Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Details of SDD Section 11.7 Downlink Control Structure (except 11.7.2.1)**
Date Submitted	**2008-09-05**
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Re:	SDD Session 56 Cleanup, Call for PHY Details
Abstract	This is revised version of Section 11.7 of IEEE 802.16m-08/003r4. This document provides further physical layer details.
Purpose	Draft for further development of the IEEE 802.16m SDD
Notice	
Release	
Patent Policy	

The Draft IEEE 802.16m System Description Document

Table of Content

11 Physical Layer

11.7 DL Control Structure

DL control channels are needed to convey information essential for system operation. The basic frame structure is illustrated in Figure 14 in Section 11.4.1. In order to reduce the overhead and network entry latency, and improve robustness of the DL control channel, information is transmitted hierarchically over different time scales from the superframe level to the subframe level. Broadly speaking, control information related to system parameters and system configuration is transmitted at the superframe level, while control and signaling related to traffic transmission and reception is transmitted at the frame/subframe level.

In mixed mode operation (legacy/802.16m), an 802.16m MS can access the system without decoding legacy FCH and legacy MAP messages.

Details of the DL control structure are described in the following sections.

11.7.1 DL Control Information Classification

Information carried in the DL control channels is classified as follows.

11.7.1.1 Synchronization information

This type of control information is necessary for synchronization and system acquisition.

11.7.1.2 Essential system parameters and system configuration information

This includes a minimal set of time critical system configuration information and parameters needed for the mobile station (MS) to complete access in a power efficient manner, including the following three types:

11.7.1.2.1 Deployment-wide common information

Deployment-wide common information and parameters such as downlink/uplink system bandwidth, TDD downlink/uplink ratio, and switching point number.

11.7.1.2.2 Downlink sector-specific information

Downlink sector-specific essential information and parameters to enable MS to further receive downlink extended broadcast information, control signaling and data. Examples of such information include antenna configuration, DL resource allocation configuration, pilot configuration.

11.7.1.2.3 Uplink sector-specific information

Uplink sector-specific essential information and parameters that are needed for the MS to perform access on the uplink. Examples include UL resource allocation configuration, system configuration for initial ranging, UL channel parameters, UL power control parameters.

11.7.1.3 Extended system parameters and system configuration information

This category includes additional system configuration parameters and information not critical for access, but needed and used by all MSs after system acquisition. Examples of this class include information required for handover such as handover trigger, neighbor BS information, etc.

11.7.1.4 Control and signaling for DL notifications

Control and signaling information may be transmitted in the DL to provide network notifications to a single user or a group of users in the idle mode and sleep mode. Example of such notification is paging, etc.

11.7.1.5 Control and signaling for traffic

The control and signaling information transmitted in the DL for resource allocation to a single user or a group of users in active or sleep modes is included in this category. This class of information also includes feedback information such as power control and DL acknowledgement signaling related to traffic transmission/reception.

11.7.2 Transmission of DL Control Information

11.7.2.1 Synchronization Channel (SCH)

<NO CHANGES PROPOSED FOR THIS SECTION>

11.7.2.2 Broadcast Channel (BCH)

The Broadcast Channel (BCH) carries essential system parameters and system configuration information. The BCH is divided into two parts: Primary Broadcast Channel (PBCH) and Secondary Broadcast Channel (SBCH).

11.7.2.2.1 Primary Broadcast Channel (PBCH) and Secondary Broadcast Channel (SBCH)

The Primary Broadcast Channel (PBCH) and the Secondary Broadcast Channel (SBCH) carry essential system parameters and system configuration information. The PBCH carries deployment wide and ~~common information. The SBCH carries~~ sector specific information. The information in the PBCH ~~and SBCH~~ may be transmitted over one or more superframes.

11.7.2.2.2 Location of the BCH

The SFH includes PBCH and the SBCH, and is located in the first subframe within a superframe.

11.7.2.2.3 ~~The SFH includes PBCH and the SBCH, and is located in the first subframe within a superframe.~~ Multiplexing of the PBCH and SBCH with other control channels and data channels

The PBCH/SBCH is TDM with the SCH.

~~If SFH occupies narrower BW than system BW,T t~~he PBCH and SBCH in SFH are FDM with data within the same subframe. The PBCH occupies exactly 2 PRUs which are distributed over the 5 MHz in which the SCH is transmitted independent of the system bandwidth.

11.7.2.2.4 Transmission format

The PBCH and SBCH are transmitted using predetermined modulation and coding schemes.

The instantaneous modulation and coding rate for PBCH is QPSK R=1/8. The PBCH may be combined over multiple frames to achieve a lower effective code rate via repetition coding. ~~and~~ T~~t~~he modulation and coding rate for SBCH are TBD.

Multiple antenna schemes for transmission of the PBCH/SBCH are supported. The PBCH is transmitted as single stream with one reference pilot stream. Cyclic Shift Diversity (CSD) is used to combine the multiple transmit antennas. The MS is not required to know the antenna configuration prior to decoding the PBCH.

~~If needed, signaling of the multiple antenna scheme used to transmit the PBCH/SBCH is TBD.~~

11.7.2.2.5 Resource allocation (physical to logical mapping, pilots, block size)

~~<Editors' Notes: This section depends on SDD text included in the DL PHY Structure.>~~

The PBCH will be allocated to 2 PRUs in a 5 MHz bandwidth. Of the 24 PRUs available in 5 MHz, the PBCH will be allocated positions 0 and 23 as show in Figure 1 below. The PRUs will utilize the one antenna pilot format defined in Section 11.5 Downlink Physical Structure. The BCH info will be encoded at R=1/8, scrambled by the Cell ID, interleaved, QPSK modulated and mapped to the allocated PRUs.

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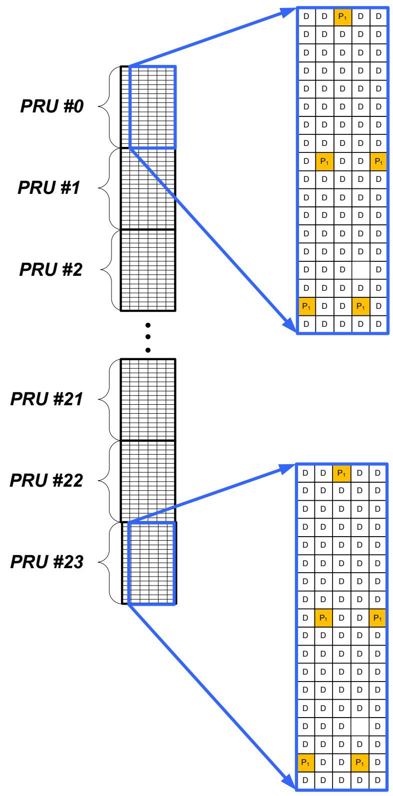

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Figure 1 PBCH Resource Allocation within the sub-frame containing the SFH

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11.7.2.3 Unicast Service Control Channels

11.7.2.3.1 Unicast service control information/content

Unicast service control information consists of both user-specific control information and non-user-specific control information.

11.7.2.3.1.1 Non-user-specific control information

Non-user-specific control information consists of information that is not dedicated to a specific user or a specific group of users.~~ It includes information required to decode the user-specific control~~. Non-user-specific control information that is not carried in the BCH may be included in this category. ~~Details of non-user specific control information are FFS.~~

11.7.2.3.1.2 User-specific control information

User specific control information consists of information intended for one user or more users. Examples of this subclass of information include scheduling assignment, power control information, ACK/NACK information.

Resources can be allocated persistently to MSs. The periodicity of the allocation may be configured.

A group message is used to allocate resources and/or configure resources to one or multiple mobile stations within a user group. Each group is associated with a set of resources. VoIP is an example of the subclass of services that use group messages.

11.7.2.3.2 Multiplexing scheme for data and unicast service control

Within a sub-frame, control and data channels are multiplexed using FDM. Both control and data channels are transmitted on logical resource units (LRU) that span all OFDM symbols in a sub-frame.

11.7.2.3.3 ~~Within a sub-frame, control and data channels are multiplexed using FDM. Both control and data channels are transmitted on logical resource units (LRU) that span all OFDM symbols in a sub-frame~~.Location of control blocks

The first 802.16m DL sub-frame of each frame contains user-specific control information.

~~The location of control blocks for non-user specific control information is TBD~~.

Control blocks for user specific control information are located 'n' 802.16m subframes apart. If a USCCH is allocated in subframe N, DL data allocations corresponding to the USCCH occur in either subframe N, N+1, ..., N+(n-1). The next USCCH is in subframe N+n of the same frame. The values of n can be 1 or 2. Other values of n (3 and 4) are FFS. For example, for n=2, USCCH in subframe N can point to resource allocation in subframe N or N+1 and the next USCCH is in subframe N+2.Transmission format

A unicast service control information element is defined as the basic element of unicast service control. A unicast service control information element may be addressed to one user using a unicast ID or to multiple users using a multicast/broadcast ID. It may contain information related to resource allocation, HARQ, transmission mode etc.

If each unicast service control information element is coded separately, this type of coding is referred to as “separate coding”, whereas if multiple unicast service control information elements are coded jointly, this type of coding is referred to as “joint coding”.

A coded control block is the output of separate coding or joint coding. The MCS of each coded control block may be controlled individually. Coded control blocks may all be transmitted at the same MCS and this transmission scheme is referred to as “fixed MCS”. If each coded block may be transmitted at a different MCS, this scheme is referred to as “variable MCS”.

Coding of multiple unicast service control information elements may therefore either be joint coding or separate coding.

MCS of coded control blocks may either be with a fixed MCS or a variable MCS.

Non-user-specific control information is encoded separately from the user-specific control information.

For user-specific control information intended for a single user, multiple information elements are coded separately. The modulation of user-specific control information is QPSK. 16 QAM is FFS. The user-specific control information is encoded with an R=1/2 code.

The user-specific control information is 32 bits long and is protected with a 16 bit CRC. The CRC is masked with the Basic CID while the control information carries the allocation information.~~The modulation and coding scheme (fixed/variable) is FFS~~. The user-specific control information is mapped to a Logical Control Resource Unit (LCRU). Each LCRU is mapped to PRU as described in section 11.7.2.3.4

Repetition coding LCRU may be used to achieve effective code rates of R=1/4, R=1/8 and R=1/16. The LCRU over which a single user-specific codeword is mapped is a called a Logical Control Allocation (LCA). The applicable coding rate is blindly detected through the aid of a tree like structure. The tree-like structure reduces the search space for the MS. Figure 2 illustrates a tree-like structure in a 4 PRU segment having only 14 possible LCA encodings providing 8 R=1/2, 4 R=1/4, 2 R=1/8 and 1 R=1/16 LCA encodings.

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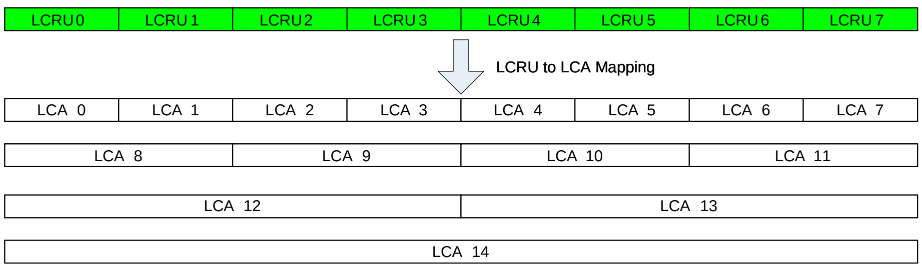

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Figure 2 Example Tree-Like Structure for Blind Decoding

The transmission format ~~(joint/separate and fixed/variable MCS)~~ for non-user-specific control information uses the same format designed for the user-specific encoding. Non-user specific allocations will employ a group CID to identify the mobiles to whom the resources are allocated. Special group IDs will be reserved to carry traffic such as the secondary broadcast channel.~~is FFS~~

11.7.2.3.4 Resource allocation (physical to logical mapping, pilots, block size)

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Two methods of resource allocations are defined for both open-loop and closed-loop transmission of the USCCH. In both cases, 4, 6, 8 or 12 PRUs shall be allocated to the USCCH in a sub-frame depending on the required USCCH capacity and the frame type, regular or irregular. The MS shall blindly detect the capacity of the USCCH.

The structure of the USCCH resource allocation is constructed to aid blind detection. For a type 1 regular subframe, the USCCH allocation consists of three segments each occupying 4 PRUs. Each USCCH segment permutes the subcarriers independently of the other segments. This independence each LRCU mapping independent of the USCCH dimension. For a type 1 irregular subframe, the USCCH allocation consists of two segments each occupying 6 PRUs. As with the regular frame, each USCCH permutes the subcarriers independently of the other segments.

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11.7.2.3.4.1 Open-Loop LCRU

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An open-loop LCRU uses a distributed subcarrier permutation as shown in Figure 3 below.

For a type 1 sub-frame, a USCCH Open-Loop Segment is comprised of 4 PRUs. These PRUs are mapped into LDRUs using subcarrier permutation defined in Section 11.5. These 4 LDRUs are further subdivided into 8 LCRUs. The pilot patterns supported are identical to those defined in Section 11.5. Figure 3 assumes a 2 Tx BS using SFBC for LCRU transmission with a two antenna pilot patter.

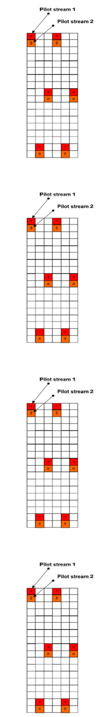

Figure 3 USCCH segment Resource Allocation for an Open-Loop USCCH

For a Type 1 irregular subframe, a USCCH Open-Loop Segment is comprised of 6 PRUs. These PRUs are again mapped into LDRUs using the subcarrier permutation defined in Section 11.5. These 6 LDRUs are further subdivided into 10 LCRUs. As before, the pilot patterns supported are identical to those defined in Section 11.5

11.7.2.3.4.2 Closed-Loop LCRU

An closed-loop LCRU uses a distributed tile permutation as shown in Figure 4 below. Each LCRU is composed of a number of Physical Control Mini Tiles (PCMT). Each PCMT is equally divisible into a PRU and contains dedicated pilots that are pre-coded with the control information.

For a type 1 regular sub-frame, a USCCH Closed-Loop Segment is comprised of 4 PRUs. These PRUs are subdivided into 6 PCTs each 3 subcarriers by 6 symbols. Each PCMT contains 2 pre-coded pilots as shown in Figure 4. 3 PCMTs from different PRUs are grouped to form the LCRU. 8 LCRUs are interleaved over the 4 PRUs allocated to the USCCH Close-Loop Segment.

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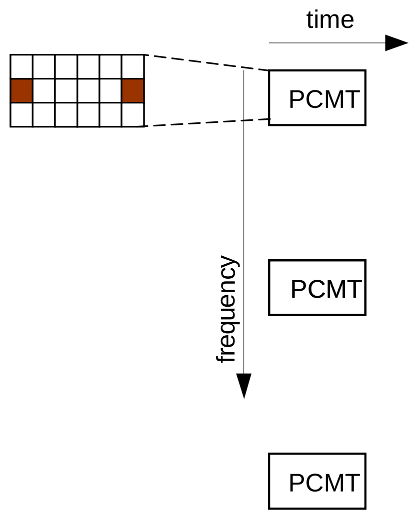

Figure 4 USCCH segment Resource Allocation for an Open-Loop USCCH in a Type 1 Regular Sub-frame

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For a type 1 irregular sub-frame, a USCCH Closed-Loop Segment is comprised of 6 PRUs. As before, these PRUs are subdivided into 6 PCMTs each 3 subcarriers by 5 symbols. Each PCMT contains 2 pre-coded pilots as shown in Figure 5. For an irregular subframe, 4 PCTs from different PRUs are grouped to form the LCRU. 9 LCRUs are interleaved over the 4 PRUs allocated to the USCCH Close-Loop Segment.

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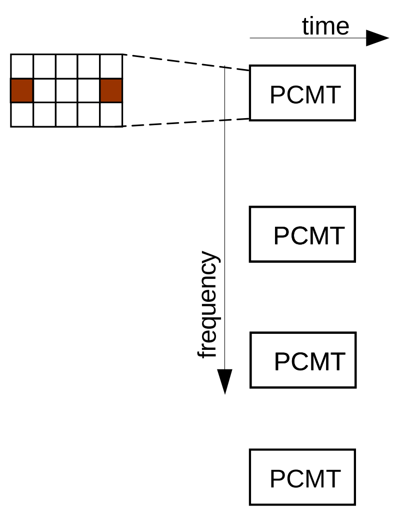

Figure 5 USCCH segment Resource Allocation for an Open-Loop USCCH in a Type 1 Irregular Sub-frame

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~~11.7.2.3.4.1Pilot structure for unicast service control channels~~

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11.7.2.4 Multicast Service Control Channels

<Editors’ Notes:This section is a placeholder for text to be developed based on SDD text that will be added to Section 15 of the SDD (Support for Enhanced Multicast Broadcast Service). >

11.7.2.4.1 Multicast service control information/content

11.7.2.4.2 Multiplexing scheme of data and multicast service control and (e.g. TDM, FDM, Hybrid TDM//FDM)

11.7.2.4.3 Location of control blocks within a frame/subframe

11.7.2.4.4 Transmission format (e.g. modulation, coding, multiple antenna schemes)

11.7.2.4.5 Resource allocation (physical to logical mapping, pilots, block size)

11.7.2.5 Transmission of Additional Broadcast information

Examples of additional broadcast information include system descriptors, neighbor BS information and paging information. The indication of the presence of additional broadcast information is FFS.

MAC management messages may be used to transmit additional broadcast information.

11.7.3 Mapping information to DL control channels

Information		Channel		Location
Synchronization information		Synchronization Channel (SCH)		FFS
Essential system parameters and system configuration information	Deployment-wide common information	Primary Broadcast Channel (PBCH)		Inside of SFH
	Downlink sector-specific information	Secondary Broadcast Channel (SBCH)	Primary Broadcast Channel (PBCH)**	Inside of SFH
	Uplink sector-specific information			
Extended system parameters and system configuration information		FFS		Outside of SFH
Control and signaling for DL notifications		FFS		FFS
Control and signaling for traffic		Unicast Service Control Channel		Outside of SFH

Table 1 Mapping information to DL control channels

11.7.4 Multi-carrier Control Structure

<Editors' Notes:This section is a placeholders for text to be developed based on SDD text that will be added to Section 19 of the SDD (Support for Multi-carrier Operation). >

The carriers involve in a multi-carrier system, from one MS point of view, can be divided into two types:

- A Primary carrier is the carrier used by the BS and the MS to exchange traffic and full PHY/MAC control information defined in 16m specification. Further, the primary carrier is used for control functions for proper MS operation, such as network entry. Each MS shall have only one carrier it considers to be its primary carrier in a cell.
- A Secondary carrier is an additional carrier which the MS may use for traffic, only per BS's specific allocation commands and rules, typically received on the primary carrier. The secondary carrier may also include control signaling to support multi-carrier operation..

Based on the primary and/or secondary usage, the carriers of a multi-carriers system may be configured differently as follows:.

- Fully configured carrier: A carrier for which all control channels including synchronization, broadcast, multicast and unicast control signaling are configured. Further, information and parameters regarding multi-carrier operation and the other carriers can also be included in the control channels.
- Partially configured carrier: A carrier with only essential control channel configuration to support traffic exchanges during multi-carrier operation.

A primary carrier shall be fully configured while a secondary carrier may be fully or partially configured depending on usage and deployment model.