Relaying Mode Selection Proposal for IEEE 802.16m

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Venue:

TGm SDD: Relay IEEE 802.16m-08/040: Call for Comments and Contributions on Project 802.16m System Description Document (SDD)

Purpose:

For consideration and adoption by TGm group

Notice:

Release:

Patent Policy:

Introduction

The System Requirements Document for IEEE802.16m requires >2x times improvement of average user throughput and the cell edge user throughput in comparison with the reference system.

To meet this requirements one of the possibilities is to use relay stations with optimal selection of the relaying modes for each MS of the system.

Table 6–Relative throughput of a data only system

Metric	**DL data** (xWirelessMAN-OFDMA Reference System)	**UL data** (xWirelessMAN-OFDMA Reference System)
Average user throughput	> 2x	>2x
Cell edge user throughput	> 2x	>2x

Relaying Modes

- Each MS is assigned a relaying mode.
- A Relaying mode defines:
  - Which access station(s) within the sector serves the MS
  - Which other access station(s) within the same sector are allowed to serve other MSs in the same time-frequency slot
- The following classes of relaying modes are defined:
  - *Division* – only one access station of the sector serves a user in a time-frequency slot.
  - *Simultaneous* – several access stations within the sector serve different MSs in the same time-frequency slot. Simultaneous modes are distinguished by the number of simultaneous transmissions in the time-frequency slot.
  - *Cooperative* – several access stations within the sector serve one MS in the same time-frequency slot.

Relaying Mode Examples (1)

- Assume that a sector has two RSs (RS1 and RS2)
- *Division* relaying modes
  - *BS-only mode*. MS operates directly with the BS. All RSs keep silence.
  - *RS1-only mode*. MS operates through RS1. RS2 and BS keep silence
  - *RS2-only mode*. MS operates through RS2. RS1 and BS keep silence

Division relaying modes are most efficient for MSs which are located in between the different access stations and therefore observe similar received signal power from these access stations. Division mode is used to reduce interference.

Relaying Mode Examples (2)

- *Simultaneous* relaying modes
  - *BS+RS1 mode.*
    - MS1 is served by the BS, MS2 is served by the RS1, RS2 keeps silence.
    - BS+RS2 and RS1+RS2 modes are defined in a similar manner.
  - *BS+RS1+RS2 mode.*
    - MS1 is served by the BS, MS2 is served by RS1, MS3 is served by RS2.

Simultaneous relaying modes in the DL are most efficient for MS that are relatively close to a given access station and thus experience weak interference from the other stations operating in the same relaying mode in the same slot. The same is applicable in the UL.

Relaying Mode Examples (3)

- *Cooperative* relaying modes
  - Cooperative relaying modes are modes when two or more access stations serve one MS in a time-frequency slot. The access stations transmit/receive in a cooperative manner according to a cooperative relaying mode. (See contributions C80216m-08_1277, C80216m-08_1278, C80216m-08_1279, C80216m-08_1280 for a specification of cooperative relaying)

Cooperative relaying modes are most efficient for MSs that observe very poor receive conditions (e.g. at the cell edges) whose performance is too low even in division modes due to interference from other cells. For such MSs the increased received signal strength and additional transmit diversity brought by the cooperation of several access stations may improve the quality of the received signals.

Relaying Mode Selection

- Relaying mode is selected for each MS along with the FFR partition and MIMO transmission scheme.
- Different relaying mode sets may be used for different deployment scenarios. For example, selection may be performed over:
  - Full set including all division, simultaneous and cooperative modes
  - Partial set including division and simultaneous modes
  - Partial set including only simultaneous modes
  - Partial set including only division modes
  - All other possible RM sets

Metrics for Relaying Mode Selection

In order to perform the relaying mode selection the scheduler must know the MS' performance in each of the relaying modes. The scheduler assigns the relaying modes to MSs so as to maximize the overall throughput in the sector.

This may be done in two ways:

- MS measures the channel quality indicators (CQI) for links between itself and the access stations within the sector and sends it to the BS. The BS then calculates the preferred relaying mode for the MS.
  - CQI feedback information element is needed
  - In case of localized permutations, CQI feedback should be reported for each subchannel to enable further frequency adaptation
- MS measures the channel quality indicators (CQI) in all relaying modes and reports the preferable mode to the BS or RS
  - RM request information element is needed

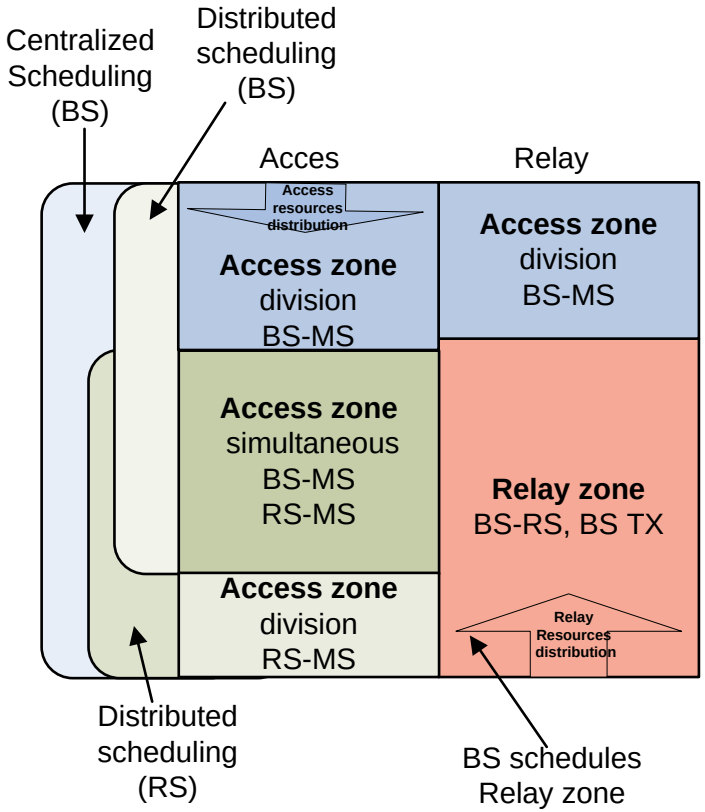
Relaying Mode selection options for the DL and UL

- Downlink
  - Relaying mode selection in the downlink is relatively simple as the useful signals and interference come from stationary sources.
- Uplink
  - In the uplink the sources of interference are constantly changing, which complicates the measurements needed for relaying mode selection.
  - MSs selected by the scheduler for simultaneous modes in the DL are generally in the regions that are physically separated, therefore they can be used in the same simultaneous mode for UL.
  - MSs selected for division mode in DL are generally in neighboring regions, therefore in the UL they should operate in the division mode.

  Therefore it is proposed to use the same relaying modes for the users in the UL as for the DL.

Relaying mode selection in centralized and distributed scheduling

- Centralized scheduling: Relaying modes for each MS are selected by the BS based on the feedback from users and RS
  - Good throughput performance optimization ability due to BS' centralized control over the entire frame
  - Additional overhead due to signaling
- Distributed scheduling: BS assigns zones in the frame for each relaying mode and allows RSs to put users into that zones in accordance with the desired relaying modes.
  - This cuts the overhead of RS resource allocation control
  - Reduces opportunities for throughput optimization since each access station controls only the users in its zones.



Proposed text to SDD

[Insert the following text into section 15 of the SDD:]

15.x Relaying modes

In 16m DL access link transmissions of the BS and RSs within a sector may be divided in time or frequency to reduce interference, or may be performed simultaneously to enable the reuse of spectrum resources between the stations. The same principle is applied to MS transmissions in the UL. In addition, in the DL, the BS and/or RSs within a sector may share the time-frequency slots to send data to the same MS in a cooperative manner. The term relaying mode is used to denote the manner in which resources are used by the BS and RSs within a sector in transmitting to or receiving from an MS. In the DL the relaying mode for an MS defines the station (BS, RS or combination of them) that sends data to the MS and also defines the other stations that send data to other MSs in the same time-frequency slots. In the UL the relaying mode of an MS defines the station in the sector (BS, RS or combination of them) that receives data from the MS and also defines the other stations that receive data from other MSs. Several classes of relaying modes are defined in 16m. These are division modes, simultaneous modes and cooperative modes.

In the DL, division relaying mode is a mode where only one station within the sector (BS or RS) sends data to the MS in a time-frequency slot. Other access stations within the sector are silent in that slot. In the UL division relaying mode is a mode where only one MS sends data to an access station in a time-frequency slot, while other MSs of the sector keep silence.

Proposed text to SDD (cont'd)

In the DL, simultaneous relaying modes are modes where two or more access stations within a sector transmit different data to different MSs. Different simultaneous modes can be defined for different combinations of access stations within a sector. In the UL under a simultaneous relaying mode several MS within a sector send data to several access stations within the same sector in the same time-frequency slot. The number of the MSs that share a time-frequency slot to receive data in the DL or to send data in the UL is denoted as the reuse factor of the simultaneous relaying mode.

In the DL, cooperative relaying modes are the modes where two or more access stations (BS and/or RSs) send data in a cooperative manner to one MS in the same time-frequency slot. Access stations not taking part in the cooperative transmission keep silence.

BSs within different sectors or cells may coordinate how they deploy relaying modes in their frames, however, this is FFS.

In 16m a specific relaying mode is selected for each MS or for group of MSs in a manner similar to the selection of the FFR partition and MIMO transmission mode. The system implements a mechanism to allow performance estimation of each MS in each supported relaying mode. CQI is sent from the MS to notify the BS of its performance in each relaying mode.

The 16m system supports both centralized and the distributed relaying mode selection mechanisms. When centralized scheduling is used, the BS selects the relaying modes for all MSs in the sector regardless of whether they operate through an RS or directly with the BS. When distributed scheduling is used, the BS arranges zones in the frame for each desired relaying mode and allows the RSs to assign their MSs to those zones in accordance with their relaying mode selection decisions.