WiFi Medium access control

- Basic principle: Carrier-sense multiple access with collision avoidance (CSMA/CA)
- Similarly to Ethernet, nodes sense the medium and only transmit when it is idle
    - Once the medium is idle, everyone waits an additional period of time (Distributed Coordination Function Inter-Frame Spacing, DIFS) before transmitting – this allows high-priority messages to get through
    - After DIFS has expired, each node selects a random backoff time and continues to wait
    - If at any point up to the expiry of the backoff timer the medium is busy, the node must start over
    - Otherwise, once the backoff timer expires, the node may transmit

(Fig. 1)

- This is possibly unfair if a node repeatedly selects a large backoff time – that node won't be able to transmit
    - If a backoff timer is interrupted by a transmission, the node keeps the old value of the backoff timer and continues from where it left off
    - Maximum idle time is thus limited to the original value of the backoff timer
    - Example
- Shorter delays are possible for high priority messages
    - Short inter-frame spacing (SIFS) – for control messages, e.g., packet acknowledgments

    - Point coordination function inter-frame spacing (PIFS) – for time-bounded services.

(Fig. 2)

Wireless Sensor Networks

- By now, two-way digital radios are inexpensive, as is computing power
- In many applications, the more data collected (from as close as possible to the phenomenon), the better
    - Example. Wildlife tracking.
    - Conventional method: Radio transponder collars.
    - New method: Sensor networking collars that continuously monitor themselves and their neighbors

(Fig. 3)

- Sensor network features
    - Inexpensive – many devices can be used, okay to lose them, add more as needed
    - Robust – Tolerant of device failure/addition
    - Distributed – auto-configuration, no single master or point of failure
    - Ubiquitous – measurements taken from as many locations as possible, as close to the phenomenon as possible

- Sensor network challenges
    - Power management – how to optimize devices for extremely long life?
    - Low complexity – how to deal with devices that have reduced computing requirements?
    - Organization – how to perform network control in a distributed manner?
    - Routing – how to get data from one place to another in a dynamic network?

IEEE 802.15.4

- IEEE 802.15.4 is a broad wireless networking standard that addresses some of the challenges in sensor networking
- As in Bluetooth and WiFi, only the bottom two layers are specified – certain protocols, e.g. ZigBee, are extensions of 802.15.4 into higher layers
- 802.15.4 physical layer:
    - ISM bands at 2.4 GHz (worldwide); other channels in North America and Europe
    - Data rates ranging from 20-250 kbps
- 802.15.4 MAC layer:
    - Direct sequence spread spectrum; slots and/or CSMA/CA (same as WiFi).
- 802.15.4 architecture:
    - Unlike Bluetooth, distinguishes between “reduced function devices” (RFD) and “full function devices” (FFD)
    - Only FFDs can be “coordinators” (like masters in Bluetooth); RFDs only connect to FFDs