**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | Draft text of transmission, reception, and acknowledgment for TG8 | |
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| Re: | Draft text of transmission, reception, and acknowledgment for 802.15.8 | |
| Abstract | This is the work in progress text of the MAC component for IEEE 802.15.8 group for PAC. | |
| Purpose | This document provides the details of draft text to IEEE 802.15.8 | |
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1. MAC protocol
   1. MPDU formats

----------------------------- Beginning of Text ------------------------------------

(Copied from IEEE 802.15.4 2011 release, clause 5.1.5 & 5.1.6, and then modified for PAC)

5.1.6 Transmission, reception, and acknowledgment

This subclause describes the fundamental procedures for transmission, reception, and acknowledgment.

5.1.6.1 Transmission

Each device shall store its current Data Sequence Number (DSN) value in the MAC Personal area network Information Base (PIB) attribute *macDSN* and initialize it to a random value; the algorithm for choosing a random number is outside the scope of this standard. Each time a data or a MAC command frame is generated, the MAC sublayer shall copy the value of *macDSN* into the Sequence Number field of the MHR of the outgoing frame and then increment it by one. Each device shall generate exactly one DSN regardless of the number of unique devices with which it wishes to communicate. The value of *macDSN* shall be permitted to roll over.

The Source Address field, shall contain the address of the device sending the frame. When a device has associated and has been allocated a short address (i.e., *macShortAddress* is not equal to 0xfffe or 0xffff), it shall use that address in preference to its extended address (i.e., *macExtendedAddress*) wherever possible. When a device has not yet associated to a PAC network, it shall use its extended address in all communications requiring the Source Address field. The destination Address field shall contain the address of the recipient.

The Destination Address field, if present, shall contain the address of the intended recipient of the frame, which may be either a short address or an extended address. The source Address field shall contain the address of the originator.

If the transmission is direct and originates due to a primitive issued by the next higher layer and the CSMA-CA algorithm fails, the next higher layer shall be notified.

The device shall process the frame using the outgoing frame security procedure described in 7.2.1.

If the status from the outgoing frame security procedure is not SUCCESS, the MLME shall issue the corresponding confirm or MLME-COMM-STATUS.indication primitive with the status parameter set to the status from the outgoing frame security procedure, indicating the error, and shall not transmit the frame.

If the status from the outgoing frame security procedure is SUCCESS, the MAC sublayer shall transmit the frame.

5.1.6.2 Reception and rejection

Each device may choose whether the MAC sublayer is to enable its receiver during idle periods. During these idle periods, the MAC sublayer shall still service transceiver task requests from the next higher layer. A transceiver task shall be defined as a transmission request with acknowledgment reception, if required, or a reception request. On completion of each transceiver task, the MAC sublayer shall request that the PHY enables or disables its receiver, depending on the values of *macRxOnWhenIdle*. The value of *macRxOnWhenIdle* shall be considered relevant only during idle periods of the CAP of the incoming superframe.

Due to the nature of radio communications, a device with its receiver enabled will be able to receive and decode transmissions from all devices complying with this standard that are currently operating on the same channel and are in its radio communications range, along with interference from other sources. The MAC sublayer shall, therefore, be able to filter incoming frames and present only the frames that are of interest to the upper layers.

For the first level of filtering, the MAC sublayer shall discard all received frames that do not contain a correct value in their Frame Check Sequence (FCS) field in the MFR, as described in 5.2.1.9. The FCS field shall be verified on reception by recalculating the purported FCS over the MHR and MAC payload of the received frame and by subsequently comparing this value with the received FCS field. The FCS field of the received frame shall be considered to be correct if these values are the same and incorrect otherwise.

The second level of filtering shall be dependent on whether the MAC sublayer is currently operating in promiscuous mode. In promiscuous mode, the MAC sublayer shall pass all frames received after the first filter directly to the upper layers without applying any more filtering or processing. The MAC sublayer shall be in promiscuous mode if *macPromiscuousMode* is set to TRUE.

If the MAC sublayer is not in promiscuous mode (i.e., *macPromiscuousMode* is set to FALSE), it shall accept only frames that satisfy all of the following third-level filtering requirements:

* The Frame Type field shall not contain a reserved frame type.
* The Frame Version field shall not contain a reserved value.
* If a destination PAC?? identifier is included in the frame, it shall match macPANId or shall be the broadcast PAN identifier.
* If a short destination address is included in the frame, it shall match either *macShortAddress* or the broadcast address. Otherwise, if an extended destination address is included in the frame, it shall match *macExtendedAddress*.
* .
* If only source addressing fields are included in a data or MAC command frame, the frame shall be accepted only if the device is in broadcasting mode.
* If the service type field is included in a data or MAC command frame, the frame shall be accepted only if the service type matches *macServiceType* (programmed by/from higher layer)*.*

If any of the third-level filtering requirements are not satisfied, the MAC sublayer shall discard the incoming frame without processing it further. If all of the third-level filtering requirements are satisfied, the frame shall be considered valid and processed further. For valid frames, if the Frame Type field indicates a data or MAC command frame and the AR field is set to request an acknowledgment, the MAC sublayer shall send an acknowledgment frame. Prior to the transmission of the acknowledgment frame, the sequence number included in the received data or MAC command frame shall be copied into the Sequence Number field of the acknowledgment frame. This step will allow the transaction originator to know that it has received the appropriate acknowledgment frame.

The device shall process the frame using the incoming frame security procedure described in 7.2.3.

If the status from the incoming frame security procedure is not SUCCESS, the MLME shall issue the corresponding confirm or MLME-COMM-STATUS.indication primitive with the status parameter set to the status from the incoming frame security procedure, indicating the error, and with the security-related parameters set to the corresponding parameters returned by the unsecuring process.

If the valid frame is a data frame, the MAC sublayer shall pass the frame to the next higher layer. This is achieved by issuing the MCPS-DATA.indication primitive containing the frame information. The security- related parameters of the MCPS-DATA.indication primitive shall be set to the corresponding parameters returned by the unsecuring process.

If the valid frame is a MAC command, it shall be processed by the MAC sublayer accordingly, and a corresponding confirm or indication primitive may be sent to the next higher layer. The security-related parameters of the corresponding confirm or indication primitive shall be set to the corresponding parameters returned by the unsecuring process.

**5.1.6.4 Use of acknowledgments and retransmissions**

A data or MAC command frame shall be sent with the AR field set appropriately for the frame. An acknowledgment frame shall always be sent with the AR field set to indicate no acknowledgment requested. Similarly, any frame that is multicast or broadcast shall be sent with its AR field set to indicate either acknowledgment requested.

**5.1.6.4.1 No acknowledgment**

A frame transmitted with its AR field set to indicate no acknowledgment requested, as defined in 5.2.1.1.4, shall not be acknowledged by its intended recipient. The originating device shall assume that the transmission of the frame was successful.

Device next higher layer

PD1 MLME

PD2 MLME

MLME-POLL.request

*Data request*

*Acknowledgment (FP = 1)*

*Data) Acknowledgment*

MLME-POLL.confirm

MCPS-DATA.indication

**Figure 24—Message sequence chart for requesting data from the coordinator when the coordinator has data pending**

The message sequence chart in Figure 25 shows the scenario for transmitting a single frame of data from an originator to a recipient without requiring an acknowledgment.



**Figure 25—Successful data transmission without an acknowledgment**

**5.1.6.4.2 Acknowledgment**

A frame transmitted with the AR field set to request an acknowledgment, as defined in 5.2.1.1.4, shall be acknowledged by the recipient. If the intended recipient correctly receives the frame, it shall generate and send an acknowledgment frame containing the same DSN from the data or MAC command frame that is being acknowledged.

The transmission of an acknowledgment frame in the CFP shall commence *macSIFSPeriod* (for short inter-frame spacing) after the reception of the last symbol of the data or MAC command frame. The transmission of an acknowledgment frame in the CAP shall commence either *macSIFSPeriod* after the reception of the last symbol of the data or MAC command frame or at a backoff period boundary. In the latter case, the transmission of an acknowledgment frame shall commence between *macSIFSPeriod* and (*macSIFSPeriod + aUnitBackoffPeriod*) after the reception of the last symbol of the data or MAC command frame.

The message sequence chart in Figure 26 shows the scenario for transmitting a single frame of data from an originator to a recipient with an acknowledgment requested.

**5.1.6.4.3 Retransmissions**

A device that sends a frame with the AR field set to indicate no acknowledgment requested may assume that the transmission was successfully received and shall not perform the retransmission procedure.



**Figure 26—Successful data transmission with an acknowledgment**

A device that sends a data or MAC command frame with its AR field set to acknowledgment requested shall wait for at most *macAckWaitDuration* for the corresponding acknowledgment frame to be received. If an acknowledgment frame is received within *macAckWaitDuration* and contains the same DSN as the original transmission, the transmission is considered successful, and no further action regarding retransmission shall be taken by the device. If an acknowledgment is not received within *macAckWaitDuration* or an acknowledgment is received containing a DSN that was not the same as the original transmission, the device shall conclude that the single transmission attempt has failed.

If a single transmission attempt has failed and the transmission was direct, the device shall repeat the process of transmitting the data or MAC command frame and waiting for the acknowledgment, up to a maximum of *macMaxFrameRetries* times. The retransmitted frame shall contain the same DSN as was used in the original transmission. Each retransmission shall only be attempted if it can be completed within the same portion of the superframe, i.e., the CAP or a CFP slot in which the original transmission was attempted. If this timing is not possible, the retransmission shall be deferred until the same portion in the next superframe. If an acknowledgment is still not received after *macMaxFrameRetries* retransmissions, the MAC sublayer shall assume the transmission has failed and notify the next higher layer of the failure.

When a frame with the Security Enabled field set to one is retransmitted, the frame shall be retransmitted without changes and without passing through the outgoing frame security procedure, as defined in 7.2.1.

**5.1.6.5 Promiscuous mode**

A device may activate promiscuous mode by setting *macPromiscuousMode*. If the MLME is requested to set *macPromiscuousMode* to TRUE, the MLME shall then request that the PHY enable its receiver.

When in promiscuous mode, the MAC sublayer shall process received frames according to 5.1.6.2 and pass all frames correctly received to the next higher layer using the MCPS-DATA.indication primitive. The source and destination addressing mode parameters shall each be set to 0x00, the MSDU parameter shall contain the MHR concatenated with the MAC payload, as illustrated in Figure 35, and the *msduLength* parameter shall contain the total number of octets in the MHR concatenated with the MAC payload. The *mpduLinkQuality* parameter shall be valid.

If the MLME is requested to set *macPromiscuousMode* to FALSE, the MLME shall request that the PHY set its receiver to the state specified by *macRxOnWhenIdle*.

**5.1.6.6 Transmission scenarios**

Due to the imperfect nature of the radio medium, a transmitted frame does not always reach its intended destination. There are three different transmission scenarios:

* Successful data transmission. The originator MAC sublayer transmits the data frame to the recipient via the PHY data service. In waiting for an acknowledgment, the originator MAC sublayer starts a timer that will expire after *macAckWaitDuration*. The recipient MAC sublayer receives the data frame, sends an acknowledgment back to the originator, and passes the data frame to the next higher layer. The originator MAC sublayer receives the acknowledgment from the recipient before its timer expires and then disables and resets the timer. The data transfer is now complete, and the originator MAC sublayer issues a success confirmation to the next higher layer. This sequence of messages for successful data transmission is illustrated in Figure 27.



**Figure 27—Successful data transmission sequence**

* Lost data frame. The originator MAC sublayer transmits the data frame to the recipient via the PHY data service. In waiting for an acknowledgment, the originator MAC sublayer starts a timer that will expire after *macAckWaitDuration*. The recipient MAC sublayer does not receive the data frame and so does not respond with an acknowledgment. The timer of the originator MAC sublayer expires before an acknowledgment is received; therefore, the data transfer has failed. If the transmission was direct, the originator retransmits the data, and this entire sequence may be repeated up to a maximum of *macMaxFrameRetries* times; if a data transfer attempt fails a total of (1 + *macMaxFrameRetries*) times, the originator MAC sublayer will issue a failure confirmation to the next higher layer. The sequence of messages for a lost data frame is illustrated in Figure 28.



**Figure 28—Lost data frame message sequence**

* Lost acknowledgment frame. The originator MAC sublayer transmits the data frame to the recipient via the PHY data service. In waiting for an acknowledgment, the originator MAC sublayer starts a timer that will expire after *macAckWaitDuration*. The recipient MAC sublayer receives the data frame, sends an acknowledgment back to the originator, and passes the data frame to the next higher layer. The originator MAC sublayer does not receive the acknowledgment frame, and its timer expires. Therefore, the data transfer has failed. If the transmission was direct, the originator retrans- mits the data, and this entire sequence may be repeated up to a maximum of *macMaxFrameRetries* times. If a data transfer attempt fails a total of (1 + *macMaxFrameRetries)* times, the originator MAC sublayer will issue a failure confirmation to the next higher layer. The message sequence for a lost acknowledgment frame is illustrated in Figure 29.



**Figure 29—Lost acknowledgment message sequence**

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