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Re:	This is in response to the call for proposals 80216j-06_034.pdf	
Abstract	This document describes the frame structure for flexible resource allocation.	
Purpose	This contribution is provided as input for the IEEE 802.16j baseline document.	
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Frame Structure for Transparent Relay

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1 Introduction

This contribution proposes a frame structure for 802.16 with MMR, which is backward compatible to the frame structure in the legacy 802.16e standard. As indicated in [1], it is necessary to maintain backward compatibility such that MS conforming to legacy 802.16e operation can fully function.

We assume that the relay station is transparent, that is, it does not transmit its own (unique) preamble. Hence, the scheduling of these relays is done centrally at the BS.

The proposed frame structure has the following advantages:

- It enables RS nodes to relay data between BS and MS for both uplink and downlink, regardless of the number of hops.
- The relaying of data from source to destination may be achieved in the same OFDMA frame.
- The frame structure enables the flexibility for BS and multiple RSs to transmit during the same OFDMA symbol.
- The frame structure enables the flexibility for BS and multiple RSs to transmit during the same burst, allowing cooperative relay, as well as allowing efficient frequency reuse (i.e. simultaneous transmission, as in [2]).

2 General Description

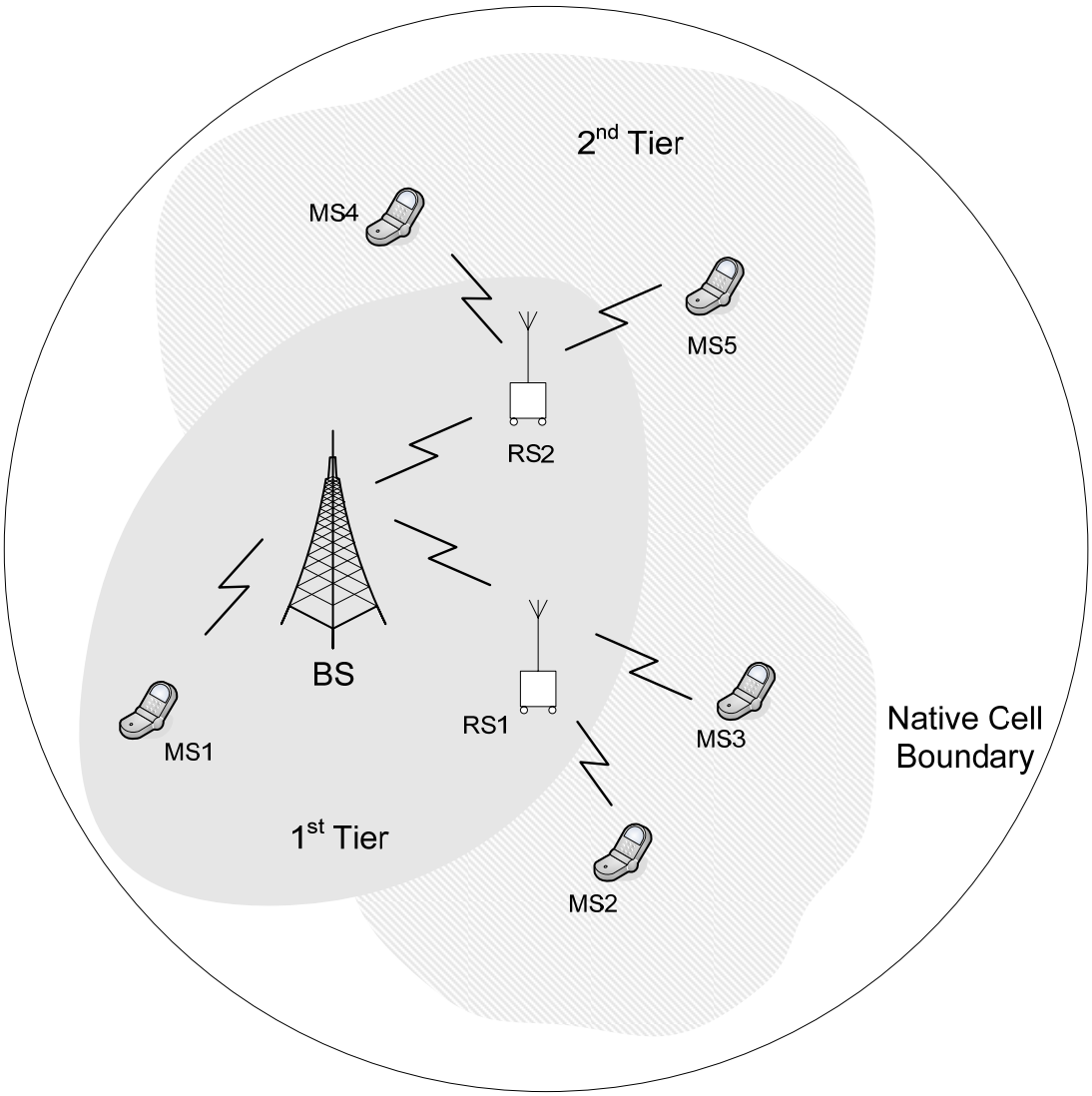

Figure 1 Typical Relay System where all relay and mobile stations can receive control information from the base station.

In this setup, we consider a relay setup where all relay stations (RS) and mobile stations (MS) receive control information such as preamble, FCH and MAP directly from the base station (BS). The RS may assist the BS in transmitting data; however, the MS is not aware of this operation. In other words, the MS is not aware of the presence of relays and continues to receive or transmit packets as if they are from or to the BS directly.

Although the transparent relay does not require the transmission of additional preamble or other broadcast information which are normally necessary for coverage extension, it is still possible to extend the cell coverage. In addition, the transparent relay does increase the link budget, and thus improve the reliability of uplink transmissions as well as increase the throughput of downlink communication. Therefore, the proposed frame structure supports both coverage extension and throughput enhancement.

3 Frame Structure for Transparent Relays

Figure 2 illustrates the proposed frame structure for systems supporting two hops. The shared transmission zone can be used for cooperative relaying, which will be explained in more details in Section 4.

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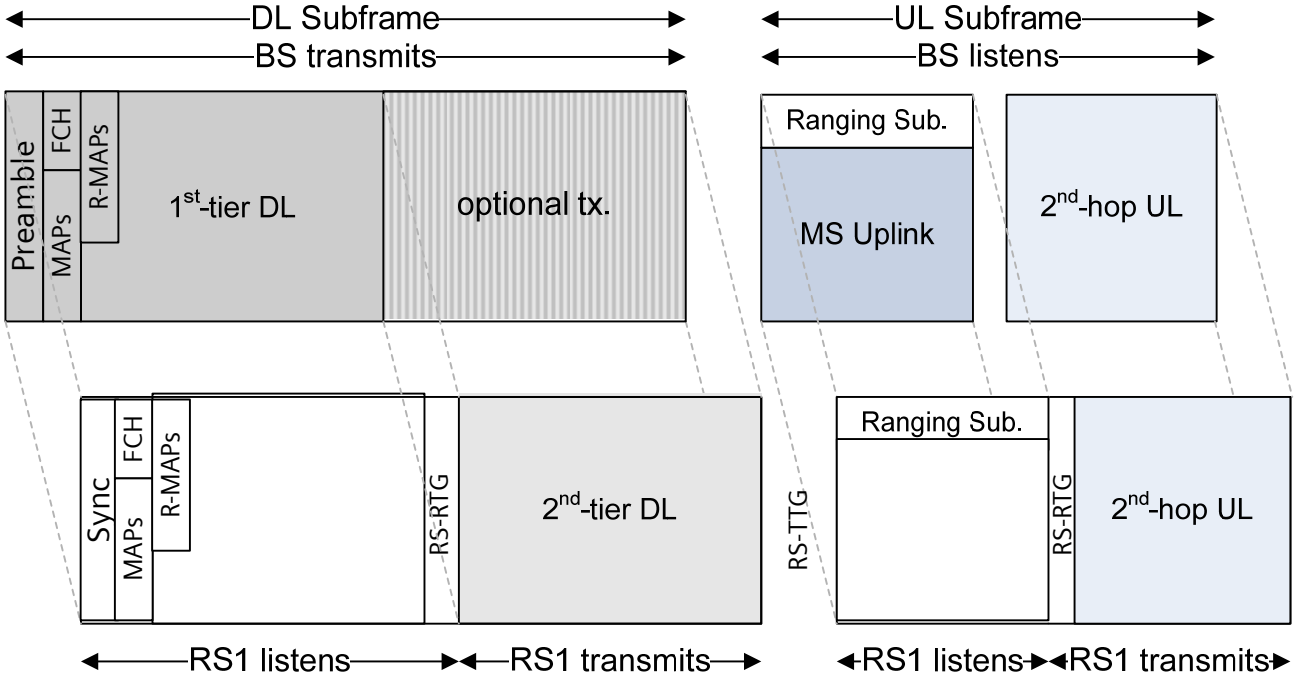

Figure 2 Frame Structure for Two-Hop Transparent Relay System

Here, the BS can transmit during the entire DL subframe. During the first part of the subframe, the resources are used solely for 1st-tier transmissions (i.e. BS-MS or BS-RS). During the second part of the downlink subframe, the resources can be used for both 1st-tier transmissions and 2nd-tier transmissions (RS-MS). This method allows the BS to be in use even after 2nd-tier transmissions are initiated. Simultaneous relaying may be enabled (but not necessary) during this portion of the downlink subframe.

The scheduler is responsible for partitioning the resources (i.e. burst allocation) in the downlink. It decides whether to enable simultaneous transmission or whether to have dedicated transmission. Note that the RS-TTG and RS-RTG take account of the RS turnaround time required to switch between transmitting and receiving modes.

Unlike the DL subframe, the UL subframe is divided into two zones by time division. The first zone is dedicated for MS uplink transmissions, and includes the ranging subchannel. In the second zone (the second-hop zone), the RS forwards data to the BS. To provide backward compatibility to existing 802.16e devices, only the MS uplink region can be used for MS uplink transmission; the second-hop zone shall be inaccessible for MS's transmissions.

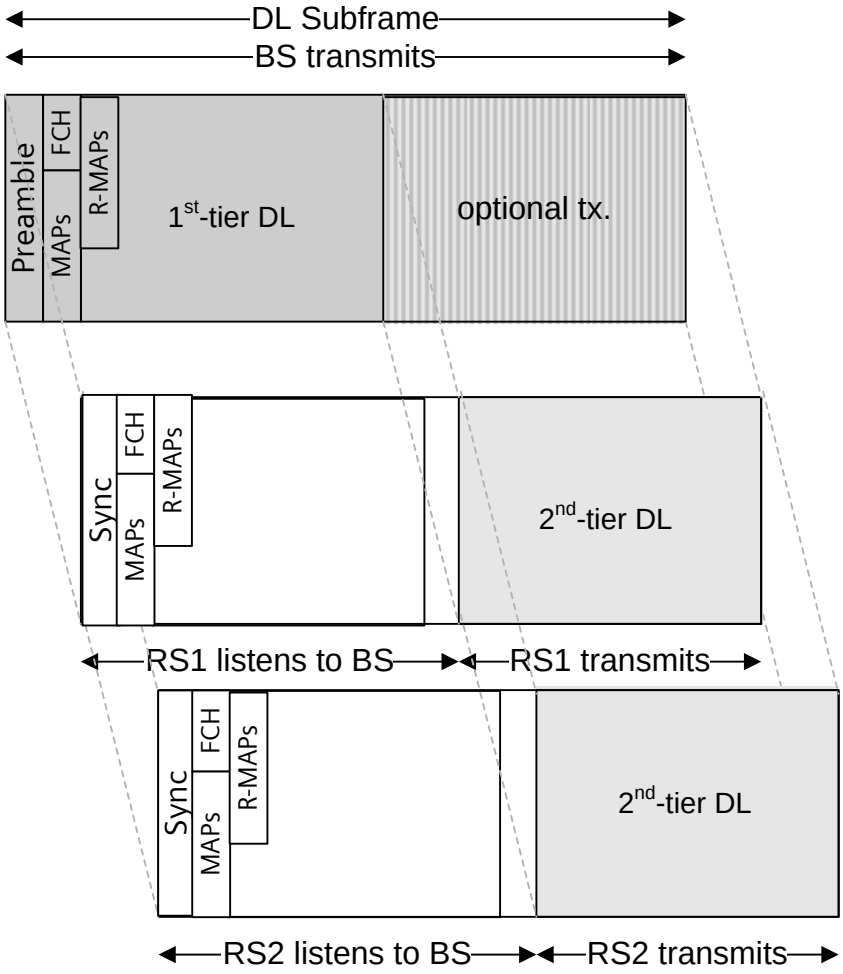

Figure 3 DL Subframe Structure for Simultaneous Transmission

Figure 3 depicts an image where 2 RS exist in a relay-enabled cell. Note that the BS, RS1, and RS2 can potentially transmit at the same time (i.e. simultaneous transmission) during the second part of the downlink subframe.

Simultaneous transmission has two forms: cooperative and non-cooperative. During cooperative simultaneous transmission, the active transmitting stations send the same information (either identical signals or STC coded) intended to the same receiver. During non-cooperative simultaneous transmission, the active transmitting stations transmit different data to different receivers.

This proposal allows both cooperative and non-cooperative simultaneous transmission. That is, we do not prohibit multiple transmitting stations from transmitting in the same burst in the downlink. The BS must decide whether to enable these modes, according to channel conditions.

Note that although Figures 2 and 3 depict a RS that does not transmit a preamble, this simultaneous transmission concept will also work for transparent RS that transmits the same preamble as the access BS. The overhead required to synchronize the RS to BS (including overhead to transmit the control information before the frame begins) does not affect simultaneous transmission.

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4 Proposed Text

[*Change the following text at the end of the subclause 6.3.7.2 as indicated*]
For the case where MR-BS supports ~~two hop~~ multi-hop relay, the DL and UL subframes shall include at least one access zone and may include one or more relay zone to enable RS operating in either transmit or receive mode. The related frame structure is defined in the OFDMA PHY specific section.

[Add the following text into section 8.4.4.7.1]

8.4.4.8 Frame structure for transparent mode

In TDD relaying systems, the BS can transmit during the entire DL subframe. During the first part of the subframe, the resources are used solely for 1st-tier transmissions (i.e. BS-MS or BS-RS). Legacy transmission of preamble, FCH, DL-MAP, UL-MAP and optional R-MAP shall occur in this region. During the second part of the downlink subframe, the resources can be used for both 1st-tier transmissions and 2nd-tier transmissions (RS-MS, RS-RS). During the third part of the downlink subframe, the resources can be used for 1st-tier, 2nd-tier and 3rd-tier transmissions (RS-MS, RS-RS). The RS-TTG and RS-RTG may be allocated by the MR-BS.

Unlike the DL subframe, the UL subframe is divided into two zones by time division. The first zone is dedicated for MS uplink transmissions, and includes the ranging subchannel. In the second zone (the second-hop zone), the RS forwards data to the BS. To provide backward compatibility to existing 802.16e devices, only the MS uplink region can be used for MS uplink transmission; the second-hop zone shall be inaccessible for MS's transmissions. The sizes of UL zones may vary in time to utilize bandwidth resources efficiently.

References

[1] IEEE C802.16j-06/050r4, “Proposed Technical Requirements for IEEE 802.16 TGj”.

[2] IEEE S802.16mmr-05/034r2, “Analysis of Simple Infrastructure Multihop Relay Wireless System”.