Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>	
Title	**DL Control Channel Structure for 16m**	
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Re:	IEEE 802.16m-08/005, "Call for Contributions on Project 802.16m System Description Document (SDD)". Target topic: Downlink Control Structures.	
Abstract	Basic DL control channel information and mapping to radio resource are discussed.	
Purpose	Discuss and accept the proposal into the baseline SDD document	
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DL Control Channel Structures for 16m

1 Introduction

This contribution proposes DL control channel structure to be included in the 802.16m system description document (SDD). DL control information can be classified into system configuration information, various management messages, DL/UL scheduling, feedback information (e.g. ACK/NACK) etc. The design of the control channel should carefully consider factors such as overhead, flexibility, complexity, and latency. Since dedicated MAC management messages will be transmitted as in-band signaling, this contribution mainly focuses on system information

2 Frame Structure Description

In order to have a clear description of DL control channel structure, it would be helpful to have a look at the frame structure example as shown in Figure 1. Each superframe is divided into multiple radio frames and furthermore each radio frame is divided into several subframes. Superframe header is transmitted at the beginning of each superframe. In case there are legacy MSs in the system, 16e preambles are transmitted at the beginning of each 5ms radio frame.

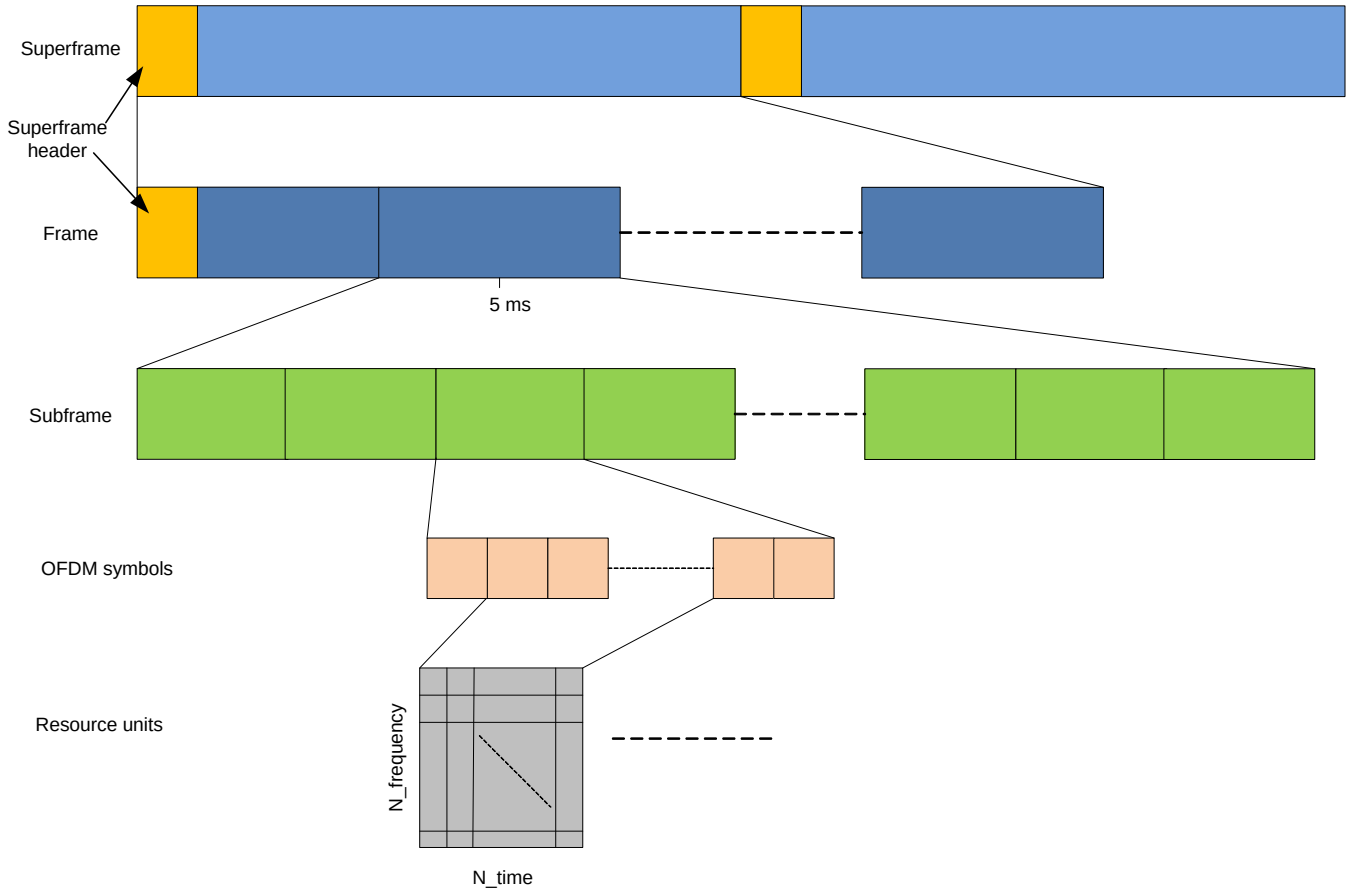

Figure 1 Frame structure example

3 Control Channel Structure

As to DL control channel, it is necessary to have at least control channels to convey the following information:

- System configuration information
  - Low fixed bit rate using predefined transport format
  - Required to be broadcast in the entire coverage area of the cell
  - Examples: FCH, DCD/UCD etc. in 16e
- Synchronization information
  - Required to be broadcast in the entire coverage area of the cell
  - Examples: preamble in 16e, synchronization channel etc.
- Resource allocation information
  - dedicated and/or common resource allocation information
  - flexible transport format
  - possibly using advanced techniques e.g. MIMO
  - Examples: MAP, sub-MAP
- Transport format
  - Used to indicate the transport format for different control channels
- Feedback (e.g. HARQ ACK/NACK) information
  - Dedicated information for one MS
- Other broadcast control messages
  - Examples: neighbor BS advertisement message, and paging information

Physical DL control channel can be mapped to superframe header and can be transmitted in every subframe/concatenated subframe depending on the information. One example of mapping between different DL control channels to physical resource is given in Figure 2.

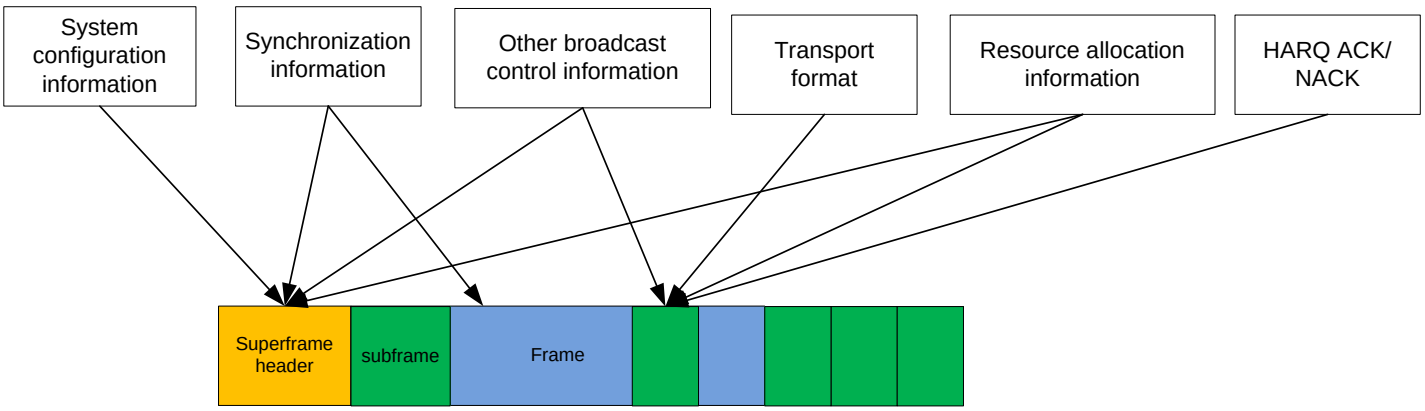

Figure 2 Example of mapping between control information and physical location in the frame structure

The following sections describe the detection, location and content of each control channels.

3.1 Synchronization Channel

Synchronization channel (e.g. preamble) is required by MS to maintain coarse synchronization with the BS. The synchronization channel can provide BS identity (ID-Cell and Segment Number) as well. These ID-Cell and Segment number are used to locate the MAP indication channel (MICH, aka 16m FCH) of the sector and defines the initial permutation used in the sector.

The preamble shall be transmitted in the first OFDM symbol of the every radio frame (5 ms).

3.1.1 Legacy Mode

In the network with both 16e and 16m MSs, there is no need to include 16m specific preamble. The reasons are:

- The current 16e preamble is transmitted in every 5 ms, and 16m MSs for the purpose of synchronization can use this as well.
- Overhead will increase if additional 16m preamble is introduced.

3.1.2 Green Field Mode

For 16m only networks, new preamble, which could be designed for multiple antennas and/or transmitted with multiple antennas, can be employed in order to have better coverage.

- Preamble index is defined as 2 bit segment number and 5 bit ID-Cell. In order to have large numbers of ID-Cell for 16m BSs, number of bits of ID-Cell can be increase from 5 to 6.
- It provides 192 additional preambles with 64 ID-Cells per Segment.

3.2 MICH – MAP Indication Channel (Aka 16mFCH)

FCH in 802.16e provides the following information:

- Number of sub-groups used in the sectors
- Repetition of DL-MAP
- MCS of DL-MAP
- Length of DL-MAP

If only major sub-groups or fewer sub-groups are used for first zone, where the DL-MAP is transmitted, then the number of OFDM symbols required to transmit DL-MAP could become very large. Especially, when there are many users with small payload scheduled in the frame, as large number of IEs are required in the DL-MAP. In order to reduce the number of OFDM symbols over which MAP messages are transmitted, it is recommended to use all sub-carriers and increase the protection of DL-MAP by using more repetition to combat interference. Furthermore, in current 802.16e, there are different MCS used to transmit MAP messages in order to have more flexibility. The problem is the heavy overhead.

In 802.16m, we propose that

- MICH is transmitted in every subframe or several concatenated subframes (Sub-frame concatenation is specified in Super-Frame Control Header).
- MICH is transmitted in the first OFDM symbol of the sub-frame or concatenated subframe.
- MICH is used to indicate the MAP related information, e.g. how many OFDM symbols/Resource blocks are used for MCH (MAP message) and repetition of MAP messages.
- We propose to have fixed MCS for MAP messages hence MCS information for MAP is not included.

MICH can be transmitted in different resource position in neighbor BSs in order to reduce the interference.

3.3 MCH (MAP Channel) (Aka MAP Message)

We proposed to have fixed MCS for MCH (MAP messages) and keep the flexibility via variable number of repetitions. Number of repetition for MCH is indicated by MICH channel. MCH is transmitted in every sub-frame or concatenated subframe and has variable size.

The MICH channel shall indicate size of MCH. There are two options to indicate the size of MCH:

- In terms of number of Resource blocks
  - Requires more number of bits in MICH therefore increases MICH overhead but provides higher granularity
  - Size of MICH will be different for different frequency band because of number of Resource blocks is higher in larger band. Therefore require different formats for MICH.
- In terms of number of OFDM symbols.
  - Requires less number of bits in MICH therefore MICH overhead is low but MCH may not fill the complete band and require unnecessary padding.
  - It is possible to support different permutation for MCH and Resource block within a sub-frame.
  - It also allows different frequency reuse for MCH and resource blocks. E.g. MCH can be transmitted using frequency reuse 3 while data can be transmitted using frequency reuse 1.

We propose that size of MCH should be indicated in terms of number of OFDM symbols.

3.4 Super-Frame Control Header (S-FCH)

Super-Frame Control Header is transmitted at the beginning of every superframe. It should include mainly the information which is relevant for the duration of the superframe and also provides basic system information for faster network search, initial network entry/re-entry and neighborhood discovery.

We propose that:

- S-FCH should be of fixed size.
- S-FCH should be transmitted using pre-defined MCS.
- It should be transmitted at fixed location so that MS can detect the S-FCH without any pre-condition of decoding any other message (except in case of legacy mode where MS is required to decode 16eFCH in order to get the sub-frame offset where S-FCH is transmitted)
  - Legacy Mode: Reserved bits in 16eFCH can be used to indicate the “sub-frame offset” where S-FCH is transmitted. When 16m MS detects the 16e preamble, it can read the 16eFCH and find out the location of S-FCH. MS decode the S-FCH in order to get system information and possibly perform remaining network entry.
  - Green field mode: S-FCH when transmitted is transmitted in the first sub-frame of Radio-frame (i.e. the subframe right after preamble). Since the location and formatting of S-FCH is pre-determined (based on permutation of ID-Cell and fixed MCS), MS can decode it and perform the CRC check.

3.4.1 Content of S-FCH

The content of superframe control header could be:

- SCD count – (System Configuration Descriptor – DCD/UCD combined)
- SCD MASK – Support hierarchical SCD
- Counter indicating when the S-FCH is applicable
- Super frame number – 8 bits
- BSID – 48 bits
- Frame configuration – concatenation of sub-frames.
- Sub-frame/concatenated sub-frame zone configuration
- Flag indicating whether broadcast information (e.g.DCD/UCD types of messages) is included in this superframe or not and possibly including a pointer in the superframe header to indicate the location of the broadcast information (e.g. DCD/UCD messages).
- If BS transmit paging messages e.g. MOB-PAG-ADV message in any of the sub-frame of the superframe then S-FCH may contain a flag indicating the presence of paging messages e.g. MOB-PAG-ADV in the superframe to enable better MS power usage during Idle Mode.
- Flag indicating transmission of messages similar to MOB-TRF_IND to enable better MS power usage during Sleep mode.
- …

3.5 Transmission of DCD/UCD

In 16e DCD/UCD messages are so large and need to be transmitted with the most robust MCS in order for all MSs in the cell to get it correctly. However there are following issues with 16e type of DCD/UCD transmission:

- Though it is required to be transmitted with robust MCS but this results in a big portion of overhead especially when few field of the DCD/UCD changes. It requires BS to either re-broadcast DCD/UCD or delay the update so that it can be transmitted at its scheduled transmission. If BS re-broadcasts then it incurs lot of overhead but if BS delay the transmission than it may impact the system performance because those changed parameters may be critical for proper system operation.
    - We propose to combine all type of system information under SCD (system configuration descriptor) and divide the SCD into sub-SCD according to the type of contents.
    - Require only single counter (SCD change count) and SCDMASK (SCD change count and SCD MASK can be transmitted in S-FCH) to manage complete system broadcast information.
    - SCDMASK will indicate which sub-SCD is changed so MS only require decoding that particular sub-SCD.

- DCD/UCD contains different types of system information. Some information does not change very often while some information changes more often. Therefore it is difficult to make a decision on the periodicity of DCD/UCD transmission. If period is too small than overhead is very high and if period is too large then system access will be longer.
    - We propose to allow different periodicity for different types of system information.

- In 16e, MS does not know when and where DCD/UCD will be transmitted therefore it requires

decoding DL-MAP in every frame until it gets the DCD/UCD information.
  - We propose to indicate either flag or pointer in the S-FCH to assist MS to find SCD in a more power efficient manner.

4 Summary

This contribution proposes examples of DL control channels and how to map to physical resources.

5 Proposed Text Changes for SDD

[Insert the following section in 16m SDD]

Section x: DL Control channel structure

DL control channel shall convey the information listed below:

- System configuration information
  - Low fixed bit rate using predefined transport format
  - Required to be broadcast in the entire coverage area of the cell
  - Examples: FCH, DCD/UCD, etc. in 16e
- Synchronization information
  - Required to be broadcast in the entire coverage area of the cell
  - Examples: preamble in 16e, synchronization channel, etc.
- Resource allocation information
  - dedicated and/or common resource allocation information
  - flexible transport format
  - possible using advanced techniques e.g. MIMO
  - Examples: MAP, sub-MAP in 16e
- Transport format
  - Used to indicate the transport format for different control channels
- Feedback (e.g. HARQ ACK/NACK) info
  - Dedicated information for one MS
  - In 16m, the feedback information should be on subframe basis
- Other broadcast control messages
  - Examples: Neighbor BS advertisement message and paging information

Physical DL control channel can be transmitted in superframe header/frame/subframe and can be transmitted in every superframe/frame/subframe depending on the types of the information. One example of mapping between different DL control channels to physical resource is given in Figure xxx.

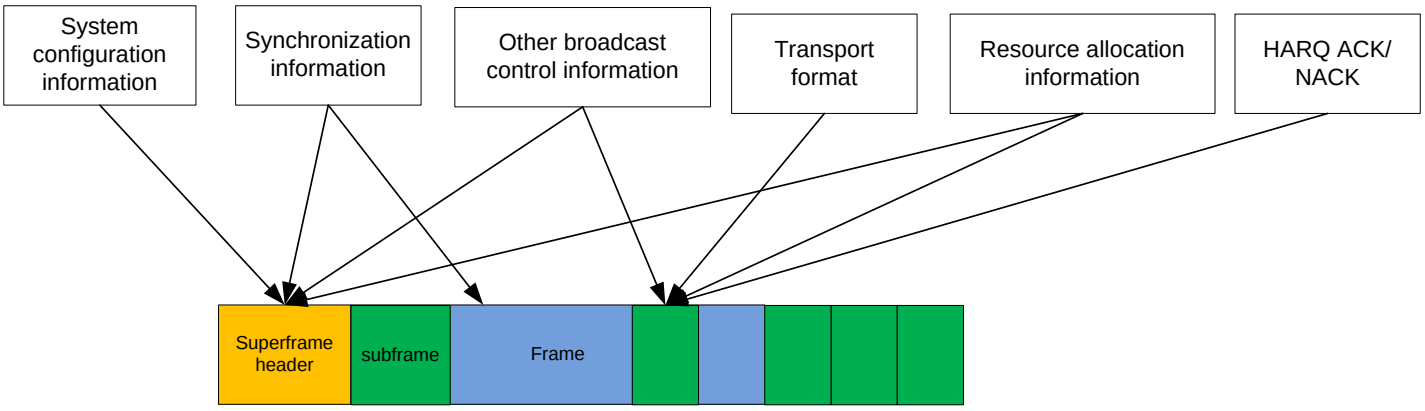

Figure xxx Example mapping between control information and physical location in the frame structure

x. 1 Synchronization Channel

Synchronization channel (e.g. preamble) is required by MS to maintain coarse synchronization with the BS. It also provides the BS identity (e.g. ID-Cell and Segment Number). These ID-Cell and Segment number are used to locate the MAP indication channel (MICH, aka 16m FCH) of the sector and defines the initial permutation used in the sector.

The preamble shall be transmitted at the beginning of every radio frame.

BS transmits legacy preamble when legacy support is enabled otherwise BS may transmit new preamble.

x.2 MICH – MAP Indication Channel (Aka 16mFCH)

MICH can be transmitted in every subframe or several concatenated subframes. MICH is transmitted in the first OFDM symbol of the sub-frame or concatenated subframe. MICH is used to indicate the MAP related information, e.g. how many OFDM symbols are used for MCH (MAP message) and repetition of MAP messages.

MICH is transmitted in different resource position in neighbor BSs in order to reduce the interference.

X.3 MCH (MAP Channel) (Aka MAP Message)

MCH (MAP message) has fixed MCS with the flexibility of variable repetitions. Number of repetition for MCH is indicated by MICH channel. MCH is transmitted in every sub-frame and has variable size. MCH can occupy one or several OFDM symbols.

X.4 Super-Frame Control Header (S-FCH)

Super-Frame Control Header is transmitted at the beginning of every superframe. It should include mainly the information which is relevant for the duration of the superframe and also provide basic system information for faster network search, initial entry/re-entry and neighborhood discovery.

S-FCH should be of fixed size and transmitted using pre-defined MCS at pre-defined location.

The content of superframe control header includes:

- SCD count – (System Configuration Descriptor – DCD/UCD combined)
- SCD MASK – Support hierarchical SCD
- Counter indicating when the S-FCH is applicable
- Super frame number
- BSID – 48 bits
- Frame configuration – concatenation of sub-frames.
- Sub-frame/concatenated sub-frame zone configuration
- Flag indicating whether broadcast information (e.g.SCD messages) is included in this superframe or not and possibly including a pointer in the superframe header to indicate the location of the broadcast information (e.gsub-SCD messages).
- If BS transmit paging messages message in any of the sub-frame of the superframe then S-FCH may contain a flag indicating the presence of paging in the superframe to enable better MS power usage during Idle Mode.
- Flag indicating transmission of traffic indication message to enable better MS power usage during Sleep Mode.

X.5 SCD - System Configuration Descriptor

All type of broadcast system information's are divided into sub-SCD according to the type of contents. Change to the broadcast information is controlled by SCD change count and SCDMASK. SCDMASK will indicate which sub-SCD is changed. SCD change count and SCD MASK is transmitted in S-FCH.
S-FCH may contain flag and/or pointer to assist MS to find SCD in a power efficient manner. Different sub-SCD may have different periodicity.