Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Design of Downlink Broadcast Control Channel for 802.16m**
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Re:	IEEE 802.16m-08/005, “Call for Contributions on Project 802.16m System Description Document (SDD)”. In response to the following topic: •proposed IEEE 802.16m Downlink Control Structure
Abstract	This contribution introduces a downlink broadcast control channel and discusses its benefit to IEEE 802.16m system
Purpose	For discussion on the downlink control channel issues and adoption on proposed text to SDD by TGm
Notice	
Release	
Patent Policy	

Design of Downlink Broadcast Control Channel for 802.16m

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1. Motivation

A downlink control signaling was proposed in [1] and the problem of long network entry is discussed. They proposed a hierarchical MAP method to strike a balance between quick network entry and bandwidth efficiency. Since the system information is broadcasted over the frames, it is beneficial to know the broadcast scheduling information in advance. In this contribution, we propose a downlink broadcast control channel (BCH) and categorize the DCD and UCD into multiple sets of sub-DCD and sub-UCD. The sub-DCDs and sub-UCDs are broadcasted in the SuperMAP over BCH. And, a system information block (SIB) message is used to announce the time appearance of the sub-DCD and sub-UCD for a broadcast cycle.

2. Introduction

In cellular networks, base station (BS) broadcasts and updates the system configuration and common control information in the downlink, while mobile stations (MS) obtain the information and perform operations accordingly. Those downlink broadcast information in 802.16 systems are transported via DCD, UCD and MAC management messages, where the broadcast interval is undefined and could be very long. For example, the longest possible DCD interval is 10 seconds [2]. Since MS needs the information of DCD and UCD to complete the synchronization procedure, the current DCD interval obviously cannot meet the maximal state transition latency of IEEE 802.16m system requirement as indicated in [3]. For quick network entry, a short DCD/UCD broadcast interval is desirable.

However, short broadcast interval could waste precious wireless bandwidth because DCD and UCD consist of lots of 802.16 configuration parameters. Analyzing those configuration parameters, it can be found that they are with different updating frequency and only some of them are required for initial network entry. Parameters, such as: system bandwidth, frame duration and HARQ parameters, are hardly changed. But, parameters, such as UL loading and contention backoff parameters, may be updated frequently if network congestion occurs. According to the current 802.16e specification, the whole DCD or UCD table should be broadcasted all over again as long as any parameter in the table is changed. Obviously, this kind of updating is inefficient. One way to broadcast efficiently is to break the big table into multiple smaller ones and broadcast them, while necessary, in different time interval via a downlink broadcast control channel (BCH).

When the whole system configuration and common control information are broadcasted in different time interval, it would be beneficial to design a scheduling information block (SIB) message to announce the broadcast interval for all the information blocks so that MS can be aware that the whole broadcast cycle. Aside from network entry, MS shall perform scanning, measurement report, handover, multimode coordination and other operational procedures while roaming around the wireless networks. Knowing the broadcast cycle, MS can arrange its operation during the non-broadcasting duration. Moreover, MS may intentionally skip some non-interested information blocks so that the MS power consumption can be enhanced. For example, MS can efficiently extend the scanning period if it intentionally skip some information updating while scanning. Another example is the idle mode operation. An MS can choose to skip the some un-related updating while staying in the idle mode.

In this contribution, the system configuration and common control information are categorized, based on their functional properties. And then, we propose a downlink control channel to periodically transport system configuration and common control information.

3. Categorization of System Information in DCD/UCD

In the contribution, the DCD (UCD) is generally categorized into a basic-DCD (basic-UCD) and multiple of sub-DCDs (sub-UCDs). The basic-DCD and basic-UCD institute of necessary information required for network entry while each sub-DCD/sub-UCD represents a set of parameters for a specific function. Table 1 and Table 2 show examples of DCD/UCD categorization, respectively. In the tables, the basic-DCD and basic-UCD contain the information of system frame number, frame configuration, ranging parameters and etc. The other parameters are embedded in the sub-DCDs and sub-UCDs.

basic-DCD	➢ system frame number ➢ BW info. ➢ frame Configuration, TTG/RTG ➢ ranging ➢ downlink burst profile ➢ etc
sub-DCD1	➢ static parameters for DL data transmission
sub-DCD2	➢ dynamic parameters for DL data transmission
sub-DCD3	➢ parameters for handover procedure
….	…

Table 1: categorization of DCD (an example)

basic-UCD	➢ uplink burst profile ➢ permutation ➢ ranging code ➢ etc
sub-UCD1	➢ static parameters of UL transmission
sub-UCD2	➢ dynamic parameters of UL transmission
sub-UCD3	➢ parameters for special subchannel configuration
sub-UCD4	➢ parameters for measurement report
…	…

Table 2: categorization of UCD (an example)

When a MS enters the cell coverage of a 802.16m BS, it can get the necessary system configuration information and ranging parameters after the reception of basic-DCD/basic-UCD. MS performs the initial ranging and other consequent operations for the initial network entry. Once it successfully registers the network, it can then decode the sub-DCDs/sub-UCDs to obtain the control parameters for other functions, such as: scanning, handover and etc.

The context of each sub-DCD and sub-UCD has different time validity and are supposed to be updated with different time interval. Generally, sub-DCDs and sub-UCDs can be classified into three types:

- static
- semi-static
- dynamic

For the static or semi-static sub-DCDs and sub-UCDs, the parameters are rarely changed and only required to update one or two times per broadcasting cycle. For the dynamic sub-DCDs and sub-UCDs, the parameters are required to change frequently to adapt to the network dynamics so that they are updated at a higher frequency. All the updating scheduling information is indicated in the SIB.

4. Downlink broadcast control channel

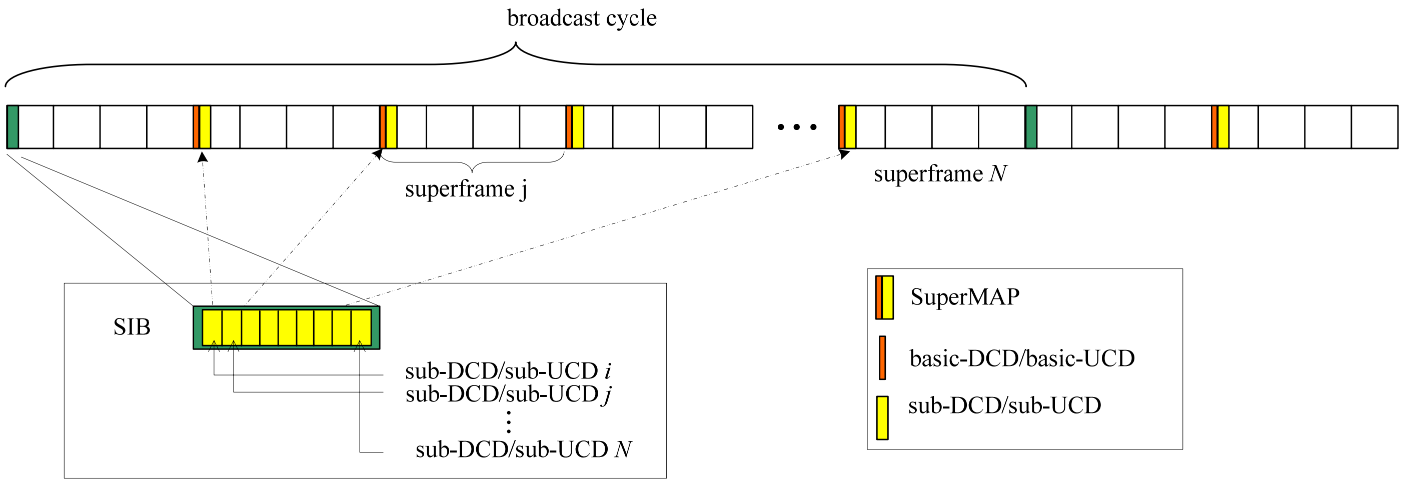

Figure 1: The illustration of downlink broadcast control channel

Figure 1 shows the proposed downlink broadcast control channel for 802.16m. In the figure, *frame* is the basic unit which is the same as the legacy 802.16 frame with 5ms duration, and one *superframe* consists of *M* frames. The overall broadcast cycle contains of *N* superframe; that is, one broadcast cycle is 5*M*N ms. A downlink BCH is allocated in the first frame of the superframe. During a whole broadcast cycle, the BCH broadcasts SuperMAP. For the first superframe, the content of the SuperMAP are scheduling information, SIB. For the *j*-th superframes, *j*=2~*N*, the content of the SuperMAP contains basic-DCD and basic-UCD and a set of sub-DCDs and sub-UCDs. Aside from the DCD and UCD, BS may periodically broadcast some MAC management messages, such as MOB_NBR-ADV, to facilitate mobility operations. The time scheduling of these MAC messages may also be broadcasted in the SIB.

The SIB indicates the time appearance of the sub-DCDs, sub-UCDs and MAC messages or MAC management messages, as illustrated in Figure 2. The *i*-th block in the SIB represents the SuperMAP of *i*-th superframe, *i*= 1~*N*. In the example, sub-DCD2 and sub-UCD2 contains dynamic parameters so they are broadcasted three times during a broadcast cycle. And, only the basic-DCD and basic-UCD are broadcasted in the SuperMAP if no parameter broadcasting is required. Noted that, each sub-DCD or sub-UCD is identified by a sub-version count. MS may choose to skip the SuperMAP decoding if the sub-version count is not changed.

Sub-DCD1/ subUCD-1	Sub-DCD2/ subUCD-2	Sub-DCD3/ subUCD-3	Sub-DCD1/ subUCD-1	Sub-DCD4/ subUCD-4	Sub-DCD2/ subUCD-2	MOB_NBR-ADV	Sub-DCD4/ subUCD-4	Sub-DCD2/ subUCD-2	N/A

Figure 2: An example of SIB message

As to the downlink or uplink transmission allocation and other specific control information, they can be broadcasted via legacy MAP or subMAP messages controlling a specific group of MS users. Figure 3 shows the relationship of SuperMAP and MAP in a superframe cycle for 802.16m-only BS, where SuperMAP appears in the first frame following MAP message and MAP appears in every frame following FCH.

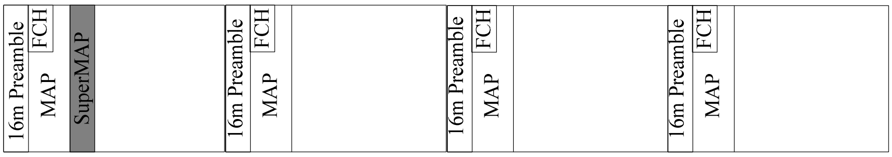

Figure 3: The relationship of SuperMAP and MAP in a superframe

5. Text Proposal

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10.x Downlink broadcast control channel

To efficiently broadcast system configuration information, the DCD (UCD) is generally categorized into a basic-DCD (basic-UCD) and multiple of sub-DCDs (sub-UCDs). The basic-DCD and basic-UCD consist of necessary information required for network entry while each sub-DCD/sub-UCD represents a set of parameters for a specific function, such as handover and measurement report. When a MS enters the cell coverage of an 802.16m BS, it can get the necessary system configuration information and ranging parameters after the reception of basic-DCD/basic-UCD. MS performs the initial ranging and other consequent operations for the initial network entry. Once it successfully registers the network, it can then decode the sub-DCDs/sub-UCDs to obtain the control parameters for other functions, such as: scanning, handover, and etc.

Figure *y* shows the downlink broadcast control channel for 802.16m. In the figure, *frame* is the basic unit which is the same as the legacy 802.16 frame with 5ms duration, while one *superframe* consists of *M* frames. The overall broadcast cycle contains of *N* superframe; that is, one broadcast cycle is 5*M*N ms. A downlink BCH is allocated in the first frame of the superframe. During a complete broadcast cycle, the BCH broadcasts SuperMAP. For the first superframe, the content of the SuperMAP are scheduling information, SIB. For the *j*-th superframes, *j*=2~*N*, the content of the SuperMAP contains basic-DCD and basic-UCD and a set of sub-DCDs and sub-UCDs. Aside from the DCD and UCD, BS periodically broadcasts some MAC management messages, such as MOB_NBR-ADV, to facilitate mobility operations. The time scheduling of these MAC messages may also be optionally broadcasted in the SIB. As to the downlink or uplink transmission allocation and other specific control information, they can be broadcasted via legacy MAP or subMAP messages controlling a specific group of MS users.

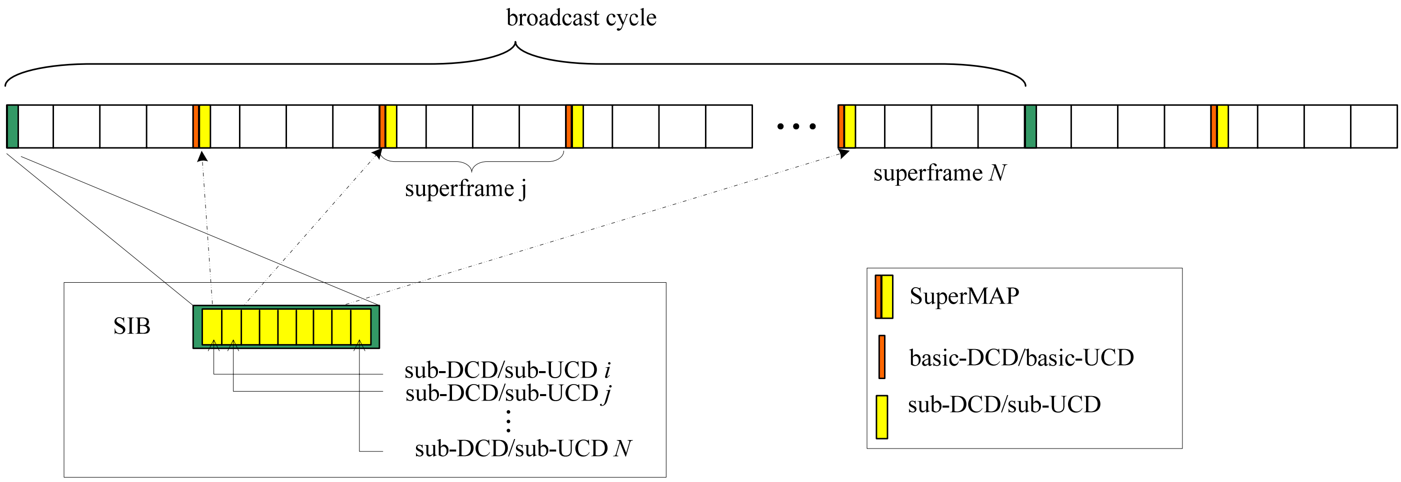

Figure *y*: downlink broadcast control channel

The SIB indicates the time appearance of the sub-DCDs, sub-UCDs and MAC messages, or MAC management messages, as illustrated in Figure *z*. The *i*-th block in the SIB represents the SuperMAP content of the *i*-th superframe, *i*= 1~*N*. In the example, sub-DCD2 and sub-UCD2 contains dynamic parameters so they are broadcasted three times during a broadcast cycle. And, only the basic-DCD and basic-UCD are broadcasted in the SuperMAP if no parameter broadcasting is required. Note that, each sub-DCD or sub-UCD is identified by a sub-version count. MS may choose to skip the SuperMAP decoding if the sub-version count is not changed.

Sub-DCD1/ subUCD-1	Sub-DCD2/ subUCD-2	Sub-DCD3/ subUCD-3	Sub-DCD1/ subUCD-1	Sub-DCD4/ subUCD-4	Sub-DCD2/ subUCD-2	MOB_NBR-ADV	Sub-DCD4/ subUCD-4	Sub-DCD2/ subUCD-2	N/A

Figure *z*: An example of SIB message

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REFERENCES

[1] IEEE 802.16m-08/091r2, "Downlink Control Signaling for Frame Structure Design of IEEE 802.16m".
[2] IEEE 802.16Cor2D4, "Part 16: Air Interface for Broadband Wireless Access System".
[3] IEEE 802.16m-07/002r4, "IEEE 802.16m System Requirements."