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Abstract	Clarifies functionalities of Sleep Mode to ensure interoperability between MS and BS
Purpose	Adopt the proposal
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Clarifications of IEEE 802.16 to ensure interoperability between MS and BS for sleep mode functionality

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1. Problem description:

During review of a number of submitted comments regarding sleep mode a number of questions and ambiguities has been raised.

Major issues that are clarified in this reply comment are:

Traffic indication preference in DSx-REQ is removed since traffic indications for a power saving class are connected to a PSC not a CID.
Correct negotiation of TRF-IND required by insertion of MS preference of TRF-IND required into the MOB_SLP-REQ message.
Clarification of MS expected behavior after MOB_TRF-IND messages are received
Restoring original intention to support all CID's to belong to multiple power saving classes, and also during REG-REQ/RSP negotiate if multiple active PSC's are supported by both the MS and the BS.
A general updated clarification of availability intervals and listening windows if multiple active PSC's are supported.
Added clarification of bandwidth request mechanism during sleep mode
Modified DL sleep control extended subheader to handle activation at a well defined start frame to ensure synchronization between BS and MS.

2. Abbreviations

In the descriptive part of this document the following abbreviations not previously defined in the IEEE 80216 abbreviation list has been used. They are though not used in the formal suggested text changes.

TIR TRF-IND-required

TTW traffic triggering wakening flag
TIP traffic indication preference

3. Detailed explanation of problems

Traffic Indication Preference vs. TRF-IND Required

In the IEEE standard today there is no mechanism for MS to indicate preference for receiving traffic indication messages MOB_TRF-IND. During service flow creation/change TIP, traffic indication preference is negotiated, but this is done per service flow whereas traffic indications is set per power saving class type I which may include multiple CID's with different settings of the parameter MOB_SLP-RSP. Since TIP is erroneous use for sleep mode it is removed and TRF-IND required is included as a parameter to MOB_SLP-REQ, where it is clarified that this is MS PSC preference, but as during all negotiation BS confirms preference by TRF-IND required setting in MOB_SLP-RSP.

Clarification of MS expected behavior after MOB_TRF-IND messages are received

In this remedy it is clarified what actions MS may perform after receiving MOB_TRF-IND messages when TRF-IND required has been set.

Optional multiple active PSC support of MS and BS

Restore the specification so that a (all) CID may belong to multiple (all) PSC's. Allow definition of multiple PSCs during REG-REQ/RSP of supported mobility features the support of multiple active PSCs may optionally be set. Fast pattern switching can thus be achieved by switching active PSC. In the case optional multiple active PSCs are not supported the mechanism of automatic deactivation of previous active PSC when another PSC is activated is specified.

Bandwidth request during sleep mode.

Contention based UL bandwidth request is performed same way as in normal mode by sending CDMA based BR during a listening interval. However since this is anonymous, UL-allocation IE can be allocated during a sleep window. In this remedy the MS can if TTW=0 request BW immediately and thus deactivate PSC or request BW at an availability interval and thus maintain the PSC active state.

DL sleep control extended subheader format to ensure synchronization between BS and MS at activation.

DL sleep control extended subheader is modified to support an absolute start frame to ensure necessary compatibility with MOB_SLP-RSP.

Clarification of power saving class type support TLV

Power saving class type support TLV is included in SBC message, but general sleep mode support capability is included in REG message. So, power saving class type support TLV should be moved from SBC to REG.
Add the multiple active PSC support bit in this TLV, and reflect the CR#425 already accepted.
This remedy supercedes CR#425.

4. Text change

[Remove Traffic Indication Preference from Table 383 in Section 11.13 on page 735 as follows]

Table 383—Service flow encodings *(continued)*

Type	Parameter
..	..
33	MBS zone identifier assignment
~~34~~	~~Traffic Indication Preference~~
35	Global Service Class Name
..	..

[Remove whole of the section 11.13.28 on page 747:]

~~***Insert new subclause 11.13.28:***~~

~~**11.13.28 Traffic Indication Preference**~~
~~This parameter specifies whether traffic on a service flow should generate MOB_TRF-IND messages to an MS in sleep mode.~~

~~Type~~	~~Length~~	~~Value~~	~~DSX~~
~~[145/146].34~~	~~1~~	~~0: No traffic indication~~ ~~1: Traffic indication~~	~~DSx-REQ~~ ~~DSx-RSP~~ ~~DSx-ACK~~

[Remove Traffic Indication Perference and its descriptions from table 124a in the section 6.3.14.4.1 on page 211 as follows]

Global service class name—A rules-based, composite name parsed in eight information fields of format ISBRLSP~~T~~R, elements reference extensible look-up tables. Each information field placeholder must be an expressed value obtained from Table 124a, as part of the name, and may not be omitted.

Table 124a—Global service flow class name information field parameters

Position	Name	Size (bits)	Value
..	..	..	..
~~T~~	~~Traffic indication preference~~	~~1~~	~~0 or 1:~~ ~~0=No traffic indication;~~ ~~1=Traffic indication~~
..	..	..	..
R	Reserved	~~4~~5	Shall be set to 0b00000

…

~~**Traffic Indication Preference**~~

~~This parameter is a single bit indicator of an MS's preference for the reception of Traffic Indication messages during sleep mode. When set it indicates that the BS may present Traffic Indication messages to the MS when data SDUs bound for the MS are present while the MS is in sleep mode.~~

[Modify the Table 109c in Section 6.3.2.3.44 on page 112 as follows]

Table 109c—Sleep-Request (MOB_SLP-REQ) message format

Syntax	Size	Notes
MOB_SLP-RSP_Message_format() {	—	—
Management message type = 50	8 bits	—
Number of Classes	8 bits	Number of power saving classes.
for (i = 0; i < Number_of_Classes; i++) {	—	—
Definition	1 bit	—
Operation	1 bit	—
Power_Saving_Class_ID	6 bits	—
if (Operation = 1) {	—	—
Start_frame_number	6 bits	
Reserved	2 bits	
}	—	—
if (Definition = 1) {	—	—
Power_Saving_Class_Type	2 bits	—
Direction	2 bits	—
TRF-IND Required	1 bit	—
Traffic_triggered_wakening_flag	1 bit	—
Reserved	~~3~~2 bits	—
initial-sleep window	~~6~~ 8 bits	—
listening-window	8 bits	—
final-sleep window base	10 bits	—
final-sleep window exponent	3 bits	—
Number_of_~~Sleep_~~CIDs	3 bits	—
for (i=0; i<Number_of_~~Sleep_~~CIDs; i++ {	—	—
CID	16 bits	—
}	—	—
}	—	—
}	—	—
TLV encoded information	*variable*	

}	—	—

[Add the following description to the Section 6.3.2.3.44 on page 113 as follows]

Direction

Defined the directions of the class's CIDs.
0b00 = Unspecified. Each CID has its own direction assign in its connection creation. Can be DL, UL, or both (in the case of management connections).
0b01 = Downlink direction only.
0b10 = Uplink direction only.
0b11 = *Reserved*.

TRF-IND_Required

For Power Saving Class Type I only.
1 = BS is requested to transmit at least one MOB_TRF-IND message during each listening window of the Power Saving Class.
This bit shall be set to 0 for other types.

Traffic_triggered_wakening_flag (for Type I only)

0 = Power Saving Class shall not be deactivated if traffic appears at the connection as described in 6.3.~~19~~21.2.
1 = Power Saving Class shall be deactivated if traffic appears at the connection as described in 6.3.~~19~~21.2.

[Modify the Section 6.3.2.3.46 on page 118 as follows]

6.3.2.3.46 Traffic Indication message (MOB_TRF-IND)

This message is sent from BS to MS on the broadcast CID or sleep mode multicast CID. The message is intended for MSs that are in sleep mode that have one or more Power Saving Class IDs defined of Power Saving Class type I, and is sent during those MS's listening-intervals. All MS with no Power Saving Class IDs defined of Power Saving Class type I shall ignore this message. The message indicates whether there has been traffic addressed to each MS that is in sleep mode. For an MS that is in sleep mode, during its listening-window the MS shall decode this message to seek an indication addressed to itself.

When an MS awakens, it will check the frame number to ensure that it did not lose frame synchronization with the BS and read the SLPID-Group Indication bit-map or Traffic Indication bit-map assigned to it ~~and decide. to continue in sleep mode or return to Normal Operation.~~ If the MOB_TRF-IND has a positive indication this message indicates that there is traffic directed to the MS and the MS shall deactivate the power saving class.

If the MOB_TRF-IND has a negative indication this message indicates that there is no current traffic pending for CIDs belonging to this PSC. The MS continues to receive all DL transmission including subsequent MOB_TRF-IND messages in the availability interval.

There are two formats for the MOB_TRF-IND message, indicated by the FMT field. When FMT = 0, if the MS does not find its own SLPID-Group Indication bit-map or Traffic Indication bit-map to its SLPID in the MOB_TRF-IND message, it will consider this as a negative indication and may continue its sleep mode. The MS shall update its SLPID if it finds its own Old_New_SLPID in SLPID_Update TLV. When FMT = 1, if the MS does not find its own SLPID in the MOB_TRF-IND message, it will consider this as a negative indication and may continue its sleep mode.

[Delete the entire Section 11.8.5 on page 712 as follows]

~~**11.8.5 Power save class types capability**~~

~~For MS supporting sleep mode, this parameter defines the capability of the MS supporting different power save class types in sleep mode.~~

~~Type~~	~~Length~~	~~Value~~	~~Scope~~
~~26~~	~~1~~	~~Bit #0: power save class type I supported. Bit #1: power save class type II supported. Bit #2: power save class type III supported. Bits #3-4: number of power save class instances supported from class types 1 and 2 Bits #5–7: number of power save class instances supported from class type III~~	~~SBC-REQ, SBC-RSP~~

[Add the following section to the section 11.4.14 on page 692 as follows]

11.7.14.2 Power saving class capability

For MS supporting sleep mode, this parameter defines the capability of the MS supporting power saving class in sleep mode.

Type	Length	Value	Scope
45	2	Bit #0: Power saving class type I supported. Bit #1: Power saving class type II supported. Bit #2: Power saving class type III supported. Bits #3: Multiple active power saving class supported Bits #4 – #9 : Total number of power saving class instances of all types supported by the MS Bits #10 - #15 : reserved	REG-REQ REG-RSP

[Add type 45 and Power saving class capability TLV in the table 369a on page 685]

Table 369a—REG-REQ/RSP management message encodings *(continued)*

Type	Parameter	Type	Parameter
20	Maximum MAC Data per Frame Support	42	MS HO TEK Processing Time
21	Packing Support	43	MAC Header and Subheader Support
22	MAC Extended rtPS Support	44	SN Reporting Base
		45	Power saving class capability

[Modify the Section 6.3.21.1 on page 228 as follows]

6.3.21.1 Introduction

Sleep mode is a state in which an MS conducts pre-negotiated periods of absence from the Serving BS air interface. These periods are characterized by the unavailability of the MS, as observed from the Serving BS, to DL or UL traffic. Sleep mode is intended to minimize MS power usage and decrease usage of Serving BS air interface resources. Implementation of sleep mode is optional for the MS and mandatory for the BS.

For each involved MS, the BS keeps one or several contexts, each one related to certain Power Saving Class. Power Saving Class is a group of connections that have common demand properties. For example, all BE and NRT-VR connections may be marked as belonging to a single class while two UGS connections may belong to two different classes in case they have different intervals between consequent allocations. A connection may belong to one or several Power Saving Classes. When BS or MS activates a new PSC, which contains CID already existing in another active PSC, it shall immediately deactivate the PSC that is currently active.

It is not allowed to activate a new PSC, by unsolicited manner, which contains CID already existing in another active PSC.

In case MS or BS defines a new PSC definition using a Power_Saving_Class_ID that is already in use, the new definition replaces the existing definition with the same Power_Saving_Class_ID provided that the affected power saving class has already been deactivated.

If MS and BS have indicated support of only one active PSC in the Power saving class capability TLV, the currently active PSC shall be deactivated immediately upon activation of another PSC.

Power Saving class may be repeatedly activated and deactivated. Activation of certain Power Saving Class means starting sleep/listening windows sequence associated with this class. Algorithm of choosing Power Saving Class type for certain connections is outside of the scope of the standard. When a PSC is reactivated, the MS shall reset the sleep window size to the initial-sleep window size according to the definition of the PSC.

There are three types of Power Saving Classes, which differ by their parameter sets, procedures of activation/deactivation, and policies of MS availability for data transmission.

Unavailability interval is a time interval that does not overlap with any listening window of any active Power Saving Class

Availability interval is a time interval that does not overlap with any Unavailability interval

During Unavailability interval the BS shall not transmit to the MS, so the MS may power down one or more physical operation components or perform other activities that do not require communication with the BS—scanning neighbor BSs, associating with neighbor BSs, etc. If there is a connection at the MS, which is not associated with any active Power Saving Class, the MS shall be considered available on permanent basis.

During Availability interval the MS is expected to receive all DL transmissions same way as in state of normal operation (no Sleep), In addition, at the beginning of each availability interval the MS shall examine the DCD and UCD change counts and the frame number of the DL-MAP PHY Synchronization field to verify synchronization with the BS. Upon detecting a changed DCD and/or UCD count in the DL MAP, unless using the Broadcast Control Pointer IE for tracking and updating DCD and/or UCD changes, the MS shall stay awake until receiving the corresponding updated messages, without changing the state of active Power Saving Classes.

— If the BS transmits the Broadcast Control Pointer IE, the MS shall read and react to this message according to the following:

1) If the DCD_UCD Configuration Change Counter has changed since MS last decoding of this IE, even if scheduled to be in a sleep interval the MS shall awaken at DCD_UCD Transmission Frame in time to synchronize to the DL and decode the DCD and UCD message in the frame, if present. If the MS fails to decode one or both of DCD and UCD, or no DCD or UCD was transmitted by the BS, the MS shall continue decoding all subsequent frames until it has acquired both updated DCD and UCD. Upon successful completion of DCD and UCD decoding, the MS shall immediately return to regular sleep mode operation.
2) If Skip Broadcast_System_Update is set to ‘0’, even if scheduled to be in a sleep interval, the MS shall awaken at Broadcast_System_Update_Transmission_Frame in time to synchronize to the DL and decode and read the DL-MAP and any message, if present. Upon completion, the MS shall immediately return to regular sleep mode operation.

MS in sleep mode may request BS to allocate a scan duration by sending MOB_SCN-REQ in case trigger action for sending MOB_SCN-REQ message is enabled by Enabled-Action-Triggered TLV. In this case, MS shall deactivate the PSC associated to basic CID before sending MOB_SCN-REQ, and the BS shall regard the MS as deactivating the PSC associated to basic CID after reception of the MOB_SCN-REQ message.

…

[Modify the section 6.3.21.2 on page 230 with the following texts]

6.3.21.2 Power Saving Classes of type I

Power Saving Class of this type is recommended for connections of BE, NRT-VR type.

For definition and/or activation of one or several Power Saving Classes of type I the MS shall send MOB_SLP-REQ or Bandwidth request and uplink sleep control header (for activation only); the BS shall respond with an MOB_SLP-RSP message or DL Sleep control extended subheader. The MS may retransmit MOB_SLP-REQ message if it does not receive the MOB_SLP-RSP message within the T43 timer.

Power Saving Class may also be defined/activated/deactivated by TLVs transmitted in RNG-REQ and RNG-RSP message.

Power saving class type I can also be deactivated by MOB_TRF-IND if traffic indication required has been negotiated for the PSC.

The following are relevant parameters:

- Initial-sleep window
- Final-sleep window base
- Listening window
- Final-sleep window exponent
- Start frame number for first sleep window
- TRF-IND required
- Traffic triggered wakening flag

Power Saving Class becomes active at the frame specified as Start frame number for first sleep window. Each next sleep window is twice the size of the previous one, but not greater than specified final value. Sleep windows of length according to equation below are interleaved with listening windows of fixed duration.

~~*Sleep window = min (2*(Previous sleep window), Final-sleep window base * 2 ^ (Final-sleep window exponent));*~~

$$sleepWin = min\ \ 2\quad prevSleepWin\quad finalSleepWinBase\quad 2^{finalSlpWinExp}$$

where

sleepWin is the sleep window,
prevSleepWin is the previous sleep window,
finalSleepWinBase is the Final-sleep window base, and
finalSlpWinExp is the Final-sleep window exponent.

Sleep windows are interleaved with listening windows of fixed duration. The BS terminates active state of Power Saving Class by sending MOB_TRF-IND message. A traffic indication (MOB_TRF-IND) message shall be sent by the BS on broadcast CID or Sleep mode multicast CID during listening window to alert MS of appearance of DL traffic demand at the corresponding connections.

When an MS receives an UL allocation after receiving a positive MOB_TRF-IND message indication, the MS shall transmit at least BR message (if there is no data to transmit, BR field of the BR PDU shall be set to 0).

~~During active state of Power Saving Class of type I, the MS is not expected to send or receive any MAC SDUs or their fragments or to send bandwidth requests at connections that belong to the Power Saving Class.~~

Power Saving Class is deactivated either by MOB_SLP-REQ/Bandwidth request and uplink sleep control header or MOB_SLP-RSP/DL Sleep control extended subheader messages. ~~or (if Traffic triggered wakening flag = 1) after one of following events:~~

- ~~BS transmits (during availability window) a MAC SDU or fragment thereof over connection belonging to the Power Saving Class~~
- ~~MS transmits a bandwidth request with respect to connection belonging to the Power Saving Class~~
- ~~MS receives MOB_TRF-IND message indicating presence of buffered traffic addressed to the MS~~

The PSC shall be deactivated if traffic triggering wakening flag is set to 1 and if any of the following conditions is met:

- MS receives a MAC SDU or fragment thereof over a transport connection belonging to the Power Saving Class
- MS transmits a bandwidth request with BR set to a value other than 0 on a transport connection belonging to the Power Saving Class

If both Traffic triggering wakening flag and TRF_IND-Required are set to 0, behavior of the PSC is the same as that of the PSC of type 2.

MS shall transmit a UL BW request if it receives UL grant for BW request after sending CDMA code during an availability or unavailability interval.

~~Assuming~~ In case TRF-IND_Required flag was set in MOB_SLP-~~REQ~~RSP, Power Saving Class shall be deactivated if MS failed to receive MOB_TRF-IND message during ~~availability window~~ any Availability interval which contains at least one listening window of Power Saving Class of type 1.

During ~~listening windows~~ Availability intervals the MS is expected to receive all DL transmissions same way as in the state of normal operations (no sleep).

[Modify the Section 6.3.2.2.7.2on page 41]

6.3.2.2.7.2 DL Sleep control extended subheader

The DL Sleep control extended subheader is sent by the BS to activate/deactivate certain Power Saving Class. The requested operation is effective from the start frame carried in the DL sleep control extended subheader according to the format defined in table 13e. BS may transmit this message to reactivate the Power Saving Class after the BS determines the end of data transmission.

The format of DL Sleep control extended subheader is as described in Table 13e.

Table 13e—DL Sleep control extended subheader format

Name	Size	Description
Power_Saving_Class_ID	6 bits	Indicates the Power Saving Class ID to which this command refers

Operation	1 bit	1 = activate Power Saving Class 0 = de-activate Power saving Class
Final_Sleep_Window_Exponent	3 bits	For PSC type III only: assigned factor by which the final-sleep window base is multiplied in order to calculate the duration of single sleep window requested by the message.
Final_Sleep_Window_Base	~~10~~ 7bits	For Power Saving Class Type III only: the base for duration of single sleep window requested by the message.
Stop_CQI_Allocation_Flag	1bit	1 = Any CQICH allocations to this MS are cancelled. 0 = CQICH allocations to this MS are still allocated and the MS shall continue to transmit channel quality information on them during its availability intervals.
Start frame	6 bits	6 LSB of frame number to start activation of PSC.
~~Reserved~~	~~4 bits~~	~~--~~