

802.15.4 – WPAN

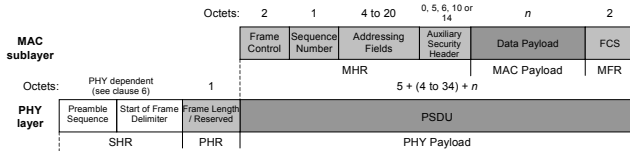
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IEEE 802.15.4 – objectives

- Star or peer-to-peer operation
- Allocated 16 bit short or 64 bit extended addresses
- Clear channel assessment by means of Energy detection (ED), Carrier sensing or CS+ED
- Carrier sense multiple access with collision avoidance (CSMA-CA) channel access
- Fully acknowledged protocol for transfer reliability
- Low power consumption
- 16 channels in the 2450 MHz band (ISM)(250kb/s), 10 channels in the 915 MHz band (US)(40 kb/s), and 1 channel in the 868 MHz(20kb/s) band (Europe)
- 2MHz-wide channels
- Allocation of guaranteed time slots (GTSSs)
- PSDU of 127 bytes !

PHY / MAC

- 2.4 GHz
 - ✓ DSSS, SF=8
 - ✓ O-QPSK
 - ✓ 2Mchips/s
- 868/915 MHz
 - ✓ DSSS, SF=15
 - ✓ BPSK
 - ✓ 300 kchip/s @ 868MHz, 600kchips/s @ 915MHz
- MAC data frame



(BTW: 802.15.4 MAC is also used by low-speed PLC devices)

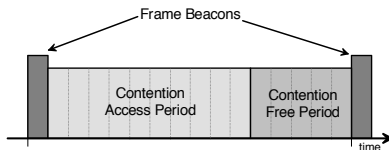
CSMA/CA in 802.15.4

- “Backoff exponent” BE : before transmitting, a node waits for a random number of slots $\leq 2^{BE} - 1$ (1 slot : $960\mu s$)
- $BE++$ when the node sees a busy channel (double backoff interval)
- (In slotted mode –beacons) The channel needs to be free during 2 consecutive time slots before transmitting (allows the previous receiver to process its frame)
- ACKs are optional
- MSDU (MAC Service Data Unit) (payload max size) 102B!

Nodes do not continuously sense the channel \rightarrow saves energy

Devices

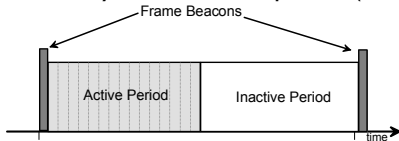
- Full-function device (FFD) or RFD (Reduced-)
- Network topology
 - ✓ Typically, a snow flake around the “PAN coordinator”
 - ✓ Routers are FFD, leaves can be RFDs
- Channel management
 - ✓ The FFD sends beacons
 - ➞ Defines contention period and (optional) contention-free period



- ✓ Beacons (if present) define the access slots boundaries (slotted CSMA/CA)

Devices (cont.)

✓ There may be an inactive period (after CFP)

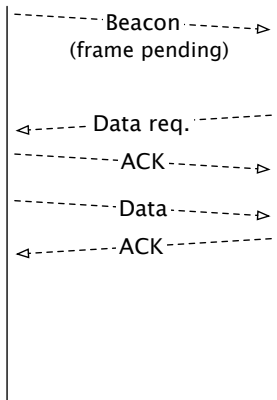


Extracting data from a coordinator

- One can not assume that a device is listening
- Data is “pulled” from the coordinator
- Data frame may signal more pending frames

PAN coordinator

Device



Zigbee – one way to build a network

- Builds multi-hop networks / On-demand routing (LOAD = simpler AODV)
 - ✓ Flood Route requests, remember route to originator
 - ✓ Unicast route reply
- Simple topology (tree around the PAN coordinator)
- Zigbee IP now uses RPL routing protocol

Sensor networks – what for?

- Smart grid (Using low data rate PLC technologies)
- Smart house (PLC, wireless...)
- Smart... parking,... you-name-it...
- IPv6 in sensor networks
 - ✓ The frame size is a problem → 6LoWPAN IP header compression
 - ✓ Routing: RPL is now RFC 6550
 - ▶ Trickle (reduces retransmissions of redundant information)
 - ▶ DODAG rooted at the sink
 - All packets travel on a “tree” rooted at the gateway
 - ▶ Storing mode, P2P...
 - ▶ Exclusively proactive (nodes advertise their position spontaneously)
 - ▶ Probably overly complex

802.15.4 evolutions

- ...15.4e: More MACs, including in particular channel hopping, preamble sampling, ...
- ...15.4g higher data rates, bigger frames