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Title	**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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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, effective scheduling scheme, and related other issues. Usually, the design of downlink control channels shall be based on the system framework, frame structure, resource block size, medium access method, etc. Here we give a general frame structure. In this contribution we will discuss the downlink control channel design base on the general frame structure elements: frame and subframe and sub-frame partition, as showed in Fig 1this general frame structure.

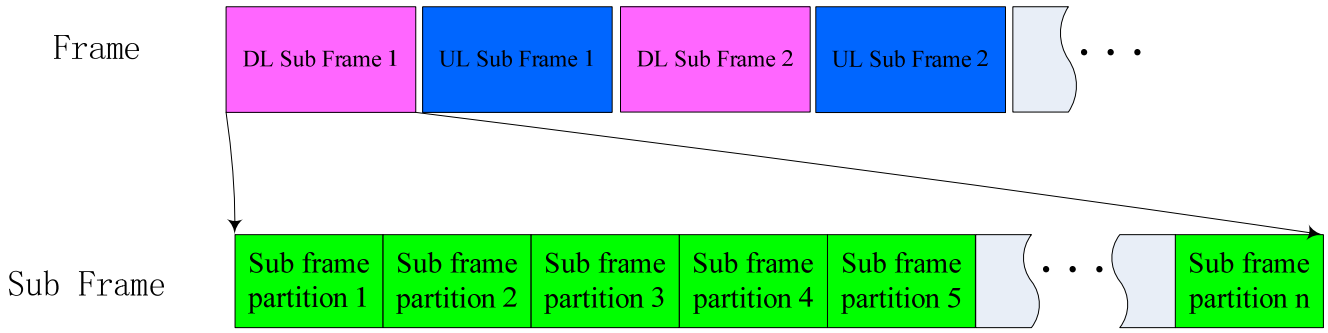

Fig 1 General Frame Structure

A subframe is comprised of one or more subframe partitions. Different subframe partitions may operate with different physical layer settings that may be better suited for communications with a certain set of MSs. The number and lengths of subframe partitions are set on a subframe by subframe basis based on what may be the best configuration for the MSs and traffic being serviced at a particular time.[3]

Fig 2 below is the control channel structure for 16m. There are three types of control channels in the scheme:

1) System Information channel
2) SCI (Scheduling-based Control Indication)
3) Sub-Frame Partition Map

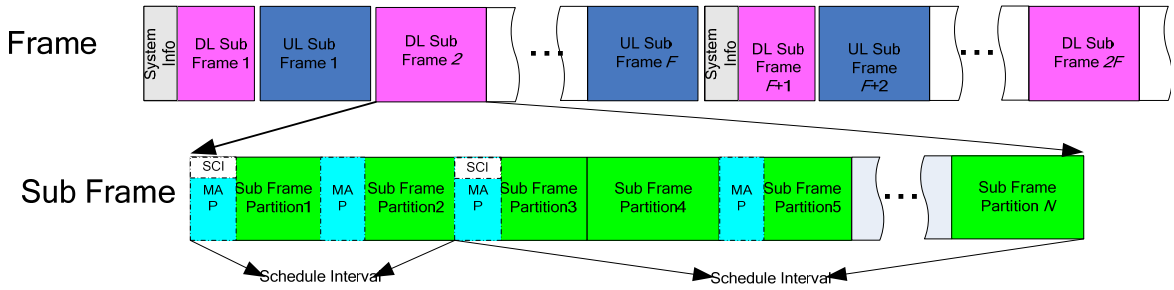

Fig 2 General Control Channels Design

- **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.

1.1 System Information channel

We think a System Information channel should be transmitted every certain numbers of frames. Within the System Information channel, the essential information related to system configuration and initialization should be transmitted to quicken the system entry and initiation process. Other common broadcast messages may be included in System Information channel.

1.2 SCI & DL Sub-Frame Partition Map

The main structure of SCI & DL Sub-Frame Partition control map are the Fig 3 below.

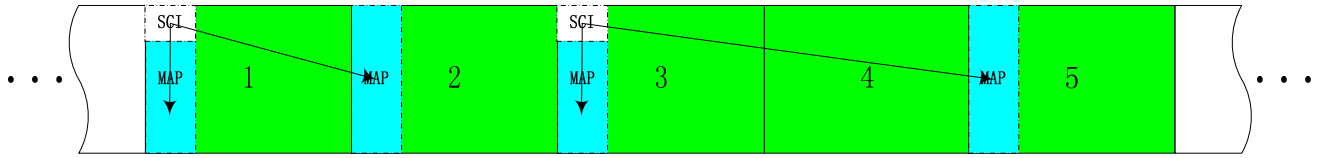

Fig 3 SCI & DL Sub-frame Partition Map

For the schedule timely, there may be multiple resource schedule intervals in frames. Scheduling-based Control indicator, namely SCI, is located at the beginning Sub-Frame Partition of each resource schedule interval. SCI is used to indicate one or more Sub-Frame Partition maps in corresponding resource schedule interval. Within each schedule interval, there can be one or more Sub-Frame Partitions maps, but there must be only one SCI.

SCI is to indicate the parameters of Sub-Frame Partition Map, such as existence, location, length, and transmission format(modulation&code, MIMO mode, etc)

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

The parameters of SCI itself are: Location (Fixed, Dynamic, or Linked list mode); Length (Constant or Vary);

Transmission format (constant or blind-detection).

The following section is to explain the location of SCI, there are 3 deviations for the location of SCI:

1) Fixed location.

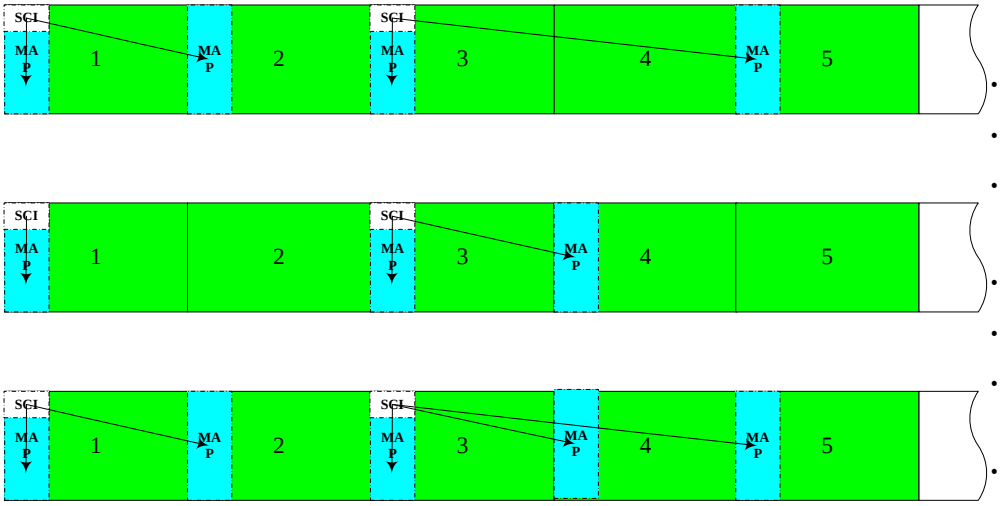

Fig 4 Fixed location SCI Scheme

In every frame or certain frames, SCI location is fixed. Sub-Frame Partition Maps in Sub-Frame Partitions are dynamic, they are indicated by SCI. Fixed location mode and it implies that terminals only need to read the specific Sub-Frame Partition for SCI. This method is good for power saving, and it is easy to implement. The shortcoming is that, it may limit the flexibility of schedule. The initial setup and change of SCI locations are indicated by System Information Channel or common control messages.

2) Dynamic location.

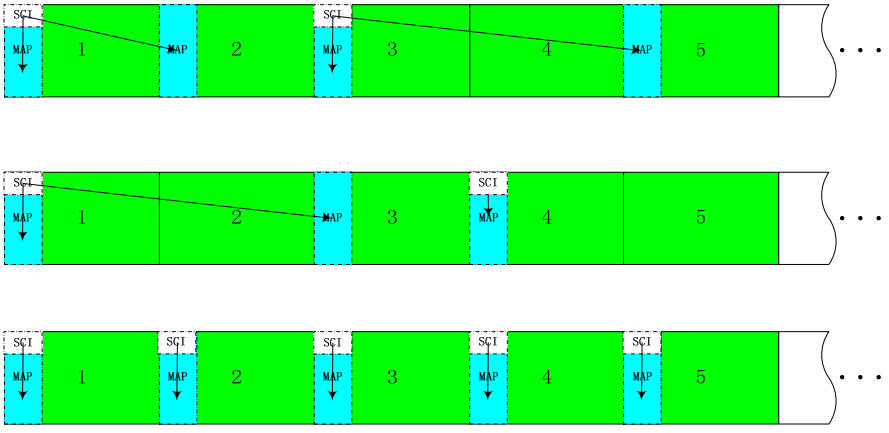

Fig 5 Dynamic location SCI Scheme

The idea is that SCI's location is variable, all depend on whether there is a schedule requirement. For example, when there should be a retransmission for the HARQ NACK feedback, SCI & Sub-Frame Partition Maps will appear to indicate the resource allocation information. Terminals should listen to each Sub-Frame Partition to make it clear whether there are SCI in the Sub-Frame Partitions. This method can response the UL feedback in time, but cost more power consumption.

3) Linked-List mode.

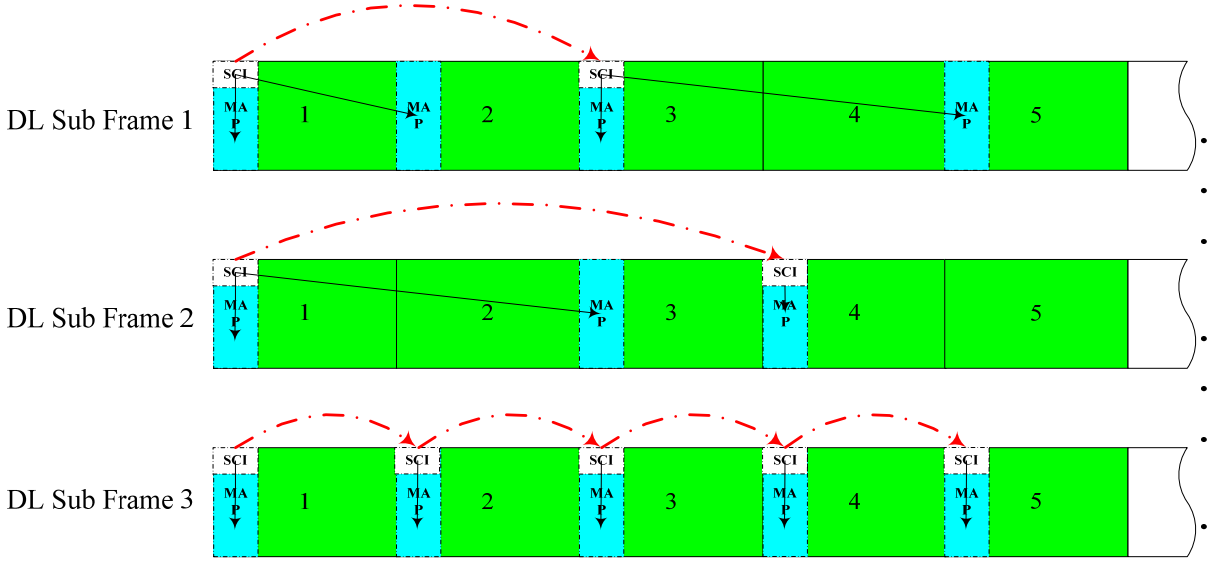

Fig 6 Linked-list mode

SCI can indicates the location of SCI next to it. When one terminal resolves the related information of SCI, it can know the location of next SCI. This SCI method seems like a linked list that can be named as Linked List mode. The scheme has the balance between the power saving and time delay performance.

According to the three schemes above, we prefer to the 3rd mode - Linked-list mode.

1.2.2 DL Sub-Frame Partition MAP

Following SCI, there are Sub-Frame Partition Maps. Within each schedule interval, there can be one or several Sub-Frame Partitions maps. Sub-Frame Partition Maps are used to indicate resource allocations in one or more Sub-Frame Partitions, these sub frame partitions can be continuous or discontinuous.

The Sub-Frame Partition MAP IE indication method can be various: tree structure, bitmap, etc.

The location of Sub-Frame Partition map has two mode :

- Mode1

  Sub-Frame Partition maps are located at the beginning of the controlled Sub-Frame Partitions respectively.

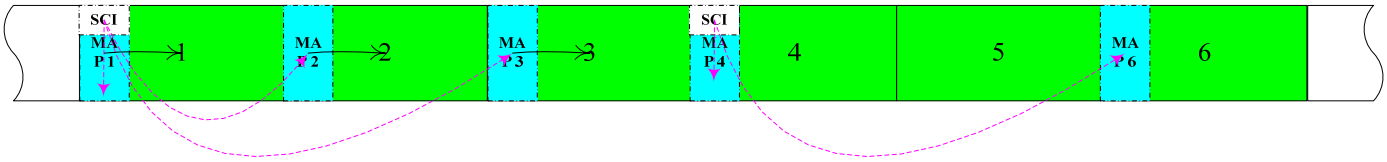

Fig 7 Mode-1 of Sub-frame Partition Maps

For this scheme, there are 2 advantages:

a. Sub-Frame Partition Maps can use high efficiency transmission mode in the controlled Sub-Frame Partitions, and it can decrease the overhead of Sub-Frame Partition Map further. For example, some Sub-Frame Partitions may have use advanced MIMO to transmit messages and data.

b. If Group schedule are implemented in resource allocation, when the group resource size is fixed, Sub-Frame Partition Map's size can be determined, the SCI can decide the group resource only, therefore the schedule of intra-group can happened after the SCI to response UL feedback as soon as possible, which is good for delay sensitive services(such as VoIP) with less delay.

- Mode2

All the Sub-Frame Partition maps are following the SCI in the beginning of 1st Sub-Frame Partition of the scheduling interval.

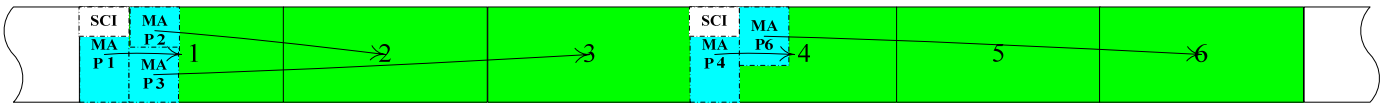

Fig 8 Mode-2 of Sub-frame Partition Maps

For this mode, a big benefit is power saving. Terminals don't have to wake up in Sub-Frame Partitions frequently to look at Sub-Frame Partition Maps. If the parameters of Sub-Frame Partition Maps (MCS, MIMO, AAS) are the same, this method can be used for further power saving.

The indication method for the two mode can be unified in the SCI, therefore the 2nd mode can be chosed according to the requirement and scenario .

1.3 Benefit of our proposal

Comparing to other resource allocation control channel designs, SCI has more advantages. Let's compare the following schemes:

Scheme 1:

In every Sub-Frame Partition, there is a Sub-Frame Partition Map and each map should have a Sub-Frame Partition Map Header. In this way, those delay sensitive services, such as VoIP, can have shorter time latency. However, terminals have more power consuming, because they have to listen to every Sub-Frame Partition , even they have nothing to receive. Moreover, Only resolving the header, the terminal can fetch the necessary information to demodulate the map at the same symbol, it has more process delay.

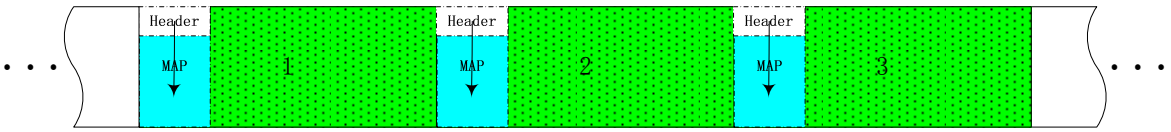

Fig 9

Scheme 2:

Within one continuous DL transmission region, there's only one schedule and putting all map messages in the front of the DL region. Terminals only read messages in the front. If there is resource allocation for one terminal, it goes to resolve data region indicated by map. Otherwise, it can ignore data in the following. The scheme can make good use of power saving for terminals. However, its disadvantage is obvious. It cannot response UL HARQ feedback as soon as possible.

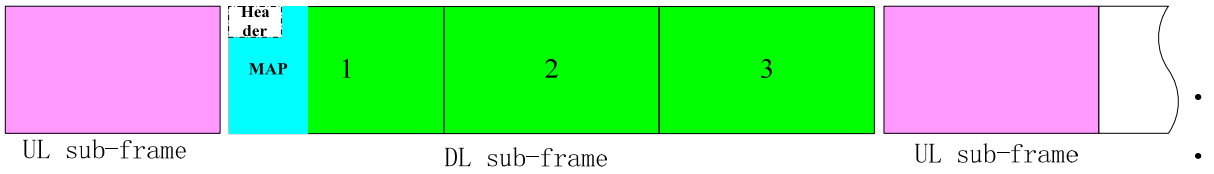

Fig 10

To make a good balance between data delay and power saving, "Scheduling-based Control Indication-(SCI)" Scheme can efficiently manage the resource allocation indication. As describe above, SCI is based on every schedule by BS and there may be multiple times schedule in one DL region. As a result, it can response the UL HARQ feedback as soon as possible. On the other hand, when schedule happens, SCI will exist. Terminals can fetch the related information of Sub-Frame Partition Map from the SCI at the beginning of schedule interval, thereby quicken the demodulation for the map message or don't have to read all Sub-Frame Partitions to know where the messages should be received.

2 Text Proposal for the 802.16m SDD

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

The general control channel

The following figure is the general control channel structure for 16m. There are three types of control channels :

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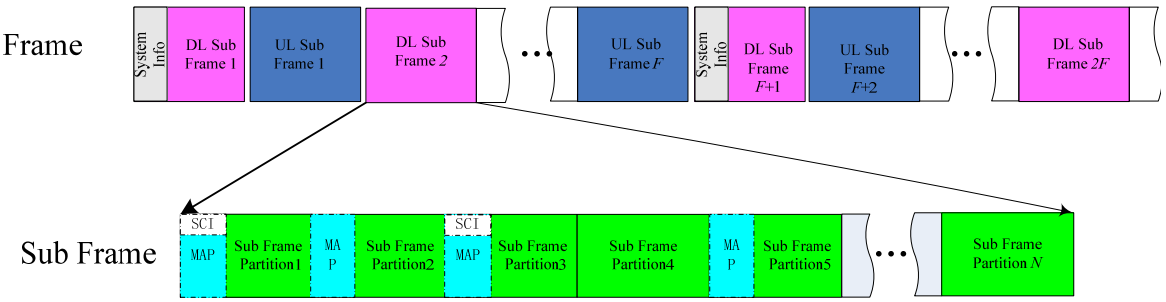

General Control Channel Design for 16m

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==========*End of Proposed Text* ==========

3 References

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

[2] IEEE 802.16e Rev2-D2

[3] C80216m-08_081r1-Base Frame Structure for IEEE 802.16m