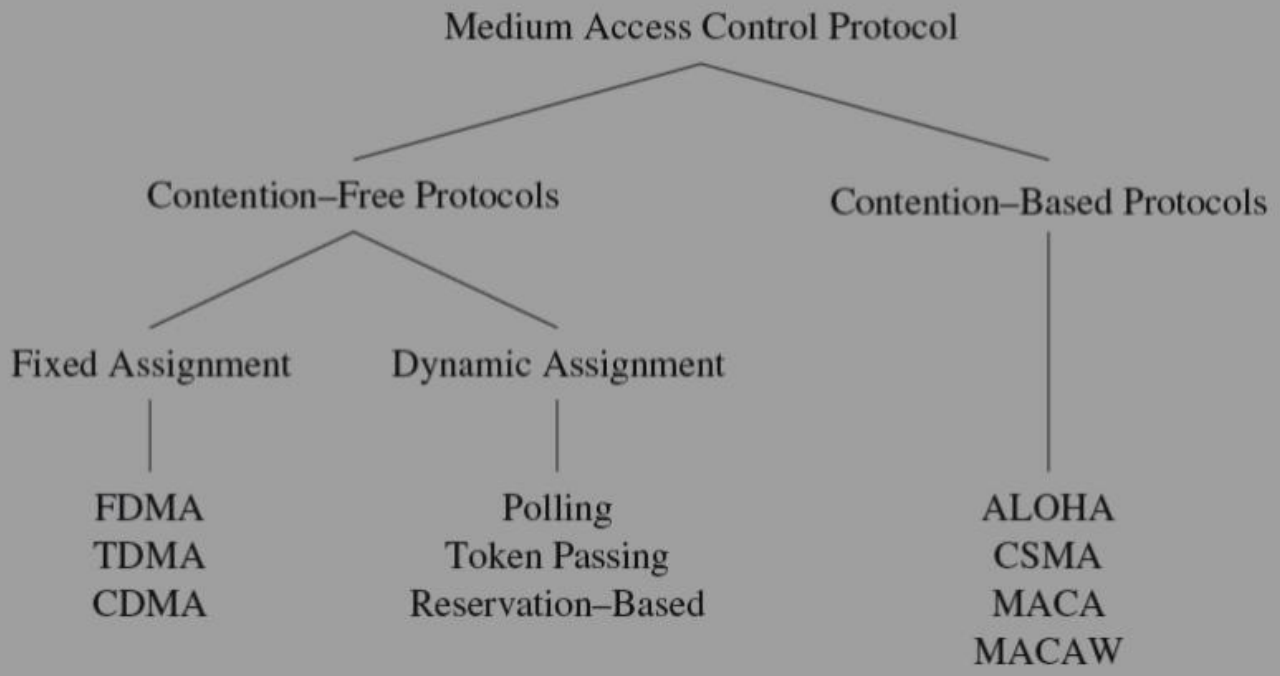
SUBJECT: WIRELESS SENSOR NETWORKS

Classification of MAC Protocols In WSNs

Elementrix Classes

MAC Protocol Categorization



Contention-Free Medium Access

- Collisions can be avoided by ensuring that each node can use its allocated resources exclusively
- Examples of fixed assignment strategies:
  - FDMA: Frequency Division Multiple Access
    - the frequency band is divided into several smaller frequency bands
    - the data transfer between a pair of nodes uses one frequency band
    - all other nodes use a different frequency band
  - TDMA: Time Division Multiple Access
    - multiple devices to use the same frequency band
    - relies on periodic time windows (frames)
      - frames consist of a fixed number of transmission slots to separate the medium accesses of different devices
      - a time schedule indicates which node may transmit data during a certain slot

Contention-Free Medium Access

- Examples of fixed assignment strategies (contd.):
  - CDMA: Code Division Multiple Access
    - simultaneous accesses of the wireless medium are supported using different codes
    - if these codes are orthogonal, it is possible for multiple communications to share the same frequency band
    - forward error correction (FEC) at the receiver is used to recover from interferences among these simultaneous communications
- Fixed assignment strategies are inefficient
  - it is impossible to reallocate slots belonging to one device to other devices if not needed in every frame
    - generating schedules for an entire network can be a taunting task
    - these schedules may require modifications every time the network topology or traffic characteristics in the network change

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Contention-Free Medium Access

- Dynamic assignment strategies: allow nodes to access the medium on demand
  - polling-based protocols
    - a controller device issues small polling frames in a round-robin fashion, asking each station if it has data to send
    - if no data to be sent, the controller polls the next station
  - token passing
    - stations pass a polling request to each other (round-robin fashion) using a special frame called a token
    - a station is allowed to transmit data only when it holds the token
  - reservation-based protocols
    - static time slots used to reserve future access to the medium
    - e.g., a node can indicate its desire to transmit data by toggling a reservation bit in a fixed location
    - these often very complex protocols then ensure that other potentially conflicting nodes take note of such a reservation to avoid collisions

Contention-Based Medium Access

- Nodes may initiate transmissions at the same time
  - requires mechanisms to reduce the number of collisions and to recover from collisions
- Example 1: ALOHA protocol
  - uses acknowledgments to confirm the success of a broadcast data transmission
    - allows nodes to access the medium immediately
    - addresses collisions with approaches such as exponential back-off to increase the likelihood of successful transmissions
- Example 2: slotted-ALOHA protocol
  - requires that a station may commence transmission only at predefined points in time (the beginning of a time slot)
  - increases the efficiency of ALOHA
  - introduces the need for synchronization among nodes

Contention-Based Medium Access

- Carrier Sense Multiple Access (CSMA)
  - CSMA with Collision Detection (CSMA/CD)
    - sender first senses the medium to determine whether it is idle or busy
      - if it is found busy, the sender refrains from transmitting packets
      - if the medium is idle, the sender can initiate data transmission
  - CSMA with Collision Avoidance (CSMA/CA)
    - CSMA/CD requires that sender aware of collisions
    - instead, CSMA/CA attempts to avoid collisions in the first place

MACA and MACAW

- Multiple Access with Collision Avoidance (MACA)
  - dynamic reservation mechanism
  - sender indicates desire to send with ready-to-send (RTS) packet
  - intended receiver responds with clear-to-send (CTS) packet
  - if sender does not receive CTS, it will retry at later point in time
  - nodes overhearing RTS or CTS know that reservation has taken place and must wait (e.g., based on the size of data transmission)
  - address hidden terminal problem and reduces number of collisions
- MACA for Wireless LANs (MACAW)
  - receiver responds with acknowledgment (ACK) after data reception
    - other nodes in receiver's range learn that channel is available
  - nodes hearing RTS, but not CTS do not know if transmission will occur
    - MACAW uses data sending (DS) packet, sent by sender after receiving CTS to inform such nodes of successful handshake

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