A Frame Structure Design for OFDMA-based Multihop Relay Networks

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Jeffrey Z. Tao, Koon Hoo Teo, Jinyun Zhang   Voice: 617-621-{7557, 7527}

Mitsubishi Electric Research Lab   Fax: 617-621-7550

201 Broadway, Cambridge, MA 02139, USA   Email: {tao, teo, jzhang}@merl.com

Toshiyuki Kuze   Voice: +81-467-41-2885

Mitsubishi Electric Corp.   Fax: +81-467-41-2486

5-1-1 Ofuna Kamakura, Kanagawa 2478501, JAPAN   Email: kuze.toshiyuki@ah.MitsubishiElectric.co.jp

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Purpose:

Propose extension and enhancement to the current frame structure in order to support OFDMA-based multihop relay networks.

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Authors:

Jeffrey Z. Tao, Koon Hoo Teo, Jinyun Zhang
Mitsubishi Electric Research Lab
201 Broadway
Cambridge, MA 02139

Toshiyuki Kuze
Mitsubishi Electric Corp
5-1-1 Ofuna Kamakura, Kanagawa
2478501, Japan

Requirements

- A general multihop relay network may assume two possible basic topologies:
    - Range extension is the primary function of relay in topology 1.
    - Relay helps improve capacity in topology 2.
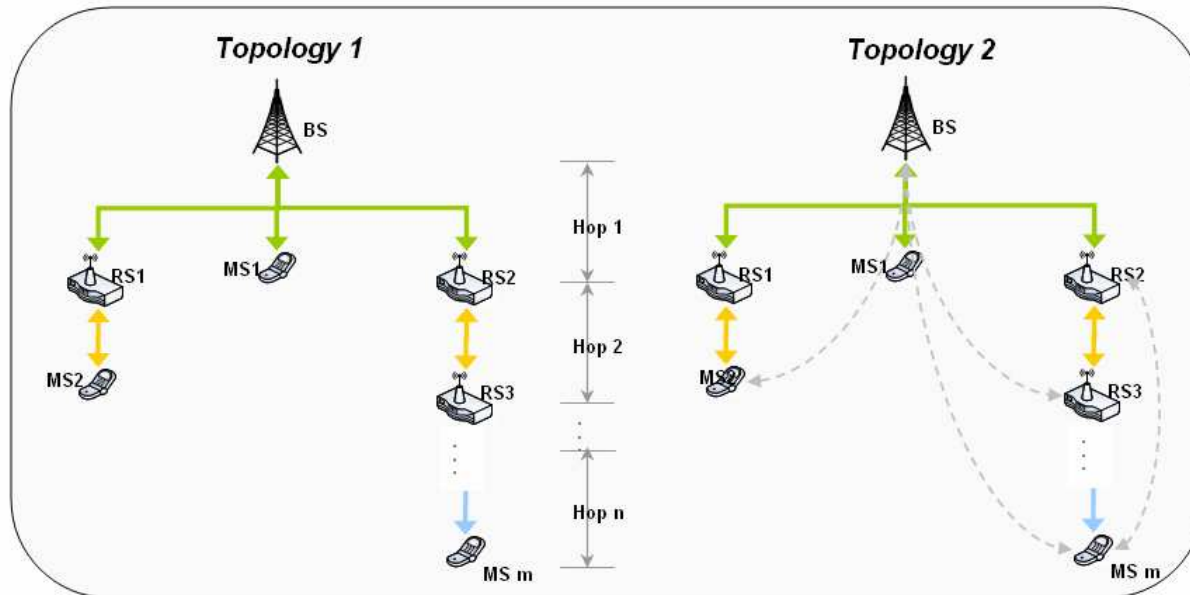
- The extended/enhanced frame structure should support following features
    - Support various network topologies
    - *Backward compatibility* with legacy MSs/SSs
    - *Flexibility* and *extensibility*
    - *Simplicity* and *efficiency*

Backward-Compatibility

- The frame structure information is broadcast by MMR-BS and RS to the RS and MSs associated with it.
- The notion of downlink (DL) and uplink (UL) subframe are still preserved, so that the legacy MSs/SSs can still operate properly.
- The format of *preamble* and key management messages (e.g., *FCH, DL-MAP, DCD, UL-MAP, UCD*) should be understood by the legacy MSs/SSs.
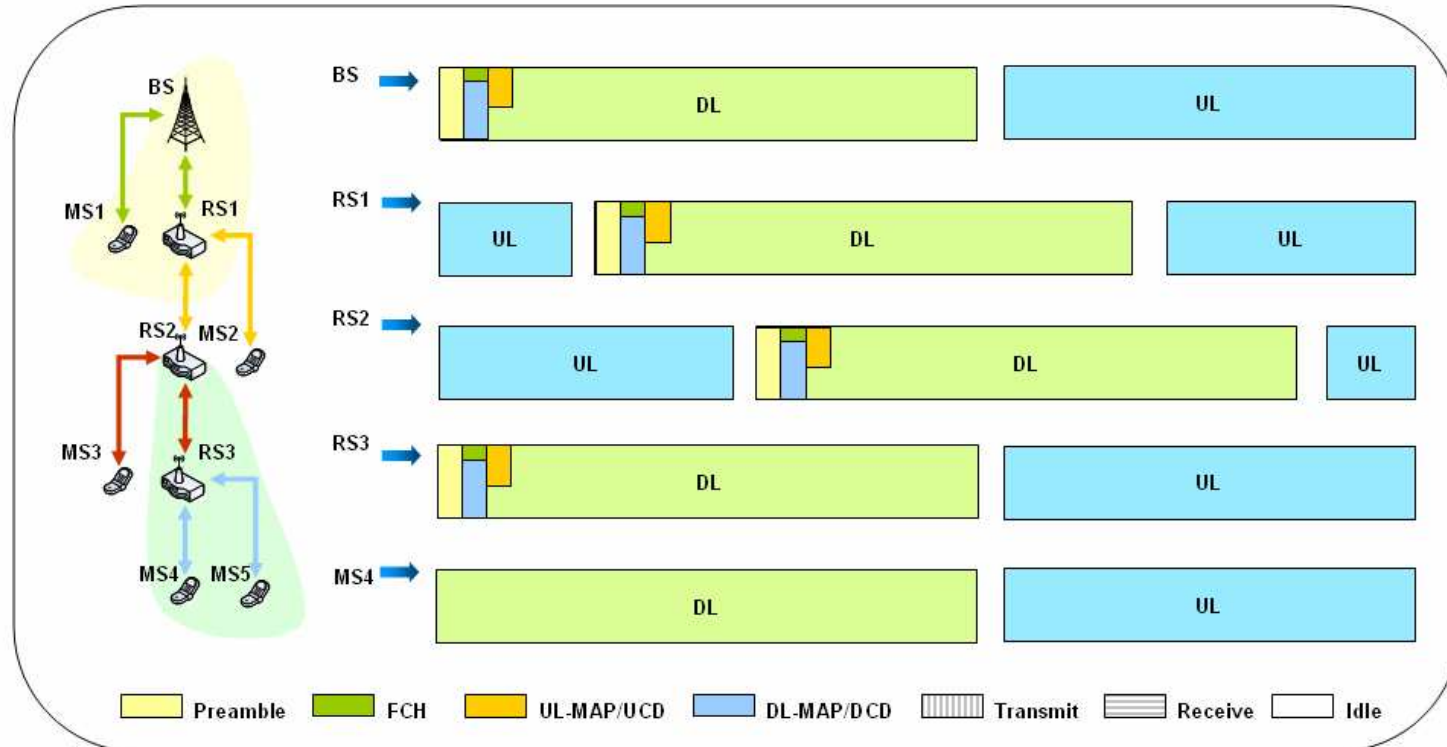
Flexibility & Extensibility

- BS and RS partition the DL and UL subframe into multiple intervals (e.g., zones) to accommodate various communication needs arising from a vast variety of network topologies and traffic conditions, and deployment scenarios.
  - From a BS or RS perspective, it can transmit, receive or stay idle during a DL and an UL subframe.
  - The conventional concept of DL and UL have been relaxed.
  - This extended notion of DL and UL is kept transparent to the legacy MSs/SSs.
  - The actual resource allocation is handled by implementation-dependent scheduling algorithm, which can assume either *centralized* or *distributed* nature.
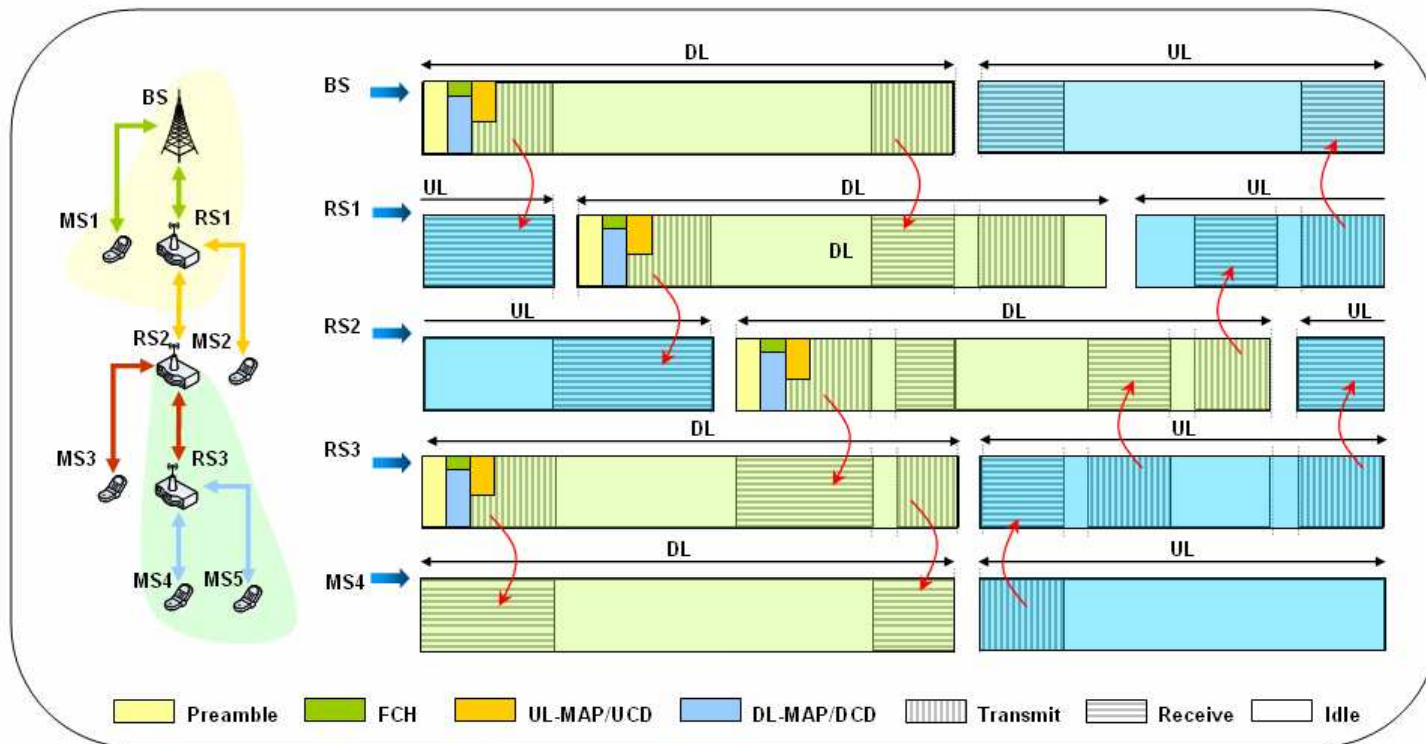
Simplicity

- BS and RS indicate to the associated RSs the change of intervals and probably the detailed schedule within such intervals.
  - Only a few new information elements and TLVs are needed.

|	Function	Extension/Enhancement Involved
DL	Switch to RX	Extend DL_zone_switch_IE, based on extended-2 IE format.
	Switch back from RX	Extend DL_zone_switch_IE, based on extended-2 IE format.
	Detailed schedule within RX interval/zone during logical DL subframe	Introduce DL_RX_MAP_IE, based upon the content of UL_MAP_IE and extended-2 IE format.
	Channel description	Extend TLVs in DCD to describe UL channel.
UL	Switch to TX	Extend UL_zone_switch_IE, based on extended-2 IE format.
	Switch back from RX	Extend UL_zone_switch_IE, based on extended-2 IE format.
	Detailed schedule within TX interval/zone during logical UL subframe	Introduce UL_TX_MAP_IE, based upon the content of DL_MAP_IE content and extended-2 IE.
	Channel description	Extend TLVs in UCD to describe DL channel.
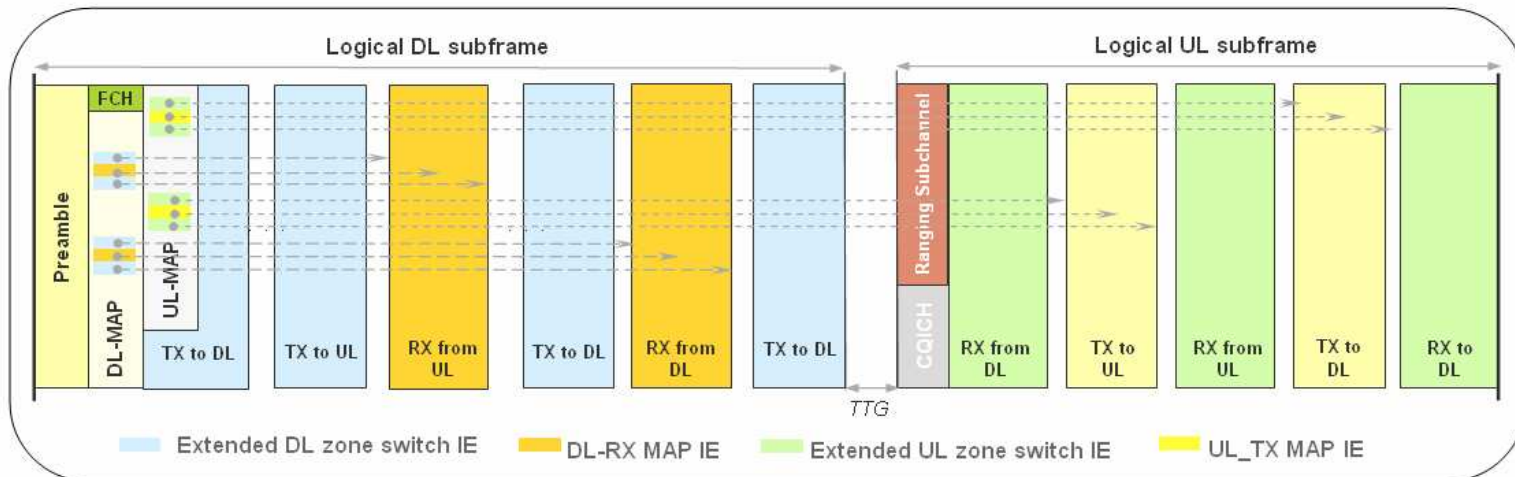
Efficiency

- Frequency/spatial reuse
  - To avoid potential interference, BS and RS may need to announce idle periods in logical DL or UL subframe.
  - Given a large enough distance, same subchannels can be reused again.

- RTG and TTG can be inserted on a needy basis.

- In capacity improvement scenario, some RSs may not need to transmit MAP messages.
  - Preamble from these RSs may still be needed.
  - The preamble from BS or upstream RSs may not be used by MSs/SSs to estimate the channel, as that preamble traverses through a different channel.
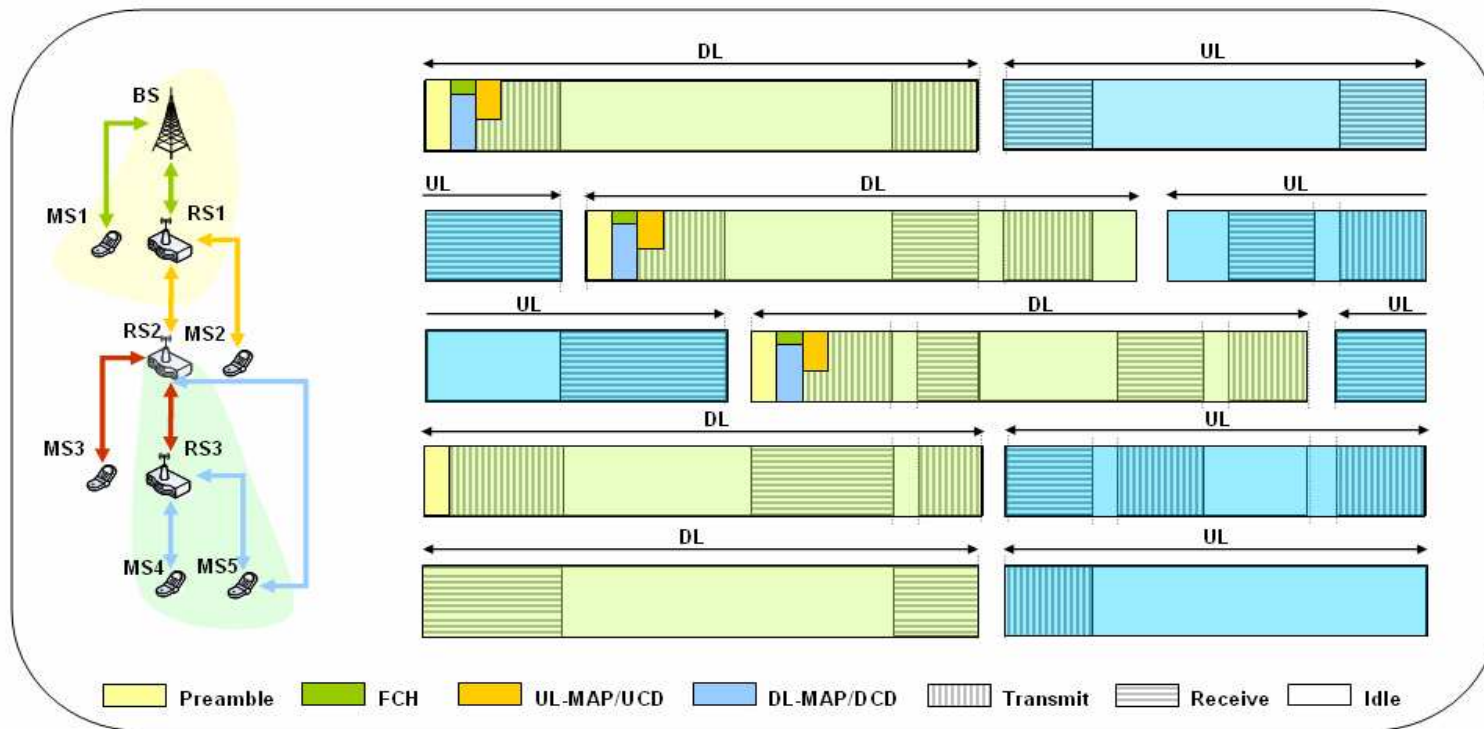
Summary

- The logical downlink and uplink subframe structure is further partitioned into intervals/zones.

- The starting and end time of these intervals/zones can be indicated by extended DL_Zone_Switch_IE and UL_Zone_Switch_IE.

- The detailed schedule of these interval/zones can be indicated by DL_RX_MAP_IE and UL_TX_MAP_IE
  - Extension of DL_MAP_IE and UL_MAP_IE
  - Assume the format of extended-2 IE format.

- The minor revisions/extensions of the zone concept, and the information elements described above enable the frame structure to support wide variety of communication needs and network topology/scenarios.