Project	IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>
Title	Multi-frame structure consistent to 802.16e for MR Networks
Date Submitted	2007-05-04
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Re:	This is a response to the call for technical contributions 80216j-07_007r2.pdf
Abstract	This contribution proposes a multiple frame operation consistent with 802.16e legacy frame structure to support multi-hop between MR-BS and RS
Purpose	Text proposal for 802.16j Baseline Document
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Multi-frame structure consistent to 802.16e for MR Networks

1. Introduction

Based on centralized scheduling and the legacy system frame structure for BS and MS, this contribution proposes a multiple frame structure for consistency with the 802.16e legacy frame structure to support multi-hop relay operation which avoids inter RSs and inter MR-BS and RS interference. In our scheme, MR-BS ignores all the intermittent RS and only does resource allocation for every MS in the network in the same way as the legacy BS does. MR-BS broadcasts the topology and frame control information to each RS. After RS receives the signal from MR-BS or superordinate RS in the current frame, it only simply relays the data bursts which belongs to its subordinate RS or MS and ignores the other data bursts.

2. Characteristics

2.1 Advantages

o complete backward compatible frame structure to 802.16e legacy system.
o no PHY revision for the legacy BS.
o without RS, multi-frame length is equal to 1. It is exactly the legacy system.
o no interference between MR-BS and RS, or between RSs anywhere in the cell.
o applicable to dynamic topology
o to allow large hop counts and enhance the flexible network deployment capability
o very simple RS deployment and less overhead.

2.2 Comparison to existing frame structures.

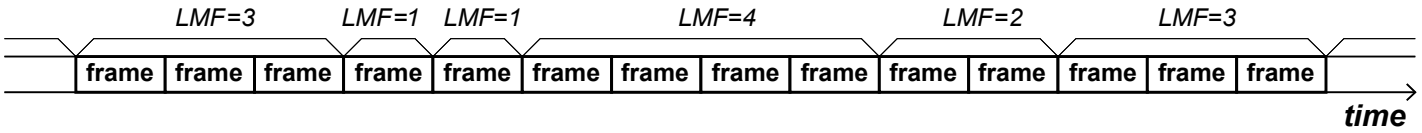
Item	Transparent FS	Non Transparent FS	Multi-frame FS
1. Coverage extension	One-hop(preamble, MAP)	Multi-hop	Multi-hop
2. Inter-RS-cell interference	NA	High	None
3. HO burden between RSs	None	Exist	None
4. Performance (*dependent on item 2 and 3*)	*In BS coverage: High* *Outer BS coverage: -*	*In BS coverage: same as 16e* *Outer BS coverage: medium*	*In BS coverage: same as 16e* *Outer BS coverage: medium*
5. UpLink delay(i.e 2-hop MS)	Not applicable	5 frames	5 frames
6. Revision part of MR-BS	BS scheduler	PHY,MAC & Upper Layer	BS scheduler
7. RS implementation feature	1 RF modem and gate logic	Bulky system	1 RF modem and gate logic
8. Usage model best fit	-	Fixed infrastructure RS Temporary RS	Fixed infrastructure RS In-Building RS Temporary RS Mobile RS
9. Client owned RS issue	Low cost	High cost Negative impact on Network stability when frequent on-off and mal-functioning	Low cost Robust when various problems in client owned RS occur
10. Topology flexibility	-	Lower flexibility Need careful RS cell planning	High flexibility b/w m-frames Fixed within multi-frame Easy to deployment
11. Frame operation	Receive/transmit relay	Alternatively receive and	Alternatively receive and

	signal in one frame	transmit between frames	transmit between frames
12. MS mobility	High in BS coverage	Frequent hand-off	Well Supported in MR-BS cell
13. Tx/Rx switching times in one frame at RS	4	3	1
14. AMC in RS	Not defined	Supported	Fixed by MR-BS within a multi-frame
15. Scheduling	Centralized scheduling only	Centralized/distributed scheduling	Centralized scheduling only

3. Proposal for Multi-frame Operation

(1) Multi-frame concept
- A Multi-frame consists of *L* subsequent frames.

LMF: length of Multi Frame



A legacy frame can be a multi-frame with multi-frame length of 1. Multi-frame structure is actually an extended version of the legacy system frame structure when it is also used for relay function.

(2) Dynamic Multi-frame considering MR topology and traffic load

The length of Multi-frame(*LMF*) is determined before the Multi-frame start time, in consideration of topology and traffic load. One method may be used to determine LMF as follows:

LMF = the length of Multi-frame = max (*MHR*+1, 2 * *MHM* + 1)

MHR : the maximum hop counts of active RSs

MHM : the maximum hop counts of MSs who have at least one UL traffic at start of Multi-frame

Example:

if no RS in a cell, *LMF* ~~= max (0+1, 2-1)~~ = 1

else if there exist 1-hop RSs and 2-hop MSs {

if at least an MS has UL data to send, LMF = max (1+1, 2*2+1) = 5

else no MS has UL data to send, *LMF* = max (1+1, 0+1) = 2

}

(3) Use of identical frame control information
- use frame control information containing Preamble, FCH and MAPs (or including DCD and UCD)
- apply identical frame control information to all of the frames in a Multi-frame except the frame number.
- an RS shall update the frame number in the received frame control information by incrementing and reassembling for relaying.
- RS ignores the bursts which are not related to the RS's subordinates.

(4) RS simultaneous transmission of preamble during the time of reception from parent RS or MR-BS.

In order to keep the MS backward compatible, RS could transmit the preamble signal during reception mode. Preamble shall be transmitted in synchronously with the reception of preamble in DL-subframe from its superordinate. We do not need Tx/Rx mode switching.

As a simple example for implementing simultaneous transmission, we can use extra preamble transmission RF modulator which starts to transmit deterministic preamble with a trigger signal from a timing controller and

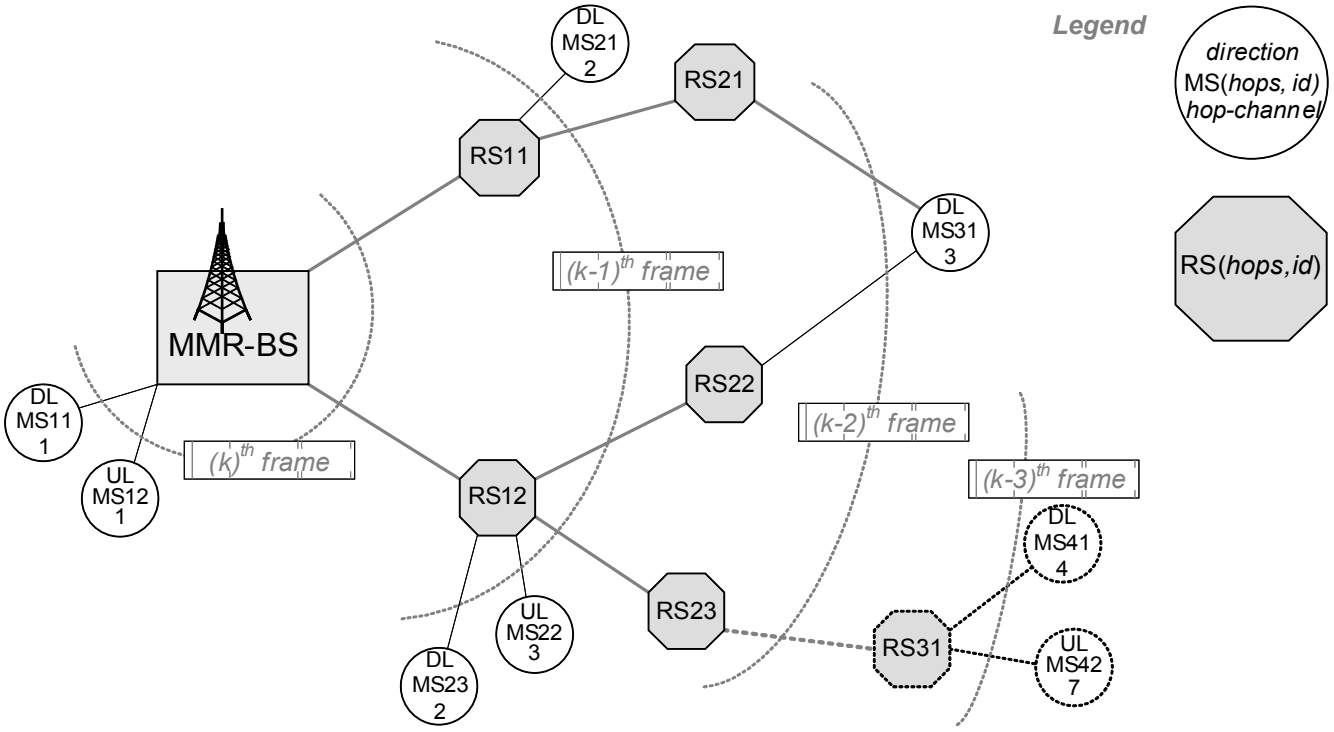
stops to transmit when preamble transmission ends.

The feed back preamble signal to Rx channel can be properly cancelled. In our multi-frame RS case since the preamble is deterministic for a certain MR-BS and it is independent from the received signal. So we can simultaneously transmit and receive the preamble signal in the implementation easily.

The feedback may cause interference to RS with simultaneous transmission and reception of preamble. But there are various methods to solve this problem. The following solutions could be adopted:

- Antenna directivity/positioning
. Rx antenna can focus on the super-ordinate direction
. the preamble Tx antenna could be installed on roof top while Rx antenna posted on side.
- Feedback interference cancellation and isolation.
- Intentional delay within CP period for Tx signal so that RS can synchronize to super-ordinate, while MS still can receive the preamble.

(5) Sample topology

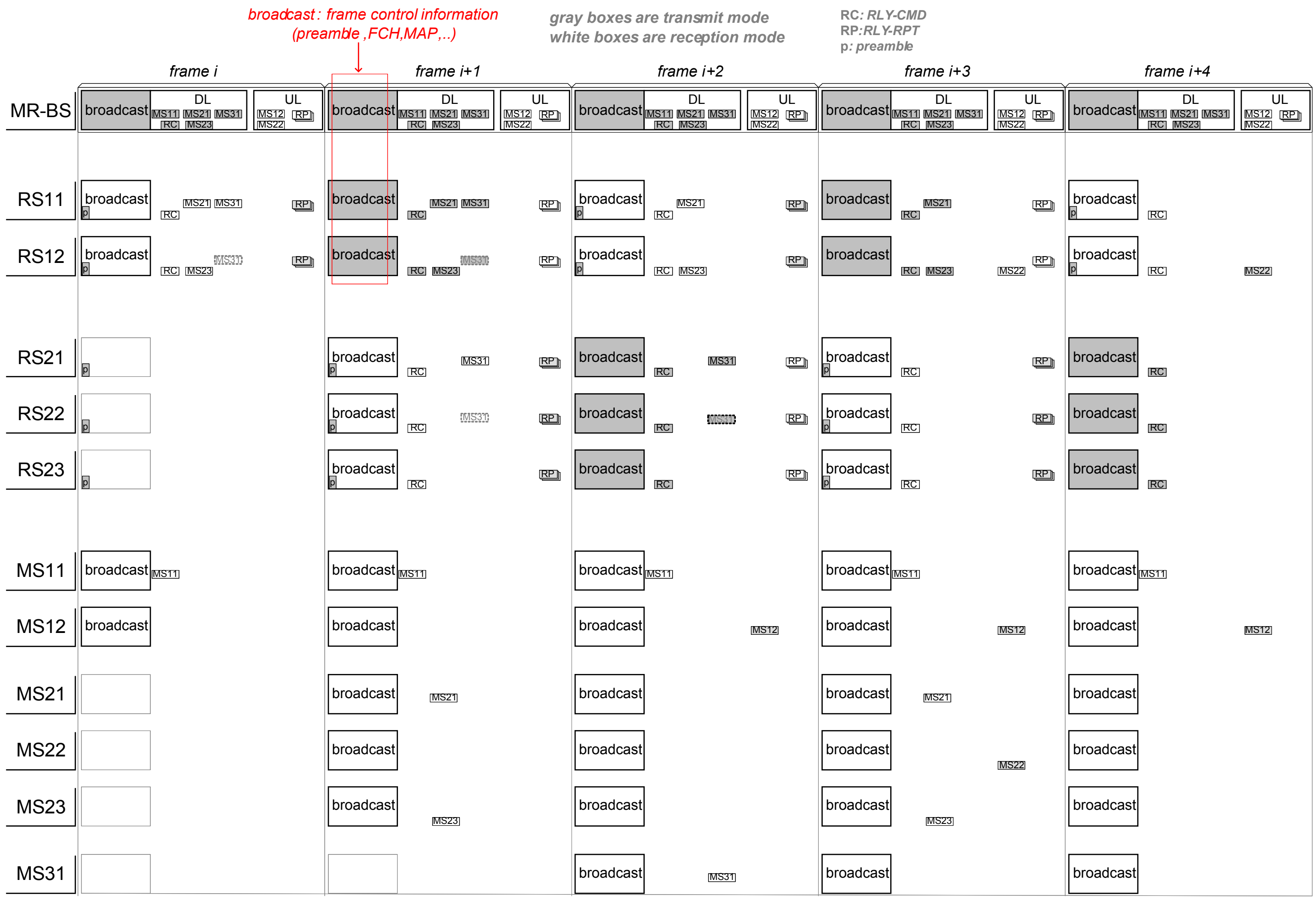


(fig. 1) A sample for showing network topology and frame transmissions of hop links during k^{th} frame transmission at MR-BS

In figure 1, k is an arbitrary frame sequence number of a Multi-frame with the range of $1 \leq k \leq LMF$(length of Multi-frame). In addition, before every Multi-frame is transmitted into the air, k shall be renewed and LMF shall be re-calculated.

An RS shall transmit received frame to subordinates according to the control message of the multi-frame.

(6) Burst transmission and reception state diagram for the sample topology



(fig. 2) Burst transmission and reception state diagram at nodes of the sample topology

4. Text Proposal

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Insert new subclause 8.4.4.7.3

8.4.4.7.3 Multi-frame structure consistent to 802.16e

A Multi-frame consists of certain number of subsequent frames. An example of the multi-frame structure is shown in Figure <xxx>.

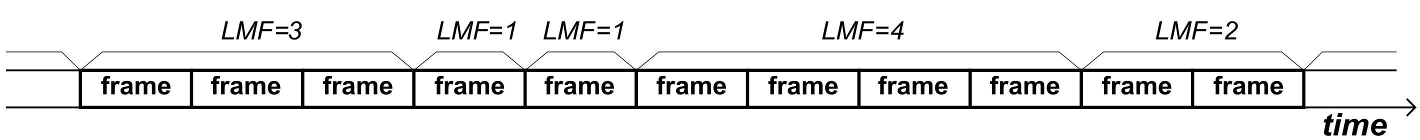

Figure <xxx> Multi-frame structure

Insert new subclause 8.4.4.7.3.1

8.4.4.7.3.1 MR-BS multi-frame structure

For the TDD mode, MR-BS uses the legacy 802.16e frame as a unit frame to construct a multi-frame by grouping these units with a repeating pattern according to the network topology. In every multi-frame for MR-BS, each unit frame is the same as in legacy 802.16e Section 8.4.4.2. Within a multi-frame, all the unit frames may use the preamble/FCH/ MAP/UCD/DCD as required by the network planning.

Insert new subclause 8.4.4.7.3.2

8.4.4.7.3.2 Relay frame structure

For the TDD mode, Relay has two mode of operation, MS-mode and BS-mode.
During MS-mode, each RS functions as a legacy MS frame operation.
During BS-mode, each RS transmits the unit frame with the same structure as described in legacy 802.16e Section 8.4.4.2, but ignores the bursts which are not related to its subordinate RS or MS.
Relay changes its operation mode between MS-mode and BS-mode.
Within a multi-frame, RS works in MS-mode at first. Only after receiving the correct frame control information (Preamble/FCH/MAP/UCD/DCD), RS shall change to BS-mode in next frame and then return to MS mode again.
RS should transmit the preamble simultaneously as it receives the preamble during MS-mode.
An example for RS unit frame structure in MS-mode is shown in Figure <yyy>.

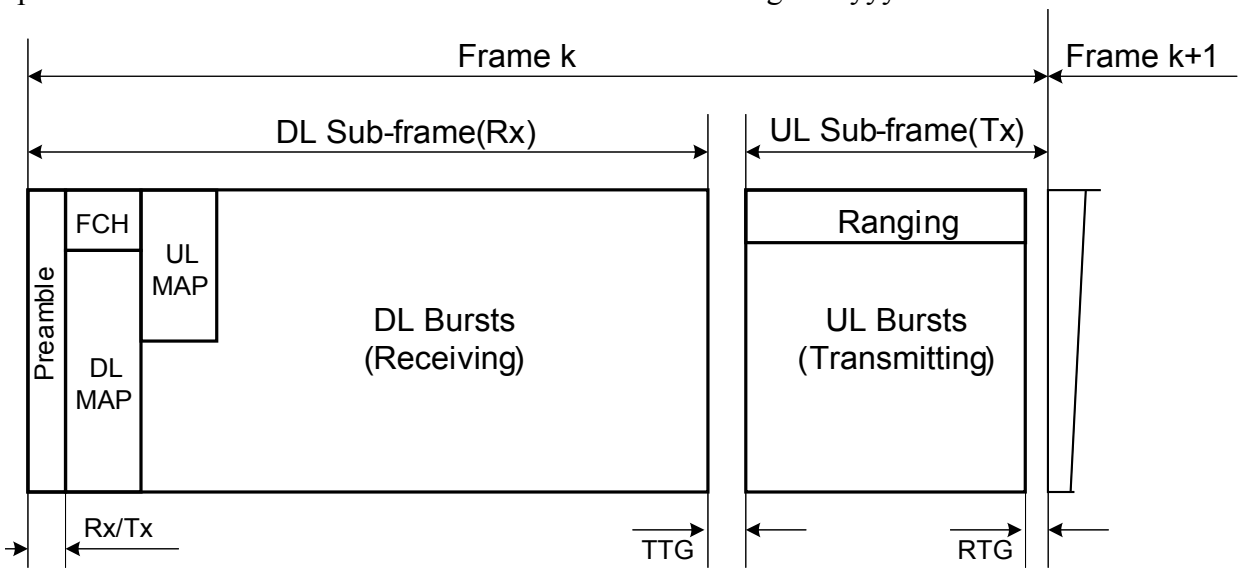

Figure <yyy> RS unit frame structure in MS-mode

An example for RS unit frame structure in BS-mode is shown in Figure <zzz>.

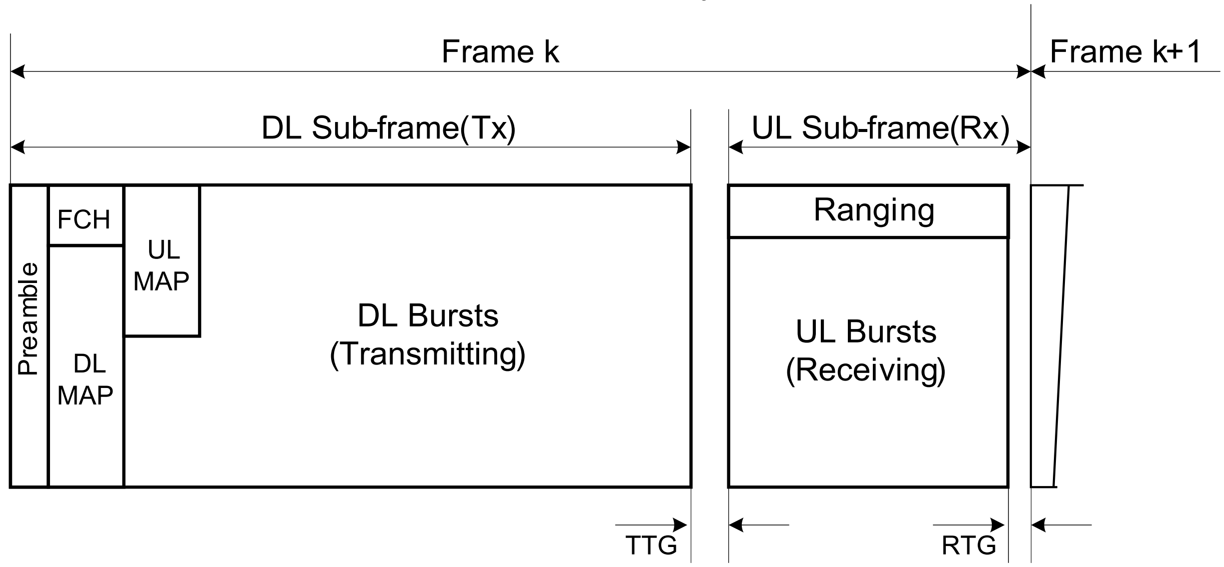

Figure <zzz> RS unit frame structure in BS-mode

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