Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**A Contribution to the TG3 and TG4 MAC: Ranging/Timing Control**
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Re:	This is a contribution to the IEEE 802.16 TG3 and TG4 MAC.
Abstract	This document proposes a simple and efficient solution to the timing control in the ranging for the TG3 and TG4 MAC. The basic idea of the proposed Ranging/Timing control strategy is to select appropriate reference points of the time offsets in the MAP messages and to calculate the time offsets appropriately so that the subscriber stations can correctly understand those time offsets without requiring the timer/clock synchronizations with the base station.
Purpose	Enhance the ranging/timing control for the TG3 and TG4.
Notice	
Release	

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Acknowledgements

The following people have contributed to this document:

Shawn Taylor

Ron Murias

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Revision History

Release Date	Document Number	Author	Change summary
2001-04-18		Lei Wang	First draft
2001-05-10		Lei Wang	Updated based on the received comments

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1 Introduction

This document proposes a simple and efficient solution to the timing control in the ranging for the TG3 and TG4 MAC.

The Ranging in the TG1 consists of controlling multiple SS parameters so that a SS can effectively communicate with the BS through the air, including timing control, Tx power level control, Tx frequency control, downlink burst type control, and address/identification assignments. This document focuses on the timing control in the ranging.

Timing control is critical to the TG1, TG3, and TG4 MACs, because they all use time-division based medium sharing strategies, such as downlink TDM and TDMA, and uplink TDMA.

However, we found out there are some open questions to the timing control for the burst mode (Mode B, PHY type =0 or 1) specified in the TG1 draft standard [TG1-D2]. For example, for the Mode B, how do the timing control strategies described in P121, Section 6.2.6.6.1, Figure 72 and Figure 73, deal with the timing pointers that cross frame boundaries since the timers are reset at every frame boundary? There is a similar question for the contention detection scheme using the ack time field in the UL-MAP for the Mode B. In addition, how to ensure all the stations (BS and SS s) reset their time stamp counter exactly at the same time?

More importantly, the TG1 timing control strategies of Mode A and Mode B require timer/clock synchronizations among the base station and the subscriber stations, which introduce implementation complexities. The proposed ranging/timing control scheme effectively avoids timer/clock synchronizations and reduces its implementation complexity.

2 Proposed Ranging/Timing Control Strategy

For a time-division based medium-sharing MAC, the key to the ranging/timing control is for all the stations to correctly identify the assigned intervals, i.e., the scheduled transmission/receiving periods. The basic idea of the proposed Ranging/Timing control strategy is to select appropriate reference points of the time offsets in the MAP messages and to calculate the time offsets appropriately so that the subscriber stations can correctly understand those time offsets without requiring timer/clock synchronizations with the base station.

2.1 Reference Points of Time Offsets in DL-MAPs and UL-MAPs

In the DL-MAPs and the UL-MAPs, the start time of the scheduled intervals are identified by the time offsets. A time offset is relative to its reference point. The time offset is in

units of mini-slot. In the proposed ranging/timing control strategy, the reference point of a time offset is the start point of the downlink frame received at a SS, that is, the time point at which a SS receives the first sample of the first symbol of the downlink frame in which the MAP message is transmitted. FIGURE 1 shows an example with the TDD systems.

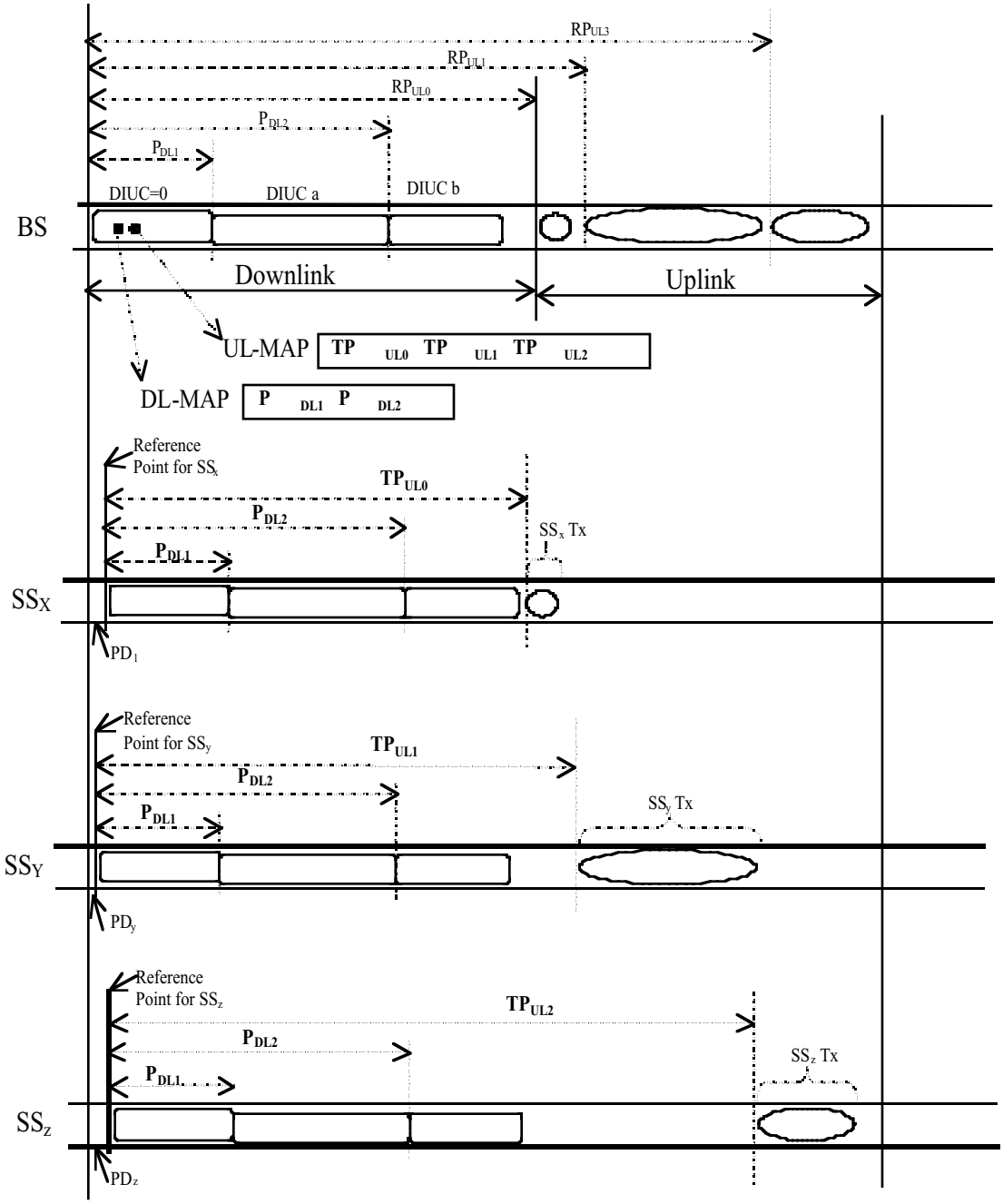

FIGURE 1. Time Offsets and the Reference Points in MAP Messages

As shown in FIGURE 1, the reference point of the time offsets is SS-specific, because the downlink frame arrives at different SS s at different times, due to different propagation

delays.

The time offsets in the DL-MAP identify the start points of the downlink intervals. With the proposed reference point, a SS can correctly identify all the specified downlink intervals.

The time offsets in the UL-MAP identify the start points of the uplink intervals. Each SS only needs to correctly identify the uplink interval that is assigned to it. The time offsets calculation algorithm is designed to guarantee a SS can correctly identify its own uplink intervals.

2.2 DL and UL Interval Lengths

The downlink intervals specified by the same DL-MAP have the same reference point of the time offsets, which is the time that the SS starts to receive the downlink frame. So, similar to TG1 DL-MAP, the length of a downlink interval is the difference between the time offset of next downlink interval and the time offset of this downlink interval.

However, the uplink intervals that are assigned to different SS s have different reference points for the time offsets, so the UL interval lengths cannot be figured out based on the time offsets specified in the UL-MAP. A new field, called Interval Length, is proposed to add into the UL-MAP information element. It specifies the interval length in number of mini-slots for the uplink interval specified by the information element. The new format of the information element in the UL-MAP is shown in FIGURE 2.

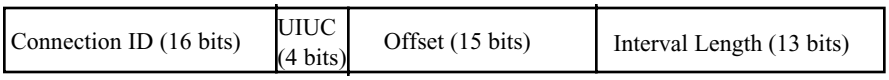

FIGURE 2. Information Element (IE) in UL-MAP

The proposed UL-MAP IE has 48 bits. The offset field is increased to 15 bits, and the new Interval Length field is 13 bits.

2.3 Time Offset Calculations

When constructing a DL-MAP, the base station calculates the time offsets for the specified downlink intervals, for example, P_{DL1} and P_{DL2}, as shown in FIGURE 1. The base station calculates the DL-MAP time offsets in the same way as the TG1 MAC, because all downlink interval time offsets have the same reference point.

When constructing a UL-MAP, the base station calculates the time offsets for the specified uplink intervals, for example, TP_{UL0}, TP_{UL1}, and TP_{UL2}, as shown in FIGURE 1. Because of different reference points, the delays between the BS Tx and the SS Rx have to be taken into account when calculating uplink interval time offsets. Such a delay consists of the

propagation delay between the BS and a SS and the processing delays at both Tx side and Rx side. The processing delays must be relatively constant, and any variation must be accounted for in the guard time between the intervals. The base station measures, stores, and maintains fairly accurate delays between itself and all its SS s.

2.4 Initial Maintenance Interval

The initial maintenance interval is a special uplink interval, which is designed for the SS s to submit their initial ranging request and is subject to collisions. At UL-MAP construction, the base station does not know which SS will attempt to use the initial maintenance interval, so the base station shall make an initial maintenance interval large enough to accommodate the worst-case delay, including the maximum propagation delay between the BS and SS s and the maximum processing delays. Both the maximum propagation delay and the maximum processing delay shall be system configurable parameters.

3 Enhancements Highlights

The proposed ranging/timing control strategy will significantly enhance the TG1 ranging/timing control, because:

(1) It successfully avoids timer/clock synchronizations between the base station and all its SS s, so that it will simplify the ranging/timing control implementation and improve the efficiency; and

(2) It only requires the base station to know and use the delays between the BS and the SS s, while the SS s do not need to. This will effectively reduce the implementation complexity at the SS s.

4 Reference

(1) [TG1-D2]: Draft Standard Air Interface for Fixed Broadband Wireless Access System, IEEE 802.16/D2-2001.