Spatial Multiplexing for Relay Links for IEEE 802.16m Systems

IEEE 802.16 Presentation Submission Template (Rev. 9)

Document Number:

IEEE C802.16m-08/1395,

Date Submitted:

2008-10-31

Source:

Alexander Maltsev, E-mail: alexander.maltsev@intel.com
Alexey Khoryaev,
Andrey Chervyakov,
Jerry Sydir

Intel Corporation

*<http://standards.ieee.org/faqs/affiliationFAQ.html>

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:

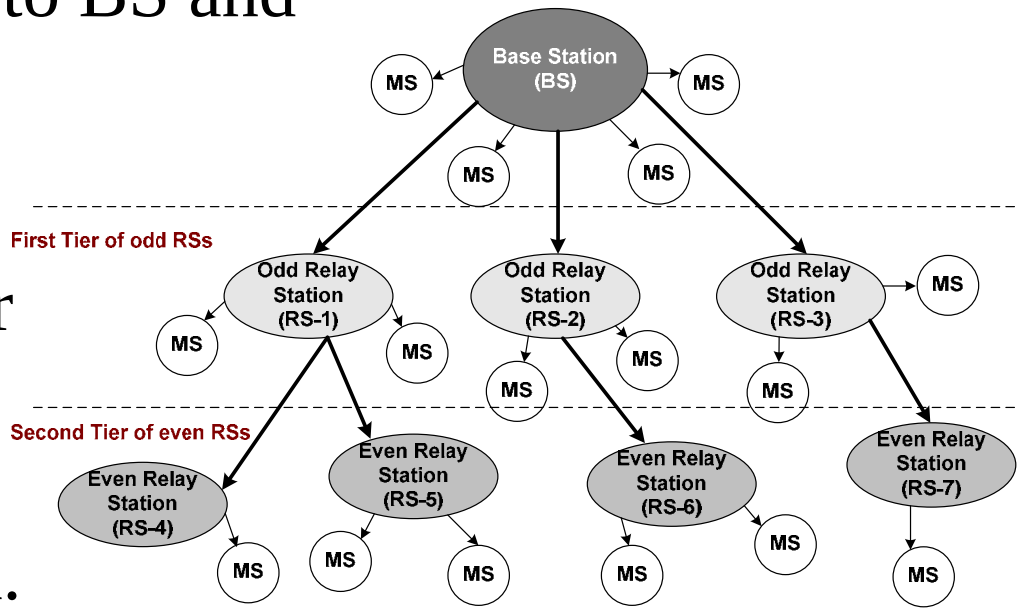
Patent Policy:

Introduction

- Current contribution proposes to use specific spatial multiplexing techniques for relay links providing significant performance increase for IEEE 802.16m system with intermediate relay stations (RSs).
- The proposed technique is in full accordance with requirements defined by IEEE 802.16m SRD:
  - *IEEE 802.16m should provide mechanisms to enable multi-hop relays including those that may involve advanced antenna technique transmission.*
  - *IEEE 802.16m shall support MIMO, beamforming operation or other advanced antenna techniques including single-user and multi-user MIMO techniques.*

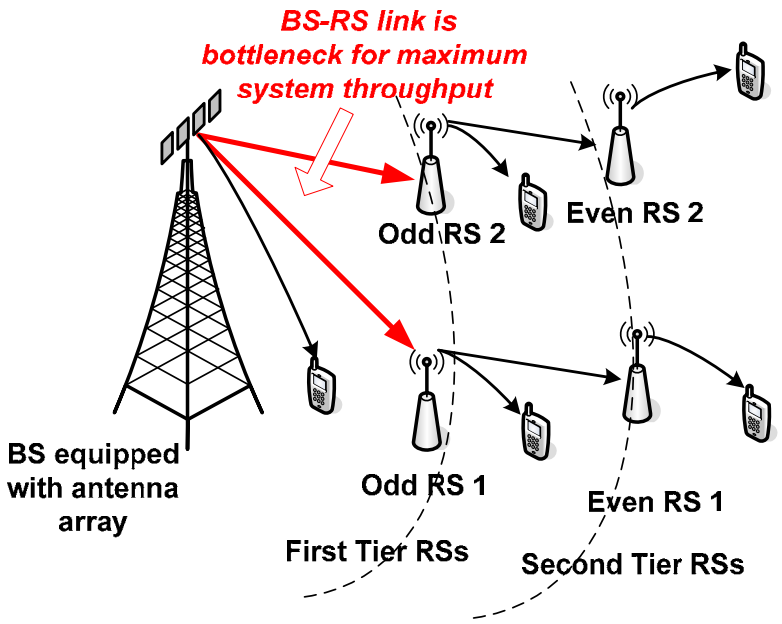
IEEE 802.16m Network Topology with RSs

- Current version of SDD assumes tree based network topology to support multi-hop RS deployment.
- The root of the tree is a BS that is able to communicate with first tier RSs (odd RSs) directly connected to BS and associated MSs.
- In multi-hop deployment the first tier RSs may pass data further to even RSs and attached MSs and so on.



Spatial Multiplexing for Relay Links - Motivation

- Problem: When several first tier RSs are deployed the maximum total network throughput is limited by the spectral efficiency of the relay link between BS and the first tier RSs:
  - Total amount of data that reach all MSs is bounded by the amount of traffic initially transmitted by the BS only.
  - Link between BS and first tier RS is the bottleneck and must have highest available spectral efficiency.
  - The subsequent hops in the relay chain are not so critical since the amount of traffic that flows from hop to hop is reduced assuming that on each hop the RSs have associated MSs and a part of received data is retransmitted to these MSs.
- Solution: *Spatial multiplexing of first tier RSs is essential method to increase the total system throughput.*



Spatial Multiplexing for Relay Links - Concept

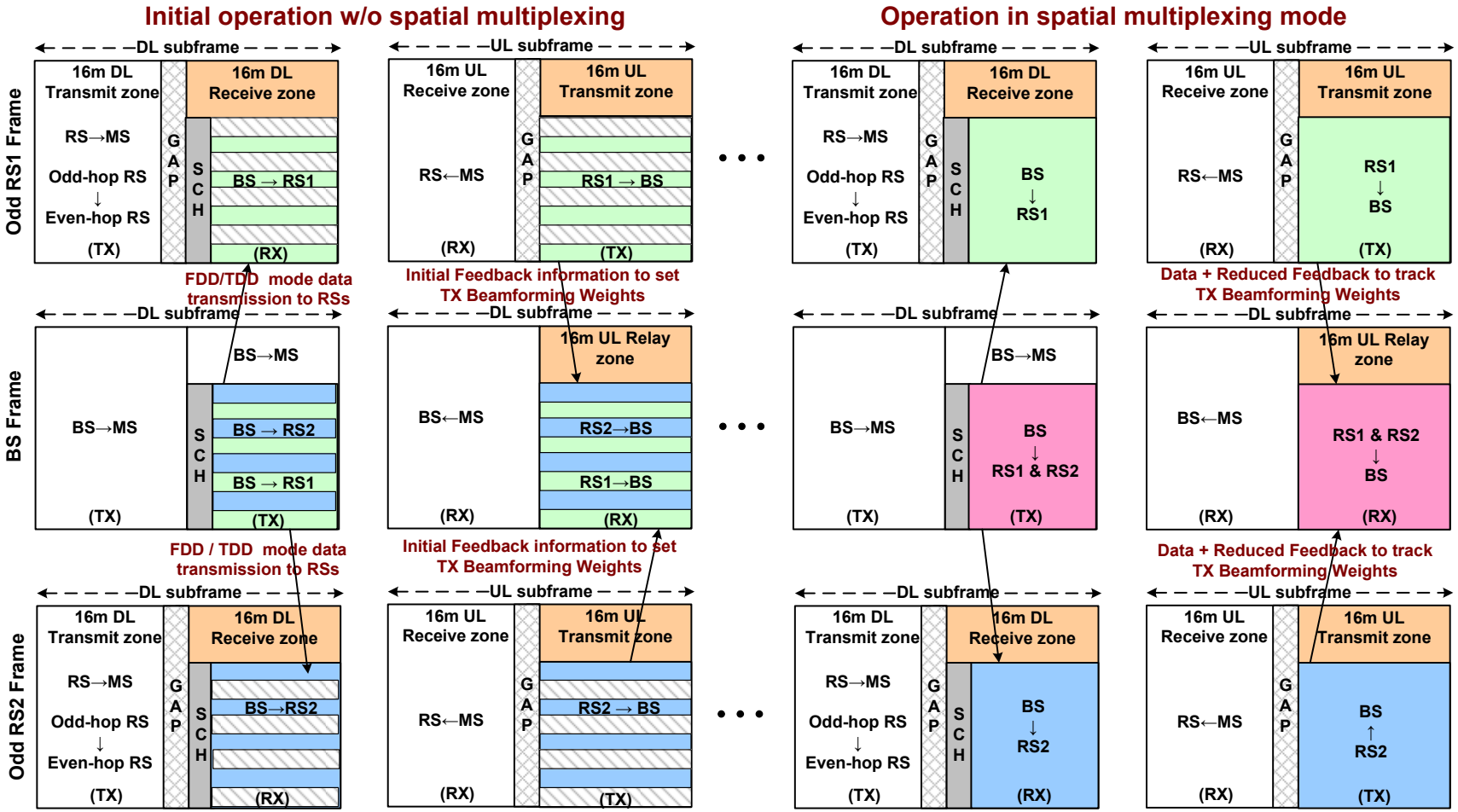
- BS exploits DL/UL spatial multiplexing techniques to organize simultaneous data transmission to/from several RSs within the first tier.
- If there is a large number of RSs within the first tier the BS may assign RSs to different spatially multiplexed groups (i.e. 2,3 or more RSs in a group depending on the number of antennas at BS) and exploit TD or FD multiplexing between different groups reducing mutual interference.
- The higher tier (2^{nd} tier, 3^{rd} tier etc.) RSs may also exploit the same spatial multiplexing techniques for data transmission if needed.
- In order to establish spatially multiplexed relay links *closed-loop approaches* will be more advantageous due to stationary RS locations.

Spatial Multiplexing for Relay Links – Concept (Continued)

- Entry to the spatial multiplexing mode is controlled by BS using channel state information for all links with 1st tier RSs:
  - In UL BS can directly measure UL channel from each of first tier RSs and decide which of them can be included in one spatial multiplexing group.
  - In DL there are two ways to get this information:
    - Rely on reciprocity of UL channel (may be supported in TDD mode if TX-RX chains at both ends are properly calibrated).
    - Use explicit feedback, that contains estimated channel state information or TX beamforming vectors and transmitted from each first tier RSs to BS.
- BS transmits specific SCH channel (preamble) for RS synchronization and estimation of Relay link channel in DL Relay zone.
- Codebook based approach can be used for initial settings of BS TX beamforming vectors.
- TX beam-forming tracking is exploited to achieve the maximum spectral efficiency of relay links:
  - TX beamforming vectors can be tracked periodically with some interval (e.g. once time per frame/superframe) or by request from RSs.
  - Due to stationary behavior of Relay link the amount of feedback for TX beamforming tracking may be reduced substantially by exploiting differential/gradient-based type of feedback information.

Entry to Spatial Multiplexing Mode

- Example of entry to spatial multiplexing mode for system with two first tier RSs:



Summary and Proposed Text to SDD

- This contribution proposes to exploit the spatial multiplexing techniques for the data transmission/reception between BS and first tier RSs.
- Proposed SDD text:

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

15.x.x Support of Spatial Multiplexing for Relay Links

IEEE 802.16m system defines a spatial multiplexing mode for relay links in the DL and UL. Closed loop multi-user MIMO algorithms are supported on the relay link to enable spatial multiplexing. In order to achieve the maximum spectral efficiency in DL mode the TX beamforming vectors are applied and tracked periodically with some interval (e.g. once time per frame/superframe) or by the request from RSs. To minimize the amount of feedback information which must be transmitted by the first tier RSs to BS, differential or gradient based closed loop algorithms are exploited for adjustment of TX beamforming vectors. The particular algorithms are for further study (FFS).