DCN 15-10-0011-00-004g Device Classification Draft version 1.000 16 Jan 2010

5.XXX Smart Utility Networks Summary

A true modern Smart Grid enables multiple applications to operate over a shared, interoperable network, similar in concept to the way the Internet works today. To put this in perspective, the electrical network in the US alone is comprised of more than 300,000,000 metering endpoints, 14,000 transmission substations, 4,500 large substations for distribution, and 3,000 public and private owners.

5.XXX Device Class Components of the IEEE 802.15.4 WPAN

In order to ensure that the wireless grid communications requirements have been addressed in the most efficient manner possible, this standard has defined three unique device classes to provide the capability of utilizing the most efficient methods of data transmission. The device class boundaries have been established based on the expected volumes of data to be transmitted during a typical 24 hour period. Each device class utilizes unique signaling attributes in order to maximize overall system performance.

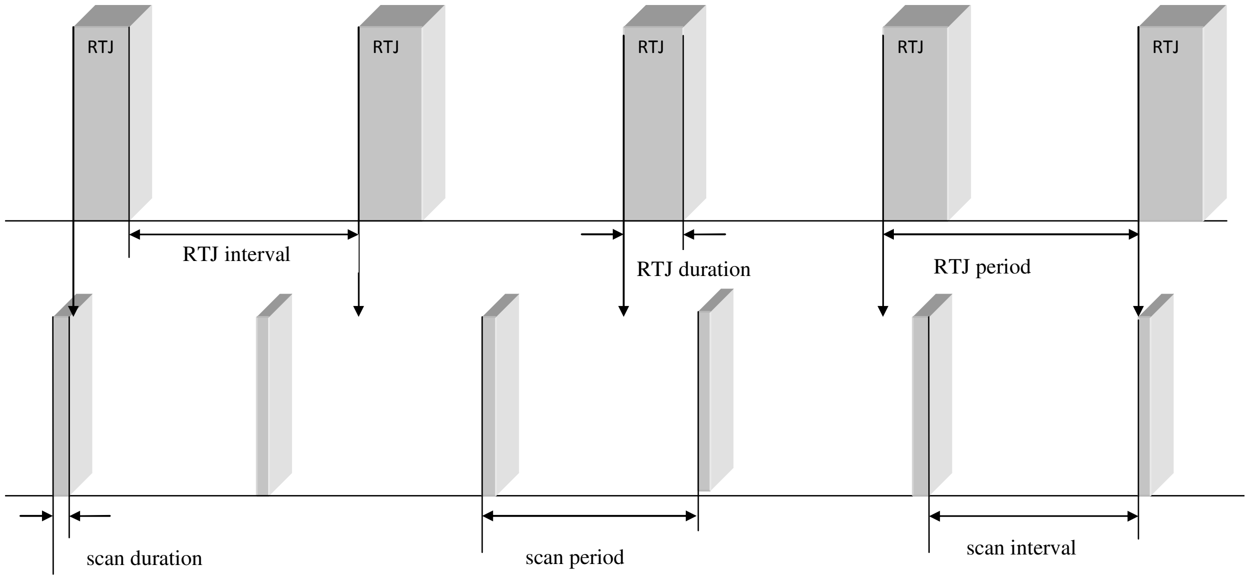
Device Class A is defined as a class of devices forming a network capable of efficiently supporting data throughput for an average greater than 10 Million symbols per supported node during a single continuous 24 hour period.

Device Class B is defined as a class of devices forming a network capable of efficiently supporting data transfer for an average range of 10 Thousand symbols through 10 Million Symbols per supported node during a single continuous 24 hour period.

Device Class C is defined as a class of devices forming a network capable of efficiently supporting data transfer on an average of less than 10 Thousand symbols per supported node during in a single continuous 24 hour period.

7.XXX Common Signaling Mode (CSM)

A single, unique common signaling mode (CSM) is established for each regulatory domain to ensure all devices within each device class share a set of common signaling attributes. All SUN devices will periodically listen for RTJ commands using the PHY attributes defined by the CSM for the supported device class during periods of inactivity. The device will utilize the passive channel scan capability defined in 7.5.2.1.3, as extended for P802.15.4g to include a scan for the Request to Join (RTJ) command. Figure Z1 provides an example that could be used to define the maximum number of scans required to capture the RTJ command. The required minimum duration and interval for RTJ scanning is defined in Table A in Annex H.



(k) = Integer

scan interval = (k) beacon period

$$\#\ \text{of scans to converge} \leq \frac{\text{RTJ period}}{\text{scan duration}}$$

FIGURE 2

Example

Beacon Period mS	1000	BI+BD
Beacon Duration mS	100	
Beacon Interval mS	900	
Scan Period mS	1015	SI+SD
Scan Duration mS	15	
Scan Interval mS	1000	K*BP
k	1	
Number of scans	66.67	
Max Scan Time S	676.67	SP*nS

Average scan time = Max Scan Time /2

Figure z1

7.XXX Capabilities Message referred to as CM

A list of all supported sets of communication attributes will be stored in the PHY PIB (6.4.2 Table 23). Following the reception of an RTJ command, an associated device will transmit a Request to Join Response (RTJR) command. Following that, the associated device should transmit a MAC data frame containing the current set of PHY operating modes using the CSM within 100mS of receiving the RTJ command.

The device attempting to join the network will set its communications attributes to match the data contained in the payload of the received CM message. The joining device will then execute the association process, as defined in 7.5.3.1.

Coordination of this type is performed by an upper layer network management entity (NME). The following text describes message structures which could be implemented by such an NME. The capabilities exchange is based on the PHY descriptor content. For each PHY operating mode, there is a unique PHY ID value assigned. For modes defined P802.15.4g, only the PHY ID value needs to be exchanged between P802.15.4g-compliant devices. The following text is a means to construct a unique PHY ID for each extended PHY operating mode defined, so that a short exchange can be accomplished between P802.15.4g-compliant devices with compatible implementations. To support integration of previously-deployed non-P802.15.4g-compliant devices (which may be capable of implementing a PHY operating mode, as described by a set of generic PHY parameters, the exchange format supports transferring the entire description also.

The capabilities message includes a capabilities vector (CV), shown in Figure z2 used to describe one or more supported PHY operating modes.

Octet:	1	Variable
	CV-Length	PHY Description List

Figure z2

The CV-Length field indicates how many PHY descriptions are contained in the PHY Descriptions list field. Each element of the list begins with a PHY ID which indicates how the PHY is described. When both devices are P802.15.4g-compliant, the PHY mode can be fully defined by the PHY ID alone and the PHY parameter vector is not required. A bit in the PHY ID signals if the parameter structure is included. The PHY ID is structured as shown in figure Z3

Bits:	1	1	TBD	24	GPM-Description
	Standard/Ext	Short/Full Desc	Short ID	OUI (if Ext set)	
	Control bits		GPM-ID		

Figure Z3

7.XXX Capabilities Message (CM) (cont.)

The Standard/Ext bit indicates if the PHY description is fully defined in P802.15.4g or if it is an implementation/vendor specific mode. If the PHY description is Standard, then only the Short ID

field is present. If this bit is set to indicate an extension PHY mode, then the Organizationally Unique Identifier (OUI) field is included (which is part of the MAC address of every 802 device); this enables the device to identify implementation-specific modes in a way assured to be unique.

The Short/Full description field indicates if the entire PHY description structure is included in this list element, or if only the PHY ID is included. This enables exchanging the complete PHY description.

An example of a full MAC frame for capabilities exchange is shown in figure z4

<table>
<tr><td>Octets:Variable</td><td>1</td><td>2</td><td>5</td><td colspan="2">2+</td><td>2/4</td></tr>
<tr><td rowspan="2">Data Frame
MHR</td><td>26</td><td>GPM-S1 ID</td><td>GPM-ExA ID</td><td>GPM-ExB ID</td><td>Full Description</td><td></td></tr>
<tr><td>CV-Length</td><td colspan="4">GPM-ID-List</td><td></td></tr>
<tr><td>MHR</td><td colspan="5">MAC Payload</td><td>FCS</td></tr>
</table>

Figure z4

When two devices have exchanged capabilities information, the NME may compare PHY capabilities sets and determine the mutually supported modes. Other factors, such as channel conditions, would normally be considered in selecting an optimal mode for network operation

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7.XXX Request to Join (RTJ) New MAC Command

The request to join command allows a low energy discovery mechanism to be used by a device to advertise to other devices that it wishes to and is capable of joining an existing PAN (beacon enabled or non-beacon enabled). This command shall be sent by an unassociated device that wishes to discover and associate with a PAN.

The RJT command is formatted as illustrated in figure z5

Octets (see 7.2.2.4)	1
MHR fields	Command Frame Identifier (see Table 82)

Figure z5

MHR fields

The Source Addressing Mode subfield of the Frame Control field shall be set to three (64-bit extended addressing). The Destination Addressing Mode subfield of the Frame Control field shall be set to two (i.e., 16-bit short addressing).

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

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

7.XXX **Request to Join Response (RTJR) New MAC command**

The request to join response is issued by an associated device upon receipt of the RTJ command. The RTJR acknowledges the request and provides a capabilities payload to the joining device, thus conveying information on the current PHY operating mode.

The RJT command is formatted as illustrated in figure z6

Octets (see 7.2.2.4)	1
MHR fields	Command Frame Identifier (see Table 82)

Figure z6

MHR fields

The Source Addressing Mode subfield of the Frame Control field shall be set to three (64-bit extended addressing). The Destination Addressing Mode subfield of the Frame Control field shall be set to three (i.e., 64-bit extended addressing).

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

The Destination PAN Identifier field shall contain the PAN identifier assigned to the responding device if it is a PAN coordinator, or set to the broadcast PAN ID (0xffff) if the device is not a PAN coordinator. The Destination Address field shall contain an extended address equal to the source address of the received RTJ command.

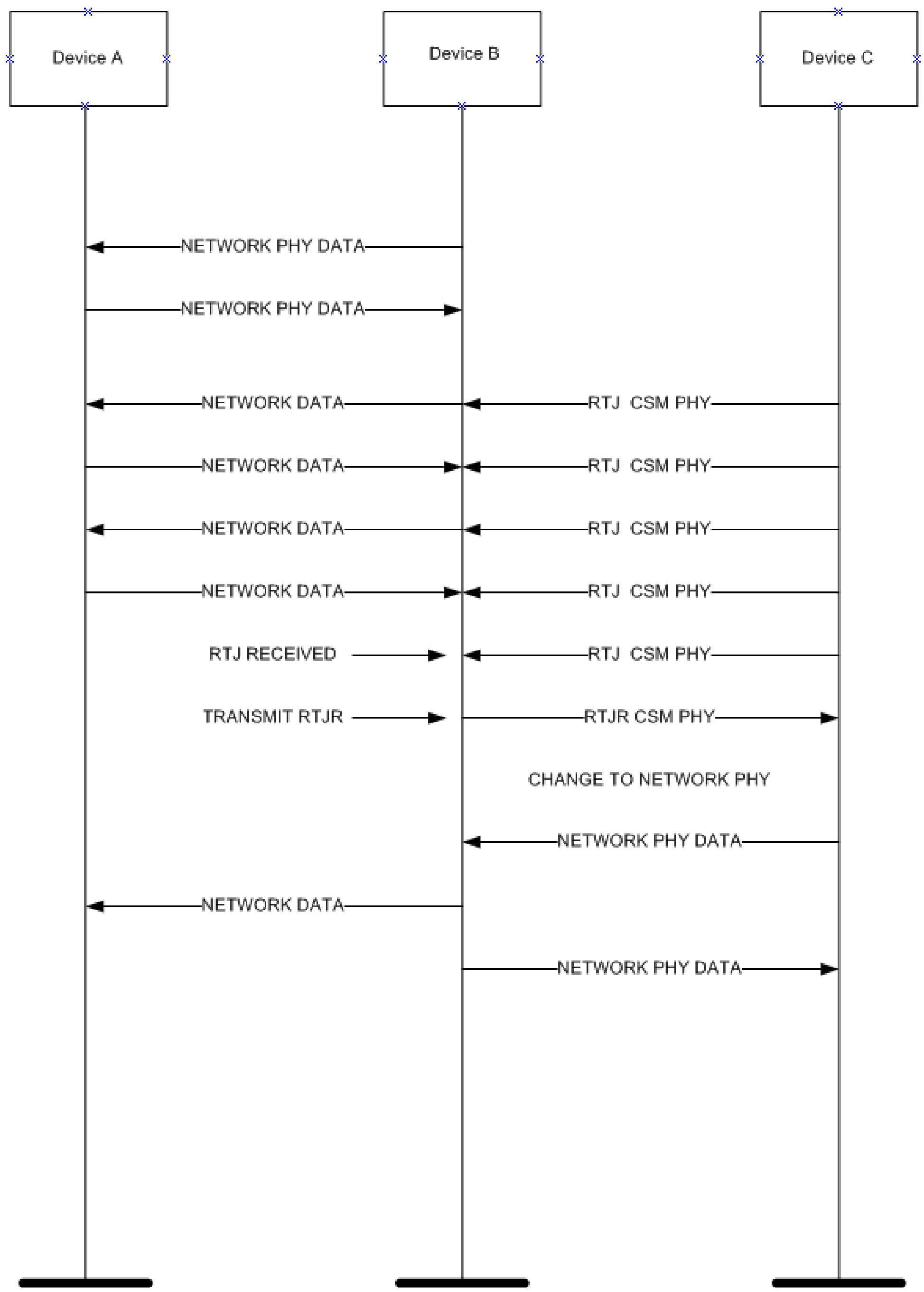
Device A
Device B
Device C
NETWORK PHY DATA
NETWORK PHY DATA
NETWORK DATA
RTJ CSM PHY
NETWORK DATA
RTJ CSM PHY
NETWORK DATA
RTJ CSM PHY
NETWORK DATA
RTJ CSM PHY
RTJ RECEIVED
RTJ CSM PHY
TRANSMIT RTJR
RTJR CSM PHY
CHANGE TO NETWORK PHY
NETWORK PHY DATA
NETWORK DATA
NETWORK PHY DATA

Figure 2

Annex H Table A

Index	Class	Band	Domain	Mod	Rate	BT/FFT	BW	DataRate	SD	SI
1	C	220-222	US	GFSK	1.00	0.5	12.5kHz	2.4kb/s	10	200
2	A	400-430	Japan	QPSK	0.50	16	200kHz	100kb/s	10	1500
3	B	400-430	Japan	GFSK	1.00	0.5	200kHz	50kb/s	10	1500
4	A	426-467	Japan	QPSK	0.50	16	200kHz	100kb/s	10	1500
5	B	426-467	Japan	GFSK	1.00	0.5	200kHz	50kb/s	10	1500
6	C	450-470	US	GFSK	1.00	0.5	12.5Khz	2.4kb/s	10	200
7	A	470-510	China	QPSK	0.50	16	200kHz	100kb/s	10	1500
8	B	470-510	China	GFSK	1.00	0.5	200kHz	50kb/s	10	1500
9	A	863-868	Europe	QPSK	0.75	8	100kHz	50kb/s	10	500
10	B	863-870	Europe	GFSK	1.00	0.5	200kHz	50kb/s	10	1500
11	A	868-870	Europe	QPSK	0.50	16	200kHz	100kb/s	10	1500
12	C	901-902	US	GFSK	1.00	0.5	12.5Khz	2.4kb/s	10	200
13	A	902-928	US	QPSK	0.50	16	200kHz	100kb/s	10	1500
14	B	902-928	US	FSK	1.00	0.5	200kHz	50kb/s	10	1500
15	A	950-956	Japan	QPSK	0.50	16	200kHz	100kb/s	10	1500
16	B	950-956	Japan	GFSK	1.00	0.5	200kHz	50kb/s	10	1500
17	A	2400	US	QPSK	0.50	16	200kHz	100kb/s	10	1500

6.4.2 PHY PIB attributes   TABLE 23

PHY Parameter Table

Attribute	**Type**	**Valid Range**	**Description**
ClassIndex	Integer (1)	1 -255	
PHYType	Enumeration	FSK, OFDM, DSSS	Content of following parameters may vary by PHY type.
ModOrder	Enumeration	{2…n}	{2,4} for defined FSK modes
FSKModIndex	Integer	0-45	0.25- 2.5 in steps of 0.05
GFSKBT	Enumeration	BT_0.5 BT_1.0 BT_OFF	Gaussian Pulse Shaping used. If BT_OFF no pulse shaping filter (FSK)
SymbolRate	Integer	1kHz - 1MHz	Integer 1Hz steps. (3 octets will give a 1 to 16MHz range)
ChannelSpacing	Integer	1KHz to 10 MHz	Integer Hz steps (3 octets will give a 1 to 16MHz range)
FirstChannelFreq	Integer	1 Hz to 37.7GHz	Specifies the center frequency of the first channel in the list in 10Hz units
NumChannels	Integer	1 to 65000	Number of channels in the band/sub-band described (Note 1)