Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Fast Paging and Broadcast Configuration Update Indication
Date Submitted	**2004-08-17**
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Re:	Recommendations to add a Fast Downlink Notification broadcast indication channel to be used for fast paging and broadcast update indication to mobile terminals.
Abstract	This contribution recommends adding a new optional physical channel to allow fast paging and broadcast indication to allow efficient idle mode operation and longer standby time for battery powered mobile terminals.
Purpose	To be discussed and considered in preparation of new text for idle mode section.
Notice	
Release	
Patent Policy and Procedures	

Fast Paging and Broadcast Update Notification Indication

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Background

In IEEE802.16e each MSS is has a 48-bits universal MAC address or MSS Identification number (MSS-ID) at the time of registration or network entry.

The system also supports the idle mode for the mobile in which the MSS is not actively involved in any data or signaling exchange with the base station. However the MSS does periodically monitor various broadcast channels/messages looking for any incoming paging messages for it and/or any system parameter or configuration updates on broadcast messages.

Every time a mobile wakes up to check these updates, it would need to parse through all relevant broadcast and paging messages in the FCH, DL-MAP, UL-MAP and other channels to determine if there is any message for it or any updated system parameter. Reading these information, needs performing FFT at the receiver, PHY processing, in terms of de-interleaving, demodulation, decoding, etc., and MAC layer processing. Also, note that the size of these messages is considerable. OFDMA DL-MAP has about 104 bits of broadcast information, possibly several extended IE's, and for many active users, several CID data allocations. These CIDs per user could be basic CIDs, primary or secondary CIDs, and traffic CID. Therefore, FFT operation on one or two OFDMA symbol only takes a small portion of the processing time and power to read, and interpret these messages. As a result, if we can skip PHY and MAC processing of these messages, we can save a considerable amount of power, and allow longer standby time for battery powered mobiles.

The system instead can quickly notify mobiles of presence of any system broadcast message update or paging and new allocations for a mobile by using a new physical channel called Fast Downlink Notification Channel (FDLN).
This channel only carries a large number of binary indicators referring to page messages in the following frame. The mobile can look at one of these indicators based on its MSS-ID's to see if there is anything in the DL MAP addressed to that user. Since the number of indicators may be less than the number of MSS-ID's, the mobile may need to apply a hashing function to map its MSS-ID to specific indicator.

One simple way for mobile to hash to one of these indicators based on its MSS-ID, is to use the indicator with index $Mod_N(\text{MSS-ID}/N_{FNC\_P})$, where N_{FNC_P} is the number of tones defined for Paging Indicators in Fast Notification Channel.

In the same process, the mobile can also check to see if there is any parameter update in the primary broadcast control channels such as DL-MAP, DCD and UCD. This can be

achieved by dedicating broadcast change indicator in this channel. All mobiles need to check this configuration change indicator, up on waking up, regardless of their MSS-ID.

Also to expedite the detection of these indicators, it is best to use un-coded On-Off Key indicators and over one or two symbols.
Note that this feature can be supported as an optional capability and the presence, position and the size of this channel can be indicated, e.g. 64, 128 or 256 tones, on the FCH channel, e.g. using some of reserved bits in DLFP.

Proposed Text Change:

1. [Add the following text as Section 6.3.21.9 of Draft IEEE802.16/D4]

6.3.21.9 Fast Downlink Notification Channel

The Fast Downlink Notification Channel (FDLN) is an optional channel used to reduce the processing required to monitor paging and broadcast control channels and to reduce the MSS's battery consumption during the idle mode.

The support for FDLN as well as it size and repetition scheme shall be indicated in the Downlink Frame Prefix (DLFP) as shown in section 8.4.4.3. This channel may consist of 48, 96, 144 or 192 subcarrier with 2or 4 repetitions as specified in Table 266a.

When supported, this channel is located between the DL-MAP and UL-MAP, and consists of N_{FDLN} binary indicators. Each binary indicator on the FDLP channel is modulated with On-Off Key (OOK) modulation on a single subcarrier.

Each Repetition of the FDLN consists of one binary Broadcast Change Indicator and N_{FP} binary Fast Paging Indicators, numbered 1,2, … , N_{FP} ($N_{FP} = N_{FDLN} - 1$). Each indicator is set or reset according to the following:

- The Broadcast Change Indicator shows any changes in the systems and configuration parameters, such as DCD and UCD. The BS shall set this indicator to "1" only when it wants the idle MSS's to read the DL-MAP and UL-MAP at least once per paging interval. The BS sets this indicator to '0' otherwise.
- A Fast Paging Indicator with index 'i' is set to '1' whenever in the next frame there is a page message for at least one MSS with a MSS-ID that hashes to that index 'i'. The hashing method is based on the following equation:

$$FP\_Index = \mathrm{mod}_{N_{FP}}(MSS\_ID / N_{FP}) \qquad (2)$$

All idle MSS's shall wake up periodically to read paging and broadcast control messages based on procedures defined in section 6.3.21.7.

When FDLN is supported, the MSS's, one frame before the end of its paging interval, shall read FCH and then check the status of Broadcast Change Indicator and one of Fast Paging Indicators based on the hashing method described above, and then performs the following:

- If the Broadcast Change indicator is set to '1', the MSS shall read all the broadcast control messages in the following frames until it captures all configuration changes, otherwise the MSS goes back to sleep.
- If the Fast Paging Indicator with index hashed by mobile MSS_ID, is set to '1' the MSS shall read all the DL-MAP in the following frame to see if there is any paging or new DL allocations for the mobile, otherwise the MSS goes back sleep.

The format of FDLN channel is shown in Table 130f.

Note that since the size of DL-MAP is given in DLFP, the mobile can quickly jump to the beginning of this message without PHY and MAC processing of DL-MAP.

Table 130f— Fast DL Notification Channel

Syntax	Size	Notes
Broadcast_Notification	1 bit	0-Don't check the broadcast messages of the next DL-MAP 1-Check the broadcast messages of the next DL-MAP
MSS_Notifications	*variable*	
}		

2. [Change the Table 266a in page 111 of Draft IEEE802.16/D4, Section 8.4.4.3 to the following, and add the specified text]

Table 266a—OFDMA downlink Frame Prefix format

Syntax	Size	Notes
DL_Frame_Prefix_Format() {		
Used subchannel bitmap	6 bits	Bit #0: Subchannels 0-11 are used Subchannel group 0 Bit #1: Subchannels 12-19 are used Subchannel group 1 Bit #2: Subchannels 20-31 are used Subchannel group 2 Bit #3: Subchannels 32-39 are used Subchannel group 3 Bit #4: Subchannels 40-51 are used Subchannel group 4 Bit #5: Subchannels 52-59 are used Subchannel group 5
Ranging_Change_Indication	1 bits	

Repetition_Coding_Indication	2 bits	00 - No repetition coding on DL-MAP 01 - Repetition coding of 2 used on DL-MAP 10 - Repetition coding of 4 used on DL-MAP 11 - Repetition coding of 6 used on DL-MAP
Coding_Indication	3 bits	0b000 - CC encoding used on DL-MAP 0b001 - BTC encoding used on DL-MAP 0b010 - CTC encoding used on DL-MAP 0b011 = ZT CC used on DL-MAP 0b100 to 0b111 –*Reserved*
DL-MAP_Length	8 bits	
FDLN_Length_Repetition	3 bits	000-Fast DL Notification channel not supported 001-FDLN supported, length 48, repetition coding 2 010-FDLN supported, length 48, repetition coding 4 011-FDLN supported, length 96, the repetition coding 2 100-FDLN supported, length 96, repetition coding 4 101-FDLN supported, length 144, repetition coding 2 110-FDLN supported, length 144, repetition coding 4 111-FDLN supported, length 192, repetition coding 2
Reserved	1bit	Shall be set to zero
}		

FDLN_Length_Repetition
These three bits define the length and repetition coding of the Fast Down Link Notification Message in number of subcarriers