A Frame Structure for Multihop Relays

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Purpose:

Review and adopt.

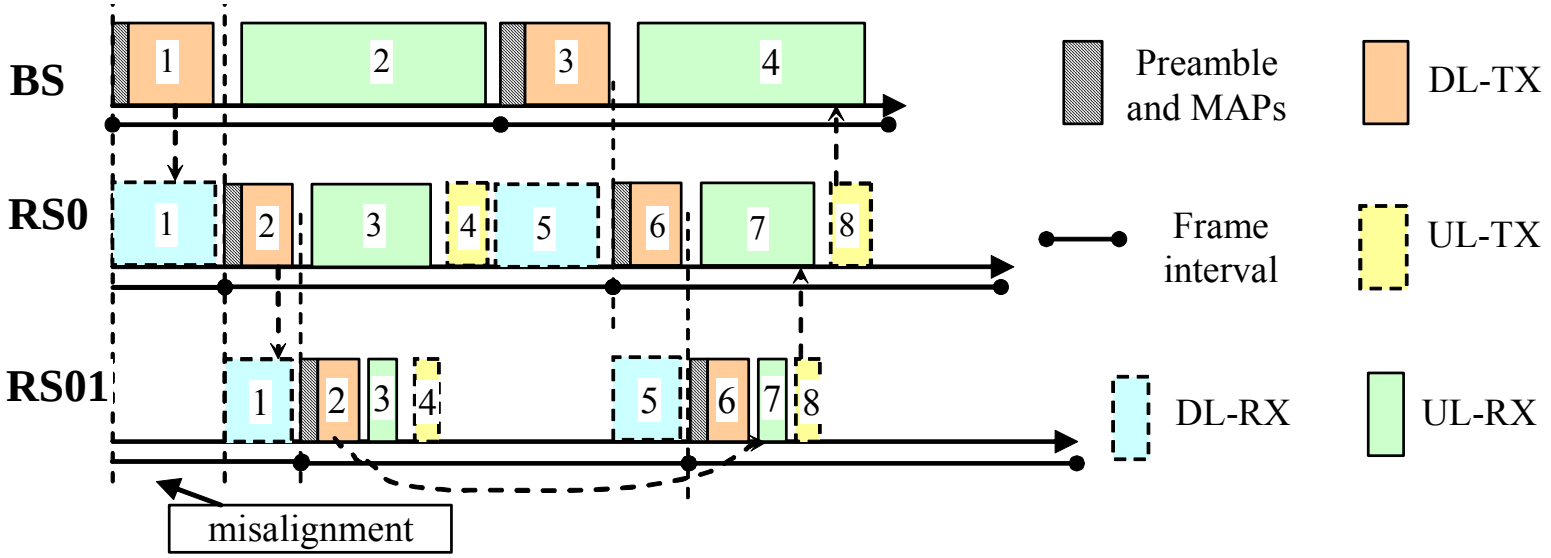
Outline

- Introduction
- Single-Frame Structure
- Flexible Frame Structure
- Comparison
- Conclusions

Introduction

- The contribution provides some comments with respect to the frame structure for multihop relays (RSs).
- Compare single-frame structure (SFS) that provides the best propagation delay with the proposed scheme called flexible frame structure (FFS) that introduces some trade-offs.
- A RS has to perform the following operations:
  - DL-TX: downlink traffic transmission;
  - UL-TX: uplink traffic transmission to transfer data to access station ;
  - UL-RX: uplink traffic reception;
  - DL-RX: downlink traffic reception of data from the access station.

Single-Frame Structure



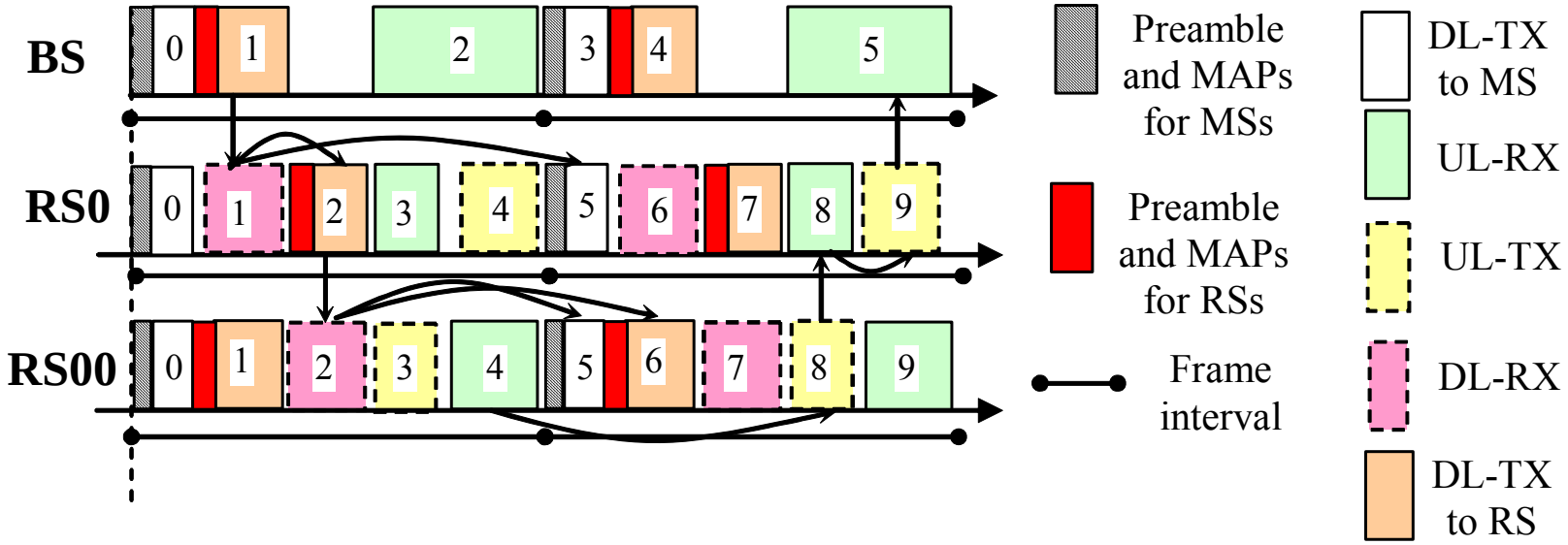
- RS0 (RS01) receives its data from BS (RS0) before a new RS0 (RS01) frame starts.
- The higher order *n*-hops transmit first on uplink.
- Succession of events that show round-trip delay are depicted in the figure.

- The entire path of relays behaves like a single SS, i.e. minimum propagation delay.
- Higher order *n*-hops relays have less time to operate, which can introduce sync and scheduling problems.
- Extending the relay path is difficult.

Some Guidelines

- **All MMR-BS and RS should transmit access preamble at the beginning of the BS frame.**
- **DL/UL Access Region should be present in every frame.**
- **Minimum amount of DL symbols and UL symbols should be maintained from MS perspective (Wimax MTG profile conformance).**
- **Cross interference between DL/UL should be avoided in TDD system.**

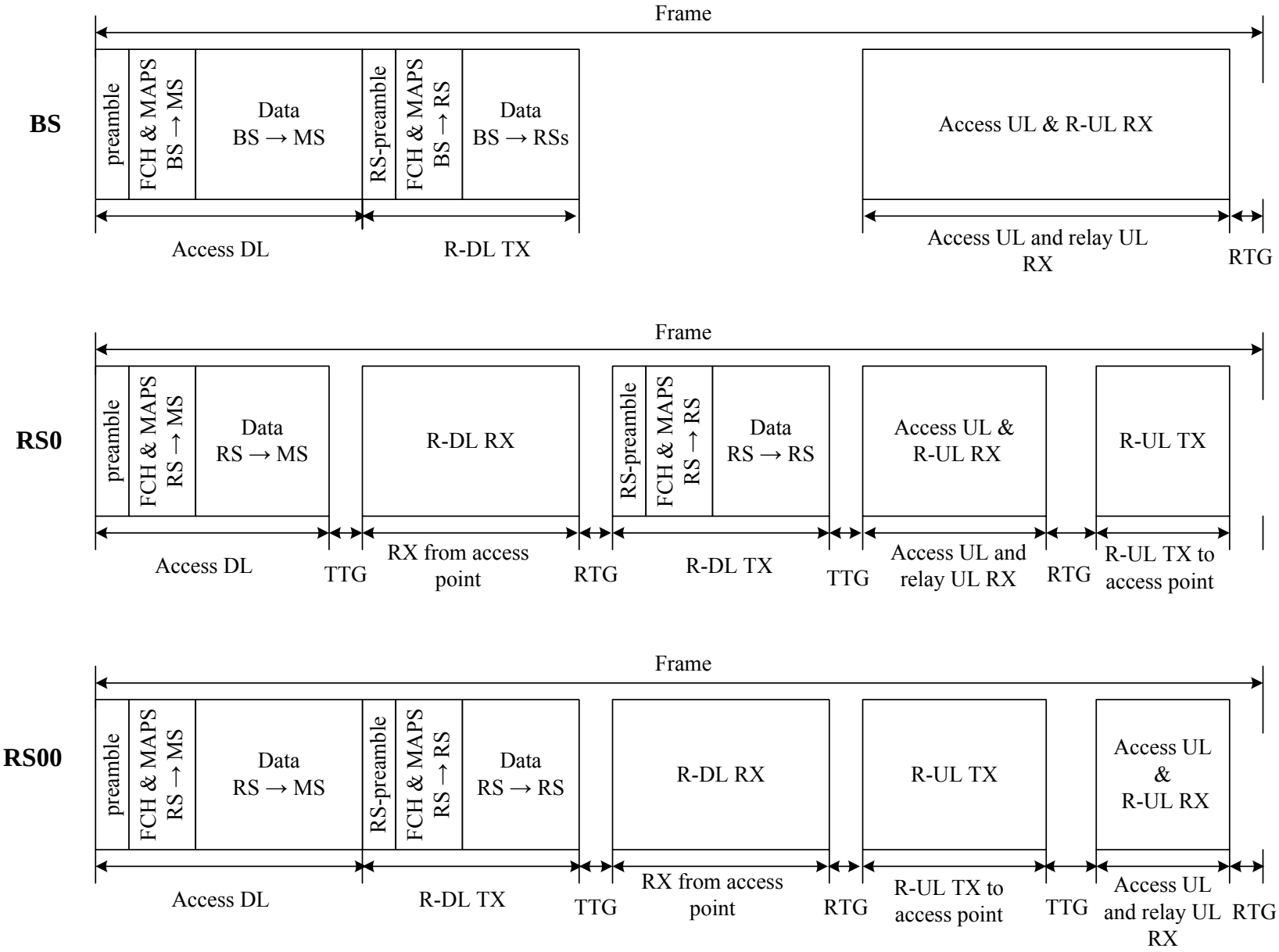
Flexible Frame Structure



- The *n*-hop relays with *n* even have the start of the aligned with BS.
- Succession of events that show round-trip delay are depicted in the figure.

- Each 2 hops adds about 1 frame one-way delay.
- Higher order *n*-hops relays use better the frame interval, i.e. can improve capacity or link reliability.
- Extending the relay path is easy.

Flexible Frame Structure (contd.)



Flexible Frame Structure: Features

- The frame duration for FFS is the same as for BS.
- Increasing the path of relays is straightforward.
- RS uses efficiently the TX/RX intervals:
  - Increase the capacity;
  - Increase the link reliability;
- Handles both centralized and distributed scheduling.
- Each 2 hops adds about 1 frame duration one-way delay.
- Cooperative relay is supported.
- Frequency/Segment can be reused within the BS/RS coverage area.

Comparison

Feature	Single-frame structure (SFS)	Flexible frame structure (FFS)	Comments
Centralized scheduler	Yes	Yes	Centralized scheduler has to take into account the delay for the FFS, if more than 1 hop is involved.
Distributed scheduler	Yes	Yes	SFS may not have enough time to do decoding and schedule data immediately, thus may introduce delay.
Bottleneck	Last hop relay	First hop relay	FFS has more flexibility to deal with additional RS hops.
Capacity	Bad	Good	FFS utilizes better the frame duration interval (See example in the Word document).
Link reliability	Bad	Good	FFS reliability depends mainly on the reliability of the first hop. For SFS, the reliability of *all* hops is important; SFS has longer idle intervals that are not used to improve the link reliability.
Adding RS in the path	Bad	Good	FFS is very flexible. For SFS can be very difficult.
One way-delay	Good	Bad	FFS adds about 1 frame delay per 2 hops. SFS has no delay.
Synchronization	Bad	Good	SFS has shorter transmission bursts cycles that can result in poor synchronization.

Conclusions

- The contribution detailed some drawbacks of the single-frame relay structure:
  - inflexibility with respect to adding new hops;
  - shorter transmission bursts can produce poor synchronization and channel estimation, the scheduling requirements are very tight.
- In order to alleviate these problems, a relay frame structure that provides more flexibility at the expense of increasing the one-way propagation by about one frame duration per 2 hops is proposed. Thus, the proposed relay frame structure offers:
  - a seamless increase of the relays' path length;
  - relaxed time requirements for scheduling, possibility to use more robust modulation coding schemes for a reliable transmission;
  - an increase in the system capacity;
  - less number of transitions between TX and RX modes.