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Re:	IEEE 802.16m-08/016r1 - Call for Contributions on Uplink Control Structure
Abstract	This contribution suggests the uplink control channel structure for CQICH and ACKCH.
Purpose	For discussion and adoption for 802.16m SDD
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Uplink Control Structure for IEEE 802.16m Systems

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Introduction

System requires various uplink feedback information such as channel state information (CSI) or channel quality information (CQI), MIMO related information, ACK/NACK signal, Ranging signal, BW request signal, etc. These feedbacks from MS consume uplink resources but are essential to operate properly and to increase downlink throughput. For better DL performance, more UL feedback should be provided by sacrificing UL resources in legacy system, and it consequently reduces UL throughput. Therefore, it is necessary for 802.16m system to have resource efficient UL feedback structure provisioning enough feedback channels without reducing UL throughput. In this document, we propose the efficient uplink control channel structure for CQICH and ACKCH.

Uplink control channel structure for IEEE 802.16m systems

The 16m frame consists of DL subframes and UL subframes as the example of figure 1. Each DL subframe has own control channel and each UL subframe also has its own control channel. In usual, resource allocation along time in uplink is better approach than assignment along frequency because of power limitation of MS, especially in cell edge. But the control channel over multiple UL subframes makes ACK/NACK latency too long. Therefore we consider a control channel region within a UL subframe and it makes the uplink channel allocation simple because BS can indicate the region by notifying only the number of RU (Resource Unit) in frequency axis.

And we also suggest the control channel is allocated some dedicated region separated with the data channel because the data channel and the control channel might have different power control mechanism and it's easy to control inter-cell interference by separating the region of two channels.

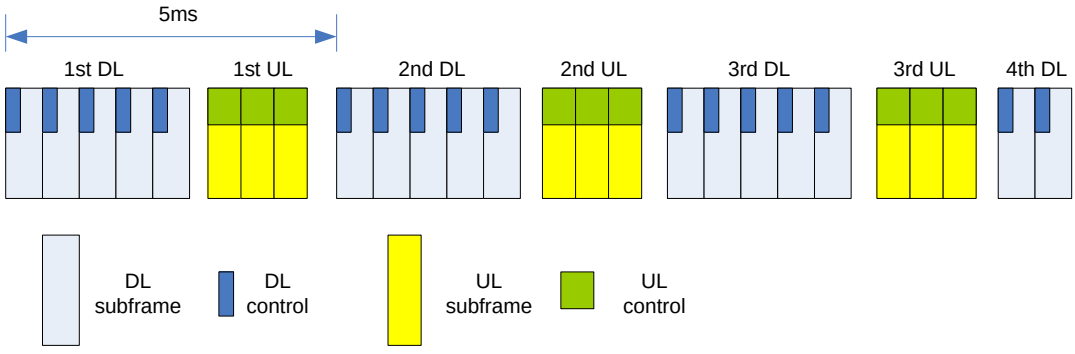

Figure 1. The example of 802.16m frame structure

The UL control region in a UL subframe is distributed in all bandwidth to get the frequency diversity gain. The region consists of several control RUs and the location and number of the RUs are indicated by downlink broadcast message. The control RU consists of several distributed tiles and the RU in each cell has different composition of the tiles to avoid inter-cell interference with other cell control channel. The tile is a unit of several adjacent subcarriers and contiguous symbols, for example 6 subcarriers x 3 symbols, or 6 subcarriers x 6 symbols.

There is an example of control channel structure as shown in figure 2. We assume that a tile has dimension of 6 subcarriers x 3 symbols and a control RU has even number of tiles. The half tiles are located in the first 3 symbols and the others are in the second 3 symbols. The tile location in frequency of the first 3 symbols and second 3 symbols may be same with each other. If a tile is made of 6 subcarriers x 6 symbols, it is located in same subcarriers in all 6 symbols.

A control RU has one or several CQICH or ACKCH. They are allocated in FDM or CDM in a control RB.

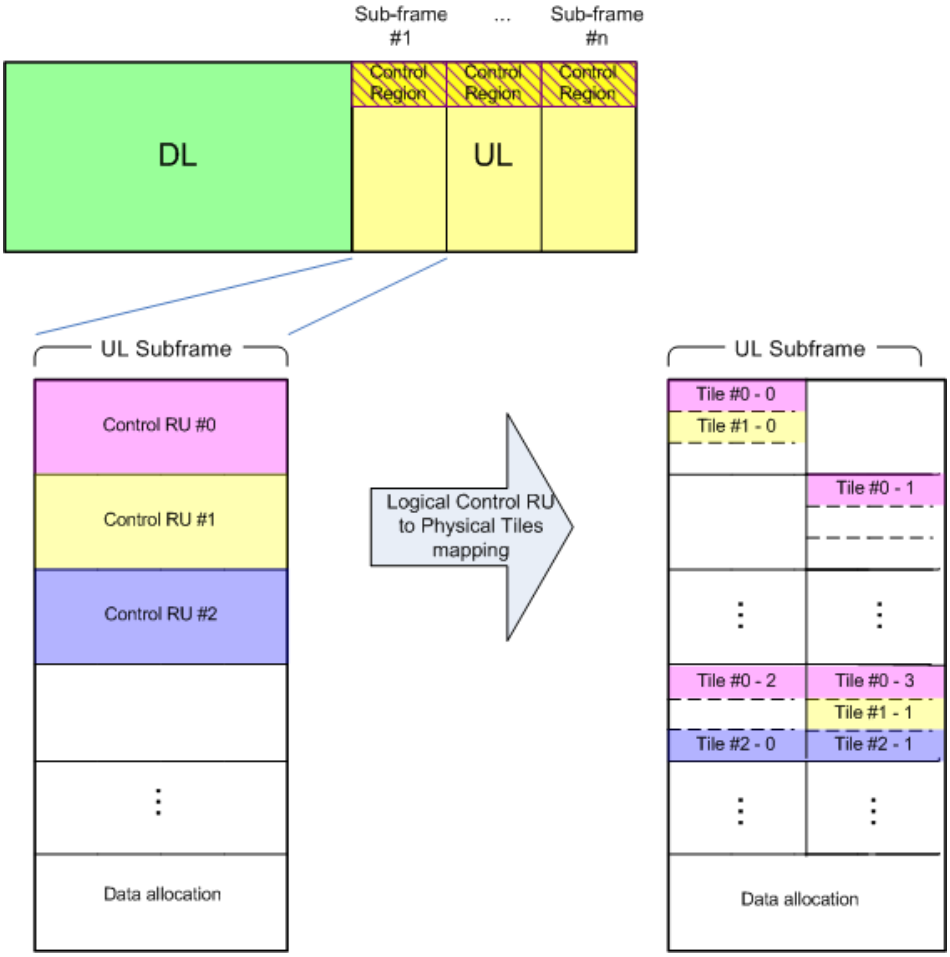

Figure 2. An example of uplink control structure

CQICH for 802.16m System

MS transmits the feedback information such as channel quality information, codebook index, or rank information through CQICH. The MS may have one or several information simultaneously and the information is transmitted in one or several CQICHs. A CQICH may carry several bits made of a kind of information or several kinds of information.

The region of CQICH may be located separately with the region of ACKCH. But when a MS transmits both CQICH and ACKCH simultaneously, the MS can transmit ACK information with CQI information through CQICH. The CQICH index is indicated through DL control channel to each MS.

The CQICHs are allocated in a control RU in CDM. There are multiple CQICHs multiplexed by orthogonal

code in a control RU. The CQI information is mapped in all tiles of a control RU and spreaded by orthogonal code in frequency axis. Figure 3 is an example of a tile structure. A tile is 6 subcarriers x 3 symbols and the middle of the symbols is allocated to pilots and the others are for data symbols. Two of feedback information S_1, S_2, …, S_N are allocated to this tile along time. And the two symbols are spread in frequency axis with 6-length code. BS can multiplex CQICHs as many as the number of the orthogonal code in a control RU.

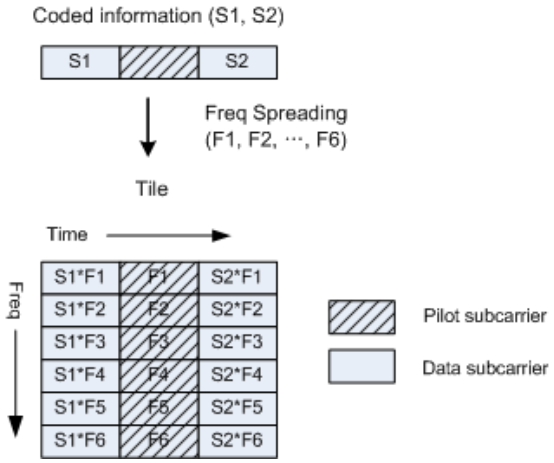

Figure 3. The example of data and pilot mapping in a tile for CQICH

ACKCH for 802.16m System

MS transmits the acknowledge information about DL HARQ burst through ACKCH. The information may be ACK/NACK as the response of DL HARQ burst and DTX if needed. When a MS transmits several acknowledge information, it is coded or repeated separately or jointly each other and carried through ACKCH.

The region of ACKCH is located separately or jointly with the region of CQICH. And there are two methods to indicate the allocated channel index to MS. One is to indicate the index directly through DL control channel to each MS as same method of CQICH, but it has the problem to increase downlink resource overhead. And the other method is to allocate default ACKCH per DL RU. Because the MS knows the index of assigned DL RU, the MS can transmit ACK/NACK through ACKCH of the same index. It doesn't need to indicate the index to MS, but it cause uplink resource overhead.

The BS allocates several ACKCHs in a control RU in FDM and CDM. A control RU is divided by several parts in FDM and the each part consists of several ACKCH in CDM. For example, a part consists of tile #0-0 and #0-1 of figure 2 and other part consists of tile #0-2 and #0-3. Each part has several code-multiplexed ACKCHs. The CDM of ACKCH is similar to that of CQICH.

Proposed Sections/Subsections in the System Description Document (SDD)

There is the proposed text in SDD as below.

---------- *Start of the Text* ----------

[*Editor's Notes: add the following into the TGm System Description Document*]

11. Physical Layer

11.x Uplink control structure

MS transmits the feedback information such as Channel State Information (CSI) or Channel Quality Information (CQI), MIMO related information, ACK/NACK signal, and BW request signal through uplink control channel.

Uplink control channel is constructed in a dedicated control region in each subframe as in figure xxx. The control region has several control RUs (Resource Units) which are consisted of even number of the distributed tiles. The tile consists of adjacent 6 subcarriers and contiguous 3 symbols. The half tiles are located in the first 3 symbols and the other of six tiles is in the second 3 symbols.

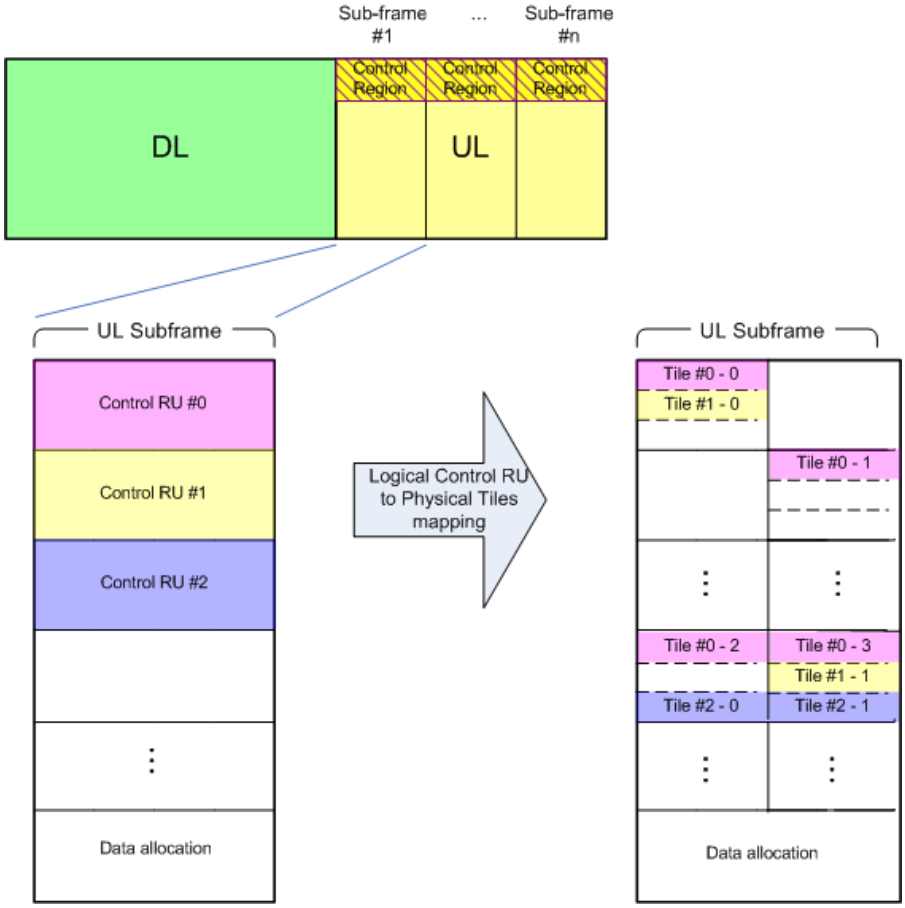

Figure xxx

11.x.1 CQICH

MS transmits the feedback information such as Channel State Information (CSI) or Channel Quality Information (CQI), MIMO related information through CQICH consisting of [FFS] tiles. Tiles are multiplexed by orthogonal code to be assigned to multiple MS's.

When a MS should transmit both CQICH and ACKCH simultaneously, the MS can transmit ACK information with CQI information through CQICH without using ACKCH.

[More detail scheme is FFS.]

11.x.2 ACKCH

MS transmits ACK/NACK information to downlink bursts through ACKCH. The region of ACKCH is indicated by BS through broadcast message. ACKCH is comprised of [FFS] tiles and several ACKCH are multiplexed in tiles with orthogonal sequences.

[More detail scheme is FFS.]

11.x.3 Bandwidth request

[FFS]

---------- *End of the Text* ----------

Reference

[1] IEEE P802.16Rev2/D3, “DRAFT Standard for Local and metropolitan area networks - Part 16: Air Interface for Broadband Wireless Access Systems,” February 2008.

[2] IEEE 802.16m-07/002r4, “IEEE 802.16m System Requirements,” October 2007.

[3] IEEE 802.16m-07/037r2, “IEEE 802.16m Evaluation Methodology,” December 2007.

[4] C80216m-08_118r4