IEEE P802.15
Wireless Personal Area Networks

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Re:	[]		
Abstract	[This is the draft of the TG4j Amendment]		
Purpose	[To enable editing of the draft TG4j MBAN amendment.]		
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IEEE Standard for
Local and metropolitan area networks–

Part 15.4: Low-Rate Wireless Personal Area Networks (LR-WPANs)

Amendment: Alternative Physical Layer Extension to support Medical Body Area Networks (MBANS) services operating in the 2360-2400 MHz band

Sponsor

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Prepared by the IEEE 802.15 Working Group for Wireless Personal Area Networks

Committee IEEE802

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Abstract: This amendment defines a physical layer for IEEE 802.15.4 in the 2360 to 2400 MHz band which complies with Federal Communications Commission (FCC) MBAN rules. This amendment defines modifications to the MAC needed to support this new physical layer.

Keywords: MBANS, medical body area network

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Introduction

This introduction is not part of IEEE P802.15.4j/D00, Draft Standard for Amendment: Alternative Physical Layer Extension to support Medical Body Area Network (MBAN) services operating in the 2360-2400 MHz band.

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Rick Alfin, *Co-Vice Chair*
Patrick W. Kinney, *Co-Vice Chair and Secretary*
James P. K. Gilb, *Working Group Technical Editor*
Clint Chaplin, *Treasurer*

Raymond Krasinski, *Task Group 4j Chair*
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The following members of the IEEE 802.15 balloting committee balloting committee voted on this draft. Balloters may have voted for approval, disapproval, or abstention.

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Jin-Meng Ho	Ranjeet K. Patro	Betty Zhao

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Contents

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NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.

The editing instructions are shown in ***bold italic***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~strikethrough~~ (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Deletions and insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editing instructions, change markings, and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.

1. Overview

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

Insert the following new reference alphabetically into Clause 2:

IEEE Std 802.1D-2004, IEEE Standard for Local and Metropolitan Area Networks: Media Access Control (MAC) Bridges[1].

3. Definitions

3.1 Definitions

3.2 Acronyms and abbreviations

Insert the following acronym alphabetically into 3.2:

MBANS	medical body area network services

4. General description

5. MAC protocol

5.1 MAC functional description

5.1.1 Channel access

5.1.2 Starting and maintaining PANs

5.1.2.1 Scanning through channels

5.1.2.2 PAN identifier conflict resolution

5.1.2.3 Starting and realigning a PAN

5.1.2.3.1 Starting a PAN

5.1.2.3.2 Realigning a PAN

[1] *IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://standards.ieee.org).*

5.1.2.3.3 Realignment in a PAN

5.1.2.3.4 Updating superframe configuration and channel PIB attributes

Insert the following after 5.1.2.3.4:

5.1.2.3.5 Channel switch notification

The channel switch notification procedure is initiated by the next higher layer by issuing the MLME-CHANNELSWITCH.request primitive, as described in 6.2.18.1, to the MLME.

When a coordinator wants one of its associated devices to switch its operating channel at a specific time, the MLME of the coordinator shall send the channel switch notification command in the manner specified by the TxIndirect parameter of the MLME-CHANNELSWITCH.request primitive previously sent by the next higher layer. If TxIndirect is TRUE, the MLME of the coordinator shall send the channel switch notification command to the device using indirect transmission; i.e. the channel switch notification command frame shall be added to the list of pending transactions stored on the coordinator and extracted at the discretion of the device concerned using the method described in 5.1.6.3. If the command frame is not successfully extracted by the device, the coordinator shall consider the device disassociated. Otherwise, the MLME shall send the channel switch notification command to the device directly. In this case, if the channel switch notification command cannot be sent due to a channel access failure, the MAC sublayer shall notify the next higher layer.

Upon successful transmission of the channel switch command, the MAC sublayer shall issue the MLME-CHANNELSWITCH.confirm primitive with a status of SUCCESS.

If a device has received the channel switch command, as defined in 5.3.10, from the coordinator, the MLME shall issue the MLME-CHANNELSWITCH.indication primitive with the NewPANID, CoordinatorAddress, RemainingTime, ChannelNumber and ChannelPage parameters set to the respective field in the channel switch command.

Figure 16a illustrates the sequence necessary for a coordinator in a beacon-enabled PAN to successfully transmit channel switch notification command to a device using indirect transmission.

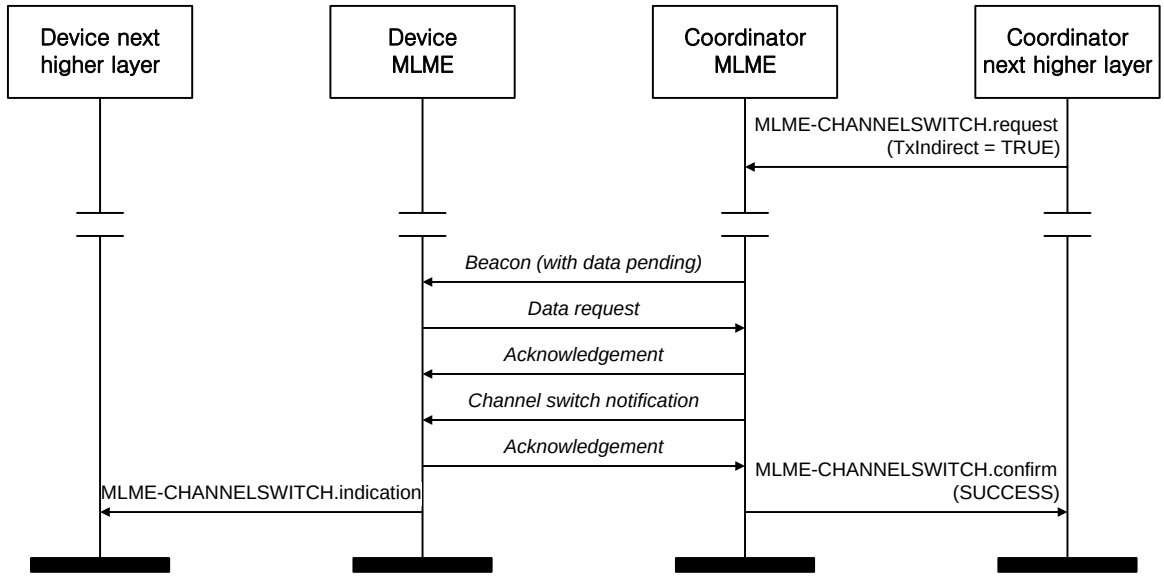

Figure 16a—Message sequence chart for channel switch notification initiated by a coordinator, using indirect transmission, in a beacon-enabled PAN

5.1.2.4 Beacon generation

5.1.2.5 Device discovery

Insert the following after 5.1.2.5:

5.1.2.6 Coordinator switch

A PAN coordinator can switch the devices that are associated to its PAN to another coordinator by using the coordinator switch and device re-alignment commands. The PAN coordinator shall first broadcast a coordinator switch request on a channel using the coordinator switch request command described in 5.3.15 indicating the number of devices that it wishes to switch. The number of devices defines the devices that are associated with its PAN. If another coordinator has the resources and is able to accept the number of devices, it may respond to the broadcast coordinator switch request by sending a coordinator switch response command to the PAN coordinator confirming that it is able to accept the defined number of devices. The time for which the PAN coordinator listens for responses after transmitting the coordinator request command is beyond the scope of this standard. The PAN coordinator shall repeat the broadcast of the coordinator switch request on all of the available channels. The sequence of coordinator switch broadcast request and coordinator switch response messages are shown in Figure 16b.

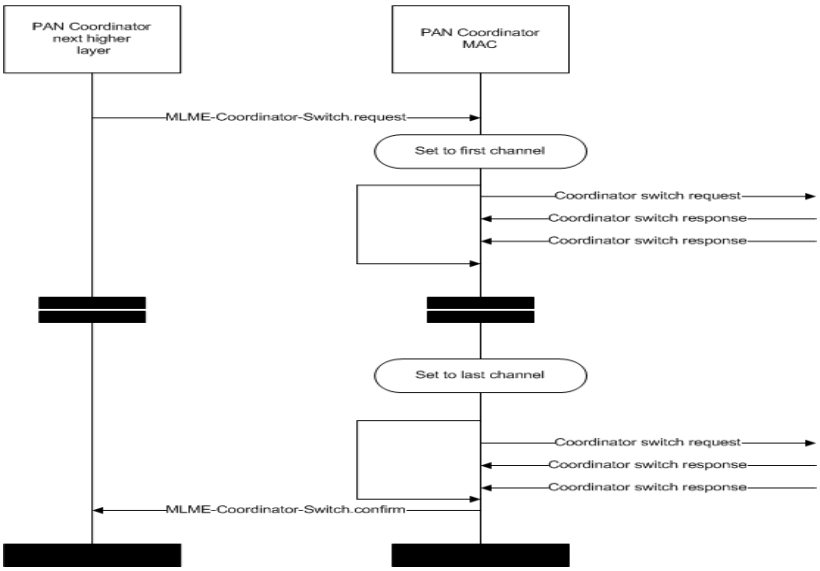

Figure 16b – Coordinator switch broadcast and response

The PAN coordinator shall then select a new coordinator and confirm to the new coordinator using the coordinator switch request command that the new coordinator shall accept the association of the number of device defined in the command. The process for the selection of a new coordinator is beyond the scope of this standard. Once the PAN coordinator has received a successful confirmation of the coordinator switching request command from the new coordinator, it shall send a channel switch notification command to its devices containing the PAN ID and the extended address of the new coordinator and the channel number and channel page that it is operating on. On receiving the channel switch notification command, the devices shall attempt to associate with the new coordinator whose details are provided in this command and shall do so without performing a channel scan. The sequence of coordinator switch selection and channel switch notification messages are shown in Figure 16c.

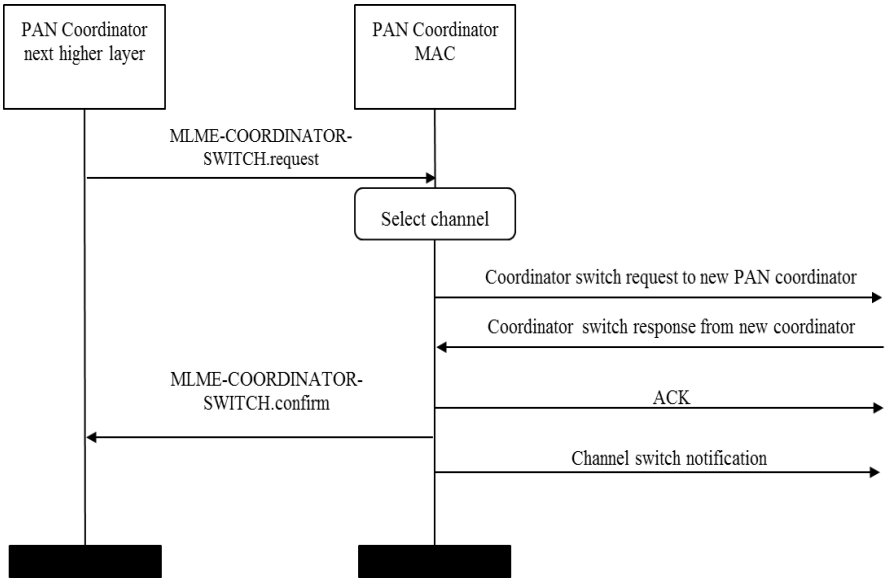

Figure 16c – Coordinator switch selection and channel switch notification

5.1.3 Association and disassocisation

5.1.3.1 Association

5.1.3.2 Disassociation

Insert the following after5.1.3.2:

5.1.3.3 Association proxy

A device shall attempt a request for grant of association proxy after having first associated with a suitable PAN. A coordinator shall allow a grant of association proxy only if *macAssociationPermit* is set to TRUE. Similarly, a device shall attempt a request for grant of association proxy only if the coordinator is currently allowing association, as indicated in the results of the scanning procedure. If a coordinator with *macAssociationPermit* set to FALSE receives a grant association proxy request command from a device, the coordinator shall ignore the command.

The MAC sublayer shall initiate the grant association proxy procedure by sending a grant association proxy request command, as described in 5.3.11, to the coordinator of the PAN; if the grant association proxy request command cannot be sent due to a channel access failure, the MAC sublayer shall notify the next higher layer.

The acknowledgment to a grant association proxy request command does not mean that the device has associated. The coordinator needs time to determine whether the current resources available on the PAN are sufficient to allow other devices to associate. The coordinator shall make this decision within *macResponseWaitTime* of receiving this command. If the coordinator has sufficient resources, it shall

allocate a set of short addresses to the devices, and its MAC sublayer shall generate a grant association proxy response command, as described in 5.3.12. The command shall specify the number of devices that have been allocated a short address, the actual short addresses that the devices may use and a status indicating a successful grant of proxy association. If the coordinator has insufficient resources its MLME shall generate a grant association proxy response command containing a status indicating a failure, as defined in Table 6. The grant association proxy response command shall be sent to the device requesting the grant of association proxy using indirect transmission; i.e., the grant association proxy response command frame shall be added to the list of pending transactions stored on the coordinator and extracted at the discretion of the device concerned using the method described in 5.1.6.3.

On receipt of the acknowledgment to the grant association proxy request command, the device shall wait for at most *macResponseWaitTime* from when the command is received for the coordinator to make its grant of association proxy decision; the PIB attribute *macResponseWaitTime* is a network-topology-dependent parameter and shall be set to match the specific requirements of the network that a device is trying to join. If the device is tracking the beacon, it shall attempt to extract the grant association proxy response command from the coordinator whenever it is indicated in the beacon frame. If the device is not tracking the beacon, it shall attempt to extract the grant association proxy response command from the coordinator after *macResponseWaitTime*. If the device does not extract a grant association proxy response command frame from the coordinator within *macResponseWaitTime*, the MLME shall issue the MLME-GRANTASSOCIATIONPROXY.confirm primitive, as described in 6.2.20.4, with a status of NO_DATA, and the request for grant of association proxy attempt shall be deemed a failure. In this case, the device shall terminate any tracking of the beacon, by issuing an MLME-SYNC.request primitive, as described in 6.2.13.1, with the TrackBeacon parameter set to FALSE.

A device shall attempt a request for an association proxy after obtaining the extended address and capability information for each of the devices for which it has requested a grant of association proxy. The method for obtaining this information from the devices is outside the scope of this standard.

The MAC sublayer shall initiate the association proxy procedure by sending an association proxy request command, as described in 5.3.13, to the coordinator of the PAN.

On receipt of an association proxy request command, the coordinator shall update the device-specific information for the allocated short address with the device extended address and the device capability information. If the coordinator finds that the device was previously associated with its PAN, it shall replace all previously obtained device-specific information. If the coordinator has successfully updated the device information, it shall respond with an association proxy response command indicating success.

A message sequence chart for grant of an association proxy is illustrated in Figure 19a.

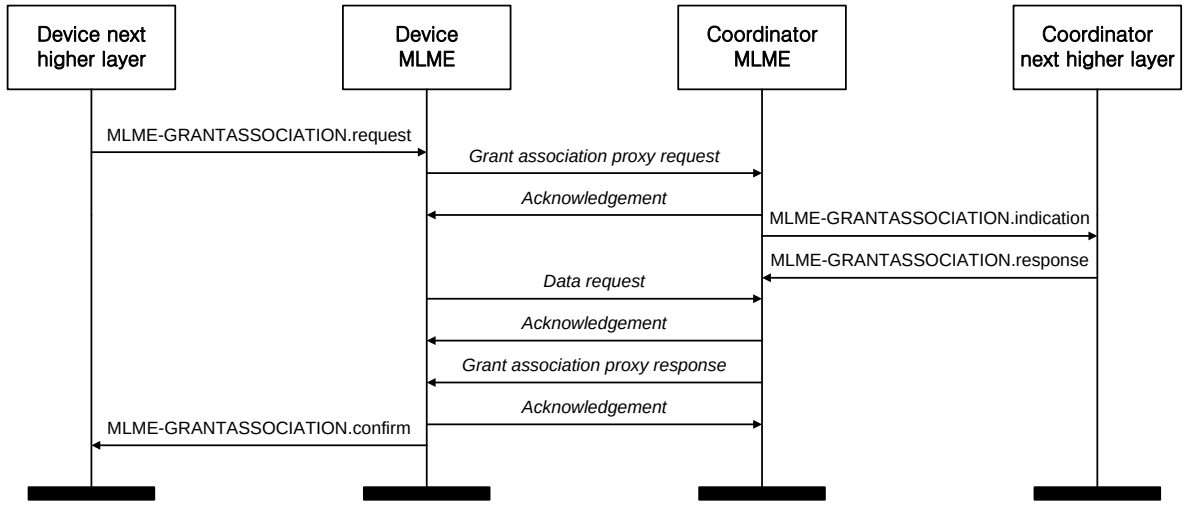

Figure 19a—Message sequence chart for grant of an association proxy

A message sequence chart for an association proxy is illustrated in Figure 19b.

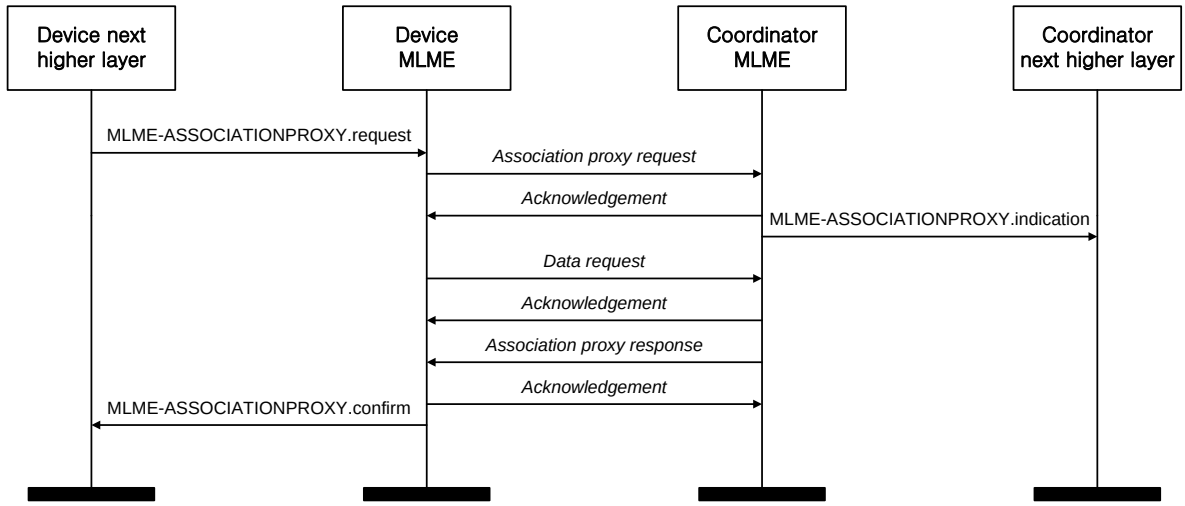

Figure 19b—Message sequence chart for an association proxy

5.1.4 Synchronization

5.1.5 Transaction handling

5.1.6 Transmission, reception, and acknowledgement

5.1.7 GTS allocation and management

5.1.7.1 CAP maintenance

5.1.7.2 GTS allocation

Insert after the second paragraph:

To request the allocation of a new periodic GTS, the MLME shall send the periodic GTS request command, as described in 5.3.9, to the PAN coordinator. The Characteristics Type field of the request shall be set to one, and the length, direction, start frame and period exponent fields shall be set according to the desired characteristics of the required periodic GTS.

Insert after the fifth paragraph:

When the PAN coordinator determines whether capacity is available for the requested periodic GTS, it shall generate a periodic GTS descriptor with the requested specifications and the short address of the requesting device. If the periodic GTS is allocated successfully, the PAN coordinator shall set the start slot in the periodic GTS descriptor to the superframe slot at which the periodic GTS begins and the GTS BSN in the periodic GTS descriptor to the number of remaining superframes for the first allocated periodic GTS slot. In addition, the PAN coordinator shall notify the next higher layer of the new periodic GTS. This notification is achieved when the MLME of the PAN coordinator issues the MLME-PERIODIC-GTS.indication primitive, as described in 6.2.19.3 with the characteristics of the allocated periodic GTS. If there is not sufficient capacity to allocate the requested GTS, the start slot and GTS BSN shall be set to zero. The PAN coordinator shall then include this periodic GTS descriptor in its beacon and update the GTS Specification field of the beacon frame accordingly. The PAN coordinator shall also update the Final CAP Slot field of the Superframe Specification field of the beacon frame, indicating the final superframe slot utilized by the decreased CAP. The periodic GTS descriptor shall remain in the beacon frame for *aGTSDescPersistenceTime* superframes, after which it shall be removed automatically. The PAN coordinator shall be allowed to reduce its CAP below *aMinCAPLength* to accommodate the temporary increase in the beacon frame length due to the inclusion of the periodic GTS descriptor.

5.1.7.3 GTS usage

5.1.7.4 GTS deallocation

Insert after the first paragraph:

A device is instructed to request the deallocation of an existing periodic GTS through the MLME-PERIODIC-GTS.request primitive, as described in 6.2.19.1, using the characteristics of the periodic GTS it wishes to deallocate. From this point onward, the periodic GTS to be deallocated shall not be used by the device, and its stored characteristics shall be reset.

Change and insert in the second paragraph as shown:

To request the deallocation of an existing GTS, the MLME shall send the GTS request command, as described in 5.3.9, to the PAN coordinator. To request the deallocation of an existing periodic GTS, the MLME shall send the periodic GTS request command, as described in 5.3.9, to the PAN coordinator. The Characteristics Type field of either the GTS Characteristics field or the Periodic GTS Characteristics field of the request shall be set to zero (i.e., GTS deallocation), and the length and direction fields shall be set according to the characteristics of the GTS to deallocate. On receipt of the acknowledgment to either the GTS request command or the periodic GTS request command, the MLME shall notify the next higher layer of the deallocation. This notification is achieved when either the MLME issues the MLME-GTS.confirm primitive, as described in 6.2.6.2, with a status of SUCCESS and a GTSCharacteristics parameter with its

Characteristics Type field set to zero or when the MLME issues the MLME-PERIODIC-GTS.confirm primitive, as described in 6.2.19.2, with a status of SUCCESS and a PeriodicGTSCharacteristics parameter with its Characteristics Type field set to zero. If either the GTS request command or the periodic GTS request command is not received correctly by the PAN coordinator, it shall determine that the device has stopped using either its GTS or its periodic GTS by the procedure described in 5.1.7.6.

5.1.7.5 GTS reallocation

5.1.7.6 GTS expiration

Insert at the end of 5.1.7.6:

The MLME of the PAN coordinator shall attempt to detect when a device has stopped using a periodic GTS using the following rules:

— For a transmit periodic GTS, the MLME of a PAN coordinator shall assume that a device is no longer using its periodic GTS if a data frame is not received from the device in the GTS at least every $2 \times m$ superframes, where m is defined below.

— For a receive periodic GTS, the MLME of the PAN coordinator shall assume that a device is no longer using its periodic GTS if an acknowledgment frame is not received from the device at least every $2 \times m$ superframes. If the data frames sent in the GTS do not require acknowledgment frames, the MLME of the PAN coordinator will not be able to detect whether a device is using its receive periodic GTS. However, the PAN coordinator is capable of deallocating the periodic GTS at any time.

The value of m is defined as follows:

$$m = P * 2(8\text{-}macBeaconOrder) \qquad 0 \leq macBeaconOrder \leq 8$$

$$m = P \qquad 9 \leq macBeaconOrder \leq 14$$

where P is defined in 5.3.9.3.

5.2 MAC frame format

5.2.1 General MAC frame format

5.2.2 Format of individual frame types

5.2.2.1 Beacon frame format

5.2.2.1.1 Beacon frame MHR fields

5.2.2.1.2 Superframe Specification field

5.2.2.1.3 GTS Specification field

Change and insert in figure 42 as shown:

Bits: 0-2	3-5	6	6
GTS Descriptor Count	Reserved	Periodic GTS Permit	GTS Permit

Figure 42–Format of the GTS Specification field

Insert at the end of 5.2.2.1.3:

The Periodic GTS Permit field shall be set to one if *macPeriodicGTSPermit* is equal to TRUE (i.e., the PAN coordinator is accepting periodic GTS requests). Otherwise, the Periodic GTS Permit field shall be set to zero.

5.2.2.1.4 GTS Directions field

5.2.2.1.5 GTS List field

Insert at the end of 5.2.2.1.5:

If a GTS descriptor represents a periodic GTS (i.e. the GTS descriptor corresponds to a periodic GTS request), the GTS Length field shall contain the four least significant bits of the *macBSN* indicating the first superframe that the periodic GTS is available for the addressed device.

5.3 MAC command frames

Insert and change as shown in Table 5:

Table 5–MAC command frames

Command frame identifier	Command frame	Tx	Rx	Subclause
0x0a	Channel switch notification			5.3.10
0x0b	Grant association proxy request			5.3.11
0x0c	Grant association proxy response			5.3.12
0x0d	Association proxy request			5.3.13
0x0e	Association proxy response			5.3.14
0x0f	Coordinator switch request			5.3.15.1
0x1a	Coordinator switch response			5.3.15.2
0x1b-0xff	Reserved			-

5.3.1 Association request command

5.3.2 Association response command

5.3.2.1 MHR fields

5.3.2.2 Short Address field

5.3.2.3 Association Status field

Insert and change as shown in Table 6:

Table 6–Valid values of the Association Status field

Association Status	Description
0x03-~~0x7f~~0x0f	Reserved
0xa0-0xbf	Number of allocated device addresses where the number is offset by 0xa0.
0xc0-0x7f	Reserved.

5.3.3 Disassociation notification command

5.3.4 Data request command

5.3.5 PAN ID conflict notification command

5.3.6 Orphan notification command

5.3.7 Beacon request command

5.3.8 Coordinator realignment command

5.3.9 GTS request command

Insert as shown in the first paragraph of 5.3.9 as follows:

The GTS request command is used by an associated device that is requesting the allocation of either a new GTS or a new periodic GTS or the deallocation of either an existing GTS or an existing periodic GTS from the PAN coordinator. Only devices that have a short address less than 0xfffe shall send this command.

Change and insert in Figure 58:

Octets: 7	1	1/2
MHR fields	Command Frame Identifier	GTS Characteristics/ Periodic GTS Characteristics

Figure 58–GTS request command format

5.3.9.1 MHR fields

5.3.9.2 GTS Characteristics field

Insert after 5.3.9.2:

5.3.9.3 Periodic GTS Characteristics field

When the GTS request command is used by an associated device that is requesting the allocation of a new periodic GTS or the deallocation of an existing periodic GTS from the PAN coordinator, the Periodic GTS Characteristics field shall be included.

The Periodic GTS Characteristics field shall be formatted as illustrated in Figure 59a.

Bits: 0-3	4	5	6-7	8-11	12-14	15
GTS Length	GTS Direction	Characteristic Type	Reserved	Start Frame	GTS Period Exponent	Reserved

Figure 59a–Periodic GTS Characteristic field format

The GTS Length field shall contain the number of superframe slots being requested for the periodic GTS.

The GTS Direction field shall be set to one if the periodic GTS is to be a receive-only periodic GTS. Conversely, this field shall be set to zero if the GTS is to be a transmit-only periodic GTS. GTS direction is defined relative to the direction of data frame transmissions by the device.

The Characteristics Type field shall be set to one if the characteristics refer to a periodic GTS allocation or zero if the characteristics refer to a periodic GTS deallocation.

The Start Frame field shall contain the value S, $0 \leq S \leq 7$, which indicates the first periodic GTS for the requesting device is being requested to occur in a superframe no later than (S+1) superframes after the current superframe.

The GTS Period Exponent field shall specify the value, N, and this shall be used to define the period P, in superframes that is being requested for the periodic GTS.

The value of P is defined as follows:

$$P = 2^{(N+1)} \qquad \text{for } 0 \leq N \leq 7$$

Insert after 5.3.9:

5.3.10 Channel switch notification command

The channel switch notification command is used by a device to notify another device to switch a channel at certain time. In MBANS, this command shall only be sent by a PAN coordinator. All devices shall be capable of receiving this command.

This command is optional.

The channel switch notification command shall be formatted as illustrated in Figure 59b.

Octets: variable	1	variable	1	1
MHR fields	Command Frame Identifier	Standard Dependent Information	Channel Number	Channel Page

Figure 59b–Channel switch notification command format

5.3.10.1 MHR fields

The Destination Addressing Mode field and the Source Addressing Mode field shall be set to indicate extended addressing for MBANS devices.

The Frame Pending field shall be set to zero and ignored upon reception. The AR field shall be set to one. The Frame Version field shall be set as specified in 5.2.3.

For MBANS devices, the Destination PAN Identifier field shall contain the broadcast PAN identifier. The Destination Address field shall contain the extended address of the destination device. The Source PAN Identifier field shall contain the value of macPANId, and the Source Address field shall contain the value of macExtendedAddress.

5.3.10.2 Standard Dependent Information

5.3.10.2.1 MBANS information

The MBANS information is formatted as illustrated in figure 59c.

Octets: 2	2/8	2
New PAN ID	Coordinator Address	Remaining Time

Figure 59c–MBANS information format

5.3.10.2.1.1 New PAN ID field

The New PAN ID field shall contain the PAN ID of the PAN coordinator that operates in the channel specified in the Channel Number field and Channel Page field. The receiving device is requested to associate with the PAN coordinator for the following communication after channel switching.

5.3.10.2.1.2 Coordinator Address field

The Coordinator Address field shall contain the coordinator address of the PAN coordinator that operates in the channel specified in the Channel Number field and Channel Page field. The coordinator address field shall contain either the coordinator short address or coordinator extended address.

5.3.10.2.1.3 Remaining Time field

The Remaining Time field shall contain the remaining time in minutes after which the channel switching shall occur.

5.3.10.3 Channel Number field

The Channel Number field shall contain the channel number that the initiating device intends to use for the following communication, and the receiving device is requested to switch to this channel number.

5.3.10.4 Channel Page field

The Channel Page field shall contain the channel page that the initiating device intends to use for the following communication, and the receiving device is requested to switch to one channel of this channel page.

Insert:

5.3.11 Grant association proxy request

The grant association proxy request command allows a FFD to associate a number of RFDs to a PAN coordinator.

Only FFDs shall be capable of transmitting and receiving this command. The FFD shall be associated with the PAN coordinator before using the grant association proxy request command.

This command is optional.

The grant association proxy request command shall be formatted as illustrated in Figure 59d.

Octets: variable	**1**	**1**
MHR fields	Command Frame Identifier	Device Number

Figure 59d – Grant association proxy request command format

5.3.11.1 MHR fields

The Destination Addressing Mode field shall be set to indicate long addressing. The Source Addressing Mode field shall be set to indicate long addressing.

The Frame Pending field shall be set to zero and ignored upon reception and the AR field shall be set to one.

The Destination PAN Identifier field shall contain the identifier of the PAN to which the grant association proxy is requested. The Destination Address field shall contain the address from the beacon frame that is transmitted by the coordinator to which the grant associated proxy request command is being sent. The Source PAN Identifier field shall contain the broadcast PAN identifier. The Source Address field shall contain the value of *macExtendedAddress*.

5.3.11.2 Device Number fields

The Device Number field shall be formatted as illustrated in Figure 59e.

Bits: 0-4	**5-7**
Number of Devices	Reserved

Figure 59e–Device Number field format

The Number of Devices shall be set to indicate the total number of devices for which device short addresses are being requested.

5.3.12 Grant association proxy response

The grant association proxy response command allows a PAN coordinator to communicate the results of a grant association proxy attempt back to the device requesting a grant association proxy.

This command shall only be sent by the PAN coordinator to a FFD that is currently trying to request a grant association proxy.

Only FFDs shall be capable of receiving this command.

The grant association proxy response command shall be formatted as illustrated in Figure 59f.

Octets: variable	**1**	**1**	**2*A***			**1**
MHR fields	Command Frame Identifier	Number of Allocated Short Addresses (*A*)	Short Address 1	…	Short Address *A*	Association Status

Figure 59f–Grant association proxy response command format

5.3.12.1 MHR fields

The Destination Addressing Mode and the Source Addressing Mode fields shall each be set to indicate extended addressing.

The Frame Pending field shall be set to zero and ignored upon reception and the AR field shall be set to one.

The PAN ID Compression field shall be set to one. In accordance with this value of the PAN ID Compression field, the Destination PAN ID field shall contain the value of *macPANId*, while the Source PAN ID field shall be omitted.

The Destination Address field shall contain the extended address of the device requesting association. The Source Address field shall contain the value of *macExtendedAddress*.

5.3.12.2 Number of Allocated Short Addresses field

If the coordinator is able to associate a number of devices to its PAN, this field shall contain the number, *A*, of short addresses that the coordinator is able to allocate, where $1 \leq A \leq 32$.

5.3.12.3 Short Address fields

The number of short address fields shall be equal to *A*, the number of short addresses that the coordinator was able to allocate. These fields shall contain the short addresses that the devices shall use in their communications on the PAN until they are disassociated.

5.3.12.4 Association Status field

Valid values of the Association Status field are defined in 5.3.2.3 and Table 6.

5.3.13 Association proxy request

The association proxy request command allows a FFD to update a PAN coordinator with the extended addresses and the Capability Information of the RFDs that have been associated using the grant association proxy request and response commands.

Only FFDs shall be capable of transmitting and receiving this command.

This command is optional.

The association proxy request command shall be formatted as illustrated in Figure 59g.

Octets: variable	**1**	**2**	**8**	**1**
MHR fields	Command Frame Identifier	Device Short Address	Device Extended Address	Capability Information

Figure 59g–Association proxy request command format

5.3.13.1 MHR fields

The Destination Addressing Mode field shall be set to indicate long addressing. The Source Addressing Mode field shall be set to indicate long addressing.

The Frame Pending field shall be set to zero and ignored upon reception and the AR field shall be set to one.

The Destination PAN Identifier field shall contain the identifier of the PAN to which the association proxy is requested.

5.3.13.2 Device Short Address

The Device Short Address field shall contain the short address of the device whose extended address and Capability Information is being transferred to the PAN coordinator.

5.3.13.3 Device Extended Address

The Device Extended Address field shall contain the extended address of the device whose information is being updated in the PAN coordinator.

5.3.13.4 Capability Information field

The Capability Information field shall contain the information of the device whose information is being updated in the PAN coordinator, and shall be formatted as illustrated in figure 50.

5.3.14 Association proxy response

The association proxy response command allows a PAN coordinator to communicate the results of an association proxy attempt to the device requesting an association proxy.

This command shall only be sent by the PAN coordinator to a FFD that is currently trying to request an association proxy.

Only FFDs shall be capable of transmitting and receiving this command.

The association proxy response command shall be formatted as illustrated in Figure 59h.

Octets: variable	**1**	**2**	**1**
MHR fields	Command Frame Identify	Short Address	Association Status

Figure 59h–Association proxy response command format

5.3.14.1 MHR fields

The Destination Addressing Mode field shall be set to indicate long addressing. The Source Addressing Mode field shall be set to indicate long addressing.

The Frame Pending field shall be set to zero and ignored upon reception and the AR field shall be set to one.

The PAN ID Compression field shall be set to one. In accordance with this value of the PAN ID Compression field, the Destination PAN ID field shall contain the value of *macPANId*, while the Source PAN ID field shall be omitted.

The Destination Address field shall contain the extended address of the device requesting association. The Source Address field shall contain the value of *macExtendedAddress*.

5.3.14.2 Short Address field

If the coordinator is not able to associate the device to its PAN, the Short Address field shall be set to 0xffff, and the Association Status field shall contain the reason for the failure.

If the coordinator is able to update the extended address and the Capability Information of the device that had been associated using the association proxy request, this field shall contain the short address of that device.

5.3.14.3 Association Status field

Valid values of the Association Status field are defined in 5.3.2.3 and in Table 6.

5.3.15 Coordinator switch

5.3.15.1 Coordinator switch request

The coordinator switch request command allows a PAN coordinator to determine whether there are any other coordinators that have the resources to accept the devices that are associated with the PAN coordinator. The coordinator switch request command also allows a PAN coordinator to confirm to a new coordinator that it has selected that coordinator to accept the devices that are associated with its PAN.

Only FFDs shall be capable of transmitting and receiving this command.

This command is optional.

The coordinator switch request command shall be formatted as illustrated in Figure 59i.

Octets: variable	**1**	**1**
MHR fields	Command Frame Identifier	Number of Devices

Figure 59i–Coordinator switch request command format

5.3.15.1.1 MHR fields

The Destination Addressing Mode field shall be set to indicate short addressing when the coordinator switch request is broadcast in a channel. Otherwise the Destination Addressing Mode field shall be set to indicate extended addressing. The Source Addressing Mode field shall be set to indicate extended addressing.

The Frame Pending field shall be set to zero and ignored upon reception and the AR field shall be set to zero.

The Destination PAN Identifier field shall contain the broadcast PAN identifier and the Destination Address field shall contain the broadcast short address when the coordinator switch request is broadcast in a channel. Otherwise the Destination PAN Identifier field shall contain the *macPANID* of the new PAN

coordinator and the Destination Address field shall contain the *macExtendedAddress* of the new PAN coordinator when the coordinator switch request is transmitted to a new PAN coordinator.

The Source PAN Identifier field shall contain the value of the *macPANID* of the source PAN coordinator. The Source Address field shall contain the value of *macExtendedAddress* of the source PAN coordinator.

5.3.15.1.2 Number of Devices field

The number of device field shall be formatted as illustrated in Figure 59j.

Bits: 0-7
Number of Devices

Figure 59j–Number of Devices field format

The Number of Devices shall be used to indicate the total number of devices that are associated with the source PAN coordinator.

5.3.15.2 Coordinator switch response

The coordinator switch response command allows another coordinator to communicate the results of a coordinator switch request attempt back to the source PAN coordinator requesting a coordinator switch.

This command shall only be sent by FFDs to the source PAN coordinator that is currently trying to request a coordinator switch.

Only FFDs shall be capable of receiving this command.

The coordinator switch response command shall be formatted as illustrated in Figure 59k.

Octets: variable	1	1	2
MHR fields	Command Frame Identifier	Switch Status	New PAN ID

Figure 59k–Coordinator switch response command format

5.3.15.2.1 MHR fields

The Destination Addressing Mode and the Source Addressing Mode fields shall each be set to indicate extended addressing.

The Frame Pending field shall be set to zero and ignored upon reception. If the coordinator switch response command is sent in response to a coordinator switch request command that was broadcast to the channel, the AR field shall be set to zero. Otherwise if the coordinator switch request command is sent directly to the new coordinator the AR field shall be set to one.

The PAN ID Compression field shall be set to zero. In accordance with this value of the PAN ID Compression field, the Destination PAN ID field shall contain the value of macPANId of the source PAN coordinator while the Source PAN ID field shall contain the broadcast PAN ID. The Destination Address field shall contain the extended address of the source PAN coordinator that sent the coordinator switch

request command. The Source Address field shall contain the value of *macExtendedAddress* of the new coordinator that is responding to the PAN coordinator switch request.

5.3.15.2.2 Switch Status field

If the new coordinator is able to associate a number of devices to its PAN, this field shall contain the value of the Number of Devices field that is received on reception of the broadcast coordinator switch request command.

If the coordinator switch request command is sent directly to the new coordinator, it shall confirm that it is able to associate a number of devices to its PAN and this field shall contain the value of the Number of Devices field that is received on reception of the coordinator switch request command. Otherwise if the new coordinator is not able to associate a number of devices to its PAN, this field shall contain 0x00.

5.3.15.2.3 New PAN ID fields

The New PAN ID field shall contain the *macPANId* of the PAN coordinator that is responding to the coordinator switch request command.

6. MAC services

6.1 Overview

6.2 MAC management service

Insert as shown in Table 8:

Table 8 – Summary of the primitives accessed through the MLME-SAP

Name	Request	Indication	Response	Confirm
MLME-CHANNELSWITCH	6.2.18.1*	6.2.18.3*		6.2.18.2*
MLME-PERIODIC-GTS	6.2.19.1*	6.2.19.3*		6.2.19.2*
MLME-GRANTASSOCIATIONPROXY	6.2.20.1*	6.2.20.2*	6.2.20.3*	6.2.20.4*
MLME-ASSOCIATION	6.2.21.1*	6.2.21.2*		6.2.21.3*
MLME-COORDINATOR-SWITCH	6.2.22.1*	6.2.22.2*	6.2.22.3*	6.2.22.4*

6.2.1 Common requirements for MLME primitives

6.2.2 Association primitives

6.2.3 Disassociation primitives

6.2.4 Communications notification primitives

6.2.5 Primitives for reading PIB attributes

6.2.6 GTS management primitives

6.2.7 Primitives for orphan notification

6.2.8 Primitives for resetting the MAC sublayer

6.2.9 Primitives for specifying the receiver enable time

6.2.10 Primitives for channel scanning

6.2.11 Primitives for writing PIB attributes

6.2.12 Primitives for updating the superframe configuration

6.2.13 Primitives for synchronizing with a coordinator

6.2.14 Primitives for requesting data from a coordinator

6.2.15 Primitives for specifying dynamic preamble

6.2.16 Primitives for channel sounding

6.2.17 Primitives for ranging calibration (for UWB PHYs)

Insert after 6.2.17:

6.2.18 Channel switch notification primitives

These primitives are used by a device to switch operating channel at a specific time and to instruct another device to switch operating channel at a specific time.

6.2.18.1 MLME-CHANNELSWITCH.request

The MLME-CHANNELSWITCH.request primitive is used by a device to instruct another device to switch operating channel at a specific time. On receipt of the MLME-CHANNELSWITCH.request primitive, the MLME of the initiating device generates a channel switch notification command.

The semantics of this primitive are:

```
MLME-CHANNELSWITCH.request      (
                                DeviceAddrMode,
                                DeviceAddress,
                                ChannelNumber,
                                ChannelPage,
                                TxIndirect,
                                NewPANID,
                                CoordinatorAddress,
                                RemainingTime,
                                SecurityLevel,
                                KeyIdMode,
                                KeySource,
                                KeyIndex
                                )
```

The primitive parameters are defined in Table 44a.

Table 44a–MLME-CHANNELSWITCH.request parameters

Name	Type	Valid range	Description
DeviceAddrMode	Enumeration	SHORT_ADDRESS, EXTENDED_ADDRESS	The addressing mode of the device which is instructed to change its operating channel at a specific time. For MBANS devices, the default value is EXTENDED_ADDRESS
DeviceAddress	Device address	As specified by the DeviceAddrMode parameter	The address of the device which should change its operating channel at specific time.
Channel Number	Integer	Any valid channel number	As defined in 5.3.10.3.
ChannelPage	Integer	Any valid channel page	As defined in 5.3.10.4.
TxIndirect	Boolean	TRUE, FALSE	TRUE if the channel switch notification command is to be sent indirectly.
NewPANID	Integer	As defined in 5.3.10.2.1.1	As defined in 5.3.10.2.1.1.
CoordinatorAddress	Device address	As defined in 5.3.10.2.1.2	As defined in 5.3.10.2.1.2.
RemainingTime	Integer	As defined in 5.3.10.2.1.3	As defined in 5.3.10.2.1.3.
SecurityLevel	Integer	As defined in Table 46	As defined in Table 46.
KeyIdMode	Integer	As defined in Table 46	As defined in Table 46.
KeySource	Set of octets	As defined in Table 46	As defined in Table 46.
KeyIndex	Integer	As defined in Table 46	As defined in Table 46.

For MBANS devices, if this primitive is received by the MLME of a coordinator with the TxIndirect parameter set to TRUE, the channel switch notification command will be sent using indirect transmission as described in 5.1.5.

If this primitive is received by the MLME of a coordinator with the TxIndirect parameter set to FALSE, the MLME sends a channel switch notification command to the device in the CAP for beacon-enabled PAN.

6.2.18.2 MLME-CHANNELSWITCH.confirm

The MLME-CHANNELSWITCH.confirm primitive is used to inform the next higher layer of the initiating device whether the channel switch notification command is transmitted successfully.

The semantics of this primitive are:

```
MLME-CHANNELSWITCH.confirm      (
                                status,
                                DeviceAddrMode,
                                DeviceAddress
                                )
```

The primitive parameters are defined in Table 44b.

Table 44b—MLME-CHANNELSWITCH.confirm parameters

Name	Type	Valid range	Description
status	Enumeration	SUCCESS, TRANSACTION_OVERFLOW, TRANSACTION_EXPIRED, NO_ACK, CHANNEL_ACCESS_FAILURE, COUNTER_ERROR, FRAME_TOO_LONG, UNAVAILABLE_KEY, UNSUPPORTED_SECURITY, INVALID_PARAMETER	The status of the transmission of channel switch notification command.
DeviceAddrMode	Enumeration	SHORT_ADDRESS, EXTENDED_ADDRESS	The addressing mode of the device which has been instructed to change the operating channel at a specific time by its PAN coordinator. For MBANS devices, the default value is EXTENDED_ADDRESS
DeviceAddress	Device address	As specified by the DeviceAddrMode parameter	The address of the device which has been instructed to change the operating channel at a specific time.

This primitive returns a status of either SUCCESS, indicating that the channel switch notification is successful, or the appropriate status parameter value indicating the reason for failure.

6.2.18.3 MLME-CHANNELSWITCH.indication

The MLME-CHANNELSWITCH.indication primitive is used to indicate the reception of a channel switch notification command.

The semantics of this primitive are:

```
MLME-CHANNELSWITCH.indication   (
                                DeviceAddrMode,
                                DeviceAddress,
                                ChannelNumber,
                                ChannelPage,
                                NewPANID,
                                CoordinatorAddress,
                                RemainingTime,
                                SecurityLevel,
                                KeyIdMode,
                                KeySource,
                                KeyIndex
                                )
```

The primitive parameters are defined in Table 44c.

Table 44c—MLME-CHANNELSWITCH.indication parameters

Name	Type	Valid range	Description
DeviceAddressMode	Enumeration	SHORT_ADDRESS, EXTENDED_ADDRESS	The addressing mode of the device transmitting the channel switch notification command. For MBANS devices, the default value is EXTENDED_ADDRESS.
DeviceAddress	Device address	As specified by the DeviceAddrMode parameter	The address of the device transmitting the channel switch notification command.
ChannelNumber	Integer	Any valid channel number	As defined in 5.3.10.3.
ChannelPage	Integer	Any valid channel page	As defined in 5.3.10.4.
NewPANID	Integer	As defined in 5.3.10.2.1.1	As defined in 5.3.10.2.1.1.
CoordinatorAddress	Device address	As defined in 5.3.10.2.1.2	As defined in 5.3.10.2.1.2.
RemainingTime	Integer	As defined in 5.3.10.2.1.3	As defined in 5.3.10.2.1.3.
SecurityLevel	Integer	As defined in Table 48	As defined in Table 48.
KeyIdMode	Integer	As defined in Table 48	As defined in Table 48.
KeySource	Set of octets	As defined in Table 48	As defined in Table 48.
KeyIndex	Integer	As defined in Table 48	As defined in Table 48.

Insert:

6.2.19 Periodic GTS management primitives

These primitives are used to request and maintain periodic GTSs.

6.2.19.1 MLME-PERIODIC-GTS.request

The MLME-PERIODIC-GTS.request primitive allows a device to send a request to the PAN coordinator to allocate a new periodic GTS or to deallocate an existing periodic GTS. This primitive is also used by the PAN coordinator to initiate a periodic GTS deallocation.

The semantics of this primitive are:

```
MLME-PERIODIC-GTS.request   (
                                PeriodicGTSCharacteristics,
                                SecurityLevel,
                                KeyIdMode,
                                KeySource,
                                KeyIndex
                                )
```

The primitive parameters are defined in Table 44d.

Table 44d—MLME-PERIODIC-GTS.request parameters

Name	Type	Valid range	Description
PeriodicGTSCharacteristics	Periodic GTS characteristics	As defined in 5.3.9.3	The characteristics of the periodic GTS request.
SecurityLevel	Integer	As defined in Table 46	As defined in Table 46.
KeyIdMode	Integer	As defined in Table 46	As defined in Table 46.
KeySource	Set of octets	As defined in Table 46	As defined in Table 46.
KeyIndex	Integer	As defined in Table 46	As defined in Table 46.

On receipt of the MLME-PERIODIC-GTS.request primitive by a device, the MLME of the device performs either the periodic GTS request procedure, as described in 5.1.7.2, or the periodic GTS deallocation procedure, as described in 5.1.7.4, depending on the value of the PeriodicGTSCharacteristics field.

6.2.19.2 MLME-PERIODIC-GTS.confirm

The MLME-PERIODIC-GTS.confirm primitive reports the results of a request to allocate a new periodic GTS or to deallocate an existing periodic GTS.

The semantics of this primitive are:

```
MLME-GTS.confirm            (
                                PeriodicGTSCharacteristics,
                                status
                                )
```

The primitive parameters are defined in Table 44e.

Table 44e—MLME-PERIODIC-GTS.confirm parameters

Name	Type	Valid range	Description
PeriodicGTSCharacteristics	Periodic GTS characteristics	As defined in 5.3.9.3	The characteristics of the periodic GTS request.
status	Enumeration	SUCCESS, DENIED, NO_SHORT_ADDRESS, CHANNEL_ACCESS_FAILURE, NO_ACK, NO_DATA, COUNTER_ERROR, FRAME_TOO_LONG, UNAVAILABLE_KEY, UNSUPPORTED_SECURITY, INVALID_PARAMETER.	The status of the periodic GTS request.

If the request to allocate or deallocate a periodic GTS is successful, this primitive will return a status of SUCCESS and the Characteristics Type field of the PeriodicGTSCharacteristics parameter will have the value of one or zero, respectively. Otherwise, the status parameter will indicate the appropriate error code, as defined in 5.1.7.2 or 5.1.7.4.

If *macShortAddress* is equal to 0xfffe or 0xffff, the device is not permitted to request a periodic GTS and the status parameter will be set to NO_SHORT_ADDRESS.

6.2.19.3 MLME-PERIODIC-GTS.indication

The MLME-PERIODIC-GTS.indication primitive indicates that a periodic GTS has been allocated or that a previously allocated periodic GTS has been deallocated

The semantics of this primitive are:

```
MLME-PERIODIC-GTS.indication        (
                                    DeviceAddress,
                                    PeriodicGTSCharacteristics,
                                    SecurityLevel,
                                    KeyIdMode,
                                    KeySource,
                                    KeyIndex
                                    )
```

The primitive parameters are defined in Table 44f.

Table 44f—MLME-PERIODIC-GTS.indication parameters

Name	Type	Valid range	Description
DeviceAddress	Device address	0x0000–0xfffd	The short address of the device that has been allocated or deallocated a periodic GTS.
PeriodicGTSCharacteristics	Periodic GTS characteristics	As defined in 5.3.9.3	The characteristics of the periodic GTS request.
SecurityLevel	Integer	As defined in Table 48	If the primitive is generated when a periodic GTS deallocation is initiated by the PAN coordinator itself, the security level to be used is set to 0x00. If the primitive is generated whenever a periodic GTS is allocated or deallocated following the reception of a periodic GTS request command, then it is as defined in Table 48.
KeyIdMode	Integer	As defined in Table 48	If the primitive is generated when a periodic GTS deallocation is initiated by the PAN coordinator itself, the security level to be used is set to 0x00. If the primitive is generated whenever a periodic GTS is allocated or deallocated following the reception of a periodic GTS request command, then it is as defined in Table 48.
KeySource	Set of octets	As defined in Table 48	If the primitive is generated when a periodic GTS deallocation is initiated by the PAN coordinator itself, the security level to be used is set to 0x00. If the primitive is generated whenever a periodic GTS is allocated or deallocated following the reception of a periodic GTS request command, then it is as defined in Table 48.
KeyIndex	Integer	As defined in Table 48	If the primitive is generated when a periodic GTS deallocation is initiated by the PAN coordinator itself, the security level to be used is set to 0x00. If the primitive is generated whenever a periodic GTS is allocated or deallocated following the reception of a periodic GTS request command, then it is as defined in Table 48.

The value of the Characteristics Type field, as defined in 5.3.9.3, in the PeriodicGTSCharacteristics parameter indicates if the periodic GTS has been allocated or if a periodic GTS has been deallocated.

6.2.20 Grant association proxy notification primitives

These primitives are used when a device requests a grant of association proxy.

6.2.20.1 MLME-GRANTASSOCIATIONPROXY.request

The MLME-GRANTASSOCIATIONPROXY.request primitive is used by a FFD to request the grant of an association proxy with a coordinator.

The semantics of this primitive are:

```
MLME-GRANTASSOCIATIONPROXY.request   (
                                     ChannelNumber,
                                     ChannelPage,
                                     CoordAddressMode,
                                     CoordPANId,
                                     CoordAddress,
                                     NumberOfDevices,
                                     SecurityLevel,
                                     KeyIdMode,
                                     KeySource,
                                     KeyIndex
                                     )
```

The primitive parameters are defined in Table 44g.

Table 44g—MLME-GRANTASSOCIATIONPROXY.request parameters

Name	Type	Valid range	Description
ChannelNumber	Integer	Any valid channel number	The channel number on which to attempt association proxy.
ChannelPage	Integer	Any valid channel page	The channel page on which to attempt association proxy.
CoordAddressMode	Enumeration	SHORT_ADDRESS, EXTENDED_ADDRESS	The coordinator addressing mode for this primitive and subsequent MPDU.
CoordPANId	Integer	0x0000–0xffff	The identifier of the PAN with which to associate.
CoordAddress	Device address	As specified by the CoordAddrMode parameter	The address of the coordinator with which to associate.
NumberOfDevices	Integer	0xa0-0xbf	Specifies the number of devices for which a grant association proxy is requested. The number is offset by 0xa0.
SecurityLevel	Integer	As defined in Table 46	As defined in Table 46.
KeyIdMode	Integer	As defined in Table 46	As defined in Table 46.
KeySource	Set of octets	As defined in Table 46	As defined in Table 46.
KeyIndex	Integer	As defined in Table 46	As defined in Table 46.

6.2.20.2 MLME-GRANTASSOCIATIONPROXY.indication

The MLME-GRANTASSOCIATIONPROXY.indication primitive is used to indicate the reception of a grant association proxy request command.

The semantics of this primitive are:

```
MLME-GRANTASSOCIATIONPROXY.indication (
                                      DeviceAddress,
                                      NumberOfDevices,
                                      SecurityLevel,
                                      KeyIdMode,
                                      KeySource,
                                      KeyIndex
                                      )
```

The primitive parameters are defined in Table 44i

Table 44i—MLME-GRANTASSOCIATIONPROXY.indication parameters

Name	Type	Valid range	Description
DeviceAddress	Device address	An extended IEEE address	The address of the device requesting a grant of association proxy.
NumberOfDevices	Integer	0xa0-0xbf	Specifies the number of devices for which an association proxy is requested. The number of devices is offset by 0xa0.
SecurityLevel	Integer	As defined in Table 48	As defined in Table 48.
KeyIdMode	Integer	As defined in Table 48	As defined in Table 48.
KeySource	Set of octets	As defined in Table 48	As defined in Table 48.
KeyIndex	Integer	As defined in Table 48	As defined in Table 48.

When the next higher layer of a coordinator receives the MLME-GRANTASSOCIATIONPROXY.indication primitive, the coordinator determines whether to accept or reject the unassociated devices using an algorithm outside the scope of this standard.

6.2.20.3 MLME-GRANTASSOCIATIONPROXY.response

The MLME-GRANTASSOCIATIONPROXY.response primitive reports the results of an MLME-GRANTASSOCIATIONPROXY.request primitive.

The semantics of this primitive are:

```
MLME-GRANTASSOCIATIONPROXY.response (
                                    DeviceAddress,
                                    NumberAllocatedShortAddresses,
                                    AssocShortAddress,
                                    status,
                                    SecurityLevel,
                                    KeyIdMode,
                                    KeySource,
                                    KeyIndex
                                    )
```

The primitive parameters are defined in Table 44j.

Table 44j—MLME-GRANTASSOCIATIONPROXY.response parameters

Name	Type	Valid range	Description
DeviceAddress	Device address	An extended 64 bit IEEE address	The address of the device requesting association.
NumberAllocatedShortAddresses	Integer	0xa0-0xbf	The number of allocated short addresses.
AssocShortAddress	Integer	0x0000–0xfffd	The short device address allocated by the coordinator on successful grant association proxy. This parameter is repeated for all of the allocated short addresses.
status	Enumeration	As defined in 5.3.2.3	The status of the grant association proxy attempt.
SecurityLevel	Integer	As defined in Table 46	As defined in Table 46.
KeyIdMode	Integer	As defined in Table 46	As defined in Table 46.
KeySource	Set of octets	As defined in Table 46	As defined in Table 46.
KeyIndex	Integer	As defined in Table 46	As defined in Table 46.

When the MLME of a coordinator receives the MLME-GRANTASSOCIATIONPROXY.response primitive, it generates a grant association proxy response command, as described in 5.3.12 and attempts to send it to the device requesting grant association proxy, as described in 5.1.3.3.

6.2.20.4 MLME-GRANTASSOCIATIONPROXY.confirm

The MLME-GRANTASSOCIATIONPROXY.confirm primitive is used to inform the next higher layer of the initiating device whether its request to grant an association proxy is successful or unsuccessful.

The semantics of this primitive are:

```
MLME-GRANTASSOCIATIONPROXY.confirm   (
                                       NumberAllocatedShortAddresses,
                                       AssocShortAddress,
                                       status,
                                       SecurityLevel,
                                       KeyIdMode,
                                       KeySource,
                                       KeyIndex
                                     )
```

The primitive parameters are defined in Table 44k.

Table 44k—MLME-GRANTASSOCIATIONPROXY.confirm parameters

Name	Type	Valid range	Description
NumberAllocatedShortAddresses	Integer	0xa0-0xbf	The number of allocated short addresses.
AssocShortAddress	Integer	0x0000-0xfffd	The short device address allocated by the coordinator on successful grant association proxy. This parameter is repeated for all of the allocated device short addresses.
status	Enumeration	The value of the status field of the association response command, as defined in 5.3.2.3, SUCCESS, CHANNEL_ACCESS_FAILURE, NO_ACK, NO_DATA, COUNTER_ERROR, FRAME_TOO_LONG, IMPROPER_KEY_TYPE, IMPROPER_SECURITY_LEVEL, SECURITY_ERROR, UNAVAILABLE_KEY, UNSUPPORTED_LEGACY, UNSUPPORTED_SECURITY, INVALID_PARAMETER	The status of the association attempt.
SecurityLevel	Integer	As defined in Table 48	As defined in Table 48.
KeyIdMode	Integer	As defined in Table 48	As defined in Table 48.
KeySource	Set of octets	As defined in Table 48	As defined in Table 48.
KeyIndex	Integer	As defined in Table 48	As defined in Table 48.

If the grant association proxy request is successful, then the status parameter shall be set to SUCCESS. Otherwise, the status parameter shall be set to indicate the type of failure.

6.2.21 Grant association proxy notification primitives

These primitives are used when a device requests a grant of association proxy.

6.2.21.1 MLME-ASSOCIATIONPROXY.request

The MLME-ASSOCIATIONPROXY.request primitive is used by a FFD to update the coordinator with the extended address and Capability Information of a device that has been associated using the grant associated proxy command 5.3.11.

The semantics of this primitive are:

```
MLME-ASSOCIATIONPROXY.request (
                              CoordAddressMode,
                              CoordPANId,
                              CoordAddress,
                              AssocShortAddress,
                              DeviceAddress,
                              CapabilityInformation,
                              SecurityLevel,
                              KeyIdMode,
                              KeySource,
                              KeyIndex
                              )
```

The primitive parameters are defined in Table 44l.

Table 44l—MLME-ASSOCIATIONPROXY.request parameters

Name	Type	Valid range	Description
CoordAddressMode	Enumeration	SHORT_ADDRESS, EXTENDED_ADDRESS	The addressing mode of the coordinator to which the association proxy is intended.
CoordPANId	Integer	0x0000–0xffff	The PAN identifier of the coordinator to which the association proxy is intended.
CoordAddress	Device address	As specified by the CoordAddrMode parameter	The address of the coordinator to which the association proxy in intended.
AssocShortAddress	Integer	0x0000–0xfffd	The short device address allocated by the coordinator on successful association.
DeviceAddress	Device address	An extended address	The address of the device requesting an association proxy.
CapabilityInformation	Bitmap	As defined in 5.3.1.2	The operational capabilities of the device requesting an association proxy.
SecurityLevel	Integer	As defined in Table 46	As defined in Table 46.
KeyIdMode	Integer	As defined in Table 46	As defined in Table 46.
KeySource	Set of octets	As defined in Table 46	As defined in Table 46.
KeyIndex	Integer	As defined in Table 46	As defined in Table 46.

The AssocShortAddress is the address that is allocated to a device during the grant association proxy request. The DeviceAddress and Capability Information are for this device.

6.2.21.2 MLME-ASSOCIATIONPROXY.indication

The MLME-ASSOCIATIONPROXY.indication primitive is used to inform the next higher layer of the coordinator of the extended address and Capability Information for a device that is allocated a short address during the grant association proxy request.

The semantics of this primitive are:

```
MLME-ASSOCIATIONPROXY.indication (
                                 CoordAddressMode,
                                 CoordPANId,
                                 CoordAddress,
                                 AssocShortAddress,
                                 DeviceAddress,
                                 CapabilityInformation,
                                 SecurityLevel,
                                 KeyIdMode,
                                 KeySource,
                                 KeyIndex
                                 )
```

The primitive parameters are defined in Table 44m.

Table 44m—MLME-ASSOCIATIONPROXY.indication parameters

Name	Type	Valid range	Description
CoordAddressMode	Enumeration	SHORT_ADDRESS, EXTENDED_ADDRESS	The addressing mode of the coordinator to which the association proxy is intended.
CoordPANId	Integer	0x0000–0xffff	The PAN identifier of the coordinator to which the association proxy is intended.
CoordAddress	Device address	As specified by the CoordAddrMode parameter	The address of the coordinator to which the association proxy in intended.
AssocShortAddress	Integer	0x0000–0xfffd	The short device address allocated by the coordinator on successful association.
DeviceAddress	Device address	An extended address	The address of the device requesting an association proxy.
CapabilityInformation	Bitmap	As defined in 5.3.1.2	The operational capabilities of the device requesting an association proxy.
SecurityLevel	Integer	As defined in Table 48	As defined in Table 48.
KeyIdMode	Integer	As defined in Table 48	As defined in Table 48.
KeySource	Set of octets	As defined in Table 48	As defined in Table 48.
KeyIndex	Integer	As defined in Table 48	As defined in Table 48.

6.2.21.3 MLME-ASSOCIATIONPROXY.confirm

The MLME-ASSOCIATIONPROXY.confirm primitive reports the results of an association proxy command to update the coordinator with the associated device-specific information.

The semantics of this primitive are:

```
MLME-ASSOCIATIONPROXY.confirm (
                              AssocShortAddress,
                              DeviceAddress,
                              status
                              )
```

The primitive parameters are defined in Table 44n.

Table 44n—MLME.ASSOCIATIONPROXY.confirm parameters

Name	Type	Valid range	Description
AssocShortAddress	Integer	0x0000–0xfffd	The short device address allocated by the coordinator on successful association.
DeviceAddress	Device address	An extended address	The address of the device requesting an association proxy.
status	Enumeration	The value of the status field of the association response command, as defined in 5.3.2.3, SUCCESS, DENIED, NO_SHORT_ADDRESS, CHANNEL_ACCESS_FAILURE, NO_ACK, NO_DATA, COUNTER_ERROR, FRAME_TOO_LONG, UNAVAILABLE_KEY, UNSUPPORTED_SECURITY, INVALID_PARAMETER	The status of the association proxy request.

If the association proxy request is successful, then the status parameter shall be set to SUCCESS. Otherwise, the status parameter shall be set to indicate the type of failure.

6.2.22 Coordinator switch notification primitives

These primitives are used when a device requests a coordinator switch.

6.2.22.1 MLME-COORDINATOR-SWITCH.request

The MLME-COORDINATOR-SWITCH.request primitive is used by a PAN coordinator to request a coordinator switch from other coordinators.

The semantics of this primitive are:

```
MLME-COORDINATOR-SWITCH.request      (
                                     ChannelNumber,
                                     ChannelPage,
                                     SrcAddrMode,
                                     DstAddrMode,
                                     NumberOfDevices,
                                     SecurityLevel,
                                     KeyIdMode,
                                     KeySource,
                                     KeyIndex
                                     )
```

The primitive parameters are defined in Table 44o.

Figure 44o–MLME-COORDINATOR-SWITCH.request parameters

Name	Type	Valid range	Description
ChannelNumber	Integer	Any valid channel number	The channel number on which to attempt a coordinator switch.
ChannelPage	Integer	Any valid channel page	The channel page on which to attempt a coordinator switch.
SrcAddrMode	Enumeration	SHORT_ADDRESS, EXTENDED_ADDRESS	The source addressing mode for this MPDU.
DstAddrMode	Enumeration	SHORT_ADDRESS, EXTENDED_ADDRESS	The destination addressing mode for this MPDU.
NumberOfDevices	Integer	0x00-0xff	Specifies the number of devices that the coordinator wishes to switch to another coordinator.
SecurityLevel	Integer	As defined in Table 46	As defined in Table 46.
KeyIdMode	Integer	As defined in Table 46	As defined in Table 46.
KeySource	Set of octets	As defined in Table 46	As defined in Table 46.
KeyIndex	Integer	As defined in Table 46	As defined in Table 46.

On receipt of the MLME-COORDINATOR-SWITCH.request primitive, the MLME of a coordinator shall first update the appropriate PHY and MAC PIB attributes, and then generates a coordinator switch command as defined in 5.3.15.

6.2.22.2 MLME-COORDINATOR-SWITCH.indication

The MLME-COORDINATOR-SWITCH.indication primitive is used to indicate the reception of a coordinator switch request command.

The semantics of this primitive are as follows:

```
MLME-COORDINATOR-SWITCH.indication   (
                                     CoordPANId,
                                     DeviceAddress,
                                     NumberOfDevices,
                                     SecurityLevel,
                                     KeyIdMode,
                                     KeySource,
                                     KeyIndex
                                     )
```

The primitive parameters are defined in Table 44p

Table 44p–MLME-COORDINATOR-SWITCH.indication parameters

Name	Type	Valid range	Description
CoordPANId	Integer	0x0000–0xfffe	The PAN identifier of the coordinator requesting a coordinator switch.
DeviceAddress	Device address	An extended address	The address of the coordinator requesting a coordinator switch
NumberOfDevices	Integer	0x00-0xff	Specifies the number of devices for which a coordinator switch is being requested.
SecurityLevel	Integer	As defined in Table 48	As defined in Table 48.
KeyIdMode	Integer	As defined in Table 48	As defined in Table 48.
KeySource	Set of octets	As defined in Table 48	As defined in Table 48.
KeyIndex	Integer	As defined in Table 48	As defined in Table 48.

When the next higher layer of a coordinator receives the MLME-COORDINATOR-SWITCH.indication primitive, the next higher layer shall determine whether it has the resources to be able to accept the association of additional devices using an algorithm outside the scope of this standard.

6.2.22.3 MLME-COORDINATOR-SWITCH.response

The MLME-COORDINATOR-SWITCH.response primitive reports the results of an MLME-COORDINATOR-SWITCH.request primitive.

The semantics of this primitive are as follows:

```
MLME-COORDINATOR-SWITCH.response     (
                                     CoordPANId,
                                     DeviceAddress,
                                     NumberOfDevices,
                                     SecurityLevel,
                                     KeyIdMode,
                                     KeySource,
                                     KeyIndex
                                     )
```

The primitive parameters are defined in Table 44q.

Table 44q–MLME-COORDINATOR-SWITCH.response parameters

Name	type	Valid range	Description
CoordPANId	Integer	0x0000–0xfffe	The PAN identifier of the coordinator requesting a coordinator switch.
DeviceAddress	Device address	An extended address	The address of the coordinator requesting a coordinator switch.
NumberOfDevices	Integer	0x00–0xff	Confirms the number of devices for which a coordinator switch is being requested.
SecurityLevel	Integer	As defined in Table 46	As defined in Table 46.
KeyIdMode	Integer	As defined in Table 46	As defined in Table 46.
KeySource	Set of octets	As defined in Table 46	As defined in Table 46.
KeyIndex	Integer	As defined in Table 46	As defined in Table 46.

When the MLME of a coordinator receives the MLME-COORDINATOR-SWITCH.response primitive, it shall generate a coordinator response command as described in 5.3.16 in response to a broadcast coordinator switch request and in response to a unicast coordinator switch request command as described in 5.1.2.6.

6.2.22.4 MLME-COORDINATOR-SWITCH.confirm

The MLME-COORDINATOR-SWITCH.confirm primitive is used to inform the next higher layer of the initiating device whether its request for coordinator switch is successful or unsuccessful.

The semantics of this primitive are:

```
MLME-COORDINATOR-SWITCH.confirm      (
                                     CoordPANId,
                                     DeviceAddress,
                                     NumberOfDevices,
                                     status,
                                     SecurityLevel,
                                     KeyIdMode,
                                     KeySource,
                                     KeyIndex
                                     )
```

The primitive parameters are defined in Table 44r.

Table 44r–MLME-COORDINATOR-SWITCH.confirm parameters

Name	Type	Valid range	Description
CoordPANId	Integer	0x0000–0xfffe	The PAN identifier of the new coordinator.
DeviceAddress	Device address	An extended address	The address of the new coordinator.
NumberOfDevices	Integer	0x00–0xff	Confirms the number of devices for which a coordinator switch is being requested. If this value is 0x00 then the coordinator switch request was unsuccessful.
status	Enumeration	SUCCESS, CHANNEL_ACCESS_FAILURE, NO_ACK, NO_DATA, COUNTER_ERROR, FRAME_TOO_LONG, IMPROPER_KEY_TYPE, IMPROPER_SECURITY_LEVEL, SECURITY_ERROR, UNAVAILABLE_KEY, UNSUPPORTED_LEGACY, UNSUPPORTED_SECURITY, INVALID_PARAMETER	The status of the association attempt.
SecurityLevel	Integer	As defined in Table 48	As defined in Table 48.
KeyIdMode	Integer	As defined in Table 48	As defined in Table 48.
KeySource	Set of octets	As defined in Table 48	As defined in Table 48.
KeyIndex	Integer	As defined in Table 48	As defined in Table 48.

If the coordinator switch request is successful, then the status parameter will be set to SUCCESS. Otherwise, the status parameter will be set to indicate the type of failure.

6.3 MAC data service

6.4 MAC constants and PIB attributes

6.4.1 MAC constants

6.4.2 MAC PIB attributes

Insert as shown in Table 52:

Table 52–MAC PIB attributes

Attribute	Type	Range	Description	Default
*macPeriodicGTSPermit**	Boolean	TRUE, FALSE	TRUE if the PAN coordinator is to accept Periodic GTS requests. FALSE otherwise.	TRUE

7. Security

8. General PHY requirements

8.1 General requirements and definitions

Iinsert in 8.1:

— O-QPSK PHY: direct sequence spread spectrum (DSSS) PHY employing offset quadrature phase¬shift keying (O-QPSK) modulation, operating in the 780 MHz bands, 868 MHz, 915 MHz, 2380 MHz, and 2450 MHz, as defined in clause 10.

8.1.1 Operating frequency range

Insert as shown in table 66:

Table 66–Frequency bands and data rates

PHY (MHz)	Frequency band (MHz)	Spreading parameters		Data parameters		
		Chip rate (kchip/s)	Modulation	Bit rate (kb/s)	Symbol rate (ksymbol/s)	Symbols
2380 DSSS	2360-2400	2000	O-QPSK	250	62.5	16-ary Orthogonal

8.1.2 Channel assignments

8.1.2.1 Channel numbering for 780 MHz band

8.1.2.2 Channel numbering for 868 MHz, 915 MHz, and 2450 MHz bands

8.1.2.3 Channel numbering for 950 MHz band

8.1.2.4 Channel numbering for CSS PHY

8.1.2.5 Channel numbering for UWB PHY

Insert after 8.1.2.5:

8.1.2.6 Channel numbering for 2380 MHz band

For channel page 7, 15 channels numbered zero to fourteen are available across the 2380 MHz band. The center frequencies of these channels are defined as follows:

$F_c = 2363 + 5\,k$ in MHz, for $k = 0, 1, \ldots, 6$

$F_c = 2367 + 5\,(k - 7)$ in MHz, for $k = 7, 8, \ldots, 13$

and $F_c = 2395$ in MHz, for $k = 14$

where

k is the channel number.

9. PHY services

10. O-QPSK PHY

10.1 PPDU format

10.2 Modulation and spreading

10.2.1 Data rate

Change and insert in the first paragraph of 10.2.1:

The data rate of the O-QPSK PHY shall be 250 kb/s when operating in the 2450 MHz, 915 MHz, ~~or~~ 780 MHz, or 2380 MHz bands and shall be 100 kb/s when operating in the 868 MHz band.

10.2.2 Reference modulator diagram

10.2.3 Bit-to-symbol mapping

10.2.4 Symbol-to-chip mapping

Insert in the first paragraph of 10.2.4:

In the 2450 MHz and 2380 MHz bands, each data symbol shall be mapped into a 32-chip PN sequence as specified in Table 73. The PN sequences are related to each other through cyclic shifts and/or conjugation (i.e., inversion of odd-indexed chip values).

Insert in the title of Table 73:

Table 73—Symbol-to-chip mapping for the 2450 MHz and 2380 MHz bands

10.2.5 O-QPSK modulation

Insert in the first paragraph of 10.2.5:

The chip sequences representing each data symbol are modulated onto the carrier using O-QPSK with half-sine pulse shaping. Even-indexed chips are modulated onto the in-phase (I) carrier, and odd-indexed chips are modulated onto the quadrature-phase (Q) carrier. In the 2450 MHz and 2380 MHz bands, each data symbol is represented by a 32-chip sequence, and so the chip rate is 32 times the symbol rate. In the 915 MHz, 868 MHz, and 780 MHz bands, each data symbol is represented by a 16-chip sequence, and so the chip rate is 16 times the symbol rate. To form the offset between I-phase and Q-phase chip modulation, the Q-phase chips shall be delayed by T_c with respect to the I-phase chips, as illustrated in Figure 70, where T_c is the inverse of the chip rate.

10.2.6 Pulse shape

Change and insert in the first paragraph of 10.2.6:

In the 2450 MHz, 915 MHz, ~~and~~ 868 MHz, and 2380 MHz bands, the half-sine pulse shape is used to represent each baseband chip and is given by:

10.2.7 Chip transmission order

Insert in 10.2.7:

During each symbol period, the least significant chip, c_0, is transmitted first and the most significant chip, either c_{31}, for the 2450 MHz and 2380 MHz bands, or c_{15}, for the 915 MHz, 868 MHz, and 780 MHz bands, is transmitted last.

10.3 O-QPSK PHY RF requirements

10.3.1 Operating frequency range

Insert as shown in 10.3.1:

— 779–787 MHz
— 868.0–868.6 MHz
— 902–928 MHz
— 2360–2400 MHz
— 2400.0–2483.5 MHz

10.3.2 Transmit power spectral density (PSD) mask

Insert in the third paragraph of 10.3.2:

When operating in the 2380 MHz and 2450 MHz bands, the transmitted spectral products shall be less than the limits specified in Table 76. For both relative and absolute limits, average spectral power shall be measured using a 100 kHz resolution bandwidth. For the relative limit, the reference level shall be the highest average spectral power measured within ±1 MHz of the carrier frequency.

Insert in the title of table 76:

Table 76—2380 MHz and 2450 MHz bands O-QPSK transmit PSD limits

10.3.3 Symbol rate

Insert as shown in 10.3.3:

The O-QPSK PHY symbol rate shall be 25 ksymbol/s when operating in the 868 MHz band and 62.5 ksymbol/s when operating in the 780 MHz, 915 MHz, 2380 MHz, or 2450 MHz bands with an accuracy of ±40 ppm.

10.3.4 Receiver sensitivity

10.3.5 Receiver interference rejection

Insert in the first paragraph of 10.3.5:

This subclause applies only to the 780 MHz, 915 MHz, 2380 MHz, and 2450 MHz bands as there is only one channel available in the 868 MHz band.

Insert in the title of table 77:

Table 77—Minimum receiver interference rejection requirements for the 780 MHz, 915 MHz, 2380 MHz, and 2450 MHz bands

Insert the following Annex I:

Annex I

(informative)

Channel bitmap

I.1 General

To assist with coexistence to the primary users of the 2360-2400 MHz band, some parts of this band may be excluded from use by MBANS devices. Those parts of the band that are excluded from use may change from time to time. Regulation requires that the operation of MBANS hub[2] devices have access to a mechanism that provides information on which parts of the band cannot be used. The description of this mechanism is beyond the scope of this annex. To assist other MBANS devices such as sensors that do not have direct access to this mechanism, a bitmap may be used by a hub device to indicate those channels that are allowed to be used by MBANS devices. The bitmap only applies to those channels that are in the 2360-2390 MHz band (channels 0-5 and 7-12). The channels in the 2390-2400 MHz band (channels 6, 13 and 14) are always available for use.

I.2 Channel bitmap

A bitmap of those channels that are available for use may be inserted into the beacon payload. The bitmap shall be formatted as shown in Table I.1.

Table I.1–Channel bitmap

Bits: 0-11	Bit 12-22	Bit 23
Channel bitmap	Valid time	Reserved

The bit-to-channel numbering of the channel bitmap field is shown in Table I.2. The channel numbering is described in 8.1.2.6.

[2] MBANS hub devices are 802.15.4 PAN coordinators.

Table I.2–Bit-to-channel numbering

Bit	Channel, *k*
0	0
1	1
2	2
3	3
4	4
5	5
6	7
7	8
8	9
9	10
10	11

The bits of the channel bitmap field shall be set to one when the corresponding channels are available for use and the bits of the channel bitmap field shall be set to zero when the corresponding channels are not available for use.

The Valid time field indicates the duration in minutes of the availability of the channel bitmap.