**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | MAC frame format including information elements  |
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| Re: | text for 802.15.8 draft covering the mac framing and information elements |
| Abstract | Text for inclusion in IEEE 802.15.8 |
| Purpose | Provision of the text to facilitate its incorporation into the draft text of the IEEE 802.15.8 standard currently under development in the 802.15 TG8. |
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***MAC frame format***

*Notes in RED (like this one) are explanatory notes not intended to be part of the standard, which should be removed when integrating the text. This text is provided with a view to its integration into the 802.15.8 draft. Heading format and suggested levels documented with X.nnn are included for reference only and may be changed appropriately by the editor when integrating this.*

1. MAC frame formats
	1. Device addresses

The MAC address of a PD shall be a 48-bit extended universal identifier (EUI-48), as defined by IEEE Std 802-2014 and assigned by the IEEE Registration Authority. When transmitted, the EUI-48 shall be sent in the canonical form defined in IEEE Std 802-2014.

* 1. General MAC frame format

The general MAC frame shall be formatted as illustrated in Figure 1.



**Figure 1—General MAC frame format**

The fields of the MAC frame appear in a fixed order; however, some fields may not be included in all frames.

* + 1. Frame control field

The Frame Control field shall be formatted as illustrated in Figure 2.



**Figure 2—Format of the Frame Control field**

The subfields of the frame control field are described below.

#### Frame type field

The Frame Type field shall be set as defined in Table 1.

**Table 1—Values of the Frame Type field**

|  |  |
| --- | --- |
| **Frame type valueb3 b2 b1 b0** | **Description** |
| 0000 | Reserved |
| 0001 | Data |
| 0010 | Acknowledgment |
| 0011 | MAC command |
| 0110to 1111 | Reserved |

Frame formats for each of the Frame Type field values are specified in 1.3.

*The DAM and SAM addressing mode definitions in the two clauses below replace (and are in agreement with) the Tables in draft D0.15.1 clause 5.7.7.1 MHR fields. That clause 5.7.7.1 should be removed, when the text here is integrated.*

#### Destination addressing mode (DAM) field

The DAM field shall be set to one of the values listed in Table 2.

**Table 2—** **Valid values of the Destination Addressing Mode field**

|  |  |
| --- | --- |
| **DAM valueb1 b0** | **Description** |
| 00 | The destination address is not present [broadcast] |
| 01 | The destination address is a full 48-bit PD MAC address. |
| 10 | The destination address is a 16-bit multi-cast group address. |
| 11 | Reserved  |

Where the destination address is not present this is the broadcast address.

#### Source addressing mode (SAM) field

The SAM field shall be set to one of the values listed in Table 3.

**Table 3—** **Valid values of the Source Addressing Mode field**

|  |  |
| --- | --- |
| **SAM valueb1 b0** | **Description** |
| 00 | The source address is not present. |
| 01 | The source address is a full 48-bit PD MAC address. |
| 10 | The source address is an 8-bit link-ID. |
| 11 | The source address is a 16-bit link-ID. |

The link-ID shall only be used when the destination address is a full 48-bit PD MAC address, (DAM = 0b01). In that case the link-ID together with the destination address uniquely identifies the source PD to the receiver. The assignment and management of link-IDs is described in <Insert the clause reference for the link-ID procedures when they are written>.

#### AR/SNS field

The AR/SNS field is a combined field coving Acknowledgement Request (AR) and Sequence Number Suppression (SNS) which are mutually exclusive operations. Table 2 lists the meaning of this field.

**Table 2—Values of the AR/SNS field**

|  |  |
| --- | --- |
| **AR/SNS valueb1 b0** | **Description** |
| 00 | SNS = 0, AR = 0  |
| 01 | SNS = 1, AR = 0 |
| 10 | SNS = 0, AR = 1, Ack Type = Immediate |
| 11 | SNS = 0, AR = 1, Ack Type = Enhanced |

The AR value specifies whether an acknowledgment is required from the recipient PD on receipt of a Data frame or MAC command, the Ack Type value specifies which of the two Ack frame formats, defined in 1.3.2, is required. If AR is 1, the recipient device shall send an Ack frame, when upon reception, the frame passes the filtering described in X.X.X.X *<Insert cross reference to the 5.2.2.2 “Reception and rejection”>.* If the AR value is zero, the recipient device shall not send an Ack frame. The AR value shall only be set to 1 for MAC command or Data Frames.

The SNS value being 1 indicates suppression of the Sequence Number field in the frame, and the sequence number shall be omitted. When SNS is 1 the Sequence Number field is not present in the frame.

*Note to group with respect to the frame version field defined below, we could just mark these bits as reserved for use future, but it is probably good to reserve them for frame version and include handling for them in the RX frame filtering rules, i.e. rejecting all frames where frame version is not 0b00.*

#### Frame Version field

The Frame Version field is an unsigned integer that specifies the version number corresponding to the frame. The frame version field shall be set to 0b00 in all frames that include this field.

#### Header IE present (HIEP) field

The HIEP field indicates whether header information elements are present in the MHR.

#### Payload IE present (PIEP) field

The PIEP field indicates whether payload information elements are present in the MAC payload.

#### Security enabled (SEC) field

The SEC field shall be set to one if the frame is protected by the MAC sublayer and shall be set to zero otherwise. The Auxiliary Security Header field of the MHR shall be present only if the SEC field is set to one.

*Note to group with respect to the reserved bit defined below, the frame filtering rules should reject a frame with this R set to 1 since this would mean some extension not defined in the current standard.*

#### Reserved (R) field

The final bit of the Frame Control field is reserved for future expansion. The R bit shall be set to 0 for transmission.

### Sequence Number field

The Sequence Number field if present specifies the sequence identifier for the frame.

### Destination Address field

The Destination Address field, when present, is either a 2-octet multicast group address or a 6-octet PD MAC address, according to the value specified in the Destination Addressing Mode subfield of the Frame Control field (see 1.2.1.4). This field shall be included in the MAC frame only if the Destination Addressing Mode subfield of the Frame Control field is nonzero. When the destination address is not present this shall represent the broadcast address.

### Source Address field

The Source Address field, when present, is either a 6-octet PD MAC address or a one or two-octet Link-ID, according to the value specified in the Source Addressing Mode subfield of the Frame Control field (see 1.2.1.4). A one-octet Link ID may be used when the Link-ID value is less than 256. A two-octet Link ID shall be employed when the Link-ID value is greater than 255. A Link-ID shall only be used when the full 48-bit PD destination address (DAM is 0b01) is present. The Source Address field shall be included in the MAC frame only if the Source Addressing Mode subfield of the Frame Control field is nonzero.

### Auxiliary Security Header field

The Auxiliary Security Header field shall be present when SEC is set to 1. The format of the Auxiliary Security Header field is TBD.

### Header Information Elements field

The Header Information Elements field is variable length and contains one or more Header IEs. This field shall only be present if the HIEP field in the Frame Control field is set. Header IEs, if present, follow the Auxiliary Security Header and are part of the MHR. IE formats are described in 1.4. Header IEs, if present, may require termination, as defined in 1.4.2.

### Payload Information Elements field

The Payload Information Elements field is variable length and contains one or more Payload IEs. This field shall only be present if the PIEP field in the Frame Control field is set. Payload IEs, if present, follow the MHR and are considered part of the MAC payload, i.e., they may be encrypted. IE formats are described in 1.4. Payload IEs, if present, may require termination, as defined in 1.4.2.

### Frame Payload field

The Frame Payload field contains information specific to individual frame types. If the Security Enabled field is set to one, the frame payload the frame may be cryptographically protected, as described in TBD.

### Frame Check Sequence (FCS)

*The text for the FCS is already defined in the 802.15.8 draft txt, in the P802.15.8\_D0.15.1.doc revision this is in clause “5.2.1.1 Frame Check Sequence (FCS)”. Please move that text to here.*

## Format of individual frame types

### Data frame format

The Data frame shall be formatted as illustrated in Figure 3.



**Figure 3—Data frame format**

#### Data frame MHR field

The Frame Type field shall contain the value that indicates a Data frame, as shown in Table 1. All other fields in the Frame Control field shall be set appropriately according to the intended use of the Data frame.

### Acknowledgement frame formats

There are two types of acknowledgement frame: the Immediate Ack and the enhanced Ack. The type to send is defined by the Ack Type specified in the AR/SNS field, as defined in 1.2.1.4.

The Frame Type field shall contain the value that indicates an Ack frame, as shown in Table 1. All other fields in the Frame Control field shall be set appropriately according to the described format of the Ack Frame.

#### Immediate Ack frame format

The Immediate Ack shall be formatted as shown in Figure 4.



**Figure 4—Immediate Ack frame format**

The MHR of the Immediate ACK shall only contain the Frame Control and Sequence Number fields. The Sequence number filed shall be copied from the frame being acknowledged. The payload of the Immediate Ack shall contain a direct copy of the addressing fields from the the frame being acknowledged.

#### Enhanced Ack frame format

The Enhanced Ack shall be formatted as shown in Figure 5.



**Figure 5—Enhanced Ack frame format**

The MHR of the Enhanced ACK shall be correctly formatted consistently with the Frame Control field. The Sequence number filed shall be copied from the frame being acknowledged. The Enhanced Ack shall have no payload other than any Payload IEs that may be included.

### MAC command frame format

The MAC command shall be formatted as illustrated in Figure 4.



**Figure 4—MAC command frame format**

The formats of the individual MAC commands are defined in x.x.x <from clause 1.1 in Doc. 15-901r1>.

#### MAC Command MHR field

The Frame Type field shall contain the value that indicates a MAC Command frame, as shown in Table 1. All other fields in the Frame Control field shall be set appropriately according to the intended use of the MAC Command frame.

## Information Elements (IEs)

### General IE format

Header IEs and Payload IEs have the same general format, shown in Figure 3. Each IE consists of a descriptor and a variable content. The descriptor has three encoding classes identified by an initial IE class field that is either the single bit-0 being clear, or, 2 bits where bit-0 is set. These are referred to as class-0, class-1 and class-3 encodings. (There is no class-2 encoding). Each of IE classes has a separate ID space. Header IEs and Payload IEs also have separate ID spaces. So, for instance, a class-0 Header IE with ID of 1, is a different IE to a class-1 Header IE with ID of 1, and also different to a class-0 Payload IE with ID of 1. The IE length field specifies the number of octets in the IE content field.



**Figure 3—General IE formats**

### IE list termination

If a header IE list is present then it needs to be terminated if it is followed by either payload IEs or MAC payload. If a payload IE list is present then it needs to be terminated if it is followed by MAC payload. Otherwise no termination is required.

The termination of Header and/or Payload IE lists is achieved using a class 0 IE with ID=0 and length=0. (The IE ID = 0 entry, is thus reserved for Header IE list termination in Table 4 and for Payload IE list termination in Table 7). These IE list terminators both have a zero length Content field.

### Header IEs

The Header IEs are defined in Table 4, Table 5 and Table 6, one table for each of the IE classes. These tables are ordered by IE ID number with a description for each and reference to the sub-clause that defines the IE and its usage.

**Table 5—Class 0 Header IEs**

|  |  |  |  |
| --- | --- | --- | --- |
| **Class 0 Header IE ID** | **IE Description** | **Acronym** | **Sub-clause** |
| 0 | Header IE list terminator. | - | 1.4.2 |
| 1 | Cyclic-Superframe Specifier IE | - |  *1.4.3.1* |
| 2 | PHY type |  | 1.4.3.2 |
| 3 | PHY mode |  | 1.4.3.3 |
| 3 to 15  | Reserved | - | - |

**Table 6—Class 1 Header IEs**

|  |  |  |  |
| --- | --- | --- | --- |
| **Class 1 Header IE ID** | **IE Description** | **Acronym** | **Sub-clause** |
| 0 | Link-ID Assignment IE | - | 1.4.3.1 |
| 0 to 511 | Reserved | - | - |

**Table 7—Class 3 Header IEs**

|  |  |  |  |
| --- | --- | --- | --- |
| **Class 3 Header IE ID** | **IE Description** | **Acronym** | **Sub-clause** |
| 0 to 15 | Reserved | - | - |

#### Cyclic superframe specifier IE

#### PHY type IE

 **Table 8—Class 0 PHY type Header IE**

|  |  |
| --- | --- |
| Bits: 0−3 | Description |
| 0 | Low mobility PHY |
| 1 | High mobility PHY |
| 2 | GFSK |
| 3 | UWB |
| 4-15 | Reserved |

 **Table 9—Class 0 PHY type Header IE**

|  |  |
| --- | --- |
| Bits: 4−7 | Description |
| 0 | 2.4 GHz |
| 1 | 5.7 GHz |
| 2 | Sub-GHz |
| 3 | UWB band |
| 4−15 | Reserved |

#### PHY mode IE

**Table 9—PHY modes low mobility PHY Header IE**

|  |  |
| --- | --- |
| Octets: 1 | Description |
| 0 | Data rate=1 Mbps; QPSK; ½ CC |
| 1 |   |

**Table 9—PHY modes high mobility PHY Header IE**

|  |  |
| --- | --- |
| Octets: 1 | Description |
| 0 | Data rate=10 Mbps; 16QAM; ½ LDPC |
| 1 |   |

**Table 9—PHY modes Sub-GHz PHY Header IE**

|  |  |
| --- | --- |
| Octets: 1 | Description |
| 0 | Data rate=1 Mbps; BPSK; ½ LDPC |
| 1 |   |

**Table 9—PHY modes high UWB PHY Header IE**

|  |  |
| --- | --- |
| Octets: 1 | Description |
| 0 | Data rate=1 Mbps; BPM-BPSK; ½ CC |
| 1 | Data rate=1 Mbps; OOK; ½ CC  |
|  |  |

#### Link-ID Assignment IE

The Link-ID Assignment IE conveys a Link-ID that the PD receiving the Link-ID Assignment IE may use for future communications to the PD that sent the Link-ID Assignment IE. The Link-ID Assignment IE shall only be conveyed in a frame with a source address (SAM not equal to 0b00) and a full 48-bit PD destination address (DAM is 0b01). The content field of the Link-ID Assignment IE shall be formatted as shown in Figure 8.

|  |
| --- |
| **Octets : 2** |
| Link-ID assignment |

**Figure 8—Link-ID Assignment IE Content field format**

### Payload IEs

The Payload IEs are defined in Table 7, Table 8 and Table 9, one table for each of the IE classes. These tables are ordered by IE ID number with a description for each and reference to the sub-clause that defines the IE and its usage.

*This Table 7 replaces the Table 93—information element IDs in the curent draft, which should be deleted, after firstly finding any references to that table 93 and changing them to reference this new Table 7.*

**Table 7—Class 0 Payload IEs**

|  |  |  |  |
| --- | --- | --- | --- |
| **Class 0 Payload IE ID** | **IE Description** | **Acronym** | **Sub-clause** |
| 0 | Payload IE list terminator. | - | 1.4.2 |
| 1 | Ranging Request Reply Time IE | RRRT IE | 13.2.3.1 |
| 2 | Ranging Reply Time Instantaneous IE | RRTI IE | 13.2.3.2 |
| 3 | Ranging Reply Time Deferred IE | RRTD IE | 13.2.3.3 |
| 4 | Ranging Preferred Reply Time IE | RPRT IE | 13.2.3.4 |
| 5 | Ranging Control Double-sided TWR IE | RCDT IE | 13.2.3.5 |
| 6 | Ranging Round Trip Measurement IE | RRTM IE | 13.2.3.6 |
| 7 | Ranging Time-of-Flight IE | RTOF IE | 13.2.3.7 |
| 8 to 15 | Reserved |  |  |

**Table 8—Class 1 Payload IEs**

|  |  |  |  |
| --- | --- | --- | --- |
| **Class 1 Payload IE ID** | **IE Description** | **Acronym** | **Sub-clause** |
| 0 to 511  | Reserved | - | - |

**Table 9—Class 3 Payload IEs**

|  |  |  |  |
| --- | --- | --- | --- |
| **Class 3 Payload IE ID** | **IE Description** | **Acronym** | **Sub-clause** |
| 0 to 15 | Reserved | - | - |

*The sub-clauses 13.2.3.1 through 13.2.3.7 references in Table 7 may be left where they are, or moved here as sub clauses of 1.4.4, editor to decide.*

*<<<<<<END OF TEXT TO BE INTEGRATED>>>>*

*The following is for discussion, and not part of the text to be integrated.*

Other IE to be considered based on mention in P802.15.8\_D0.15.1.doc

* clause *9.1.5.7 Beam Jitter field* mentions an IE
	+ The cross-correlation coefficient *ρ* is compared with the threshold found in the IE received in the SSF request frame. If *ρ* is larger than the threshold, the PD transmits an SSF response frame to the transmitter of the SSF request frame with the calculated *ρ*.
	+ The Beam Jitter (BJ) field is transmitted at the end of the self-spatial filtering (SSF) that is described in subclause 9.1.5.7. The presence of BJ field is indicated in the MAC header in the PSDU payload, and the MPDU payload in the PSDU includes the IE that contains the threshold for the correlation level used in SSF which is defined in subclause x.x. The BJ field is present only when self-spatial filtering is used

BV: What is SSF request frame, is it a MAC command frame, there is no definition. This frame could be defined to include the threshold, so an IE is not necessary.

* clause *11.1 Power control information detection* mentions an IE
	+ As illustrated in Figure 82, the power control information is either transmitted by MAC power control management frame with the power control information inserted in the IE field or payload, or transmitted with other management or data frames (i.e. piggybacked) in the IE field or payload.

BV: This figure seems has three different encoding formats and mentions a special power management frame, and also a MAC command frame and also carrying it as an IE in a data frame. Do we need all three formats? I don’t think these referred to frames have been defined. We could use an IE for this… is it header or payload. Perhaps it should be secured?