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Re:	[16jm] Relay Frame Structure - call for proposals
Abstract	
Purpose	Actions: 1. Modification of ToC 2. Capture of the text in the SDD
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802.16m Frame structure for FDD Multi-Hop Relay in OFDMA domain

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Introduction

This contribution addresses the Relay Frame structure for FDD operation.

Interference map

The interference situation is similar with the TDD case.
In the general case a Relay Station (RS) will have a number of RS surrounding it, which for the highest range and data traffic should be separated in frequency domain. For example, we will consider that the Relays have omnidirectional antennas in the access mode; in this configuration the interference created to one SS located at the cell edge is shown in the following figure:

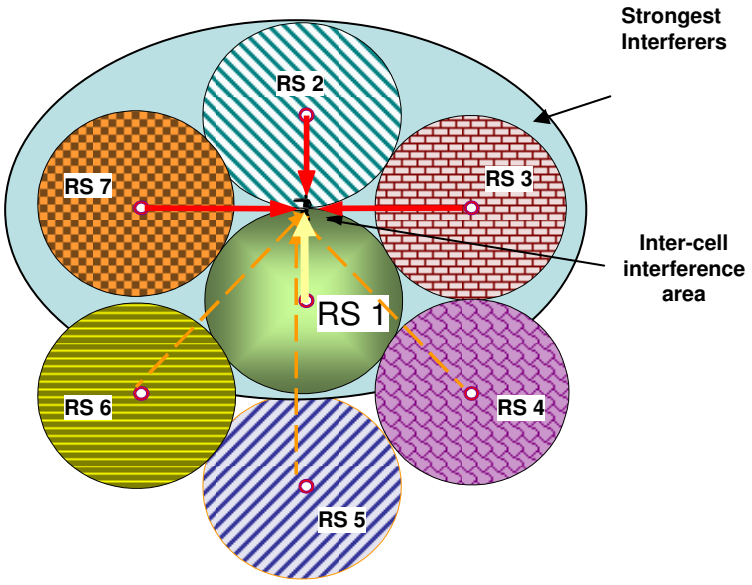

Fig. 2 The strongest interferers of a omnidirectional RS

With sector antennas there are also 4 interfering cells.

In order to separate the 4 cells which are interfering are needed 4 segments (sub-channel groups) in the OFDMA domain. These segments will allow for the maximum cell size and will be used essentially for increasing the SINR (signal to interference and noise ratio) of specific users, typically at the cell margin. A better spectral efficiency will be obtained if the links not interfering one which each other will be grouped in a “shared” allocation built from sub-channels dedicated to this usage.
For example, a deployment scenario described in SDD (fig. 3) is shown below. This “aggressive” deployment scenario suffers from interference at the intersection of “red” and “blue” passes, which conduct to low data rate or lack of coverage.

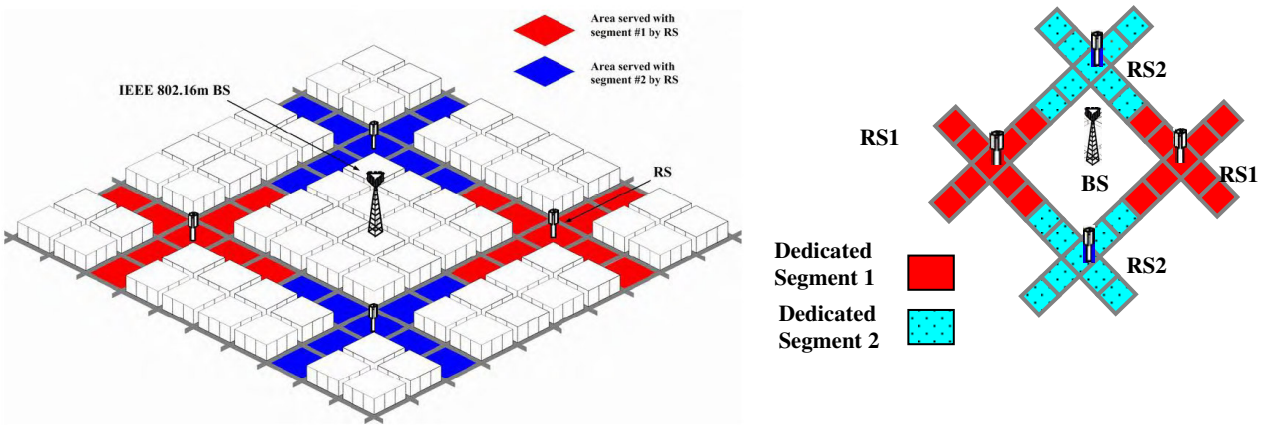

Fig 3: SDD example for aggressive segment reuse

A better spectral efficiency and coverage will be obtained if dedicated and shared segments will be introduced. In fig. 3 there are areas around the RS cell center which can be reused in parallel. We introduce in fig. 4 the idea of the Shared segment. The reused spectrum can be appreciated from fig. 4:

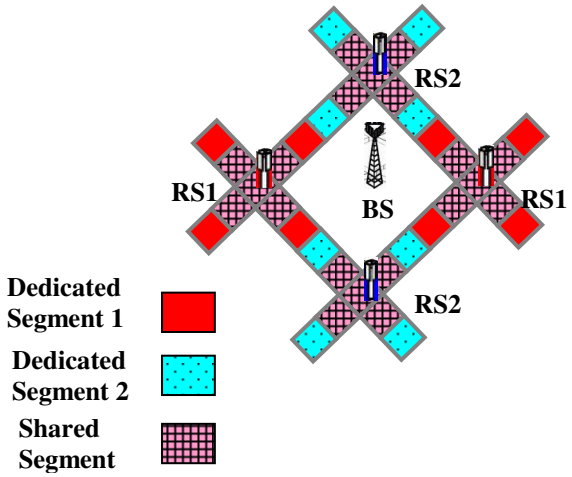

Fig. 4 Usage of dedicated and shared segments in Relay operation

If we make the simplified assumption that used spectrum is reflected by the coverage, in fig. 3 are used 9*2=18 squares while in fig. 4 are used 1+1+5=7 squares, **representing a 18/7 = 250% better spectrum efficiency.** So the use of the Shared segment may significantly increase the spectral efficiency. Usage of the dedicated segment will make possible the increased cell size.

Proposal

Insert text for SDD, clause 11.4.4 **Relay Support in Frame Structure**

11.4.4.2 FDD operation

The FDD operation is using the f1 for BS Tx and f2 for SS Tx; generally f1>f2. In order to avoid Rx/Tx operations on the same frequency are needed two time partitions.

During time partition 1 the relay transmits on both f1 and f2, while during time partition 2 the relay receives on both f1 and f2. No duplexer is needed. The BS can work in full duplex mode.

Time partition 1 (BS-Tx, RS Rx)

The functional description of the BS/Relay operation during time partition 1 is given in the figure 1. It can be seen that the Relay is the focal point of the Receive (Rx) activity.

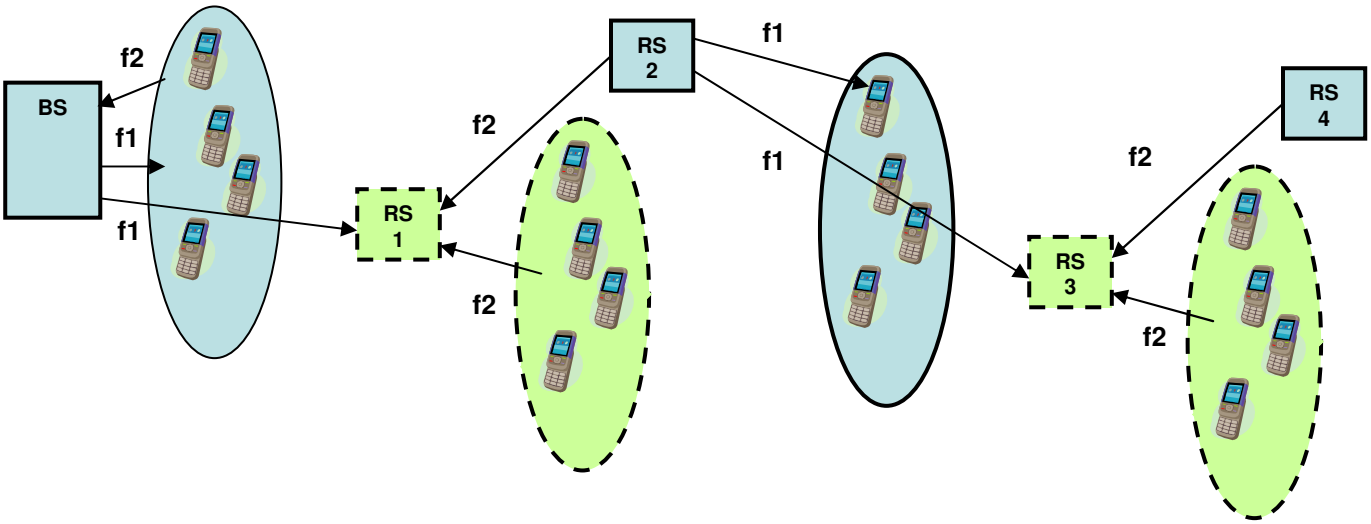

Fig. 1 Operation during time partition 1 - FDD

This time partition should include the following segments, corresponding to the fig. 1 activity:

- One DL Segment which carries the BS traffic on f1. This segment will be able to carry at least two different STC (space-time coding)/MIMO modes: one for BS-SS communication and one for BS-RS communication. This segment may be preferably split in two segments, each one using a different STC/MIMO mode. During the BS DL transmissions the RS is in the Receive Mode.

- UL Relay Segment carries:

    - Up-link traffic from the SSs (relay access mode) on f2
    - Backward link of the next hop RS, on f2.

This segment may be either split in dedicated and shared sub-channel groups or alternatively different segments may be allocated to the dedicated and shared UL RS traffic. BS downlink traffic may be also scheduled during the shared part of the Relay segment, if it will not create interference.

The RS is isolated in the access activity (RS-MS) from the BS due to the different used sub-channel segment and the significant distance between RS and BS. The isolation is increased by the usage of directional antenna for the Relay access operation and feeding link (BS-RS link).

Time partition 2 (BS Rx, RS Tx)

The functional description of the BS/Relay operation during time partition 2 is given in the figure 2. It can be seen that the Relay is the focal point of the Transmit (Tx) activity.

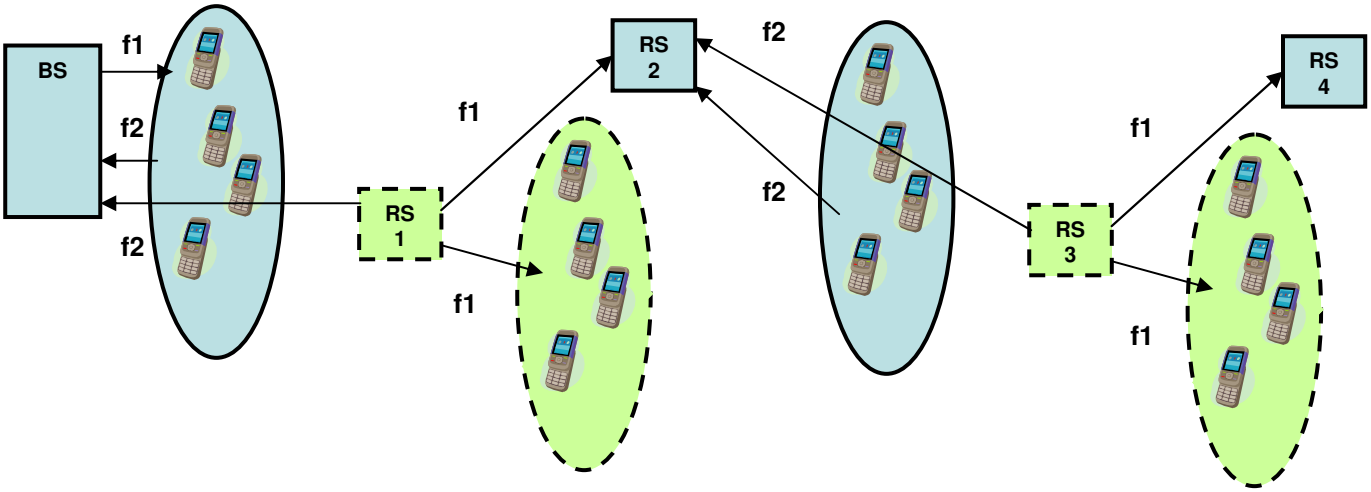

Fig. 2 Operation during time partition 2 - FDD

This time partition includes the following segments:

- BS UL Segment carries:
  - BS access traffic (SS transmissions) on f2.
  - BS-RS backward link, on f2.

  This segment will carry at least two different STC modes: one for BS-SS communication (sub-channel group for BS access mode) and one for BS-RS communication. Different sub-channel groups will be allocated to this activity.

  During the BS UL transmissions the RS is in the Transmit Mode.
- DL Relay Segment carries:
  - Downlink RS access traffic to the SSs associated with it on f1. This segment may be split in dedicated and shared segments or different segments may be allocated to the dedicated and shared DL RS traffic. The shared segment can be also used by the up-link BS activity not creating interference to Relays.
  - Forward link to the next hop RS on f1.

Frame structure

The FDD Frame structure is shown in fig. 3.
The BS is considered to be in HOP 0. The first Relay is in HOP 1. The Frame partition starts with the BS DL, which is also relevant for the Relay Stations in the hop 2n.
To each functional behavior is allocated a segment in the OFDMA domain.
A Relay will transmit in two different directions in the same time. Each transmission will use the suitable segments associated to a specific antenna and the suitable frequencies.
UL and DL activities are mixed inside the Frame. The permutations used for UL and DL shall be compatible, but not necessary identical.
The Frame Control Header (FCH) will be sent in all the DL segments which are intended for different MIMO/STC modes or for different antennae. The FCH may be sent at the start of the multi-frame only.
Preambles will be sent in DL but they can be sent also in up-link.

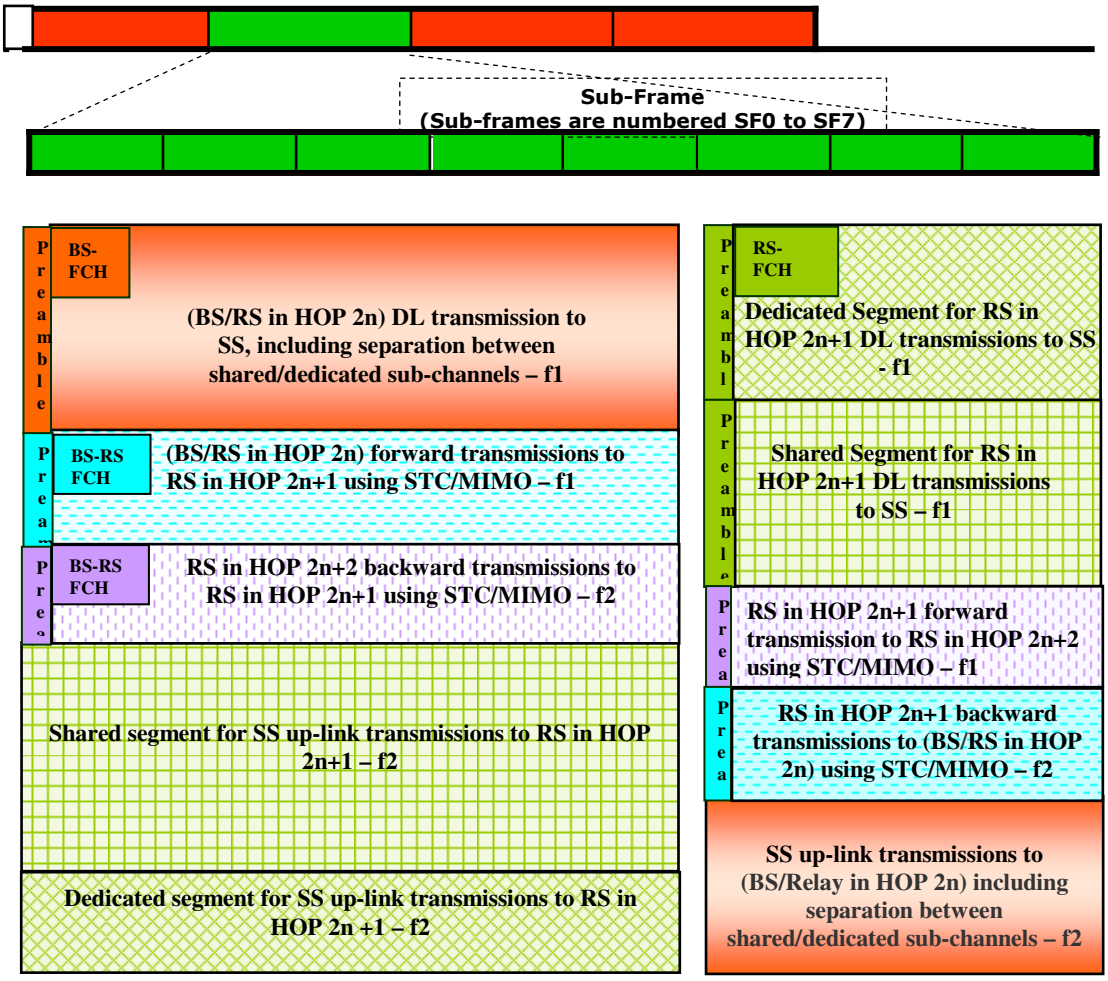

Fig. 3 FDD Frame structure

End text for SDD

Advantages

The advantages of this solution are:

- FDD operation with only two time-separated intervals
- Support for MIMO in BS-RS communication
- Significant lower data traffic forward delays; only 1 frame is needed for 2 hops. This proposal takes advantage of the new sub-frame structure, which will reduce the 802.16m latency.
- Better spectral efficiency generated by the usage of “shared segments”.