Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	**Non-transparent relay frame structure extension for multi-hop (>2 hops) support**	
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Re:	Response to the call for proposals	
Abstract	The document gives some proposals on frame structure involving relay preamble and multi-hop (>2) relay support.	
Purpose	For text changes in emerging amendment of IEEE 802.16e-2005 to support MMR functionality.	
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1 Introduction

This document gives proposals on multi-hop relaying frame structure for MR network, to response to the Call for Contribution of IEEE802.16TG.

So far, most frame structure discussion focused on 2-hop relay and has given the preliminary frame structure. In this document, some proposals are given to the preliminary frame structure to make it support multi-hop (>2 hops) relaying. By the way, an optional relay preamble is also proposed for synchronization between MR-BS and RS.

2 Optional relay preamble

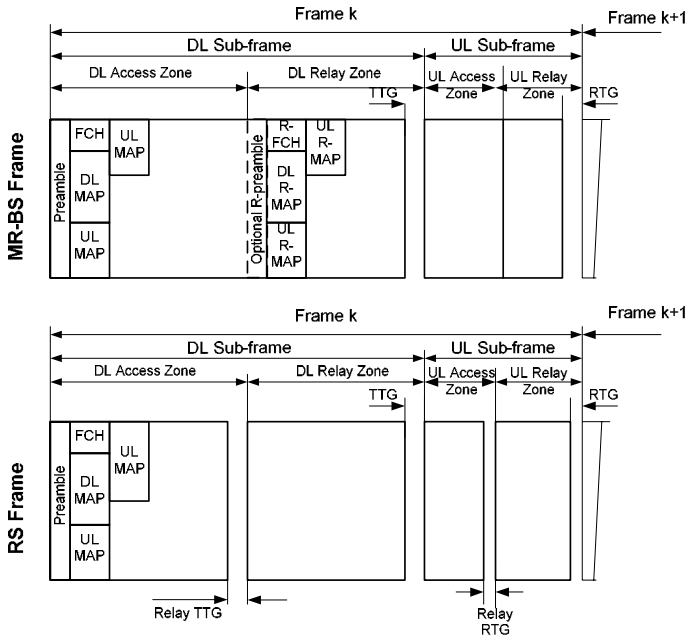

Figure 1 MR-BS and RS frame structure with relay preamble

In preliminary frame structure definition, DL Relay Zone and UL Relay Zone are inserted in DL sub-frame and UL sub-frame respectively. They are used for communication between MR-BS and RS. At the beginning of DL Relay Zone, there are relay FCH, DL-MAP and UL-MAP. But there is not preamble for RS to synchronize to MR-BS or its superordinate RS. Especially for mobile RS (MRS), the synchronization is necessary for relaying channel. Apparently, RS cannot synchronize to MR-BS via the frame head preamble, because at that time it also needs to send preamble to its own MSs. Therefore, it is necessary to add optional relay preamble at the

beginning of DL relay Zone. The relay preamble shall use specialized preamble code, which is transparent to all MS. The frame structure with relay preamble is given in figure 1.

3 Frame extension to support multi-hop relaying (>2 hops)

In the preliminary frame structure, the number, size, and location of the relay zones shall be configurable. The configuration feature makes it easy to support three or more hops. In figure 2~4, three examples are given to implement multi-hop relaying (>2 hops). These examples are suitable for different application cases. Figure 2 shows in-frame multi-hop relaying. This example requires that RS has fast forwarding processing capability. It is suitable for long duration frame, e.g. 10ms or 20ms frame. The advantage of this example is small transmission latency and the latency does not have obvious increase for the case with large hop number.

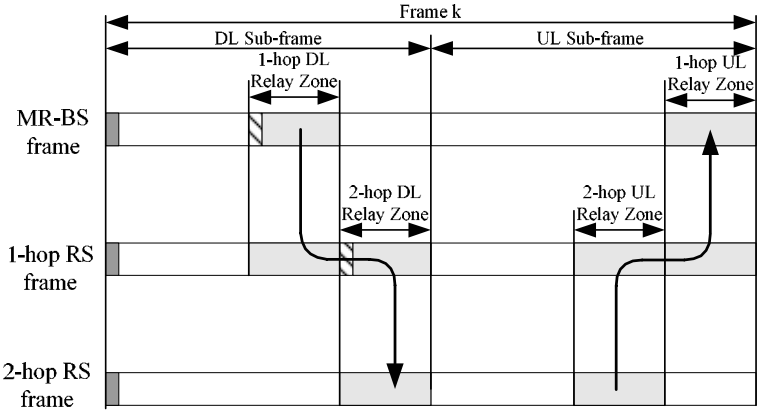

Figure 2 Example of in-frame multi-hop relaying

Figure 3 gives out-frame multi-hop relaying. In this example, one frame has multiple relay zones, but the traffic cannot be forwarded during one frame. The received traffic is always forwarded in the next frame. The traffic is scheduled in pipe-line mode. This example does not need rapid traffic processing and that is in favor of reducing implementation cost.

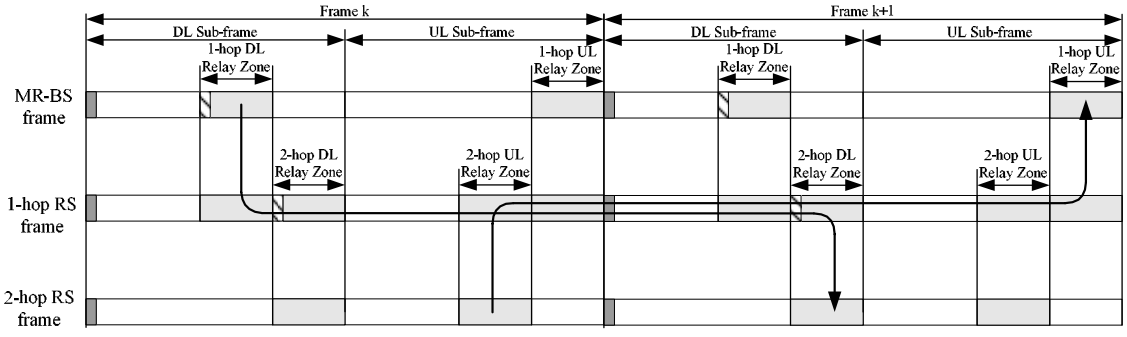

Figure 3 Example of out-frame multi-hop relaying with multiple relay zones

Another example of out-frame multi-hop relaying is given in Figure 4. It only needs one relay zone. This relay zone is used by different 1 hop relaying and 2 hop relaying alternatively. Apparently, this example will have greater latency than the other two examples. But its overhead is less than others.

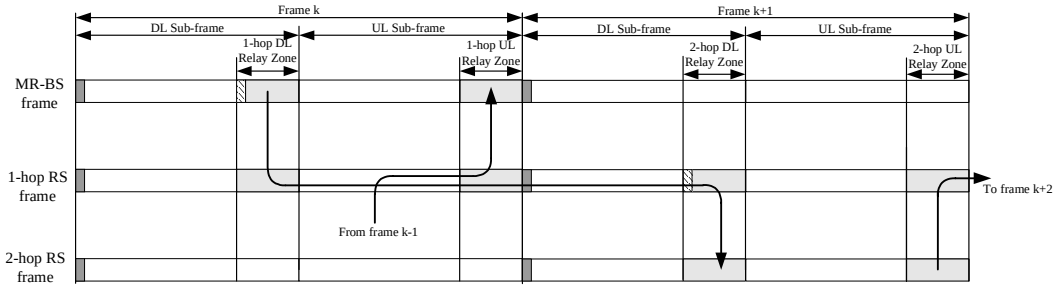

Figure 4 Example of out-frame multi-hop relaying with single relay zone

Proposed text changes

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[Insert the followings after the end of section 3:]

MR-BS frame: Frame structure for DL transmission/UL reception by MR-BS.
RS frame: Frame structure for DL transmission/UL reception by RS.
DL Access_Zone: A portion of the DL sub-frame in the MR-BS/RS frame used for MR-BS/RS to MS transmissions.
UL Access_Zone: a portion of the UL sub-frame in the MR-BS/RS frame used for MS(s) to MR-BS / RS transmissions.
DL Relay_Zone: a portion of the DL sub-frame in the MR-BS/RS frame used for MR-BS/RS to RS transmission
UL Relay_Zone: a portion of the UL sub-frame in the MR-BS/RS frame used for RS to MR-BS/RS transmission.
Relay preamble: The first symbol of DL Relay_Zone in MR-BS/RS frame used for synchronization between MR-BS/RS and RS.

[Insert the followings after the end of section 4:]

R-TTG: Relay-TTG.
R-RTG: Relay-RTG.

R-FCH: Relay-FCH
R-MAP: Relay MAP.
R-preamble: Relay preamble

[Insert the following text at the end of the subclause 6.3.7.2:]

For the case where MR-BS supports 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.

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[Change subclause 6.3.7.3 as indicated:]

6.3.7.3 DL-MAP
The DL-MAP message defines the usage of the downlink intervals on the access links for a burst mode PHY.

[Change subclause 6.3.7.4 as indicated:]

6.3.7.4 UL-MAP
The UL-MAP message defines the uplink usage on the access link in terms of the offset of the burst relative to the Allocation Start Time (units PHY-specific).

[Insert a new subclause 8.4.4.7:]

8.4.4.7 Frame structure of MR-BS and RS
This section describes the minimal requirements for an in-band frame structure for a MR-BS and its subordinate RS.
8.4.4.7.1 Frame structure for transparent mode.

8.4.4.7.2 Frame structure for non-transparent mode

8.4.4.7.2.1 MR-BS frame structure
For the TDD mode, an example of the MR-BS frame structure is shown in Figure xxx.

Each MR-BS frame begins with a preamble followed by an FCH and the DL MAP and possibly UL MAP. The DL sub-frame shall include at least one DL Access Zone and may include one or more DL Relay_Zones. The UL sub-frame may include one or more UL Access Zones and it may include one or more UL Relay_Zones. In each frame, the TTG shall be inserted between the DL sub-frame and the UL sub-frame. The RTG shall be inserted at the end of each frame. In the DL Access Zone, the subchannel allocation, the FCH transmission, and the FCH shall be defined as in Section 8.4.4.2.

The DL Relay_Zone shall include a R-FCH and a R-MAP. The DL Relay_Zone may begin with an optional R-preamble. The R-preamble is different from the preamble at the start of MR-BS frame. It is used for synchronizing between MR-BS and RS. In the DL Relay Zone, the subchannel allocation may be the same as

that in the DL Access Zone. The R-FCH may be the same as the FCH in the DL Access Zone. Other attributes of the MR-BS frame and the RS frame such as transition between modulation and coding, presence of multiple zones, may be the same as those described in 8.4.4.2.

The number, size, and location of the relay zones shall be configurable.

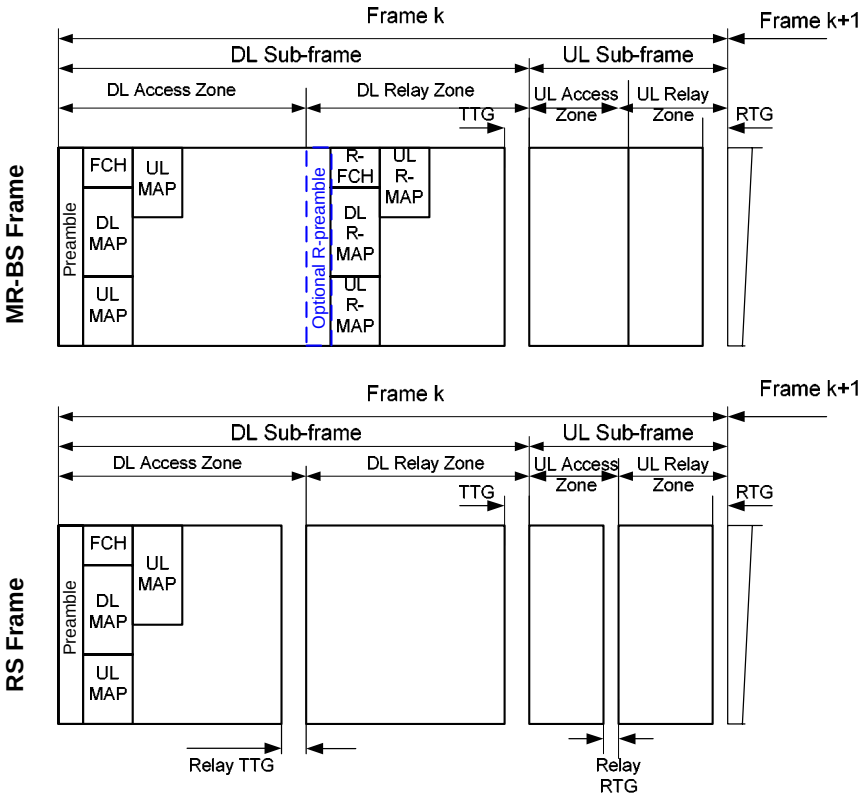

Figure xxx Example of minimum configuration for an in-band non-transparent relay frame structure

8.4.4.7.2.2 Relay frame structure
For the TDD mode, an example of an RS frame structure is shown in Figure xxx.

The Relay Station transmits its frame start preamble time aligned with its serving MR-BS frame start preamble.

The DL sub-frame shall include at least one DL Access Zone and may include one or more DL Relay Zones. An R-TTG-may be placed between a DL Access Zone and a DL Relay Zone.
The UL sub-frame may include one or more UL Access Zones and one or more UL Relay Zones. An R-RTG may be placed between a UL Access Zone and a UL Relay Zone.

If the relay station switches from transmission to reception mode, an R-TTG shall be required. If the relay station switches from reception to transmission mode, an R-RTG shall be required. There may be more than one R-TTG and more than one R-RTG inserted in the RS frame. In each frame, the TTG shall be inserted between the DL sub-frame and the UL sub-frame. The RTG shall be inserted at the end of each frame.

The contents of the FCH, DL MAP, and UL MAP in the Relay Frame may be different from those in the MR-BS Frame.

Each RS frame begins with a preamble followed by an FCH and the DL MAP and possibly a UL MAP. In the DL Access Zone, the subchannel allocation, the FCH transmission, and the FCH shall be as defined in Section 8.4.4.2.

The number, size, and location of the relay zones shall be configurable.

[Insert a new subclause 8.4.4.7.2.3:]

8.4.4.7.2.3 Relay frame structure extension to support multi-hop relaying (>2 hops)

To support multi-hop relaying (>2 hops), the RS frame structure defined in 8.4.4.7.2 shall be extended to as following figure.

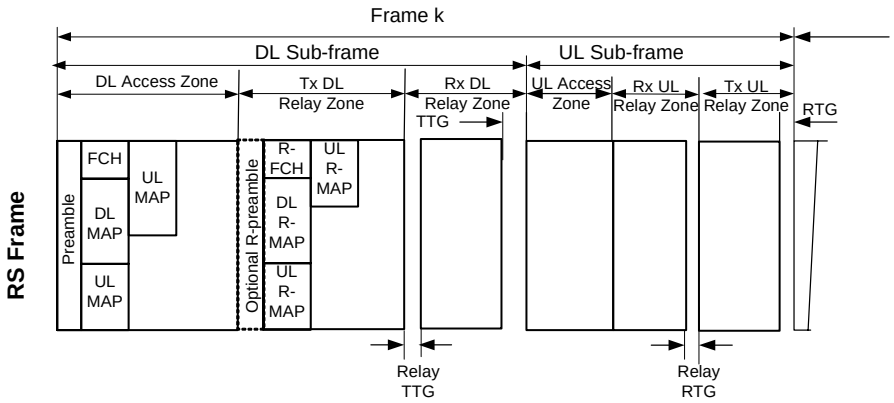

Figure xxx Example of relay frame structure for supporting multi-hop relaying (>2 hops)

The DL Relay Zone of relay frame may be Rx zone or Tx zone. The Rx DL Relay Zone is used for receiving data from MR-BS or superordinate RS. The Tx DL Relay Zone is used for transmitting data to subordinate RS. Each transmission DL Relay Zone shall include a R-FCH and a R-MAP, as well as optional R-preamble. A relay frame can only have Tx DL Relay Zone, or only have Rx DL Relay Zone, or both.

The UL Relay Zone of relay frame may be Rx zone or Tx zone. The Rx UL Relay Zone is used for receiving data from subordinate RS, and the Tx UL Relay Zone is used for transmission data to MR-BS or superordinate RS. A relay frame can only have Rx UL Relay Zone, or only have Tx UL Relay Zone, or have both.

Multi-hop relaying can select in-frame or out-frame relaying according to latency requirement, efficiency requirement, frame size, implementation cost, etc.

Following figure gives an example of in-frame multi-hop relaying. This example requires RS has fast forwarding processing capability. It has low multi-hop transmission latency and the latency does not have obvious increase for the case with large hop number.

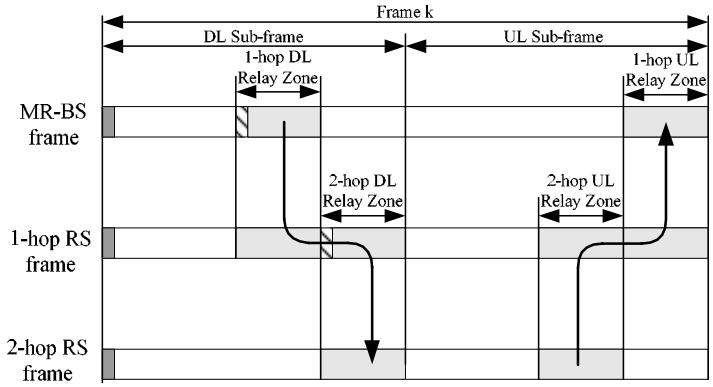

Figure xxx Example of in-frame multi-hop relaying

Following figure gives an example of out-frame multi-hop relaying. Each frame has multiple relay zones, but the traffic cannot be forwarded in one frame. The received traffic is always forwarded in the next frame.

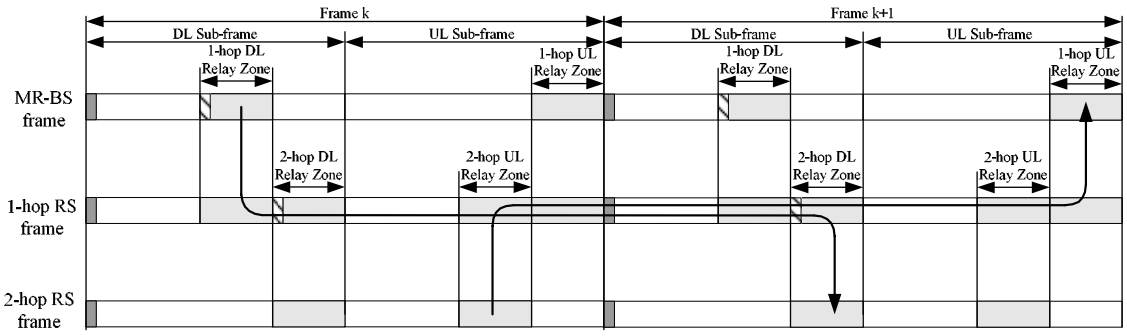

Figure xxx Example of out-frame multi-hop relaying with multiple relay zones per frame

Following figure gives another example of out-frame multi-hop relaying. Each frame only have one relay zone and it is used by 1-hop relaying and 2-hop relaying alternatively.

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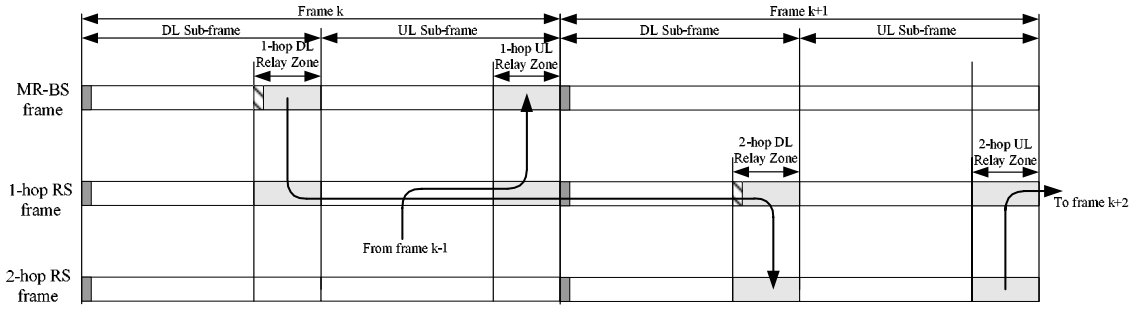

Figure xxx Example of out-frame multi-hop relaying with single relay zone per frame

++++++++++++++++++++ *End of text proposal* ++++++++++++++++++++++