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Title	**Coordinated approach for inter-cell interference management**
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Re:	16m Call for Contributions on Interference Mitigation
Abstract	Proposed 802.16m resource allocation and power rules for interference mitigation
Purpose	Actions: 1. Modification of ToC 2. Capture of the text in the SDD
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Coordinated approach for inter-cell interference management

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Introduction

It is well known that the interference mitigation is optimal when using dedicated frequency and time resources at cell edge, for each of the strong interfering sectors. In the same time, the maximum frequency efficiency is obtained when at least part of resources are used in a shared mode.

Traditionally the dedicated frequency and/or time resources are associated with Reuse 3, while the shared frequency and/or time resources are associated with Reuse 1. A suggestive illustration is done in Fig. 1: (provided in [1]).

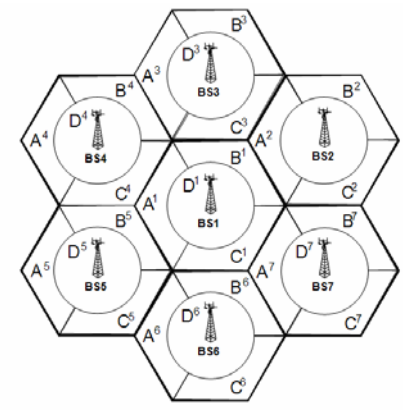

Fig. 1 Example of cell deployment

In this figure the Reuse1 areas are marked with D, while the Reuse 3 areas are marked with A, B, C.

The E-MBS coverage shall cover the entire deployment as a single frequency network and it is added in Fig. 2, as circles over the cell area.

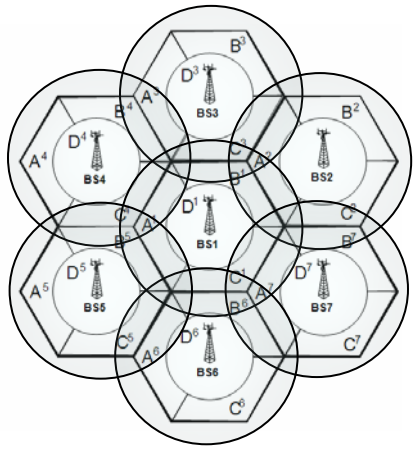

Fig. 2 Example of cell deployment including E-MBS services

Flexibility of allocation

The existing 802.16 standard allows the usage of the dedicated and shared resources in different time zones, however this approach does not allow the flexibility of resource allocation, due to the scarcity of the available sub-frames in a 5ms frame. For example, if the 5…8 sub-frames in a frame are used for:

- Support of Legacy 802.16
- Relay operation in Legacy mode
- Support of 802.16m
- Relay operation in 802.16m,

both down-link and up-link, it is obvious that no flexibility is allowed for using the dedicated and shared resources.

Interference mitigation using power control

This subject is addressed in a separate contribution.

Interference separation using MIMO

The MIMO technologies can separate the signal from the interference created by an adjacent cell, such that function of implementation of this technology by different system elements (MS, BS, Relay) should be possible:

1. Increasing the percentage of the shared allocation;
2. Using at least a fraction of the dedicated allocations by multiple sectors.

Resource allocation for interference mitigation

We propose to allocate the dedicated and shared allocations within OFDMA domain, including rules for full channel usage.

The advantages are:

- Frequency channel can be fully reused
- The interference at the cell margin is reduced
- Splitting in time domain between Reuse 3 and Reuse 1 is not longer necessary; this legacy split mode contradicts with the sub-frame concept and the Relay concept, which both add time-domain splitting.

Splitting everything in time domain introduces spectral efficiency problems due to the granularity of time resource allocations for Zones and overheads related to excessive fragmentation.

The allocation is named “SET”, which is an enhancement of the “segment” concept in the basic 802.16 standard. Was preferred the introduction of a new term in order to avoid confusions between the segments in the legacy standard and the segments in the 802.16m Amendment.

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11.4.8 Coordinated resource allocation for inter-cell interference management

The coordinated resource allocation for interference mitigation defines frequency resources to be allocated per for addressing general deployment cases.

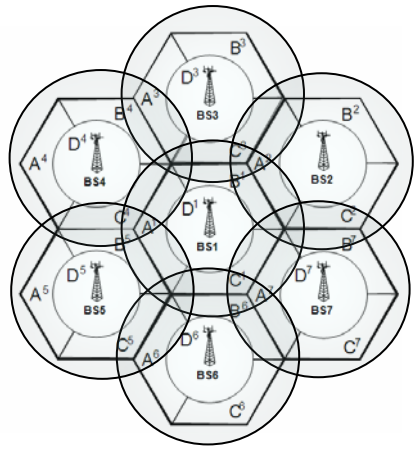

Fig. aa Example of cell deployment including E-MBS services

In fig. aa there are three different deployment cases having different interference conditions:

1. Areas of Reuse 1, for data services, traditionally located around the cell center, noted with “D”
2. Areas of Reuse 3, located at the cell edge, noted with A,B or C depending of the specific Sector
3. Areas of Reuse 1, for E-MBS (Extended Multicast-Broadcast) Services, which over circle the entire cell.

The areas of Reuse 1 providing data services can be extended towards the cell margin if the interference is mitigated using MIMO technologies.

OFDMA resources are allocated for each of the three areas. The resources are allocated in a coordinated mode between the interfering cells, coordination which may be achieved using inter-BS communication over the air, or eventually over the backbone.
A special case is represented by the allocation of resources for MIMO-based interference cancellation.

11.4.8.1 Resource allocation

The frequency channel is split in SETs, every SET comprising a number of sub-channels. Every sub-channel may use localized or distributed carrier partitions. There are two different types of SETs:

- **Shared SET**s, used by all the sectors and intended for Reuse 1 and E-MBS
- **Dedicated SET**s, used by a specific BS sector, in its operation with mitigated interference, named **Master operation**. The Dedicated SETs are intended for Reuse 3 operation. The Dedicated SET of a sector can be also used by another BS Sector, if the Master operation is not affected. Such operation of

the other sector is named "**Slave operation**" and the SET used in Slave operation is named "**Slave SET**". The interference mitigation can be achieved by power rules or MIMO-based interference rejection.

A list of the possible SETs is given below:

- **Shared E-MBS SET**, for Multi-cast and Broadcast services, forming a "single downlink frequency" channel. Base Stations may use this sub-channel partition for providing the E-MBS services. The E-MBS SET is used only in downlink.
- **Shared Control/Data SET**, used for sending/receiving Control/Data information to/from those users which do not suffer from significant interference.
- **Dedicated Control/Data SET**, typically used for sending Control/Data information at maximum power density and to receive at minimum interference. Each sector in a BS will have its dedicated SET.
- **Slave Control/Data SET**, which can be used for sending/receiving Data and eventually Control information. The transmission can take place only if it is not creating interference to the Master SETs in other Base Stations.

Fig. xx shows the down-link channel splitting in SETs, as seen by the BS Sector 1. The control elements (CCH) of each SET have fixed locations and are transmitted at the beginning of the superframe.

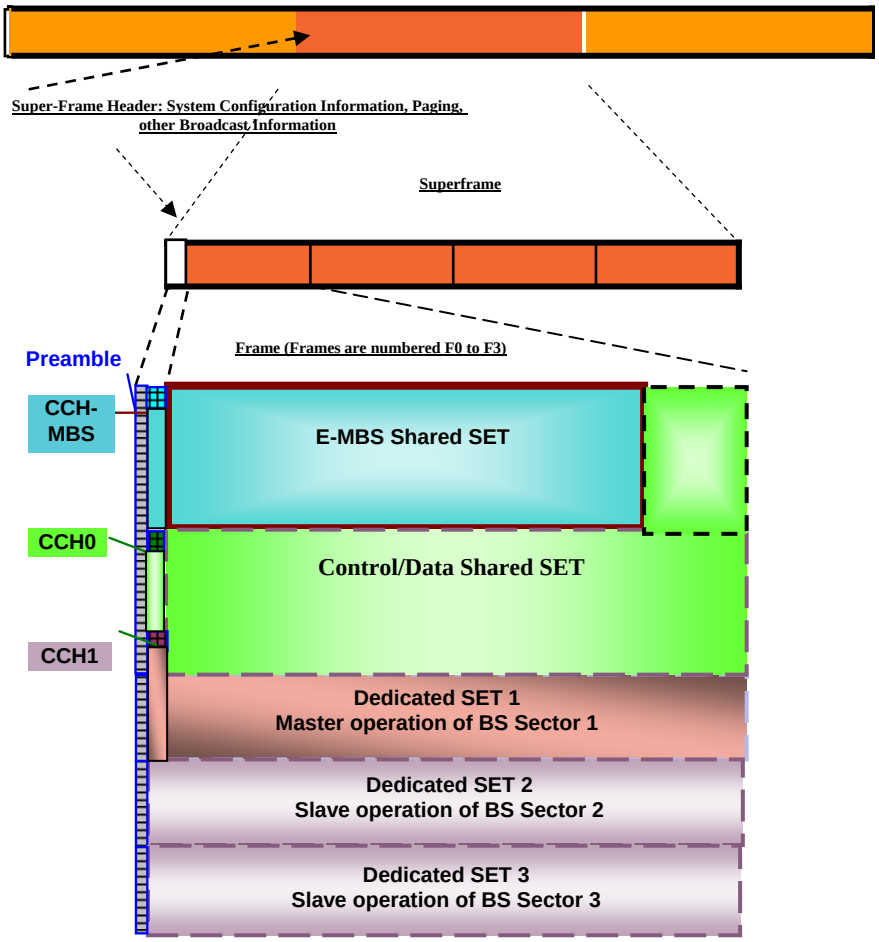

Fig. xx DL channel splitting in SETs, as seen by BS Sector 1

The superframe preamble and the Frame preambles are sent following the SET power rules.

The number of sub-channels allocated per SET may be dynamically changed every superframe. In this way, the SET capacity can be adapted to both interference and traffic conditions.

11.4.8.2 MIMO-based interference mitigation

A higher spectral efficiency may be obtained when the interference is separated in space domain, using the MIMO technologies. In such cases, the interfering radio devices may use the same OFDMA allocation; however this MIMO operation requires different OFDMA resources within a SET.

Figure yy exemplifies such a situation for down-link Shared Control/Data SET, where two different MIMO partitions are created within this SET. The MIMO 1 partition is used for the regular MIMO operation, while the MIMO 2 partition is used for both data transmission and interference cancellation. Each partition use control elements transmitted using the suitable MIMO technique.

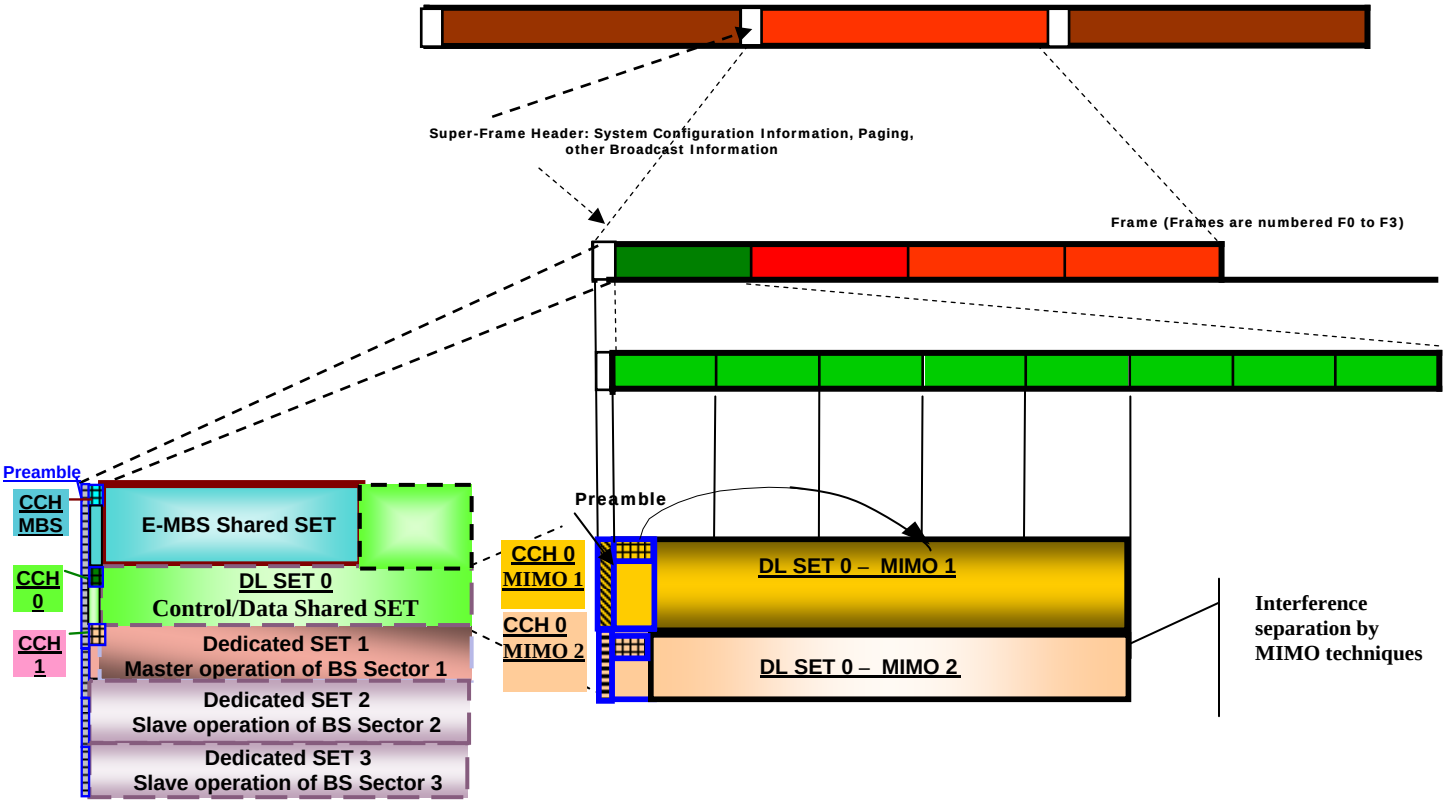

Fig. yy Example of SET splitting in Zones, within DL SET 0

End text insertion

References

[1] Zhifeng (Jeff) Tao, Amine Maaref, Koon Hoo Teo, Philip V. Orlik, Ramesh Annavajjala, Andreas F. Molisch, Jinyun Zhang, Toshiyuki Kuze , IEEE C802.16m-08/527, Resource Allocation for inter-cell interference coordination.