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| Abstract | Frame structures of MMR-BS and RS shall be defined to enable backward compatibility and efficient R-link operation. This contribution proposes frame structure design for both MMR-BS and RS. |
| Purpose | Adopt the proposed text proposal |
| Notice |  |

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# Frame Structure to Support Relay Node Operations

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## Introduction

The frame structure for the MMR-BS and RS shall be defined to enable backward compatibility and efficient R-link operation. This contribution proposes frame structure design for both MMRBS and RS.

The design for the MMRBS and RS frame structures are:

- Backward compatibility such that no changes are required for MS operation;
- Efficient R-link operation;
- Support for both in-band and out-band relays;
- Minimize delay;
- Minimize changes needed from the current frame structure;
- A single unified frame structure supporting both single-hop and multi-hop relaying
- Preferably a single frame structure to handle all usage scenarios;
- Flexibility to accommodate variable traffic flow
- Support for both centralized scheduler and distributed scheduler

This contribution proposes a frame structure for in-band relay operation. For out-band relay, the existing .16e frame structure can be used without any modifications.

The following assumptions are made for the frame structure design:

For the range extension usage scenario, the MS may not be able to see the BS’s preamble; in this case, a RS is required to transmit a preamble and broadcast information to allow the MS to synchronize to the system. In this case, the RS is required to transmit the .16e preamble and broadcast information at the same location in the frame as the BS. Therefore, control information from the MMRBS to the RS must be transmitted in a different location in the frame, since a RS may not be able to transmit and receive at the same time. In our proposal, a Relay Zone (R-Zone) is introduced for communication between the MMRBS and the RS (and similarly for communication between a RS to its child RS).

The frame structure should support simultaneous transmission between MMRBS and RS, MMRBS and MS, RS and RS, and RS and MS to maximize the spatial multiplexing gain. With this consideration, each RS should have a unique cell-ID. In the case where a spatial multiplexing is not required, a group of RS can share the same Cell-IDs (see contribution C802.16j-06/234).

## MMRBS frame structure and RS frame structure

The IEEE 802.16e frame structure can be adapted for use with RSs by allocating different Zones of the DL and UL sub-frames for BS and RS transmissions. Figure 1 shows the proposed MMRBS frame structure using a 3 hop relay system as an example. The same frame structure applies to a RS located at any hop in a multihop path.

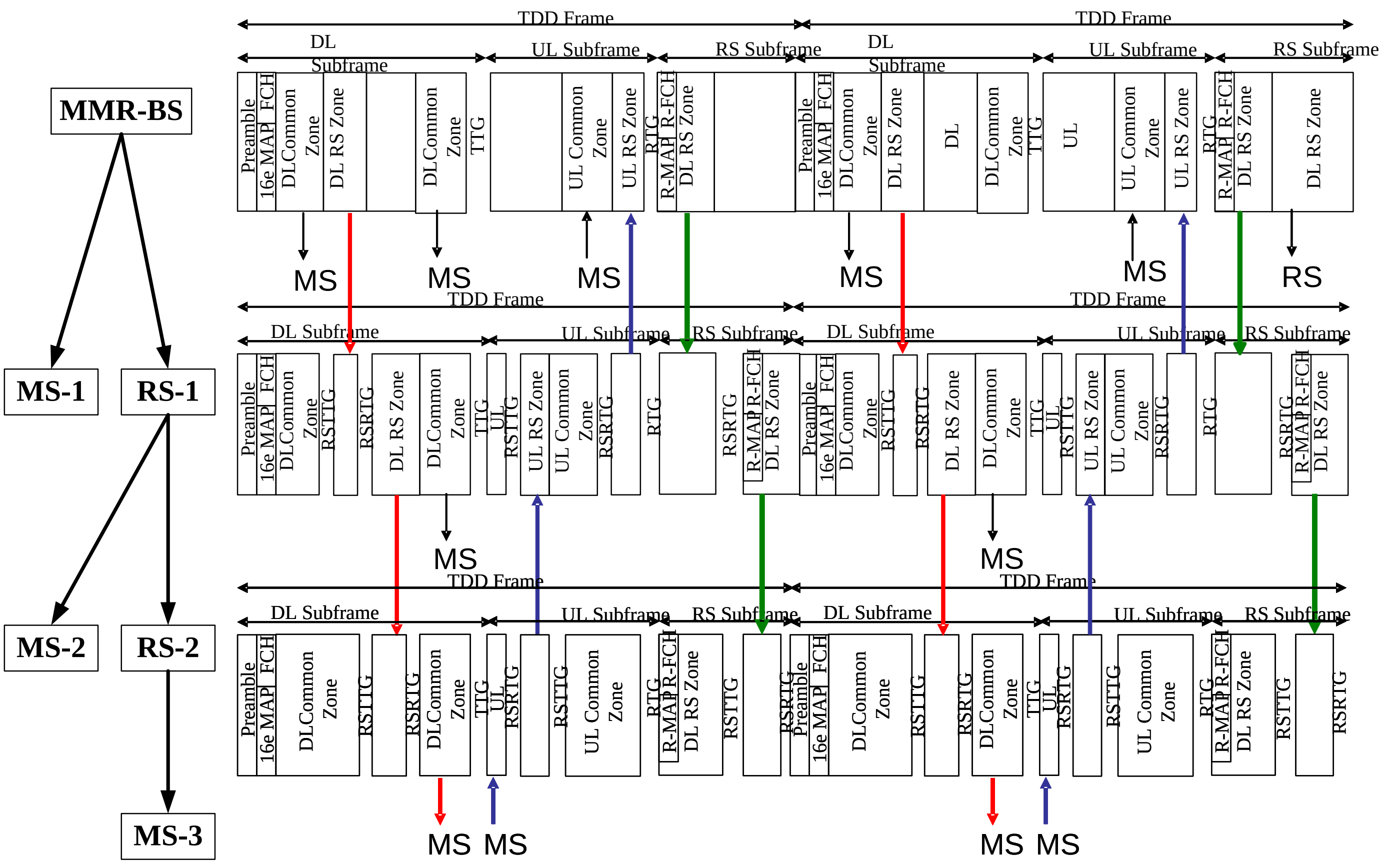

Figure 1 Proposed frame structure for an examplary 3 hop relay system

## *MMR-BS Frame Structure*

The MMRBS frame structure proposed is shown in Figure 2.

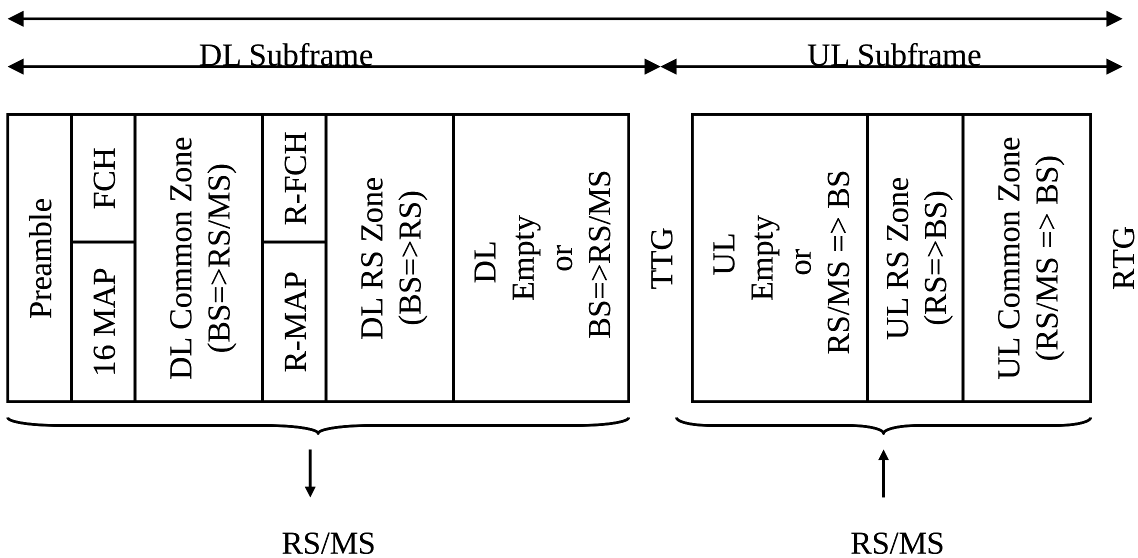


Figure 2 MMR-BS frame structure

In this frame structure, we introduced several zones:

- DL Common_Zone
- DL RS_Zone
- UL Common_Zone
- UL RS_Zone

The DL sub-frame may contain a DL Common_Zone, which is a portion of the DL sub-frame used by an MMR BS for transmission to an MS(s) and/or to an RS(s) that is not required to transmit a preamble, FCH and MAPs at the beginning of the frame. The DL sub-frame may contain zero or one or multiple DL Common Zones.

The DL sub-frame may contain a DL RS_Zone, which is a portion of the DL sub-frame used by an MMR-BS for transmission to an RS(s). The DL RS_Zone is dedicated for the purpose of communication between an MMR-BS and RSs between which it is possible to establish a radio link, and is introduced for the following reasons:

- To enable a serving RS with single radio to transmit an 802.16e preamble, FCH and perhaps MAPs (when needed) to ensure normal operation of an 802.16e MS;
- The control signaling such as resource assignment (R-MAP) between an MMRBS and an RS within the RS_Zone may be transmitted using a more efficient format than that of the 16e MAP IEs to save MAC overhead;
- The data between an MMRBS and an RS within the RS_Zone may be transmitted using more efficient modulation/coding rate and antenna technologies;
- More efficient sub-channelization within RS_Zone may be implemented.

The DL RS_Zone contains R-FCH and R-MAP. R-FCH is used to indicate the R-MAP transmit format and R-MAP is used for the similar functions as DL/UL-MAP.

The rest of the DL sub-frame may be left empty (i.e., no data transmission) if a MMRBS scheduler decides to work with the RS in TDM fashion to reduce the interference, i.e., the duration is reserved for RSs serving their MSs. Alternatively, a MMRBS scheduler may schedule data transmission to an MS(s) in this part of the DL sub-frame, at the same time as RS transmissions, assuming that interference is properly managed.

To reduce the scheduling latency, an optional RS Subframe may be created to include one or multiple DL RS_Zone, as shown in Figure 3. From a MS perspective, RS Subframe is part of the UL Subframe.

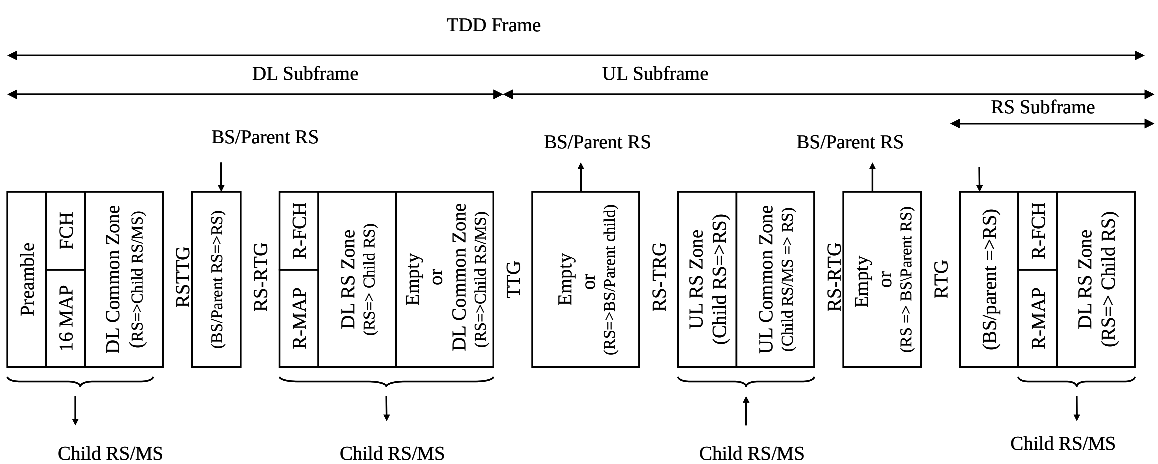

Figure 3 MMR-BS frame structure

## *RS Frame Structure*

The proposed RS frame structure is shown in Figure 4.

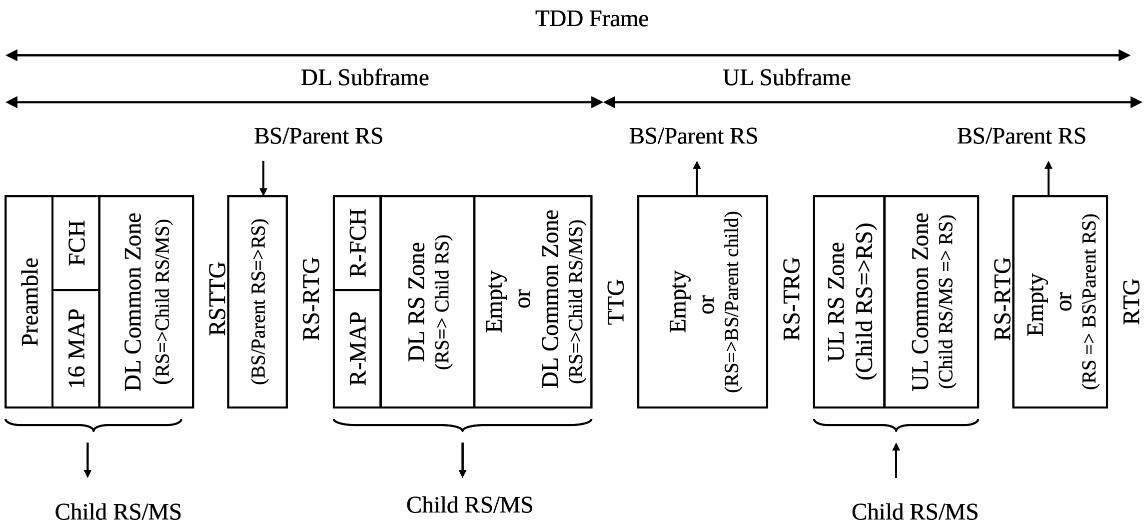


Figure 4 RS frame structure

The frame structure of a serving RS is similar to that of a MMR-BS, except that there may be more than one TTG and more one RTG included for a RS to turn around between transmission and receiving

An RS(s) may use a DL Common_Zone, present in the DL sub-frame, for transmission to MS(s) and or to child RS(s) that are not required to transmit a preamble, FCH and MAPs at the beginning of the frame. RS(s) may use zero or one or multiple DL Common Zones. A RS(s) may use a DL RS_Zone, present in the DL sub-frame, for transmission to child RS(s) that are required to transmit a preamble, FCH and MAPs at the beginning of the frame. RS(s) may use zero or one or multiple DL RS Zones.

The UL sub-frame may contain an UL Common Zone, which is a portion of the UL sub-frame used by an MS(s) for transmission to an MMR BS and or an RS(s). The UL sub-frame may contain zero or one or multiple UL Common Zones.

The UL sub-frame may contain an UL RS Zone, which is a portion of the UL sub-frame used by an RS for transmission to an MMRBS and or an RS(s). The UL sub-frame may contain zero or one or multiple UL RS Zones.

To reduce the scheduling latency, an optional RS Subframe may be created to include one or multiple DL RS_Zone, as shown in Figure 5. From a MS perspective, RS Subframe is part of the UL Subframe.

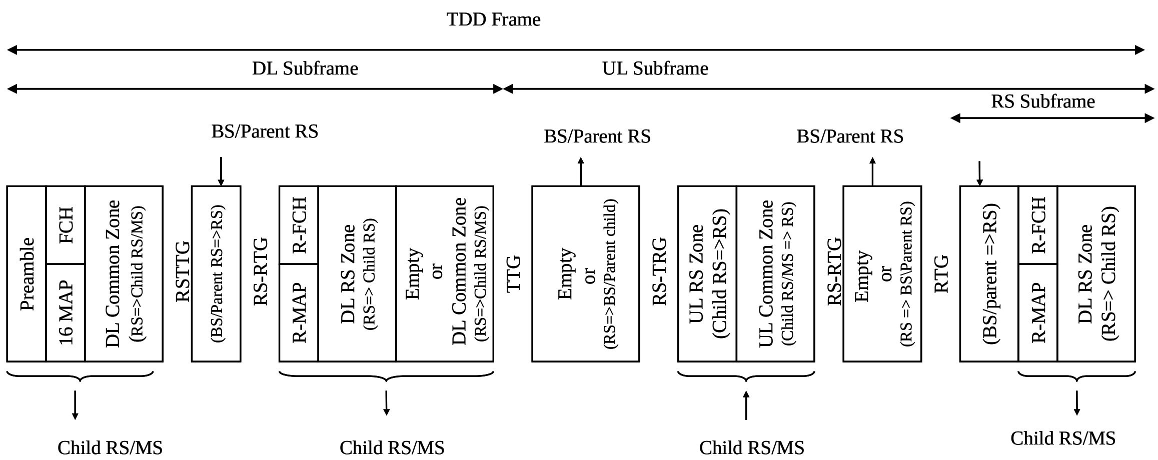


Figure 5 RS frame structure

## Proposed text change

*[Replace 8.4.4.7 by the following text on Page 370 ]*

8.4.4.7 Frame structure of MMRBS and RS

This section describes the frame structure for a MMRBS and a serving RS.

8.4.4.7.1 MMRBS frame structure

When implementing a TDD system, the MMRBS frame structure is shown in Figure XXX.

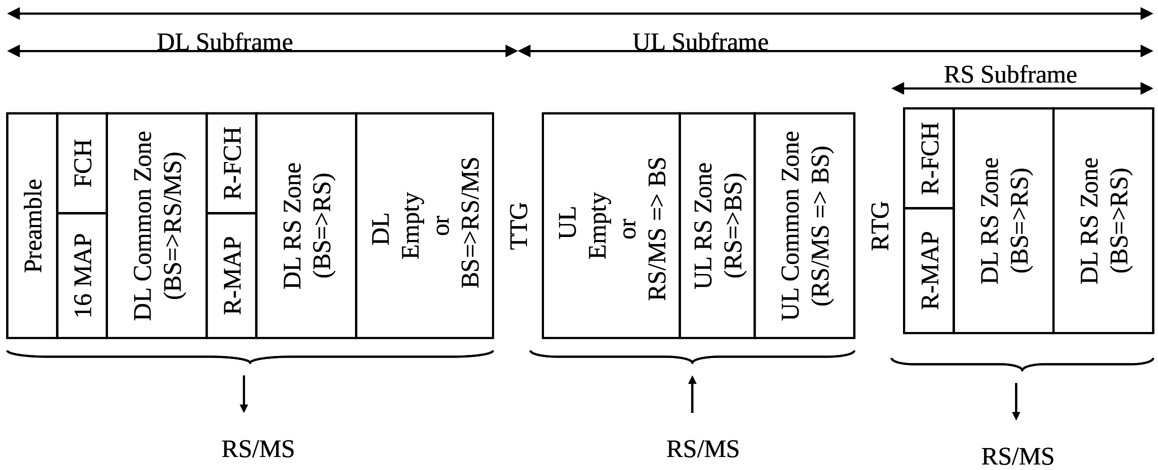


Figure XXX. MMRBS frame structure.

Each MMRBS frame begins with preamble followed by a DL sub-frame and a UL sub-frame, and an optional RS sub-frame.

The frame may contain the following zones:

- **DL Common_Zone:** a fraction of DL sub-frame used by an MMR-BS for transmission to an MS(s) and or to an RS(s) that is not required to transmit a preamble, FCH and MAPs at the beginning of the frame;
- **UL Common_Zone:** a fraction of UL sub-frame or RS sub-frame (if exists) used for the transmission of 802.16e MS(s)/RS(s) to MMR-BS;
- **DL RS_Zone:** a fraction of DL sub-frame used by an MMRBS for transmission to an RS(s);
- **UL RS_Zone:** a fraction of UL sub-frame used for receiving from RS(s).

The DL sub-frame may include one or multiple Common_Zones and zero or one or multiple DL RS_Zones. The UL sub-frame may include zero or one or multiple UL Common_Zones and zero or one or multiple UL RS_Zones. The RS sub-frame may include one or more DL RS_Zones.

In each frame, the TTG and RTG shall be inserted between DL sub-frame and UL sub-frame and at the end of each frame, respectively to allow a MMRBS to turn around.

The first DL RS_Zone within a frame shall include R-FCH and may include R-MAP for the purpose to signal the resource assignment for RSs and may include resource assigned to RS(s).

An MMR-BS uses 802.16e MAPs to signal the resource assignments to 802.16e MS(s) and RS(s), which are not required to transmit an 802.16e preamble, FCH and MAPs and uses R-MAP to signal the resource assignment to RS(s) that need to transmit the 802.16e preamble.

### 8.4.4.7.2 Frame structure of RS

When implementing a TDD system, the frame structure of a RS with preamble transmission is shown in Figure XXX.

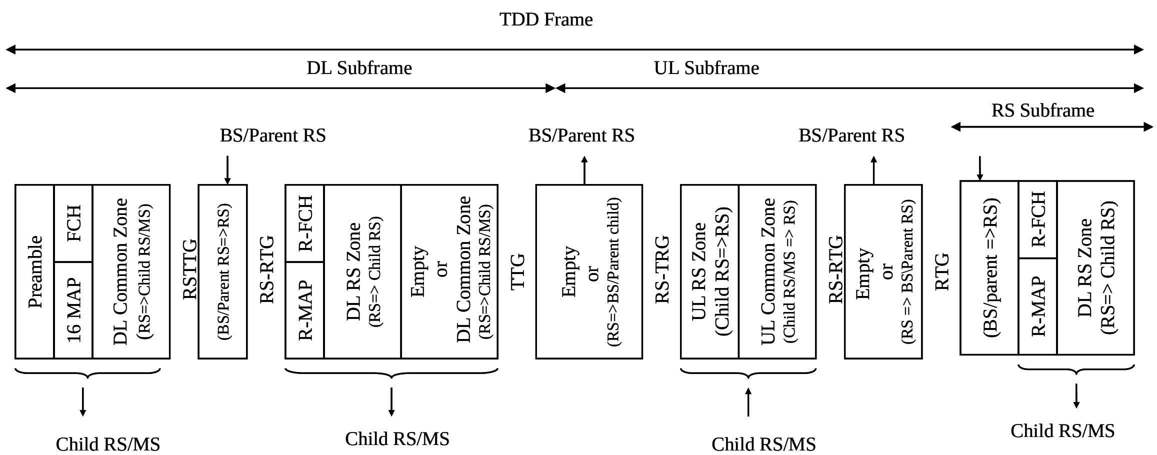


Figure XXX. Frame structure of RS with preamble transmission.

The frame of RS with preamble transmission (serving RS) begins with 802.16e preamble followed by a DL sub-frame, a UL sub-frame, and an optional RS sub-frame.

The frame may contain the following zones:

- **DL Common_Zone:** a fraction of DL sub-frame used for the transmission of a serving RS to 802.16e MSs and/or its child RSs, if any, which are not required to transmit 802.16e preamble
- **UL Common_Zone**: a fraction of UL sub-frame used for receiving from 802.16e MS(s) and child RS (if any)
- **DL RS_Zone:** a fraction of DL sub-frame used for transmission of a serving RS to its child RS(s), if any, which are required to transmit preamble.
- **UL RS_Zone:** a fraction of UL sub-frame used for receiving from child RS(s)

The frame structure of a serving RS is similar to that of a MMRBS, except that there may be more than one RS-TTG and more one RS-RTG included for a RS to turn around between transmission and receiving.

8.4.4.7.3 R-FCH channel

If a DL RS_Zone contains a R-FCH channel, the R-FCH channel shall be transmitted in the first sub-channel. The R_FCH shall be transmitted using QPSK rate ½ with four repetitions. The R-FCH contains the RS-Zone Prefix as described in 8.4.4.7.4. The location of first DL RS_Zone is described by FCH in the same frame as described in 8.4.4.3 and by R-FCH of the previous frame. A RS, during network entry, to identify the location of the first DL RS_Zone based on FCH. A RS, during normal operation, identifies the location of the first DL RS_Zone based on the R-FCH transmitted in the previous frame.

RS-Zone prefix

The RS-Zone prefix is a data structure transmitted on R-FCH of a DL RS_Zone. The RS-Zone prefix includes information regarding the location of RS_Zone in the next frame, information required for decoding R-MAP and etc. Table XXX defines the format of RS_Zone prefix.

| Syntax | Size (bits) | Notes |
|---|---|---|
| RS_Zone_Prefix_format () { | | |
| RS_Zone location | 6 | The field indicates the OFDM symbol index reference to the beginning of next frame in unit of 2 OFDM symbols |
| R-MAP length | 5 | Length in unit of sub-channel |
| MCS index used for R-MAP | 4 | Modulation and coding index |
| RS_Zone/Common_Zone indicator | 1 | 1: the following zone is a Common_Zone, i.e., this RS_Zone only includes OFDM symbols containing the R-FCH and R-MAP<br>0: the following zone is a RS_Zone, i.e., this RS_Zone includes more OFDM symbols (rather than only symbols containing the R-FCH and R-MAP) for RS related bursts |
| } | | |

**RS_Zone location**

An indicator regarding the location of RS_Zone in the next frame. The first OFDM symbol in each frame is indexed as 0. The RS_Zone location indicates the OFDM symbol index relative to the first OFDM symbol in next frame. The unit is 2 OFDM symbols.

**R-MAP length**

The length in sub-channels of R-MAP message that immediately follows the RS_Zone prefix.

**MCS index used for R-MAP**

An indicator indicating the modulation and code rate used for R-MAP message.

**RS_Zone/Common_Zone indicator**

An indicator indicating whether this RS_Zone only includes OFDM symbols containing R-FCH and R-MAP and is followed by a Common_Zone or this R-FCH is the beginning of a longer RZ-Zone, i.e., this RS_Zone includes more OFDM symbols (rather than only symbols containing the R-FCH and R-MAP) for RS related bursts.

*[Change row 9 in Table 268 in Page 359 as indicated]*

| Syntax | Size | Notes |
|---|---|---|
| ~~*Reserved*~~ RS_Zone Prefix location | ~~4 bits~~ | ~~Shall be set to zero~~ Indicates the OFDM symbol index relative to the beginning of current frame in unit of 2 OFDM symbols. |

*[Insert the following sentence at end of page 359]*

**RS_Zone Prefix location**

Indicates the OFDM symbol index relative to the beginning of current frame in unit of 2 OFDM symbols.

[1] "Relay Grouping and PUSC Segment Selection for FCH/MAP Transmission", Hang Zhang, Derek Yu, Peiying Zhu, Wen Tong, David Steer, Gamini Senarath, Mark Naden, G.Q. Wang, Kanchei (Ken) Loa, Yung-Ting Lee, Yi-Hsueh Tsai, Chih-Chiang Hsieh, Heng-Iang Hsu, Shiann-Tsong Sheu, C802-16j_06/234

[2] "Relay Station Modes - design objectives of relaying frame structure", Kanchei (Ken) Loa, Yung-Ting Lee, Yi-Hsueh Tsai, Heng-Iang Hsu, Shiann-Tsong Sheu, Hang Zhang, Derek Yu, Peiying Zhu, Wen Tong, David Steer, Gamini Senarath, Mark Naden, G.Q. Wang, C802-16j_06/205