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| Title | **Cooperative Relaying Scheme for IEEE 802.16j** |
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| Re: | This document is in response to call for technical proposals IEEE 80216-06/027 dated 15 October 2006. |
| Abstract | This document describes cooperative relaying scheme for IEEE 802.16. |
| Purpose | This contribution is provided as input for the IEEE 802.16j baseline document. |
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| Release |  |
| Patent Policy and Procedures |  |

# Cooperative Relaying Scheme for IEEE 802.16j

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## 1 Introduction

This contribution proposes to allow virtual MIMO using relay stations by using space-time block codes. For rate 1 codes, there is a performance improvement without any increase in backhaul communication. By implementing STBCs across different physical transmitting stations (virtual STBC), additional spatial diversity is introduced.

For this proposal we focus on the rate one codes in 802.16-2004[1]/802.16e-2005[2], such as code A in sections 8.4.8.1.4, 8.4.8.3.3 for 2 transmit antennas, and 8.4.8.2.3, 8.4.8.3.5 for 4 transmit antennas.

The concept of virtual MIMO has been discussed in previous contributions such as [3]. Such a concept provides the following advantages:

- Low complexity and ease of implementation
- Reuse of existing techniques in legacy standard
- Increase in performance (diversity) without sacrificing bandwidth

The following must be ensured:

- Synchronization between RS is imperative to prevent ISI
- Power balance is required to improve effectiveness

## 2 Assumptions

This contribution assumes that there is at least one RS in the cell. For simplicity of the description, we assume that the transmitting stations are all relay stations (although a base station can also be involved). The link quality between each RS and the MS should (independently) be similar enough to support similar coding rates.

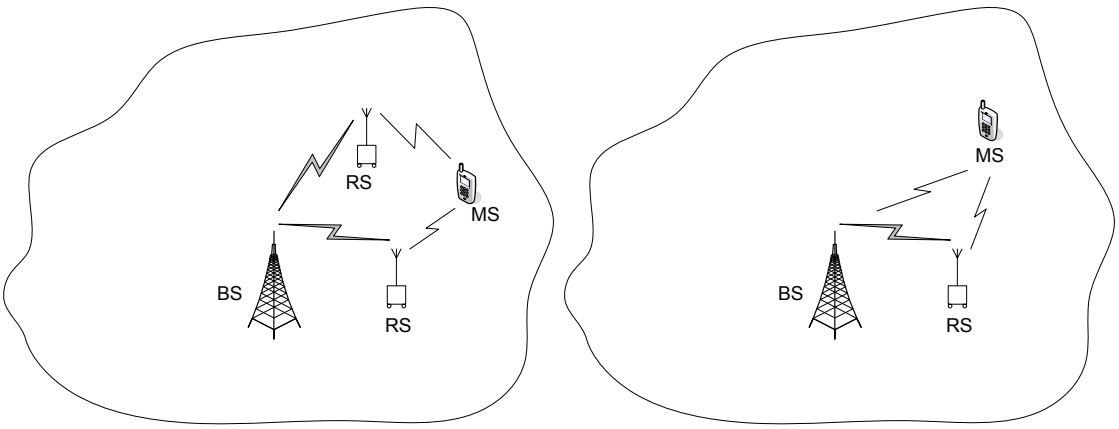


Figure 1. Two examples of virtual MIMO in use.

## 3 Proposal for 2-Antenna Virtual STBC

We propose to allow two antennas that are spatially separated to cooperate in the relay operation. This can be done by having the antennas transmit correlated data in Alamouti fashion. The MS performs Alamouti

decoding as in the legacy standard. During the backhaul, if decoding at a relay node is not correct, then the relay does not perform the relaying operation. To the receiver, this appears as a deep fade.

Additional backhaul is not necessary because of the wireless broadcast medium. For rate 1 codes, if the BS transmits to RS1, then RS2 can listen to that message as well. However, additional signaling is necessary to indicate to each RS to operate in virtual STBC mode.

Before virtual STBC is in operation, the BS must make a decision whether to use 2-antenna virtual STBC or 1-antenna "simple relaying".

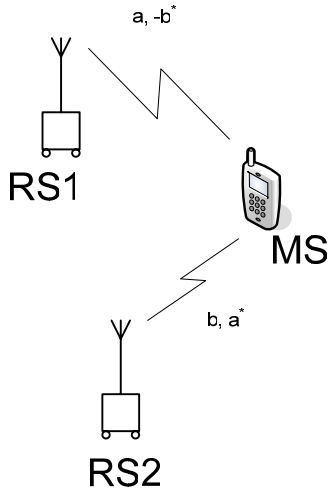


Figure 2. Example of two-antenna virtual STBC.

## 4 Proposal for 4-Antenna Virtual STBC

We propose to allow four antennas on spatially separated RSs to cooperate in the relay operation. This can be done by having the antennas transmit correlated data in Alamouti fashion with four antennas, such as Code C in Sections 8.4.8.2.3, 8.4.8.3.5 of the standard. Furthermore, the antennas in use are always in different physical locations. The MS performs decoding as in the legacy standard. During the backhaul, if decoding at a relay node is not correct, then the relay does not perform the relaying operation. To the receiver, this appears as a deep fade.

Additional backhaul is not necessary because of the wireless broadcast medium. For rate 1 codes, if the BS transmits to RS1, then RS2 can listen to that message as well. However, additional signaling is necessary to indicate to each RS to operate in virtual STBC mode.

Before virtual STBC is in operation, the BS must make a decision whether to use 4-antenna virtual STBC or alternate "simple relaying" methods.

The following figure depicts two RS, each equipped with two transmit antennas. A similar method can be employed for three RS (with a total of four transmit antennas), as well as four RS (each equipped with one transmit antenna).

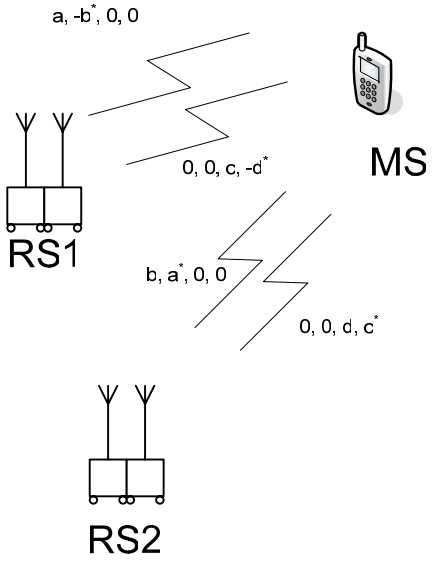


Figure 3. Example of four-antenna virtual STBC. In this example, the four antennas are spread over two RSs in different locations.

## 5 Proposed Text

[TBD]

## 6 References

[1] IEEE 802.16-2004, “Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems”.

[2] IEEE 802.16e-2005, “Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems, Amendment 2: Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands *and* Corrigendum 1”.

[3] IEEE C802.16j-06/006r1, “Cooperative Relay in IEEE 802.16j MMR”.