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Re:	A response to a Call for Technical Proposal, http://wirelessman.org/relay/docs/80216j-06_034.pdf
Abstract	The relay has an additional requirement of aligning its downlink transmissions with the BS compared to the MS alignment requirement in 802.16e. Since relay is re-transmitting the preamble and data to its mobiles this is required to avoid deterioration of performance. In addition, a relay may obtain sync from another relay thus any misalignment could accumulate when the number of hops increased. Uplink too needs similar alignment.
Purpose	To adopt the proposed text
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Frame Alignment Requirement in Relays

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Nortel

1 Introduction

Usually, a RS (relay station) can use the same mechanism as a MS (mobile station) to synchronize its downlink frame and uplink frames in order to receive data from the BS (base station) over the downlink and transmit data to the BS over the uplink.

When doing so, MS's receive frame from the BS over the downlink would be shifted from that of the BS's transmission frame approximately by an amount equal to the propagation delay of the strongest path from the BS to the MS. MS's uplink transmission frame would be about round trip delay shifted from the BS's downlink transmission frame due to the requirement that the BS requires to receive the signals from all the MSs aligned in time. This is shown in Figure 1.

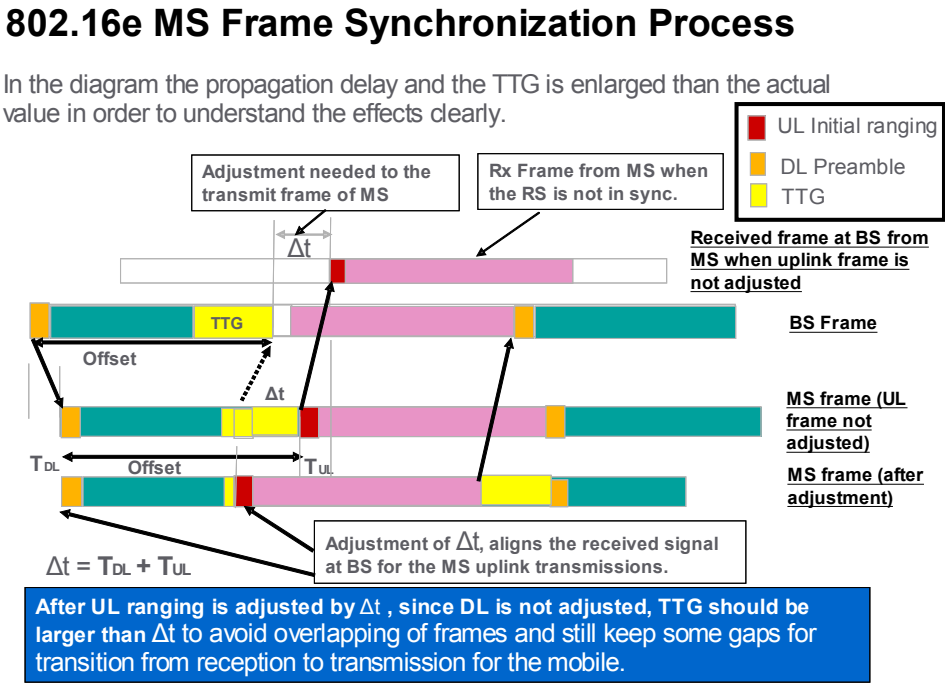


Figure 1 MS Frame alignment in 802.16e

However, a RS has two additional functions above the MS's functions:

(1) a RS has to send data to its children (MS or another RS) over the downlink.

(2) a RS has to receive data (and uplink ranging messages) from its children.

If the timing at the RS is allowed to be delayed compared to that of the BS by an amount approximating propagation delay similar to that of a MS, many system parameters may need to be adjusted and proper operation of many functions may be mipacted. Some of these are:

(1) Accumulation of the mis-alignment over multi-hops which would make relays several hops away from the base impacted;

(2) The system parameters set for proper operation such as prefix durations, TTG, RTG, UL ranging may need to be adjsusted

(3) In particular, for the range extension case, prefix may be not be enough. A major advantage of relay is to make the mobiles outside BS coverage areas can be served – as BS may not be abel to support them even if enough signal is there due to insufficient prefix duration.

(4) Various measurement system

(5) Performance which depends on synchronized transmissions such s MDHO and FBSS.

These are described in more detail below:

The tolerances in the system relating to the prefix duration used to address multi-path delays, the TTG/RTG gaps kept for receive and transmission transitions in the radio and propagation delay variation among different MS-BS links, and UL ranging slot duration may not be sufficient and may cause severe interference and performance issues.

In addition, any difference in the timing at the RS and the BS may impact measurement systems as well. For example, RS preambles send by different relays and BS may be not time-aligned and RSs outside the coverage area may cause problems. In addition, the performance of the operations such as SHO and fast cell switching may be impacted.

Furthermore, for networks including multi-hop relaying, the delays would add up when we go along the paths and potentially cause even more severe issues due to non-alignment of frames. Some times the relays are used to extend the coverage area and the delays if added up that could make the limits allowed in the system in sufficient.

In this contribution, we show that this alignment can be adjusted by the relay in a TDD system using the information it receives for the uplink frame alignment used currently by the MS under 802.16e standard and we propose that strict alignment requirement be specified in the standard for smooth operation of the relay under diverse environments.

2 Proposal

There are four frames with different timing advances.

(1) RS receive from its parent in the Downlink
(2) RS Transmission to the parent in the uplink
(3) RS Transmission to its child over the downlink
(4) RS receive from MS in the uplink

In order to have proper operation we propose that:
(1) the relay RX and TX signals with BS be synchronized with the BS similar to a MS as indicated above;
(2) the relay TX and Rx signals with its children be time-aligned with the BS Tx and Rx frames respectively to a certain achievable accuracy.

The BS frames, above four RS frames and MS frames after alignment are shown in Figure 2.

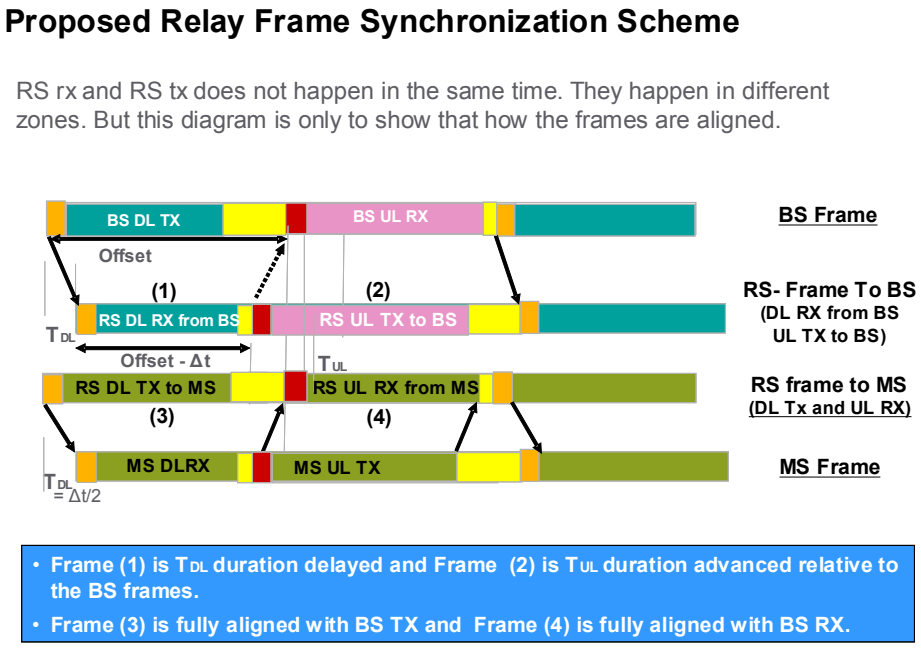


Figure 2 MS Frame alignment in 802.16e

In the above figure, RS downlink transmissions are exactly aligned with the BS downlink frame thus the current prefix requirements need not to be changed and measurement accuracy would not be impacted. RS uplink transmissions are aligned such that all its children's transmissions would receive in the same time as the BS would receive from its children.

A simple method to establish above alignment is explained below.

The RS DL receive frame from the BS is shifted from that of the BS due to the propagation delay and the frame times may be little bit different from RS to RS. An uplink frame is received at the BS from the RS when there has been no adjustment is shown in Figure 1. Thus the amount of adjustment Δt needed to have the receiving frames from different mobiles or relays receive at the BS in the same time, can be determined by the BS and is transmitted to the MS under 802.16, so that MS can adjust its uplink transmission frame**.** Due to inaccurate adjustment evaluation, this process may be repeated several times until accurate alignment happens at the BS reception. We propose that RS follows the same method to align its uplink frames to its parent and adjusted frame is also shown in Figure 1. As can be seen the total adjustment required for a given RS is its round-trip delay to its parent.

Now if relay transmission in the downlink to its children is to be aligned with the BS downlink transmission to its children, the RS downlink transmission frame (to its children) should be advanced T_{DL}, the parent to child propagation delay. In a TDD system we can assume these two delays are same and therefore, if the round trip delay is evaluated as mentioned above the adjustment needed for the RS downlink frame to its children is half of the round trip delay.
Once downlink frame is aligned, the uplink alignment can be done similar to the current 802.16e method by child sending an uplink ranging signal and parent informing the adjustment needed relative to the already adjusted downlink frame.

Since the amount of adjustment needed can be achieved using the local information to the RS, there is no extra messaging required but it is proposed that the requirement be specified in the 802.16j document in order to guarantee proper operation of the system. Alternatively, MR-BS or the parent node may send a message to its child RS the adjustment needed for the child's downlink frame.

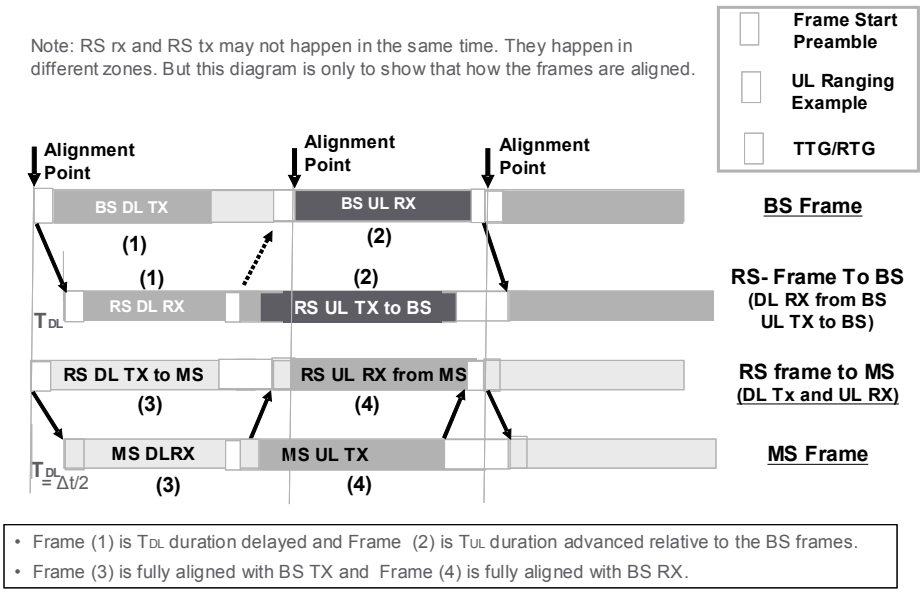
3 Proposed Text Modifications

[Insert following text into **8.4.4.7.2.2***]*

8.4.4.7.2.2 Relay frame structure

XXX Alignment Requirements for Relay Transmission and receive frames for communication with its child nodes (RS and MS).

In order to achieve proper operation, the relay downlink transmission to its children (RS or MS) should be time-aligned with the MR-BS's downlink transmission to its children (RS or MS).



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

Figure XXX Frame Alignment Illustration