**IEEE P802.15**

**Wireless Personal Area Networks**

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| Source | [] [Blind Creek Associates] [] | Voice: [ +1.408.395.7202 ] Fax: [ ] E-mail: [ ben @ blindcreek.com ] |
| Re: | [TG4k LECIM PHY development, MAC support] | |
| Abstract | Working draft for MAC additions necessary to support the LECIM PHYs | |
| Purpose | Draft standard development | |
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Draft for

NOTE: When preparing a draft amendment, the editors will include only the section headings where changes to the base standard are made. Amendments, when completed, will not contain any empty sub-clauses. In this outline all of the clauses and sub-clauses of the base standard are included for preliminary draft development (and because it is easier in Word). If there is no annotation in a section it is likely the amendment would not have contents for that section.

This outline is based on P8021.15.4-2011 taking into account (nearly) approved amendments 15.4e, 15.4f and 15.4g. By the time LECM balloting begins these will be completed approved amendments.

This is a working draft outline so it excludes the IEEE Boilerplate that will be added to the draft prior to balloting.

No additions Clause 1 are expected.

1. Overview
   1. General
   2. Scope
   3. Purpose
2. Normative references

No changes expected.

1. Definitions, Acronyms and Abbreviations
   1. Definitions
   2. Acronyms
2. General Description

Clause 4 is informative “big picture” overview. Normative text does NOT go in clause 4. The specific behaviors, structures and formats of things go in the appropriate PHY and MAC clauses.

* 1. General

Will add overview clauses as needed.

* 1. Components of the WPAN

Add in this clause any new categories of “device” that LECM adds, for example, assumptions about LECM coordinator vs LECM end device.

* 1. Network topologies
     1. Star network formation

May add a paragraph about LECM assumption of STAR topology, with very low duty cycle, long sleep times.

* + 1. Peer to peer network formation
  1. Architecture
     1. PHY layer (PHY)
     2. MAC Sub-layer (General Characteristics)

The following MAC enhancements are included to support of Low Energy Critical Infrastructure Monitoring PHIs defied in clause 17:

* Enhanced timing and synchronization capabilities to support synchronous and asynchronous channel access in both beacon enabled and non-beacon enabled operation
* MPDU fragmentation to support extremely low data rates and limited PSDU sizes
* MAC SAP and PIB extensions for PHY control and configuration
  1. Functional Overview
     1. Superframe Structure
        1. General
        2. Use of superframe structure for LECIM

A grief description of superframe structure for LECM. A high level description, with references to the informative annex for details.. Might show general SF configuration for synchronous access concept, sync slots, downlink slots, uplink slots, and so on.

* + 1. Data transfer model

May describe synchronized channel access (how MAC and PHY are used together). Refer to appropriate sub-clauses for normative descriptions.

* + - 1. Data transfer to a coordinator

A general overview of the uplink commnication

* + - 1. Data transfer from a coordinator
      2. Peer-to-peer data transfers

No changes expected.

* + 1. Frame Structure

Add a figure for ‘Schematic view of the PPDU with MPDU Fragmentation’.

* + 1. Improving probability of successful delivery

Description of MPDU fragmentation as a reliability enhancing mechanism.

* + - 1. CSMA-CA mechanism

Add description of the prioritized access method.

* + - 1. ALOHA mechanism
      2. Frame acknowledge
      3. Data verification

Overview description of the incremental ACK and/or new ACK modes added for MPDU fragmentation

* + 1. Power consumption considerations

A good place to give overview of the “Low Energy” part of LECM.

* + 1. Security

No changes expected

* 1. Concept of primitives

No changes expected.

1. MAC protocol
   1. MAC functional description
      1. Channel Access
         1. Superframe structure

If there are additions to the 15.4-2011, DSME, or TSCH superframe/slotframe structure, describe in a sub-clause here.

* + - 1. Incoming and outgoing superframe timing
      2. Interframe spacing (IFS)
      3. CSMA-CA Algorithm

Modifications to support the priority channel access.

* + - 1. TSCH-Slotframe structure
      2. LLDN Superframe structure
      3. LE-Functional description

Add description of the additional low energy mechanism and/or additions to CSL and/or RIT. May add a detailed description of the operation in a later subclause as done for CSL and RIT in 4e.

* + 1. Starting and maintaining PANs

New methods to support LECIM go here, additions to scan for example.

* + 1. Association and disassociation

Expect there may be some sort of abbreviated link context setup considerations.

* + 1. Synchronization

Probably some additional considerations for LECIM for both beacon and non beacon cases.

* + - 1. Synchronization with beacons
      2. Synchronization without beacons
      3. Orphaned device realignment
      4. LECIM Synchronization

Alternately we may just add a separate section, or fold in to beacon or non-beacon cases as appropriate.

* + 1. Transaction handling
    2. Transmission, reception, and acknowledgment

Expect all sub-clauses will have some changes related to MPDU fragmentation

* + - 1. Transmission
      2. Reception and rejection

Expect some additional filtering for MPDU fragmentation will be required based on context ID, sequence # or something like that.

* + - 1. Extracting pending data from a coordinator

No changes expected; MPDU fragmentation should run ‘below’ this function.

* + - 1. Use of acknowledgments and retransmissions

Add appropriate subclauses for incremental acknowledge and retransmission of fragments. Since these will be inserted between existing clauses they get the number of the preceding subclause with “a” appended.

* + - * 1. No acknowledgment
        2. a Incremental fragment acknowledgement
        3. a Incremental fragment retransmission
      1. Promiscuous mode

No changes expected for LECIM.

* + - 1. Transmission scenarios

Expect a few new ones to be needed.

* + 1. GTS allocation and management

Don’t’ expect changes in here.

* + 1. Ranging

No changes expected.

* + 1. LLDN Transmission states

No changes expected.

* + 1. Deterministic and synchronous multi-channel extension (DSME)
    2. LE-transmission, reception and acknowledgment
       1. Coordinated sampled listening (CSL)
       2. Receiver initiated transmission (RIT)
       3. LECIM Alternate/Hybrid LE scheme

Obviously we need a better sub-clause title, this is where the new LE mechanism(s) should be described in detail. I expect the form used for CSL and RIT are probably a good starting point for an outline.

* + 1. Asynchronous multi-channel adaptation (AMCA)
  1. MAC frame formats

Initially propose we not modify existing frames, but add another to cover the fragmentation cell format and procedures. Expect to add new Information Elements to 5.2.4, which will require adding to table 4b and new subclauses starting at 5.2.4.23.

* 1. MAC command frames

Possibly a new command or two will be needed to support LE, channel access or MPDU fragmentation.

* 1. MPDU Fragmentation

Describe the fragmentation cell process. Alternately we can put the functional description as 5.1.13 and add the cell format to 5.2.5.

* + 1. MPDU PHY adaptation, fragmentation and reaassembly
    2. Fragment cell formats

1. MAC services

Will need to extend existing services.

1. Security

Very few changes I hope!

1. General PHY requirements
2. PHY services
3. O-QPSK PHY
4. Binary phase-shift keying (BPSK) PHY
5. Amplitude shift keying (ASK) PHY
6. Chirp spread spectrum (CSS) PHY
7. UWB PHY
8. GFSK PHY
9. SUN PHYs

Added by 15.4g TG.

1. MSK PHY

Added by 15.4f RFID TG.

1. LRP UWB PHY

Added by 15.4f RFID TG.

1. LECIM PHYs