IEEE 802.15.4

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Introduction

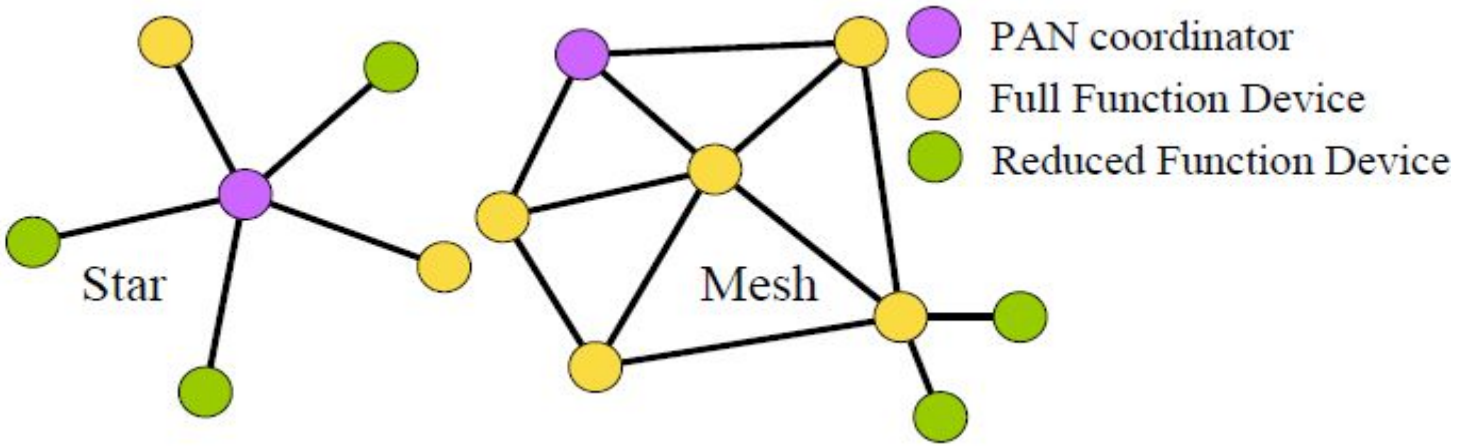
- A technical standard which defines the operation of low-rate wireless personal area networks (LR-WPANs)
- Specifies the physical layer and media access control for LR-WPANs
- It is the basis for the Zigbee, ISA100.11a, WirelessHART, MiWi, 6LoWPAN specifications.

Specifications

- The basic framework conceives a 10-meter communications range
- Data rates of 250 kbps, 40 kbps, and 20 kbps
- Two addressing modes; 16-bit short and 64-bit IEEE addressing.
- CSMA-CA channel access
- Fully handshaked protocol for transfer reliability.

Topologies

- Star and peer-to-peer
- Two types of devices: Full Function device (FFD), Reduced Function device (RFD)

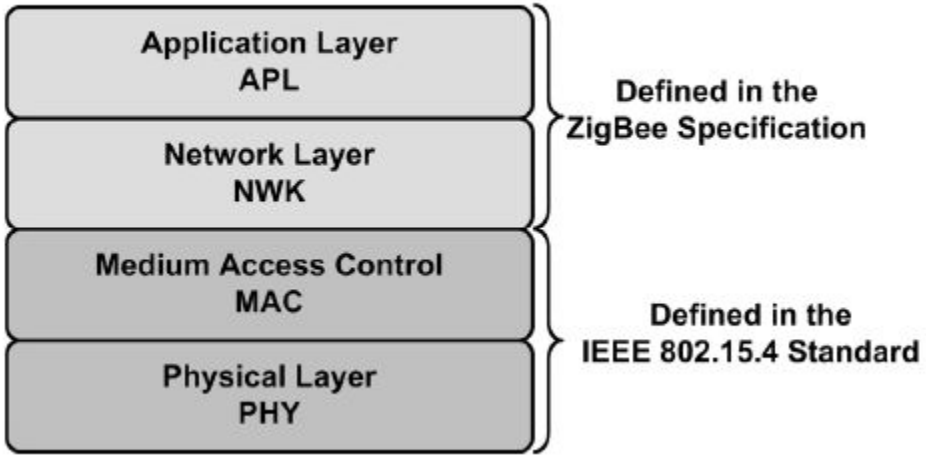


Coordinator

- FFDs can become coordinator and can also route messages to other nodes
- RFDs cannot become coordinator and can only be a leaf
- FFD that starts a PAN becomes the coordinator
- In star topology, all communication is to/from the coordinator
- In P2P topology, FFDs can communicate directly also.

Protocol Architecture

- Layer definition is based on OSI model.
- The layers defined in the standard are -
  - Physical Layer
  - MAC Layer



The Physical Layer

- Responsible for data transmission and reception using a certain radio channel.
- IEEE 802.15.4(2003) adopted a wideband physical layer using Direct Sequence Spread Spectrum technique (DSSS).
- It provided physical layer operations in three frequency bands
  - 868 MHz band - 20 kb/s
  - 915 MHz band - 40 kb/s
  - 2.4 GHz ISM band - 250 kb/s
- In the later revisions that followed many additional bands were added and the supported data rates were improved.

The Physical Layer

The physical layer of the IEEE 802.15.4 is in charge of the following tasks

- Activation and deactivation of the radio transceiver
- Energy Detection (ED) within the current channel
- Link Quality Indication (LQI)
- Clear Channel Assessment (CCA) - energy detection mode, carrier sense mode and carrier sense with energy detection mode.
- Channel Frequency Selection

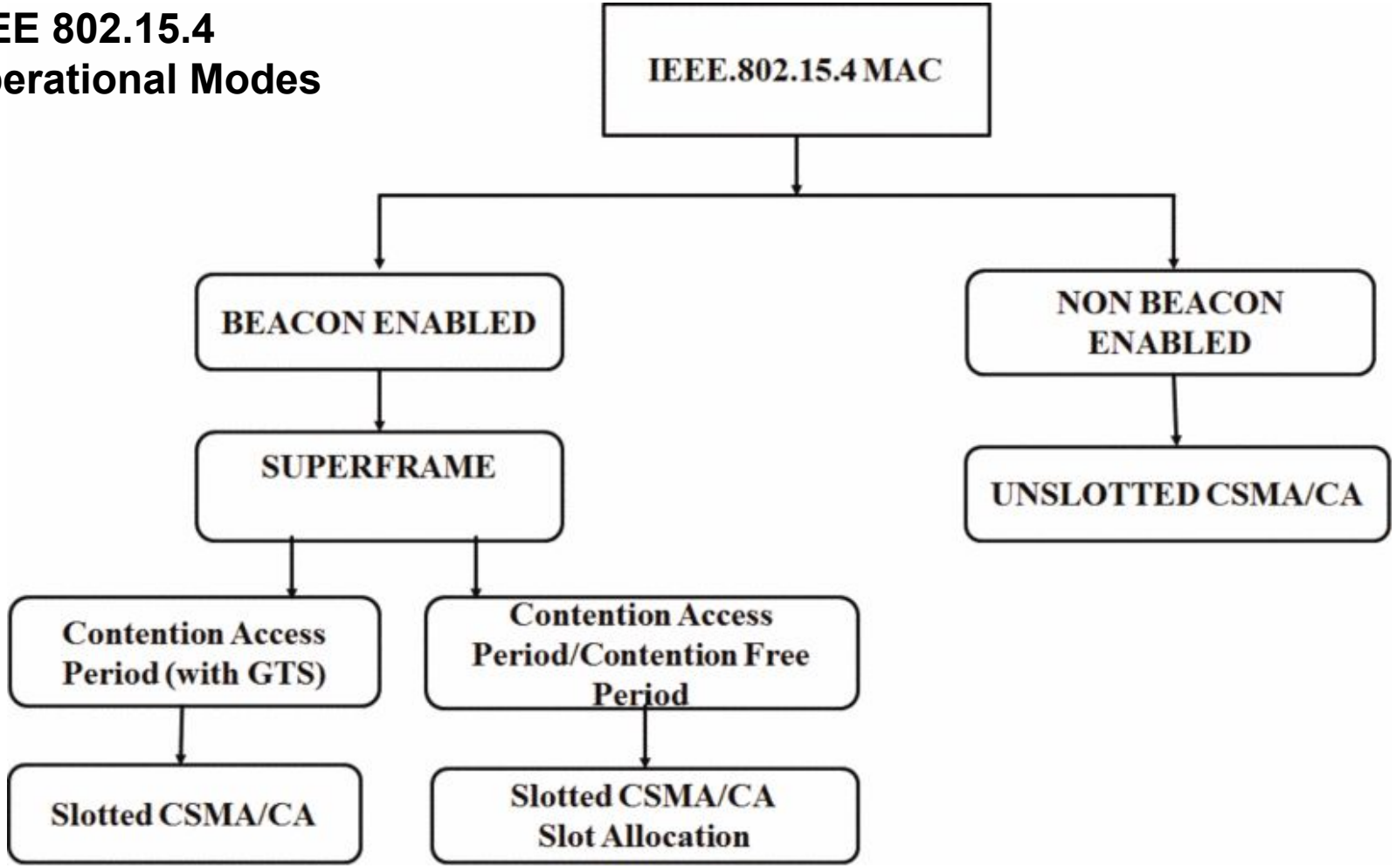
Physical Layer Frame Format

Preamble	Delimiter	Header	Physical Data Service Unit (PSDU)
4 bytes	1 byte	1 byte	<= 127 bytes

MAC Layer

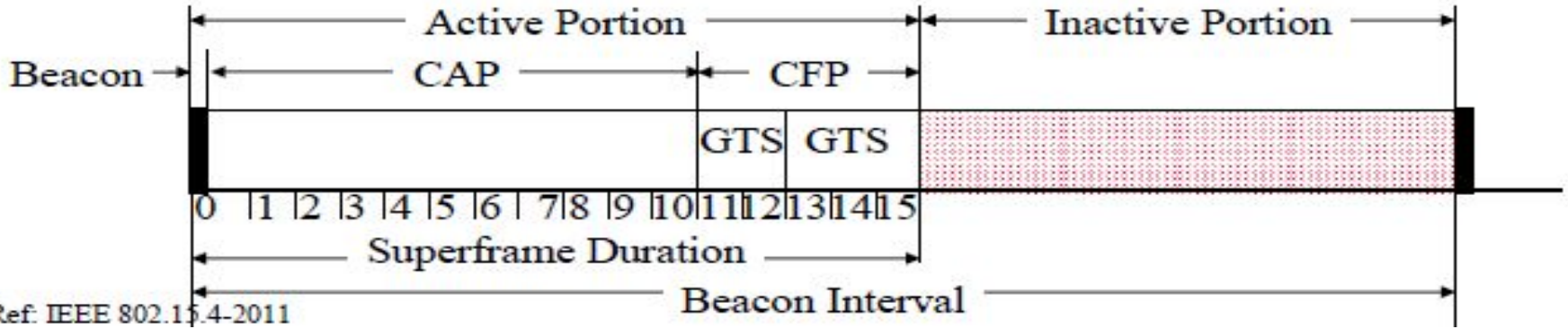
- There are four types of MAC frames: data frames, MAC command frames, acknowledgment frames and beacon frames.
- The MAC layer has the following features: association and disassociation, acknowledged frame delivery, channel access mechanism, frame validation, guaranteed time slot management, and beacon management.
- The IEEE standard supports two types of channel access mechanisms:
  - non-beacon enabled
  - beacon-enabled.

IEEE 802.15.4 Operational Modes



Beacon-Enabled CSMA/CA

- Coordinator sends out beacons periodically.
- Part of the beacon interval is inactive Everyone sleeps.
- Active interval consists of 16 slots
- Guaranteed Transmission Services (GTS): For real-time services. Periodic reserved slots.
- Contention Access Period (CAP). Slotted CSMA.



Ref: IEEE 802.15.4-2011

Beaconless Operation:

- Devices use Unslotted CSMA
- Whenever a device wants to send data
  - It waits for a random back-off time
  - It performs CCA
    - Sends data if channel is idle
    - Else waits for random back-off time and again perform CCA.

Mac Layer Frame Format

Frame control	Sequence number	Dst Address	Src Address	Payload	Frame check sequence
2 bytes	1 byte	0-20 bytes		Variable	2 bytes

Thank You