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Title	Latency Related Downlink Control Channel Design of IEEE 802.16m	
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Re:	IEEE 802.16m-08/005 –Call for Contributions on Project 802.16m System Description Document (SDD); Proposed 802.16m Downlink Control Channel Design	
Abstract	This contribution covers the considerations about the downlink control channel for IEEE802.16m	
Purpose	To be discussed and adopted by TGM for use in the IEEE 802.16m SDD	
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Latency Related Downlink Control Channel Design of 802.16m

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1. Introduction

To meet the system requirement of IEEE 802.16m, the downlink control channel design should consider the lower latency, lower overhead, and related other issues. Usually, the design of downlink control channels shall be based on the system framework, frame structure, resource block size, etc.

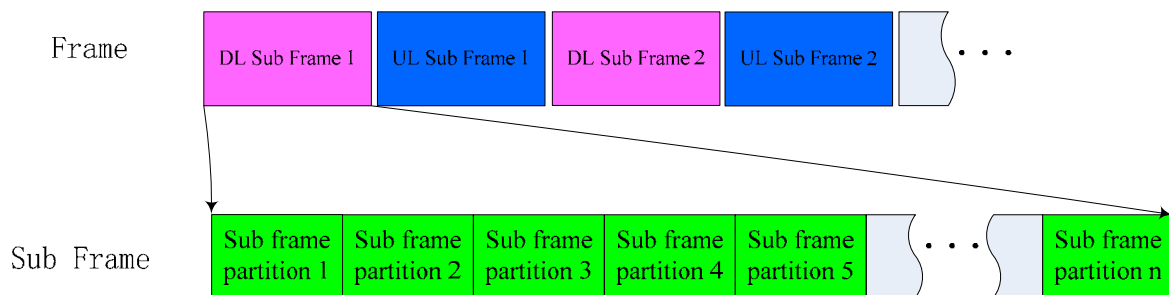


Fig1 General Frame Structure

In this contribution we will propose a latency related downlink control channel design based on the general frame structure elements: sub-frame and sub-frame partition, as shown in Fig 1. Different sub-Frame partitions may have different latency performance, especially with asymmetric DL/UL allocation ratio for TDD system, further more, some sub-frame partitions may have timely CQI or measurement information to be used in the scheduling decision, for example, those DL sub-Frame partitions near the RTG, so different sub-Frame partitions are controlled in a manner to support different service with different QoS, for example, low latency service and high data rate but time insensitive service(for example, Best effort).

2. Proposed approach

2.1 general control channel

As mentioned in contribution C80216m-08/224, there are three types of control channels: System Information channel,SCI (Scheduling-based Control Indication) and Sub-Frame partition MAP.

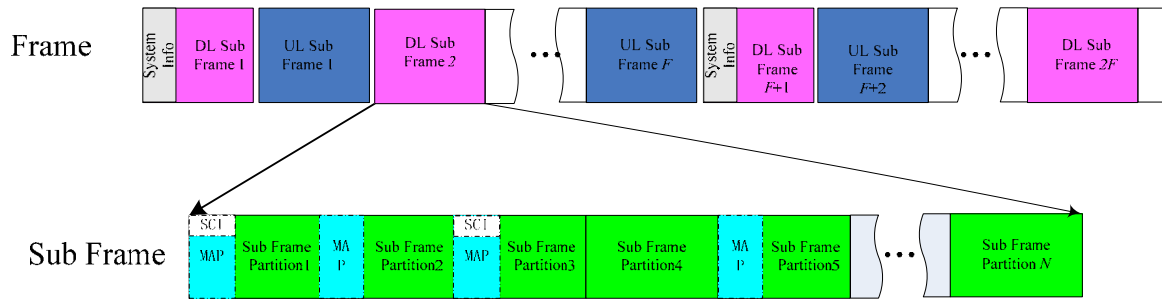


Fig2 three types of control channels

- **System Information channel**

System Information channel may appear each certain numbers of frames. It occupies one or more symbols in the beginning of these frames. The system information channel includes frame's control information and some system broadcast information, such as system configuration and initialization information to facilitate network entry and initialization.

- **SCI (Scheduling-based Control Indication)**

Scheduling-based Control Indication, namely SCI, is design to control one or more Sub-Frame Partition maps in one resource schedule interval. The SCI can indicate the necessary information of Sub-Frame Partition MAPs. The SCI is designed to reduce transmission latency, save terminal power, and optimize schedule performance in the 16m system.

- **Sub-Frame Partition MAP**

Sub-Frame Partition Map is designed for resource allocation of Sub-Frame Partition. One Sub-Frame Partition map can control one or more sub frame partitions.

2.2 Issue specific in TDD system:

Different sub-frame partitions may have different latency performance, especially with asymmetric DL/UL allocation ratio. As shown in the figure 2 (suppose all the subframe partitions are with the same duration, UL/DL ratio=2:5), if the processing time in MS and BS is assumed to be 2 subframe partition length, then in DL, subframe partition 2,3 will have a RTT=7 subframe partitions length, but for subframe partition 1,4,5, as there are not enough processing time in BS and MS, the RTT will be larger than 7 subframe partition length.

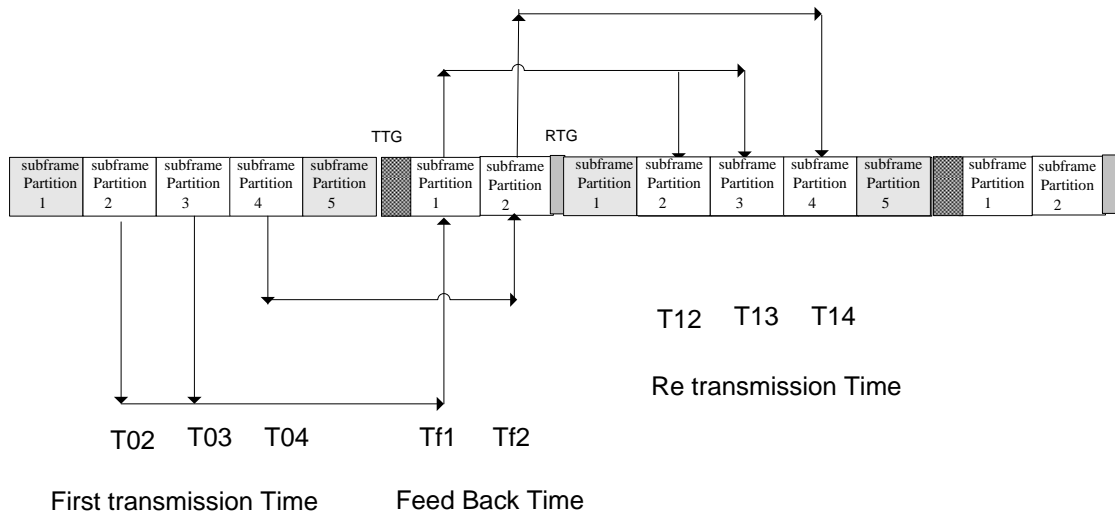


Fig 3 sub-frame partitions with different latency performance

For TDD, some subframe partitions may have timely CQI or measurement information to be used in the scheduling decision. The control channel design should support different services with different QoS ,for example, low latency service and high data rate but time insensitive service.

2.3 The scheme description

Some sub-frame partitions are used to support low latency service or users, others are used as high data rate but time insensitive services or users. The ratio between the low latency sub-frame partitions and the time insensitive sub-frame partitions can be configurable;

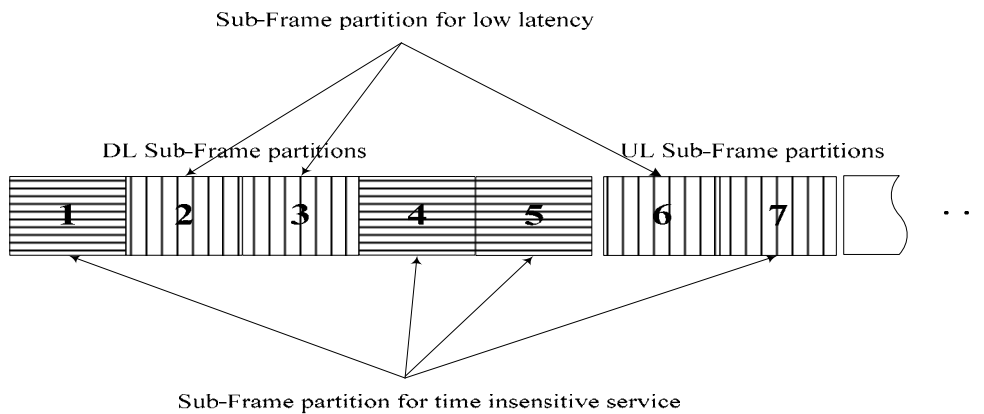


Fig 4 latency related sub-frame partition

Those sub-frame partitions used to support low latency service can be allocated per sub-frame partition to reduce latency, for example, there can be control channel located in sub-frame partition 2 and partition 3 for the DL resource allocation within sub-frame partition 2 and 3, and for the UL resource allocation grant within UL

sub-frame partition 6 and 7, as shown in figure 5.

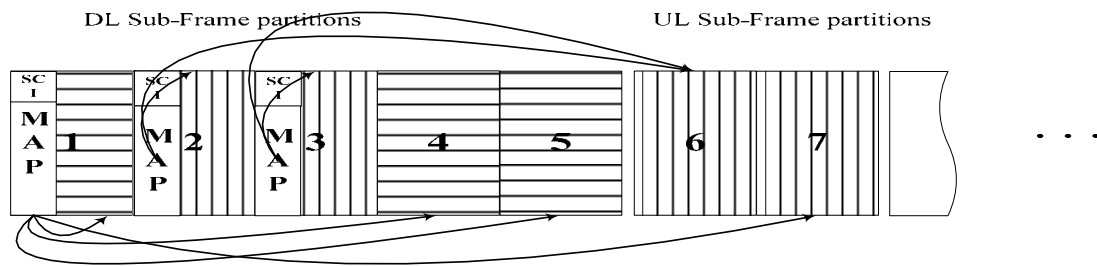


Fig 5 sub-frame partition MAPs

The left sub-frame partitions are used to support time insensitive but high data rate service can be scheduled by one Sub-Frame partition MAP, for example, there can be only one control channel located in Sub-Frame partition 1 of every frame, for the DL resource allocation within the aggregated multi Sub-Frame partition (consists of Sub-Frame partition 1, 4, and 5), and UL resource allocation grant for UL sub-frame partition 7.

According to this design, the control overhead is reduced, channel coding gain is obtained by multi Sub-Frame partition (be time successive or not) aggregation, and more efficient micro-sleep is supported.

For the low latency sub-frame partition, the timing relation between the UL grant and the allocated UL sub-frame partition should be prefixed, this is an implicit one to one relation so there is no need to signal, and synchronous HARQ (both adaptive or non adaptive) can be used for downlink data transmission for delay-sensitive services with small size packets because we can reduce the signalling overhead.

For time insensitive sub-frame partitions, asynchronous HARQ can be used, since it could provide more scheduling flexibility, for example, it could improve the spectral efficiency in DL through scheduling many DL users in the former part of one TDD frame.

Control channel position for low latency sub-frame partitions is indicated as semi-static information, and it is carried in the system information channel or separate messages with shortened Bitmap, for example, the control channel position for low latency sub-frame partitions in the fig.3 is by $BM1=[0\ 1\ 1\ 0\ 0]$, where 1 indicates the subframe partition contains a control channel; the length of the shortened Bitmap ($L_1=5$ in this case) is DL subframe partition numbers within a frame, and it can be get from the DL/UL allocation information in the System Information channel.

The DL Resource allocation of time insensitive service is carried in the first sub-frame partition MAP and indicated by shortened bitmap, for example $BM2=[1\ 1\ 1]$ indicate allocation for sub-frame partition 1, 4, 5, that is, the bit in $BM2$ corresponding to the "0" bit in $BM1$. The length of the shortened Bitmap is $L_2 = L_1 - s$, where s is the low latency subframe partition numbers in DL. The indication of the allocated subframe in the UL grant is similar, so multi-subframe partition allocation is supported.

The high level signaling is used to tell the MS which kind of services (sub frame) can be used.

3 Text Proposal for the 802.16m SDD

=====Start of Proposed Text =====

Different sub-frame partitions may have different latency performance. Some sub-frame partitions are used to support low latency service or users, others are used as high data rate but time insensitive services or users. The ratio between the low latency sub-frame partitions and the time insensitive sub-frame partitions can be

configurable;

Those sub-frame partitions used to support low latency service can be allocated per sub-frame partition to reduce latency. The left sub-frame partition used to support time insensitive but high data rate services can be scheduled by one sub-frame partition MAP.

Control channel position for low latency sub-frame partitions is indicated as semi-static information and is carried in the system information channel with shortened Bitmap. The DL Resource allocation of time insensitive service is carried in the first DL sub-frame partition MAP and indicated by shortened bitmap.

4 References

[1] IEEE 802.16m-07/002r4, IEEE 802.16m System Requirements, 2007-10-19

[2] IEEE 802.16e Rev2-D2

[3] C80216m-08_081-Base Frame Structure for IEEE 802.16m

[4] 07-282r2 Updated Proposal for IEEE 802.16m System Architecture and Protocol Structure

[5] C80216m-08/224, Control channel design for IEEE 802.16m