***Insert after 5.5.5.2 the following subclause.***

**5.5.6 Channel Asymmetry Consideration**

Single common channel approach may not be able to connect all devices in the PAN. The variance of channel condition can be large and channel asymmetry between two neighboring device can happen. Asynchronous Multi-Channel Adaptation (AMCA) is a solution to handle such case. The AMCA is performed in non-beacon mode, and is described in 7.5.12.

***Insert after 7.1.2.4 the following subclause.***

**7.1.2.5 AMCA-MAC management service**

When the macAMCAenabled is set to TRUE, the MAC management services shall comply with Table 46d. The primitives are discussed in the subclauses referenced in the table.

Table 46d—Summary of the primitives accessed through the MLME-SAP for AMCA

| Name | Request | Indication | Response | Confirm |
| --- | --- | --- | --- | --- |
| MLME-ASSOCIATE | 7.1.3.1 | 7.1.3.2 | 7.1.3.3 | 7.1.3.4 |
| MLME-SCAN | 7.1.11.1 |  |  | 7.1.11.2 |

***Rename command names in Table 82 as follows.***

DSME-Asymmetric multi-channel beacon request 🡪 AMCA-Asymmetric multi-channel beacon request

DSME-Multi-channel hello 🡪 AMCA-Multi-channel hello

DSME-Channel probe 🡪 AMCA-Channel probe

***Insert before 7.4 the following subclauses.***

* + 1. **AMCA-commands**
       1. AMCA-Multi-channel beacon request command

The AMCA-multi-channel beacon request command is used by a device that is performing asymmetric multi-channel active scan.

The AMCA-multi-channel beacon request command shall be formatted as illustrated in Figure 65.dd.

| octets: (see 7.2.2.4) | 1 | 4 |
| --- | --- | --- |
| MHR fields | Command Frame Identifier (see Table 82) | Scan Channels |

Figure 65.dd—AMCA-multi-channel beacon request command format

The Destination Addressing Mode subfield of the Frame Control field shall be set to two (e.g., 16-bit short addressing), and the Source Addressing Mode subfield shall be set to zero (e.g., source addressing information not present).

The Frame Pending subfield of the Frame Control field shall be set to zero and ignored upon reception, and the Acknowledgment Request subfield shall be set to zero.

The Destination PAN Identifier subfield shall contain the broadcast PAN identifier (i.e., 0xffff). The Destination Address subfield shall contain the broadcast short address (i.e., 0xffff).

The Scan Channels subfield is represented in 27-bit bitmaps. The 27 bits (b0, b1,... b26) indicate which channels are to be scanned (1 = scan, 0 = do not scan) for each of the 27 channels supported by the ChannelPage parameter.

* + - 1. AMCA-Multi-channel hello command
         1. General

The AMCA-multi-channel hello command is used to inform neighboring devices of the device’s designated channel.

The AMCA-multi-channel hello command shall be formatted as illustrated in Figure 65.ee. This command is optional for AMCA‑devices.

| Octets: (see 7.2.2.4) | 1 | 1 |
| --- | --- | --- |
| MHR fields | Command Frame Identifier (see Table 82) | Hello Specification |

Figure 65.ee—AMCA-multi-channel hello command format

1. * + - 1. MHR fields

The Destination Addressing Mode subfield of the Frame Control field shall be set to two (e.g., 16-bit short addressing), and the Source Addressing Mode subfield shall be set to zero (e.g., source addressing information not present).

The Frame Pending subfield of the Frame Control field shall be set to zero and ignored upon reception, and the Acknowledgment Request subfield shall be set to zero.

The Destination PAN Identifier subfield shall contain the broadcast PAN identifier (i.e., 0xffff). The Destination Address subfield shall contain the broadcast short address (i.e., 0xffff).

* + - * 1. Hello Specification field

The Hello Specification field shall be formatted as illustrated in Figure 65.ff.

| Bits: 5 | 1 | 2 |
| --- | --- | --- |
| Designated Channel Index | Hello Request | Reserved |

Figure 65.ff—Hello specification field format

The Designated Channel Index subfield is 5 bits in length and shall contain the designated logical channel index number of the device.

The Hello Request subfield is 1 bit in length and shall indicate whether the AMCA-multi-channel hello command needs AMCA-multi-channel hello from its neighbors. When a device receives the AMCA-multi-channel hello command with Hello Request bit set to’1’, the device shall transmit a AMCA-multi-channel hello command with Hello Request set to ‘0’.

* + - 1. AMCA-Channel probe command
         1. General

The channel probe command is used to check the link quality of the specified channel.

The channel probe command shall be formatted as illustrated in Figure 65.gg. This command is optional for AMCA‑device.

| Octets: (see 7.2.2.4) | 1 | 2 |
| --- | --- | --- |
| MHR fields | Command Frame Identifier (see Table 82) | Channel Probe Specification |

Figure 65.gg—Channel probe command format

* + - * 1. MHR fields

The Source Addressing Mode subfield of the Frame Control field shall be set to two (16-bit extended addressing), and the Destination Addressing Mode subfield shall be set to the same mode as the destination device to which the channel probe command refers.

The Frame Pending subfield of the Frame Control field shall be set to zero, and the Acknowledgment Request subfield shall be set to one.

The Destination PAN Identifier field shall contain the identifier of the PAN of the destination device to which to check the link quality. The Destination Address field shall contain the address of the destination device to which the channel probe command is being sent.

The Source PAN Identifier field shall contain the value of macPANId, and the Source Address field shall contain the value of macShortAddress.

* + - * 1. Channel Probe Specification field

The Channel Probe Specification field shall be formatted as illustrated in Figure 65.hh.

| Bits: 2 | 5 | 5 | 4 |
| --- | --- | --- | --- |
| Channel Probe Subtype | Designated Channel | Probe Channel | Reserved |

Figure 65.hh—Channel Probe specification format

The Channel Probe Subtype subfield is 2 bits in length and shall be set to one of the non-reserved values listed in Table 84.d.

Table 84.f—Values of the Channel Probe Subtype subfield

| Channel Probe subtype value b1b0 | Description |
| --- | --- |
| 00 | Request |
| 01 | Reply |
| 10 | Probe |
| 11 | Reserved |

The Designated Channel subfield is 5 bits in length and indicates the originator’s designated channel.

The Probe Channel subfield is 5 bits in length and indicates the channel that needs to be probed.

***Insert before 7.6 the following subclauses.***

* + 1. Multi-Channel adaptation
       1. General

Single common channel approach may not be able to connect all devices in the PAN. The variance of channel condition can be large and channel asymmetry between two neighboring device can happen. Multi-channel adaptation is a solution to handle such case.

Two types of multi-channel adaptation is specified, which are synchronous multi-channel adaptation and asynchronous multi-channel adaptation. The synchronous multi-channel adaptation is performed in beacon-enabled mode, and is handled by DSME-GTS as described in 7.5.4.4. The asynchronous multi-channel adaptation is performed in non-beacon mode, and is described in this subclause.

* + - 1. Receiver-based communication

It is possible that there exists no common channel that two devices can communicate in DSME-GTS mode as there are many available channels. In that case, each device selects its designated channel based on its local link quality, and keep listening to its designated channel. When another device wants to communicate with it, the sender device shall switch to the designated channel of the receiver device and transmit a DATA frame. Then the sender device shall switch back to its own designated channel and keep listening. On receipt of the data frame from the sender device, the receiver device shall switch to the designated channel of the sender device and transmit an ACK frame (if requested). After sending the acknowledge frame, the receiver device shall switch back to its own designated channel and keep listening at last.

illustrated the receiver-based communications.



Figure 73.m— Receiver-based communication

* + - 1. Asymmetric multi-channel active scan

An asymmetric multi-channel active scan allows device to detect the designated channel of each coordinator or detect the best channel for the device.

The asymmetric multi-channel active scan over a specified set of logical channels is requested using the MLME-SCAN.request primitive with the ScanType parameter set to 0x04.

For each logical channel, the device shall first switch to the channel, by setting *phyCurrentChannel* and *phyCurrentPage* accordingly, and send a multi-channel beacon request command (see 7.3.11). Upon successful transmission of the multi-channel beacon request command, the device shall enable its receiver for [*aBaseSuperframeDuration* \* (2*n* + 1)] symbols, where *n* is the value of the *ScanDuration* parameter. During this time, the device shall reject all non-beacon frames and record the information contained in all unique beacons in a PAN descriptor structure (see Table 55 in 7.1.5.1.1). After this time, the device shall switch to the next channel and repeat the same procedure. The device shall stop repeating this procedure after visiting every channel twice.

If *linkqualityscan* flag is FALSE, the device may stop after it receives a beacon and decide the current channel as its designated channel. If *linkqualityscan* flag is TRUE, the device make decision on its designated channel comparing LQI or RSSI of the received beacons.

On receipt of the multi-channel beacon request command, the coordinator shall transmit a beacon (see 7.2.2.1) over a set of logical channels specified in the asymmetric multi-channel beacon request command. Upon successful transmission of the beacon, the coordinator shall switch to the next channel after [*aBaseSuperframeDuration* \* (2*n* + 1)] symbols, where *n* is the value of the *ScanDuration* parameter, and send another beacon. The coordinator shall repeat the same procedure over all the logical channels specified in the asymmetric multi-channel beacon request command.

* + - 1. Multi-Channel Hello

Multi-channel hello mechanism allows a device to announce its designated channel to its one-hop neighbor devices.

After successfully performing the asymmetric active scan and the association, the device shall transmit the same multi-channel hello command on each channel sequentially starting from its designated channel. The device can request multi-channel hello of neighbors by setting the Hello Request of the multi-channel hello command to ‘1’. When its neighbors receive the multi-channel hello command with Hello Request set to’1’, each neighbor shall transmit a multi-channel hello command on the designated channel of the requesting device with Hello Request set to ‘0’.

Channel Probe can probe other channels and switch to a better channel. After switching to the new channel, the device shall broadcast a multi-channel hello command to its one-hop neighbors to notify the new channel.

The channel probe over a specified logical channel is requested using the MLME-SCAN.request primitive with the ScanType parameter set to 0x05.

The device can check the condition of its designated channel by using the handshake mechanism. The procedure of the handshake channel probing is described as follows.

The request device sends a channel probe request command frame to one of its neighbors on the designated channel of the neighbor. On receipt of the channel probe request command, the neighbor sends a channel probe reply frame back to the request device on the originator’s channel indicating in the channel probe request command. The request device shall check the LQI or RSSI of the channel probe reply frame upon receiving it. The request device determines that the link quality of the channel is bad if the device have not received the channel probe reply frame after [*aBaseSuperframeDuration* \* (2*n* + 1)] symbols from the reception of probe reply, where *n* is the value of the *ScanDuration* parameter.

***Insert after annex M.7 the following subclauses.***

***M.8 Asymmetric Mutli-Channel Adaptation (AMCA)***

Single common channel approach may not be able to connect all devices in the PAN. The variance of channel condition can be large and channel asymmetry between two neighboring device can happen. Such case is likely to happen in large, geographically diverse networks such as smart utility networks, infrastructure monitoring networks, and process control networks. Asynchronous Multi-Channel Adaptation (AMCA) is a solution to handle such case. The AMCA is performed in non-beacon mode, and is described in 7.5.12.