Project	**IEEE 802.16j Broadband Wireless Access Working Group**
Title	**Do we need another frame structure for relaying?**
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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 suggests to use the frame structure defined in IEEE802.16e as is, and to apply the relay related modifications with MAC messages.
Purpose	For discussion during session #46
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1 Considerations and motivations

The MS (built to meet the 802.16e standard) is unaware of any relay existence. The introducing of relays into the system cannot change the air frame structure received by the MS and it must be identical to the IEEE802.16e frame structure.

For the MS, all air frames are transmitted from base stations, since the IEEE802.16e standard implicitly assumes a one-to-one BS-to-frame correspondence. This, however, is not a mandatory implementation and the relays enable the frame transmission from entities other than BS (e.g., a relay, a collection of relays). The allocation of Downlink frame transmission is our principal degree of freedom when considering DL-frame adjustments.

In the following we illustrate a few possibilities of frame transmission allocation in a system with relays. They demonstrate that the current frame structure is flexible enough to support relays activity for capacity and coverage enhancement.

2 Downlink frame transmission allocation

The downlink frame transmission is explained with the Virtual BS (VBS) notion.

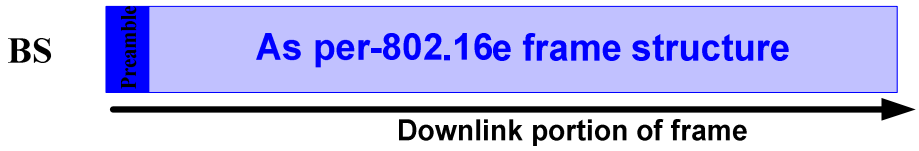
Virtual BS (VBS) is a collection of BS and RS presenting themselves as one BS to the MSs. VBS is identified by the transmission of a unique preamble.

In the examples below only time/zone axis is shown for clarity. Same logic applies to sub-channels.

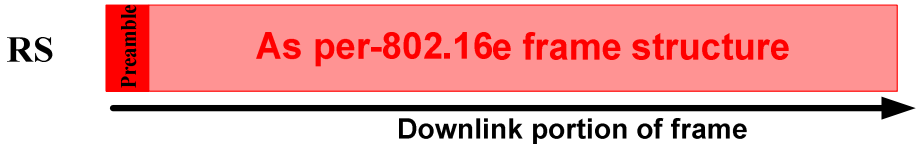
The IEEE802.16e standard implicitly assumes that all frames, i.e. BS, are aligned (Handset manufacturers also assume that in handover?). Following the 802.16e standard, all air frames and downlink/uplink portions are implicitly assumed to be aligned in time (contribution IEEE C802.16j-06/031 discusses other two frame alignment options). If the RS is half-duplex, the MAP information between the BS and the RS is carried by MAC messages in a pre-defined place in the frame. This has no effect on the MS.

VBS Examples:

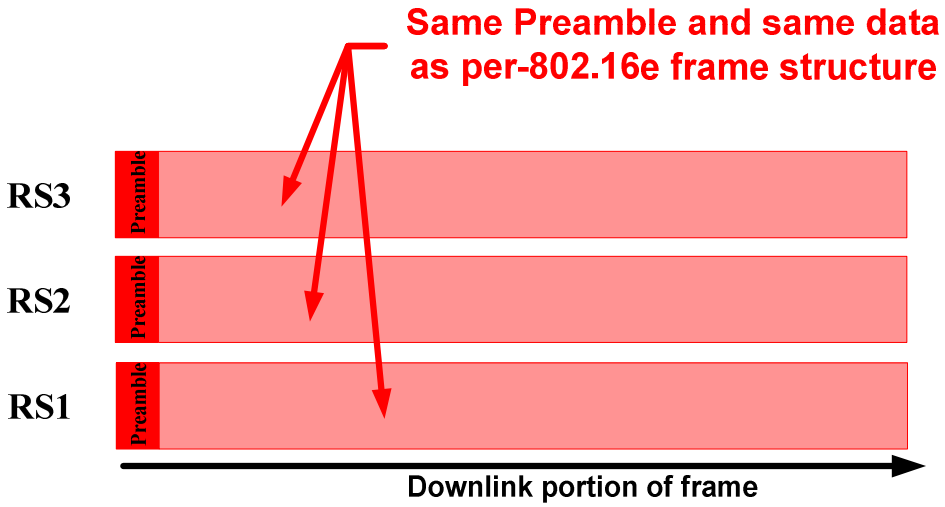
1- VBS made of one BS. In this case the MS receives all data and control from this one BS just like in a non-relayed system.



2- VBS made of one RS. In this case the MS receives all data and control from this one RS

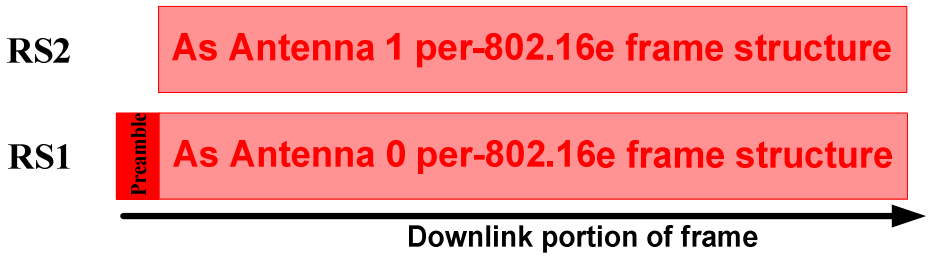


3- VBS made of several RS, all transmit the same preamble. In this case the MS receives all data and control from all RS, all RS send the same waveform, and MS is unable to tell if the VBS has one antenna or more. MS detects one BS with one antenna (antenna 0)



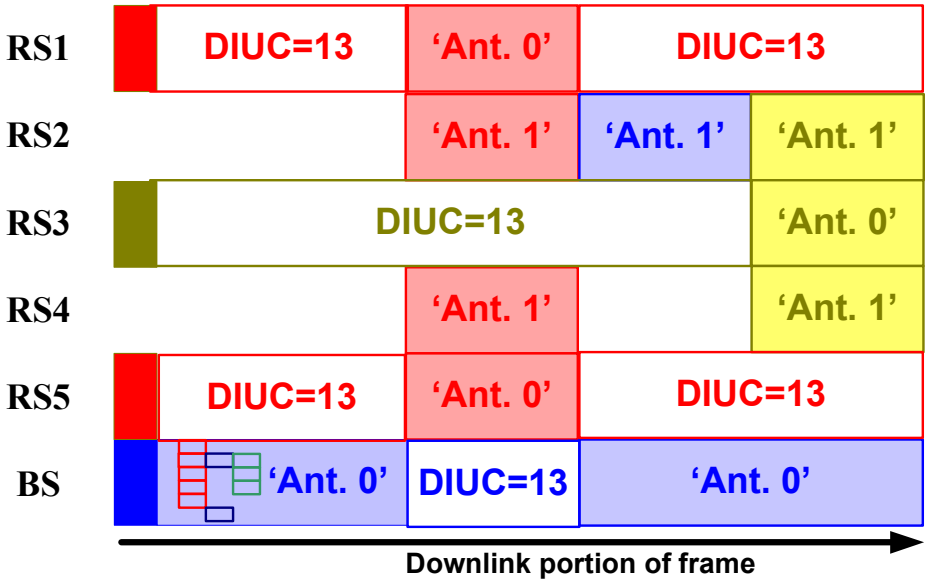
4- VBS made of several RS, not all of them transmit a preamble. In this case the MS regards the VBS as a BS with more than one antenna. The RS

transmitting the preamble is 'antenna 0', and other RS are antenna 1,2 and 3



5- VBS made of BS and several RS, only BS transmits the preamble. In this case the MS regards the VBS as a BS with antenna array. The BS transmitting the preamble is antenna 0, and other RS are antenna 1, 2 and 3.

6- In the following drawing the MS detects 3 VBS. Each VBS is indicated with a different frame color. Safety zone is used to enable TDM between different VBS transmission. RS2 and RS4 are used in two VBS.



Interference control

The allocation of frame transmission to the various relays depends on the RS deployment (especially when RS is client owned) and on the MS distribution.

The allocation is likely to be quasi-static or distributed for multihop relaying and to change on a per-frame basis in one hop system (dynamically coordinated by the base station with MAC messages). These RRM-like algorithms have a great impact on the system performance and they provide significant tools for controlling the interference. The allocation is vendor specific and is outside the scope of the standard.

3 Uplink frame transmission allocation

Data from MS to BS can be relayed via one RS or more

1- The BS instructs one RS or more to relay the MS data

2- Each RS receives the data and decodes it

3- Each RS that decoded the data successfully (e.g., CRC) forwards the data to the BS

4- All the RS uplinks are aligned and they transmit the data in the same slots.

4 Summary

The current frame structure is flexible enough to support the entire relay operation variants. It is important to leave to the vendors the freedom to implement their algorithms and to optimize them for certain scenarios. Mandating a small number of frame structures may limits the applicability of relays. Only the MAC messages controlling the RS transmission and reception allocation should be in the standard.