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FACULTY OF EGINEERING AND TECHNOLOGY

WSN (MCS-033)

LECTURE -24

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OUTLINE

- Overview of the IEEE 802.15.4 MAC Protocol
- MCQ
- Reference

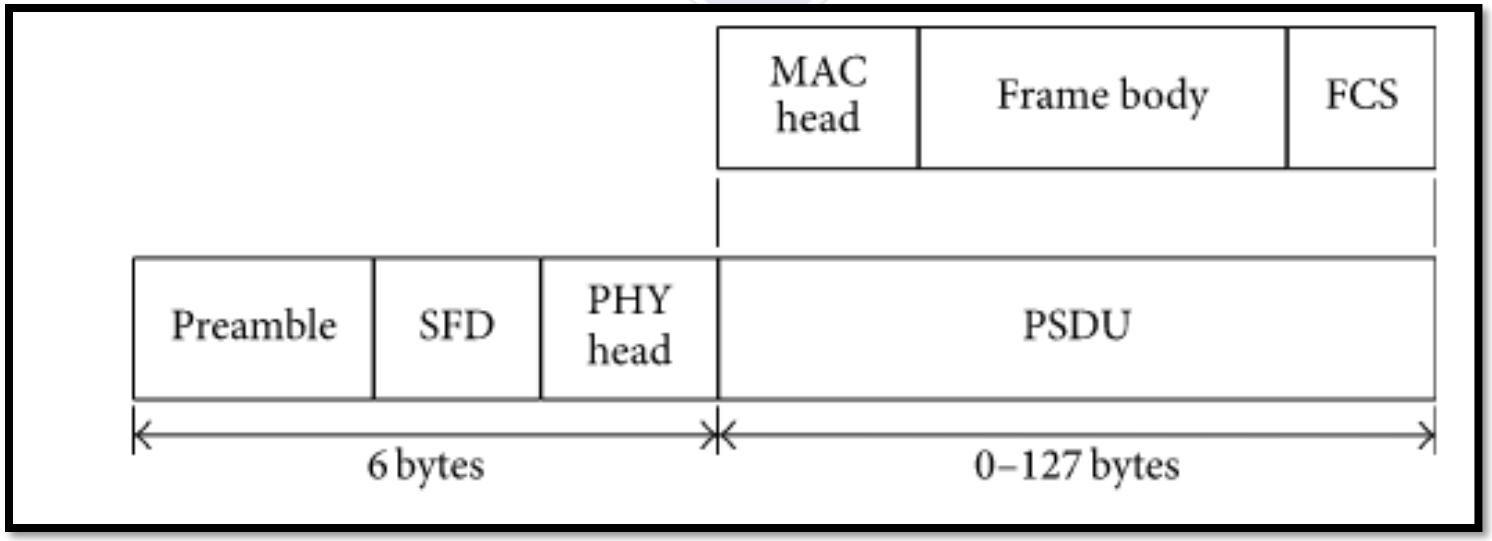
Overview of the IEEE 802.15.4 MAC Protocol

In the following we will describe the IEEE 802.15.4 MAC sublayer since our proposal is an enhancement of it.

The IEEE 8.2.15.4 MAC Frame

MAC Frame Structure

Illustrated in Figure 1 is the frame structure in MAC layer defined as the MAC protocol data unit (MPDU) encapsulated in the data service unit of the PPDU frame. The MPDU defines the frame structure in the MAC layer. Each frame consists of the following basic fields.



OVERVIEW OF THE IEEE 802.15.4 MAC PROTOCOL

MAC Frame Structure

(i)A MAC header, which comprises Frame Control Field (FCF), duration, address, and sequence control information. FCF is used to inform the recipient what type of packet he just received and how the address information is stored. Address field can be left out or consists of up to 20 bytes depending on the 8 type of frame.

(ii)A variable length frame body, which contains information specific to the frame type.

(iii)A frame check sequence (FCS), which contains a Cyclic Redundancy Code (CRC) checksum of the MPDU.

OVERVIEW OF THE IEEE 802.15.4 MAC PROTOCOL

MAC Frame Structure

The frame structures have been designed to keep the complexity to a minimum while at the same time making them sufficiently robust for transmission on a noisy channel. Each successive protocol layer adds to the structure with layer specific headers and footers. This standard defines four frame structures.

(i)Beacon frame, used by a coordinator to transmit beacons.

(ii)Data frame, used for all transfers of data.

(iii)Acknowledgment frame, used for confirming successful frame reception.

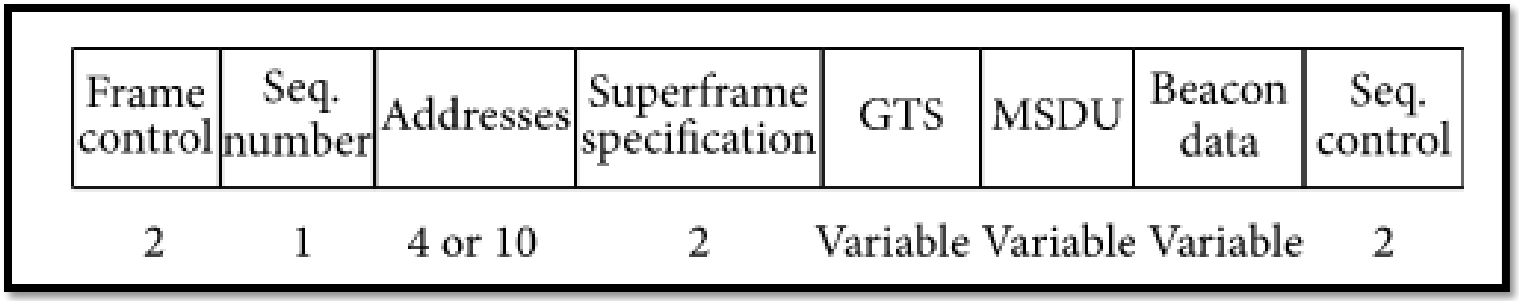
(iv)MAC command frame, used for handling all MAC peer entity control transfers.

OVERVIEW OF THE IEEE 802.15.4 MAC PROTOCOL

Beacon Frame

In beacon enabled mode, the beacon is transmitted at the start of slot 0 without the use of CSMA/CA. In fact, the coordinator periodically sends beacons to synchronize all attached devices, identify the PAN, and announce the superframe structure to manage the communication from end devices to the coordinator. The first part of the superframe is slotted and CSMA/CA is used as channel access mechanism, while the second is composed of slots reserved for particular nodes by the network coordinator. Beacon contains the information on the addressing fields, the superframe specification, the GTS fields, the pending address fields, and so forth. In non-beacon enabled mode, no beacon and superframe are transmitted. The channel access is based on unslotted CSMA/CA.

Beacon frame format is depicted in Figure .



OVERVIEW OF THE IEEE 802.15.4 MAC PROTOCOL

Communication Protocol

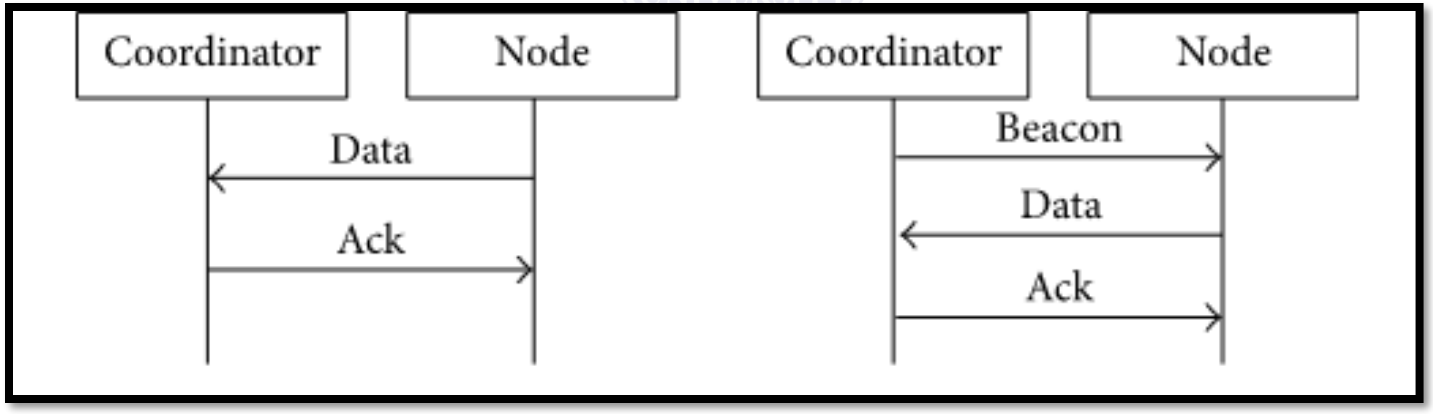
The data transmission mechanism in ZigBee networks is supported by two operational modes: with or without beacon enabled mode. The operation mode is selected by the PAN coordinator. For communication of packets between nodes, ZigBee MAC protocol can use both CSMA and GTS (Guaranteed Time Slot) protocols. In GTS scheme, it uses TDMA protocol to reduce the idle listening that decreases energy consumption considerably.

When a device wishes to transfer data in a non-beacon enabled mode, it simply transmits its data frame, using unslotted CSMA/CA, to the coordinator. The coordinator acknowledges the successful reception of the data by transmitting an optional acknowledgment frame. The transaction is now complete.

OVERVIEW OF THE IEEE 802.15.4 MAC PROTOCOL

Communication Protocol

When a device wishes to transfer data to a coordinator in a beacon enabled mode, it first listens for the network beacon. When the beacon is found, the device synchronizes with the superframe structure. At the appropriate time, the device transmits its data frame, using slotted CSMA/CA, to the coordinator. The coordinator may acknowledge the successful reception of the data by transmitting an optional acknowledgment frame. These sequences are presented in Figure .



OVERVIEW OF THE IEEE 802.15.4 MAC PROTOCOL

CSMA/CA

The Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) is widely employed in wireless networking due to its simplicity and performance efficiency. It has been adopted as a medium access control protocol by many standards such as the IEEE 802.11 Wireless Local Area Networks (WLANs), IEEE 802.15.3, and IEEE 802.15.4 Wireless Personal Area Networks (WPANs). The CSMACA variants employed in these standards provide robustness against unstable channel conditions and higher capacity than other random access algorithms.

Range and default value of BE.

Attribute	Default value	Range
macMinBE	3	0-*macMaxBE*
macMaxBE	5	3–8
macMaxCSMABackoff	4	0–5

OVERVIEW OF THE IEEE 802.15.4 MAC PROTOCOL

CSMA/CA

The slotted CSMA/CA shall first initialize the NB, the CW, and the BE. The BE shall be initialized to the value of macMinBE. Then, the slotted CSMA/CA locates the boundary of the next back off period. It shall delay for a random number of complete backoff periods. Next, it requests that the PHY performs a CCA. This last shall start on a back off period boundary. In detail, after backoff counter expires (reaches zero), the node must perform two clear channel assessments (CCAs) before trying to transmit. The two CCA operations ensure prevention of potential collisions. Transmission occurs if both CCAs are successful (sense the channel idle). If the channel is assessed to be busy, the MAC sublayer shall increment both the NB and the BE by 1, ensuring that BE shall be no more than macMaxBE. And it shall also reset CW to 2. If the value of the NB is less than or equal to the macMaxCSMABackoffs, the slotted CSMA/CA algorithm shall back off to Step 2 in Figure (random duration).

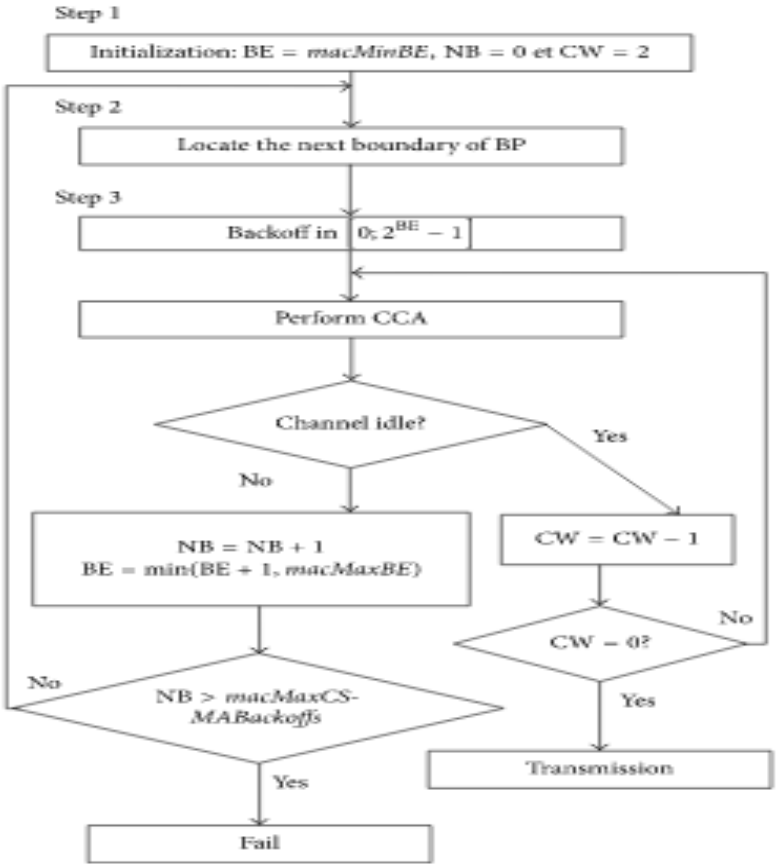
OVERVIEW OF THE IEEE 802.15.4 MAC PROTOCOL

CSMA/CA

If the value of NB is greater than macMaxCSMABackoffs, the slotted CSMA/CA algorithm shall terminate with a channel access failure status. If the channel is assessed to be idle, the MAC sublayer in a slotted CSMA/CA system shall ensure that the contention window has expired before commencing transmission. To do this, the MAC sublayer shall first decrement the CW by one and then determine whether it is equal to 0. If it is not equal to 0, the slotted CSMA/CA algorithm shall return to Step 3 in Figure . If it is equal to 0, the MAC sublayer shall begin transmission of the frame on the boundary of the next back off period. Table shows range and default value of BE.

OVERVIEW OF THE IEEE 802.15.4 MAC PROTOCOL

Slotted CSMA/CA algorithm of IEEE 802.15.4.



MCQ

1. Draw the pictographic view of Electro-magnetic spectrum.

2. List any four design goals of WLANs.

3. Write down the challenges in designing a Sensor Network.

4. Explain the concept of Rumor routing.

5. What do you know about beacons? Explain.

REFERENCES

- https://www.academia.edu/25414253/UNIT-2_MAC-1_2.1_Issues_in_Designing_Mac_Protocol_for_Ad_Hoc_Wireless_Network
- https://pdfs.semanticscholar.org/f921/bde77a607cb69ca7127ebe7f68a04d412677.pdf
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