**IEEE P802.15**

**Wireless Personal Area Networks**

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| Source | Trang Nguyen, Nam Tuan Le, and Yeong Min Jang (Kookmin University) |
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| Abstract | Summary on OCC MACs  |
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# **Summary on OCC MACs**

1. **MAC Supperframe**

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| --- | --- |
| **Unidirectional information broadcasting** | **Bidirectional data transfer** **(OCC for both downlink and uplink)** |
| PHY 4 modes | PHY 4 |
| PHY 5 modes | x |
| PHY 6 modes | PHY 6  |

From our perspective, unidirectional information broadcasting modes shall not implement any MAC supper frame.

On the other hand, bidirectional data transfer modes shall optionally implement a simple channel access (e.g. unslotted ALOHA). Whenever TRX has data, it just transmits.

|  |  |  |
| --- | --- | --- |
|  | **Information Broadcasting** | **Bidirectional data transfer** |
| **Channel access** | No | Yes |
| **Addressing** | Source (optional) | Source or Destination |
| **Security** | No | Optional |
| **Acknowledgement** | No | Optional (prefer NO) |
| **Superframe structure** | No | Optional |

1. **MAC frame formats**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **MHR** | **MSDU** | **MFR** |
|  | IEEE 802.15.7-2011 | Frame control: 2 octetsSequence No.: 1Addressing fields: Acknowledge field:Polling field:Security header: | Frame payload | FCS |
| PHY 4 | UFSOOK | x | - | CRC-3 (optional) |
| S2-PSK | x | - | x |
| S8-PSK | x | - | x |
| Twinkle VPPM | Addressing fields (source) | - | FCS |
| HS-PSK | Addressing fields | - | Optional |
| Offset-VPPM | x | - | FCS: 2  |
| PHY 5 | RS-FSK | Frame control: 1Sequence No.: 1Addressing fields: 0/2 | - | FCS: 2  |
| CM-FSK | Config. via MAC attributes | - | x |
| C-OOK | Config. via MAC attributes | - | x |
| Packet PWM/PPM | N/A | N/A | N/A |
| PHY 6 | Kookmin A-QL | Frame control: 1Addressing fields: 1 -Source address (IB mode) - Source/Dest. address (D2D mode) | - | Optional |
| Kookmin HA-QL | Config. via MAC attributes | - | x |
| VTASC | Frame control: 2Sequence No.: 1Addressing fields: 0/2/8 | - | FCS: 2 |
| Invisible data embedded display |

##  **2.1 MHR Format**

|  |  |  |
| --- | --- | --- |
|  |  | **MHR** (octets) |
|  |  | Frame control | Sequence number | Addressing fields | Ack. field | Polling field | Aux. Security Header |
|  | **15.7-2011** | 2 | 1 | multi subfields | 0/3/9 | 0/2/8 | 0/5/6/0/14 |
| **PHY 4** | UFSOOK |  |  |  |  |  |  |
| S2-PSK |  |  |  |  |  |  |
| S8-PSK |  |  |  |  |  |  |
| Twinkle VPPM |  |  | Source Address |  |  |  |
| HS-PSK | 1 |  | 1(Source/Dest.) |  |  |  |
| Offset-VPPM |  |  |  |  |  |  |
| **PHY 5** | RS-FSK | 1 | 1 |  Source Add.:0/2Dest. Add.:0/2 |  |  |  |
| CM-FSK | Config. over MAC attributes |
| C-OOK | Config. over MAC attributes |
| Packet PWM/PPM | N/A |
| **PHY 6** | Kookmin A-QL | 1 |  | 1(Source/Dest.) |  |  |  |
| Kookmin HA-QL | Config. over MAC attributes |
| VTASC | 2 | 1 | 0/2/8 |  |  |  |
| Invisible data embedded display |

Comments

* If frame control field is disable, there is no need of MAC supper frame. Thus, low-rate OCC modes without MHR field on MAC shall be implemented on information broadcasting (IB mode).
* When MHR is disable, multiple MACs may be supported in the same network by re-configuring the MAC attributes.
* Frame control field is necessary at a situation that D2D is supported. A TRX generates a source address when it broadcasts data to multiple TRXs; and it generates a destination source address when it solely targets the communication to a specific one.

# MACs Configuration

* + For low-rate modes, different OCC MACs are configurable via MAC attributes. The subfields of MHR field shall be configured via MAC attributes
	+ For high-rate modes, MAC frame formats are presented.

**Our comment**:

Those MAC PIB attributes are designed for OCC modes only. I guess LiFi modes do not require those attributes. That’s why mandatory MAC attributes start with “macOcc…”.

## **I- MAC PIB Attributes**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Attribute** | **Ident.** | **Type** | **Range** | **Description** |
| macFrameVersion | - | 3 bit | 000- 111 | This attribute specifies the OCC MAC frame version.000: IEEE Std 802.15.7-2011001: IEEE Std 802.15.7-201x OCC010-111: Reserved |
| macOccFrameType | - | 3 bit | 000- 111 | This attribute specifies the OCC MAC frame.000: Unidirectional Information Broadcasting (IB) frame001: Light-ID frame010: Bidirectional data transfer (D2D mode)011-111: Reserved |
| macOccSecurityEnable | - | Boolean | T/F | This is to configure security mode.FALSE: Security disable (all the OCC broadcasting modes)TRUE: Security enable |
| **1- Light-ID MAC frame format (Indoor scenario)** |
| macLightIdPrefix | - | byte | 0x00- 0xff | The Light-ID prefix field to indicate further information of the frame, such as company ID. |
| macLightIdFrameSubtype | - | 3 bit | b000 -b111 | This specifies the subtype of Light-ID MAC frame. Thus the subtype also gives the information of the frame length.000: 3 subfields Light-ID001: 4 subfields Light-ID010: Mixed Light-ID subtypes (including the full and the shorten IDs)011-111: Reserved |
| macLightIdFullIdCycle | - | Int. | 0-7 | This attribute is present solely *macLightIdFrameSubtype* = 010. 0: No shorten ID1: (1 full ID || 22 shorten IDs) 3-7: Reserved |
| macLightIdSubfield1Length | - | Int. | 0-7 | This attribute specifies the length of subfield 1 of Light-ID payload.0: 0 byte (for the shorten frame type)1: 1 byte2: 2 byte3-7: Reserved |
| macLightIdSubfield2Length | - | Int. | 0-7 | Same as macLightIdSubfield1Length |
| macLightIdSubfield3Length | - | Int. | 0-7 | This attribute specifies the length of subfield 3 of Light-ID payload.0: 1 byte1: 2 byte2-7: Reserved |
| macLightIdSubfield4Length | - | Int. | 0-7 | This attribute specifies the length of subfield 4 (optional subfield) of Light-ID payload.0: 0 byte1: 2 byte advertisement indicator2-7: Reserved |
| **2- Unidirectional IB mode MAC frame format** |
| macIBSourceAddressEnable |  | Boolean | T/F | This is to enable the source addressing for OCC IB.TRUE: Source Addressing is enableFALSE: Source Addressing is disable |
| macIBSourceAddress |  | 1 byte |  | This specifies the address of the transmitting source if the IB Source Addressing is enable.Otherwise, it sets to 0xff. |
| **3- Bidirectional Data transfer MAC frame format (D2D)** |
| macD2DSourceAddressModeEnable |  | Boolean | T/F | This is to enable the source addressing mode for OCC D2D.TRUE: Source Addressing ModeFALSE: Destination Addressing Mode |
| macD2DSourceDestAddress |  | 2 byte | 0x0000 – 0xffff | The Address field corresponds to the D2D Address Mode.If Destination Addressing Mode is enable, this attributes specifies the address of the intended recipient of the frame. Otherwise, this specifies the address of the transmitting source. |
| macD2DSecurityHeader |  | 2 byte | 0x0000 – 0xffff | The security header corresponds to the secured D2D mode.This attribute is set to 0xffff if the security flag is disable. |
|  |  |  |  |  |

## **II- MAC Format of Individual frames**

### **2.1- Light-ID MAC frame format**

The configuration of Light-ID MAC frame format is performed over MAC attributes:

*macOccFrameVersion*: 001

*macOccFrameType*: 001

*macOccSecurityEnable*: FALSE

MAC frame is light-ID frame when *macOccFrameType* = 001. The other MAC attributes for Light-ID frame (*macLightIdPrefix*, *macLightIdFrameSubtype*, *macLightIdFullIdCycle*, *macLightIdSubfield1Length*, *macLightIdSubfield2Length*, *macLightIdSubfield3Length*, and *macLightIdSubfield4Length*) shall configure the specification of the MAC frame used.

For the subtype of MAC frame formats of Light-ID that has *macLightIdFrameSubtype* =000 or *macLightIdFrameSubtype* =001, the format of MAC is only payload field as shown in Fig. 01. The subfields of the payload shall be formatted according to the selected frame subtype over the remaining attributes (*macLightIdSubfield1Length*, *macLightIdSubfield2Length*, *macLightIdSubfield3Length*, and *macLightIdSubfield4Length*).

|  |
| --- |
| Variable |
| Frame payload (3/4 subfields) |
| MSDU |

**Figure 01 – Light\_ID frame format for selected subtype 000 and 001.**

For the subtype of MAC frame formats of Light-ID that has *macLightIdFrameSubtype* =010, different MAC subframes, including a full ID frame (subtype 000 or 001) and multiple shorten ID frames, shall be transmitted as shown in Fig. 02. The shorten ID frame shall contain only the last subfield of the full ID frame payload.



**Figure 02 – Light\_ID frame format for selected subtype 010 (with different MAC subframes).**

Each subframe shall contain a prefix of 3 bits subtype that indicate the value of m*acLightIdFrameSubtype.* The interframe interval between two full ID frames is configured over *macLightIdFullIdCycle*.

### **2.2- Unidirectional IB mode MAC frame format**

All unidirectional IB modes shall configure MAC frame format over OCC MAC PIB attributes:

*macOccFrameVersion*: 001

*macOccFrameType*: 000

*macOccSecurityEnable*: FALSE

For low rate OCC modes (S2-PSK, S8-PSK, CM-FSK, C-OOK, HA-QL), two additional MAC attributes, *macIBSourceAddressEnable* and *macIBSourceAddress*, shall configure the addressing of the selected IB mode. Security is disable for all IB modes, therefore no MAC attribute for security is needed. Source address is optionally enable in case multiple sources are considered. If source address is enable, *macIBSourceAddress* shall configure the source addressing.

On the other hand, higher rate OCC modes (HS-PSK, and A-QL modulation) shall configure IB frame format over MHR subfields, not MAC PIB attributes. In this case, the MAC frame format shall be formatted as Fig. 03.



**Figure 03 – Information broadcasting MAC frame format for high rate OCC mode (HS-PSK and A-QL)**

### **2.3- Bidirectional Data transfer MAC frame format (D2D)**

All bidirectional data transfer modes shall configure MAC frame format over OCC MAC PIB attributes:

*macOccFrameVersion*: 001

*macOccFrameType*: 010

*macOccSecurityEnable*: FALSE/TRUE

Once the D2D mode is selected, low rate OCC D2D modes (S2-PSK, S8-PSK, CM-FSK, C-OOK, HA-QL) shall configure the other characteristics of MAC frame format over three additional MAC attributes, *macD2DSourceAddressModeEnable*, *macD2DSourceDestAddress*, and *macD2DSecurityHeader*.

 Compared to IB mode, Security is optionally enable over the MAC attribute *macOccSecurityEnable,* thus *macD2DSecurityHeader* is optionally presented.

On the other hand, higher rate OCC D2D modes (HS-PSK, and A-QL) shall configure D2D MAC frame format over MHR subfields, not MAC PIB attributes. In this case, the MAC frame format shall be formatted as Fig. 04.



**Figure 04 – Bidirectional data transfer MAC frame format for high rate OCC mode (HS-PSK, and A-QL)**