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| Re: | Call for Contributions: Multi-tier Networks (16-13-0152-01-000q) |
| Abstract | This contribution proposes duty-cycle mode termination procedure that shall be performed by a small BS in duty-cycle mode. |
| Purpose | To discuss and adopt the proposed texts in IEEE P802.16q AWD |
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# Duty-Cycle Mode Termination

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# Introduction

The purpose of this contribution is to clarify duty-cycle mode termination procedure.

According to the termination procedure defined in the current AWD, an entity that makes a decision on duty-cycle mode termination is different in each termination scenario as shown in Figure 1. In case of NCMS-initiated termination, an NCMS makes a decision on the mode termination when it receives HO request from other network entity, whereas a BS does when it receives RNG-REQ from an MS for network (re)entry. Moreover, the BS terminates the duty-cycle mode whenever it receives the RNG-REQ message. In some cases, the termination of the duty-cycle mode may degrade the performance of MSs in neighbor BSs. For example, if the BS terminates the duty-cycle mode to accept a new initial network entry, it may increase interference to MSs at cell edge of neighbor BSs. Since initiation and termination of duty-cycle mode in a certain BS may affect the throughput of MSs in neighbor BSs and/or BS power saving performance, it’s better for the NCMS to makes any decisions on BS mode transition considering an entire access network performance.



Figure 1 – Current termination procedure

The proposed termination procedure is captured in Figure 2. In the proposed procedure, only NCMS makes a final decision on BS mode transition in all termination scenarios. There is no difference in NCMS-initiated termination procedure. In BS-initiated termination procedure, the BS requests duty-cycle mode termination when it receives RNG-REQ during an Active Interval. The request primitive may include MS information (MS identifier, network entry type, etc) to help the NCMS to make a decision on mode transition. If the NCMS allows the mode transition, then the BS performs mode transition and proceeds with the network (re)entry with the requesting MS.



Figure 2 – Proposed termination procedure

# Proposed Texts

----------------- Start of the text proposal --------------------------------------------------------------------------------------

[*Remedy 1: Change the texts on page 74, line 1 as follows:*]

If a BS that supports duty-cycle mode receives a request from a BS power controller to enter duty-cycle mode, it shall respond to the request and perform the operations described below. If there are active MSs connected to the BS when it receives the request, the BS shall perform the BS-initiated handover as specified in 6.3.20.2 to ensure service continuity of the MSs prior to activating duty-cycle mode. After completion of handovers for the MSs, the BS activates duty-cycle mode at Action time specified in the received request. If the handovers are not completed before the Action time or if any MSs cancel or reject the handover requested by the BS, the BS shall transmit a response to notify the BS power controller of the failure~~request for cancellation of the duty-cycle mode to the BS power controller~~ and continue to stay in normal operation mode. If there aren’t active MSs connected to the BS when the BS receives the request from the BS power controller and there is no new MS that attempts initial network entry or handover to the BS until the Action time, the BS enters duty-cycle mode at the Action time. Otherwise, the BS shall notify the BS power controller of the failure~~transmit a request for cancellation of the duty-cycle mode to the BS power controller~~ and continue to stay in normal operation mode.

If a BS in duty-cycle mode receives a request from the BS power controller to terminate the duty-cycle mode, it shall terminate the duty-cycle mode and go back to the normal mode after transmitting a response to the BS power controller.

If a BS in duty-cycle mode receives a RNG-REQ message from an MS that performs initial network entry or network reentry during an AI of the duty-cycle mode, it shall transmit a request for termination of duty-cycle mode to the BS power controller. When the BS power controller receives the request from the BS, it determines whether the requesting BS has to terminate the duty-cycle mode or not. Criteria for termination of the duty-cycle mode may include factors such as MS performance degradation, BS power saving performance, and inter-cell interference. For example, the BS power controller may accept the request triggered by network reentry from HO and may reject the request triggered by initial network entry. Algorithms or policies for determining the termination of duty-cycle mode are out of scope of this standard.

If the request is accepted by the BS power controller, the BS transits to the normal mode and proceed with initial network entry or network reentry by transmitting a RNG-RSP message with “Ranging Status” set to Success or Continue. If the request is rejected by the BS power controller, the BS continues to stay in duty-cycle mode and transmits the RNG-RSP message with “Ranging Status” set to Abort. In case the BS power controller rejects the request for termination of the duty-cycle mode, the BS may redirect the MS to a nearby BS by including the information of the nearby BS in the RNG-RSP message.

A BS in the duty-cycle mode shall support all available intervals of a paging cycle if it supports idle mode operation. Figure 17-4 provides an example where a BS in the duty-cycle mode supports a single paging cycle.

[*Remedy 2: Change subclause 14.2.12.1 as follows:*]

**14.2.12.1 M-BPM-REQ**

This primitive is used by a BS or an NCMS to control BS power management operation. The NCMS generates this primitive to request the IEEE 802.16 entity (BS) to perform operational mode transition and update of operation parameters for a specific operation mode. The possible Action\_Types for this primitive are listed in table below:

|  |  |
| --- | --- |
| Action\_Type | Description |
| Duty-cycle mode | Duty-cycle mode transition procedure between BS and NCMS. |
| Standby mode | Standby mode transition procedure between BS and NCMS |

**14.2.12.1.1 M-BPM-REQ (Action\_Type = Duty-cycle mode)**

**14.2.12.1.1.1 Function**

This primitive is used by the NCMS to control an operational mode of a BS and to update operational parameters for duty-cycle mode. This primitive is also used by the BS to request a termination of duty-cycle mode~~report BS-initiated mode transition~~ to the NCMS. The primitive is only used between IEEE 802.16 entity and NCMS at BS side.

**14.2.12.1.1.2 Semantics:**

The following parameters are included in this primitive:

**M-BPM-REQ**

(

Operation\_Type: Action,

Action\_Type: Duty-cycle mode,

Destination: BS, NCMS

Attribute\_List:

Operation,

Duty-cycle pattern,

Action time,

Reason,

MS information

)

Operation

Indicates a type of operation.

0: initiate duty-cycle mode

1: terminate duty-cycle mode

2: update of duty-cycle pattern

Duty-cycle pattern

Indicates a duty-cycle pattern that shall be used during duty-cycle mode. This parameter includes a length of an inactive interval, a length of an active interval and start frame offset. In case Operation is set to 2, the BS in duty-cycle mode shall update the current duty-cycle pattern with this duty-cycle pattern. This parameter is included in this primitive only when this primitive is generated by the NCMS.

Action time

Indicates a time when the BS initiates duty-cycle mode or updates duty-cycle pattern.

Reason

Indicates a reason for mode transition. This parameter is included in this primitive only when this primitive is generated by the BS in duty-cycle mode to request~~report~~ the termination of duty-cycle mode (e.g., due to MS initial network entry or network reentry during an active interval).

MS information

Information on the MS that performs initial network entry or network reentry (e.g., MS identifier, network entry type). This parameter is included in this primitive only when this primitive is generated by the BS in duty-cycle mode to request the termination of duty-cycle mode.

**14.2.12.1.1.3 When generated**

* NCMS to BS: When a BS power controller in the NCMS makes a decision on mode transition of a BS for some reasons (e.g., interference mitigation, BS power saving, etc), the BS power controller in the NCMS generates this primitive to request the BS to initiate or terminate the duty-cycle mode. This primitive is also generated by the NCMS to request the BS in duty-cycle mode to update a duty-cycle pattern for an efficient operation of the duty-cycle mode.
* BS to NCMS: When a BS in duty-cycle mode has to terminate the duty-cycle mode for some reasons (e.g., a new initial network entry or network reentry), the BS generates this primitive to request~~report~~ the termination of the duty-cycle mode to the BS power controller in NCMS ~~after transition to normal mode~~.

**14.2.12.1.1.4 Effect of receipt**

* NCMS to BS: If the BS receives this primitive, it shall perform the operation indicated by Operation parameter included in this primitive. If the Operation parameter is set to 0 (initiate duty-cycle mode), the BS first triggers its attached MSs, if any, to handover to the neighbor cells. After the completion of the operation requested by the NCMS, the BS shall generate M-BPM-RSP primitive to respond to this primitive.
* BS to NCMS: If the NCMS receives this primitive, it makes a decision on the request mode transition. If the NCMS accepts the request, it transmits M-BPM-RSP primitive with “Result” set to success. Otherwise, it transmits M-BPM-RSP primitive with “Result” set to failure.~~updates the current operational mode of the BS as normal mode and responds by generating M-BPM-RSP primitive.~~

[*Remedy 3: Change subclause 14.2.12.2 as follows:*]

**14.2.12.2 M-BPM-RSP**

This primitive is used by the BS or the NCMS in response to M-BPM-REQ primitive for BS power management. The possible Action\_Types for this primitive are listed in table below:

|  |  |
| --- | --- |
| Action\_Type | Description |
| Duty-cycle mode | Duty-cycle mode transition procedure between BS and NCMS. |
| Standby mode | Standby mode transition procedure between BS and NCMS |

**14.2.12.2.1 M-BPM-RSP (Action\_Type = Duty-cycle mode)**

**14.2.12.2.1.1 Function**

This primitive is used by the BS or the NCMS in response to M-BPM-REQ primitive for BS power management.

**14.2.12.2.1.2 Semantics:**

The following parameters are included in this primitive:

**M-BPM-RSP**

(

Operation\_Type: Action,

Action\_Type: Duty-cycle mode,

Destination: NCMS, BS

Attribute\_List:

Operation,

Result,

Reason

)

Operation

Indicates a type of operation. The value of this parameter shall be the same as one included in the received M-BPM-REQ primitive.

0: initiate duty-cycle mode

1: terminate duty-cycle mode

2: update of a duty-cycle pattern

Result

Indicates a result of the operation indicated by the Operation parameter included in the received M-BPM-REQ primitive. This parameter may include ‘success’ and ‘failure’.

Reason

Indicates a reason for failure. This parameter is included in this primitive only when the Result parameter in this primitive is set to ‘failure’.

**14.2.12.2.1.3 When generated**

* BS to NCMS: If the BS receives the M-BPM-REQ primitive, it generates this primitive after performing the operation indicated by Operation parameter included in the M-BPM-REQ primitive.
* NCMS to BS: If the NCMS receives the M-BPM-REQ primitive, it updates the current operational mode of the BS as normal mode and responds by generating this primitive.

**14.2.12.2.1.4 Effect of receipt**

* BS to NCMS: If the Result parameter is set to ‘success’, the NCMS updates a current operational mode of the BS. The NCMS may notify neighbor BSs of information on the BS’s operational mode and relevant parameters. This information may be used by the neighbor BSs for radio resource management. If the Result parameter is set to ‘failure’, the NCMS may re-generate M-BPM-REQ primitive or terminate the transaction according to service provider’s policy. If the NCMS does not receive this primitive within a pre-defined time, the NCMS regards this transaction as failure.
* NCMS to BS: If the BS receives this primitive, it terminates this transaction.

**14.2.12.2.2 M-BPM-RSP (Action\_Type = Standby mode)**

**14.2.12.2.2.1 Function**

This primitive is used by the BS or the NCMS in response to M-BPM-REQ primitive for BS power management.

**14.2.12.2.2.2 Semantics:**

The following parameters are included in this primitive:

**M-BPM-RSP**

(

Operation\_Type: Action,

Action\_Type: Standby mode,

Destination: BS, NCMS

Attribute\_List:

Operation,

Result,

Reason

)

Operation

Indicates a type of operation.

0: initiate standby mode

1: terminate standby mode

2: update of standby mode parameter

Result

Indicates a result of the operation indicated by the Operation parameter included in the received M-BPM-REQ primitive. This parameter may include ‘success’ and ‘failure’.

Reason

Indicates a reason for failure. This parameter is included in this primitive only when the Result parameter in this primitive is set to ‘failure’.

**14.2.12.2.2.3 When generated**

* BS to NCMS: If the BS receives the M-BPM-REQ primitive, it generates this primitive after performing the operation indicated by Operation parameter included in the M-BPM-REQ primitive.
* NCMS to BS: If the NCMS receives the M-BPM-REQ primitive, the NCMS generates this primitive after making a decision on the request mode transition. If the NCMS accepts the request, it generates M-BPM-RSP primitive with Result parameter set to ‘success’. Otherwise, it generates M-BPM-RSP primitive with Result parameter set to ‘failure’~~updates the current operational mode of the BS according to the Operation parameter in the received M-BPM-REQ primitive after generating this primitive~~.

**14.2.12.2.2.4 Effect of receipt**

* BS to NCMS: If the Result parameter is set to ‘success’, the NCMS updates a current operational mode of the BS. The NCMS may notify neighbor BSs of the BS’s operational mode for them to manage neighbor BS list. If the Result parameter is set to ‘failure’, the NCMS may re-generate M-BPM-REQ primitive or terminate the transaction according to service provider’s policy. If the NCMS does not receive this primitive within a pre-defined time, the NCMS regards this transaction as failure
* NCMS to BS: ~~If the BS receives this primitive, it terminates this transaction.~~If the Result parameter in the received M-BPM-RSP primitive is ‘success’, the BS terminate duty-cycle mode and transmits a RNG-RSP message to accept an MS’s network access. If the Result parameter in the received M-BPM-RSP primitive is ‘failure, the BS continues to stay in duty-cycle mode and transmits a RNG-RSP message to reject an MS’s network access.

----------------- End of the text proposal --------------------------------------------------------------------------------------