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Title	**Frame Structures for 7MHz and 8.75MHz Channel Bandwidths**
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Re:	"802.16m AWD" IEEE 802.16m-09/0012, "Call for Contributions on Project 802.16m Amendment Working Document (AWD) Content" – Call for Comments on Amendment Working Document.
Abstract	This contribution proposes frame structures for 7MHz and 8.75MHz channel bandwidths.
Purpose	To be discussed and adopted by TGm for the 802.16m AWD.
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Frame Structures for 7MHz and 8.75Mhz Channel Bandwidths

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1. Introduction

In the current 802.16m SDD [1] and AWD [2], for 7MHz and 8.75MHz channel bandwidths OFDMA parameters only are defined, no descriptions of frame structure there. In this contribution we discuss and propose frame structures for 7MHz and 8.75MHz for inclusion into the 802.16m Amendment.

Before discussing the detailed frame structures, we need to identify the issue and requirement in design of frame structures for 7MHz and 8.75MHz.

1) The issue is that the 10MHz frame structure cannot be applied to 7MHz and 8.75MHz without modification. It is because the number of OFDMA symbols per frame is not the same among different channel bandwidths; i.e. 48 symbols for 10MHz, but 43 and 34 symbols for 8.75MHz and 7MHz, respectively. The subframe configuration in the 10MHz frame structure, i.e. 8 subframes per 5ms frame, therefore cannot be kept in 7MHz and 8.75MHz by using only a combination of type-1 subframe (6 symbols) and type-3 subframe (5 symbols).
2) There may be two design approaches for 7MHz and 8.75MHz frame structures: One is to reduce the number of subframes per frame while employing the current three subframe types only (type-1, type-2, type-3). The other is to reduce the number of OFDMA symbols per subframe while keeping the configuration of 8 subframes per frame. Both options have their own drawbacks. Especially, the second approach may produce another new subframe type; it implies that a new PRU should be defined accordingly. An impact of the irregular subframe is more serious in UL than DL, because a new title structure for UL control channel is needed. Therefore, the first approach is more desirable in design of 7MHz and 8.75MHz frame structures, so as to avoid another new subframe type.
3) In design of 7MHz and 8.75MHz frame structures, the legacy support requirements defined in SRD [3] shall be considered. In particular, the DL to UL symbol ratio employed in the current practical WiMAX systems shall be supported; i.e. DL:UL = 27:15 for 8.75MHz, DL:UL = 21:12 for 7MHz [4].

After due consideration of the issue and requirements above, we have developed the 7MHz and the 8.75MHz frame structures. They are presented and discussed in the following sections.

2. Frame Structures for 7MHz

The proposed frame structure for 7MHz is shown in Figure 1. In this structure, a 5ms frame consists of six subframes. For the ratio of DL:UL = 21:12, downlink is comprised of one type-1 subframe and three type-3 subframes, uplink of two type-1 subframes. No irregular subframe type is employed in UL.

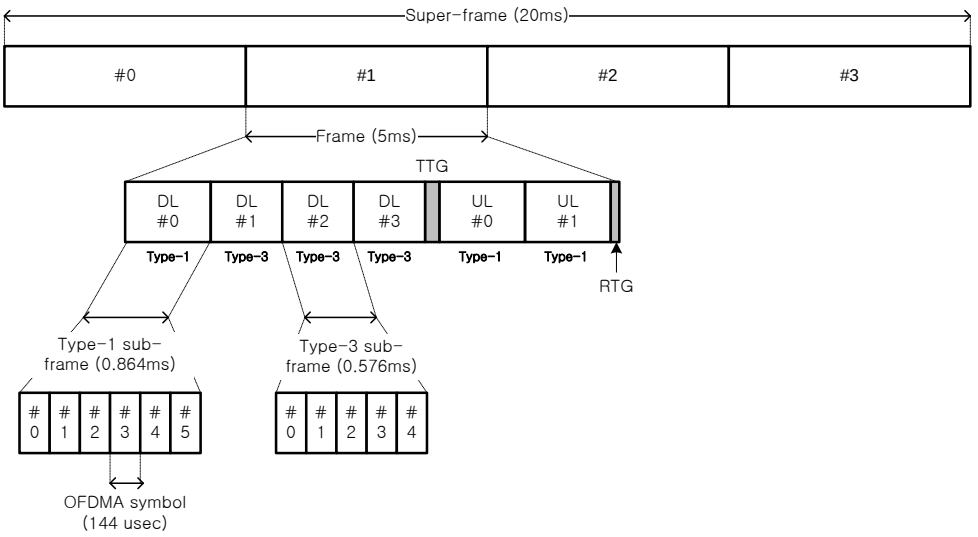

Figure 1. Frame Structure in TDD mode for 7 MHz channel bandwidths (CP=1/8 Tb)

3. Frame Structures for 8.75MHz

Design of the 8.75MHz frame structure is more complicated and tricky. For DL to UL symbol ratio of 27:15, the uplink of 15 symbols should be divided into multiple subframes, but then it is not easy to avoid the use of irregular subframe type.

Various options for UL configuration for DL:UL = 27:15 are listed-up and compared in Table 1. All options in the table have the same downlink configuration of DL = {6, 6, 5, 5, 5}, i.e. two type-1 subframes and three type-3 subframes. Each option has its own pros and cons, but the most critical is whether the option mandates a new UL control structure design or not. Another UL control structure only for 8.75 MHz is much burden to the specification. In this sense, we have chosen the options C, which reuses the UL control structure of type-1 subframe. The option A-2 also allows to reuse the UL control structure of type-1 subframe, but it may degrade the performance of UL control channel due to one symbol truncation.

Table 1. Various options for UL configuration for 8.75MHz frame structure with DL:UL = 27:15

UL configuration options		Pros	Cons
A-1	UL = {5, 5, 5}	- No impact on upper-level control procedure (scheduling, HARQ, …) - Easy new PRU design (the same PRU as in DL)	- Need New UL control design - Need New PRU design for 4 symbols (considering one sounding symbol)
	New UL Control structure for 5 symbol		
A-2	UL = {5, 5, 5}	- No impact on upper-level control procedure (scheduling, HARQ, …) - Easy new PRU design (the same PRU as in DL) - No need of new UL Control design	- Performance degradation of UL Control channel due to the truncation - Need New PRU design for 4 symbols (considering one sounding symbol)
	Re-use UL Control structure of 6 symbol (by truncation)		
B-1	UL = {6, 6, 3}	- No impact on HARQ operation - Less burden to UL control design (Only New ACK design)	- Need New PRU design for 3 symbols - Need New ACK channel design
	UL ACK channels only in 3-symbol subframe		

B-2	UL = {6, 6, 3} No UL Control structure in 3-symbol subframe	- No need of new UL control design	- Need New PRU design for 3 symbols - Impact on DL HARQ operation (Different ACK timing from 10MHz frame structure)
C	UL = {6, 9} Re-use UL Control structure of 6 symbol in 9-symbol subframe	- No need of new UL control design	- Need New PRU design for 9 symbols (but easier than for 3 symbols) - 7 subframes / frame (Different DL & UL HARQ timings from 10MHz frame structure)

Figure 2 shows the proposed frame structure for 8.75MHz based on the option C. In this structure, one frame consists of seven subframes. For the ratio of DL:UL = 27:15, downlink is comprised of two type-1 subframes and three type-3 subframes. Uplink is comprised of one type-1 subframe and one new type-4 subframe, i.e. 9-symbol subframe.

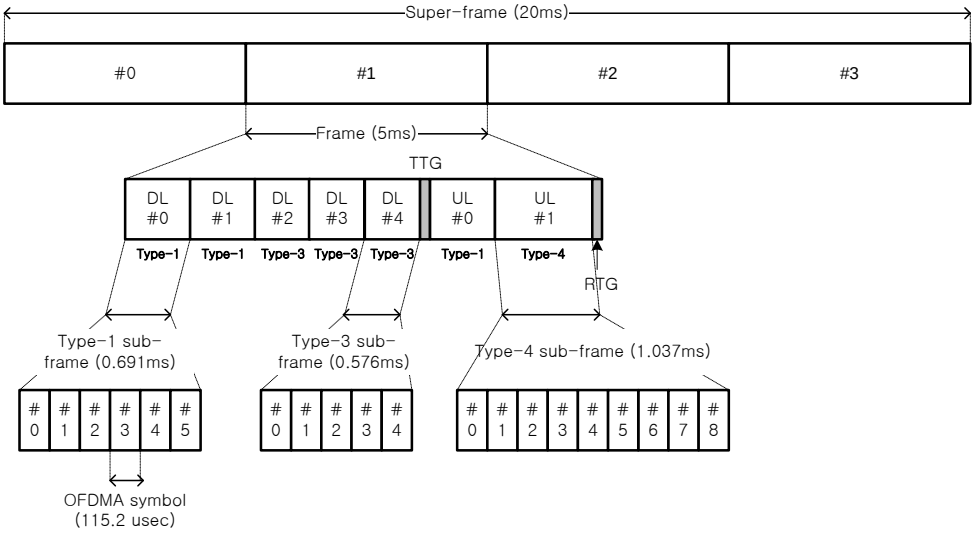

Figure 2. Option C for 8.75 MHz Frame Structure with DL:UL = 27:15 (CP=1/8 Tb)

4. Text proposal for inclusion in the 802.16m AWD

[Remedy 1: Add the following text in 42 on the page 14, in 15.3.3.1:]

4) the type-4 subframe which consists of nine OFDMA symbols.

[Remedy 2: Change the text from line 39 to 40 on the page 16, in 15.3.3.2.2, as follows:]

In a TDD frame with DL to UL ratio of D:U, the 1st contiguous D subframes and the remaining U subframes

are assigned for DL and UL, respectively, where D + U = 8 for 5, 10 and 20 MHz channel bandwidths, D + U = 7 for 8.75 MHz channel bandwidth, and D + U = 6 for 7 MHz channel bandwidth.

[Remedy 3: Insert the following text and Figure after Figure 391 in page 17]

Figure xxx illustrates an example TDD frame structure with D:U = 5:2, which is applicable to the nomial channel bandwidth of 8.75MHz with G = 1/8. In Figure xxx the first and second DL subframes and the first UL subframe are type-1 subframes, the other DL subframes are type-3 subframes, and the last UL subframe is a type-4 subframe. TTG and RTG are 87.2 µs and 74.4µs, respectively.

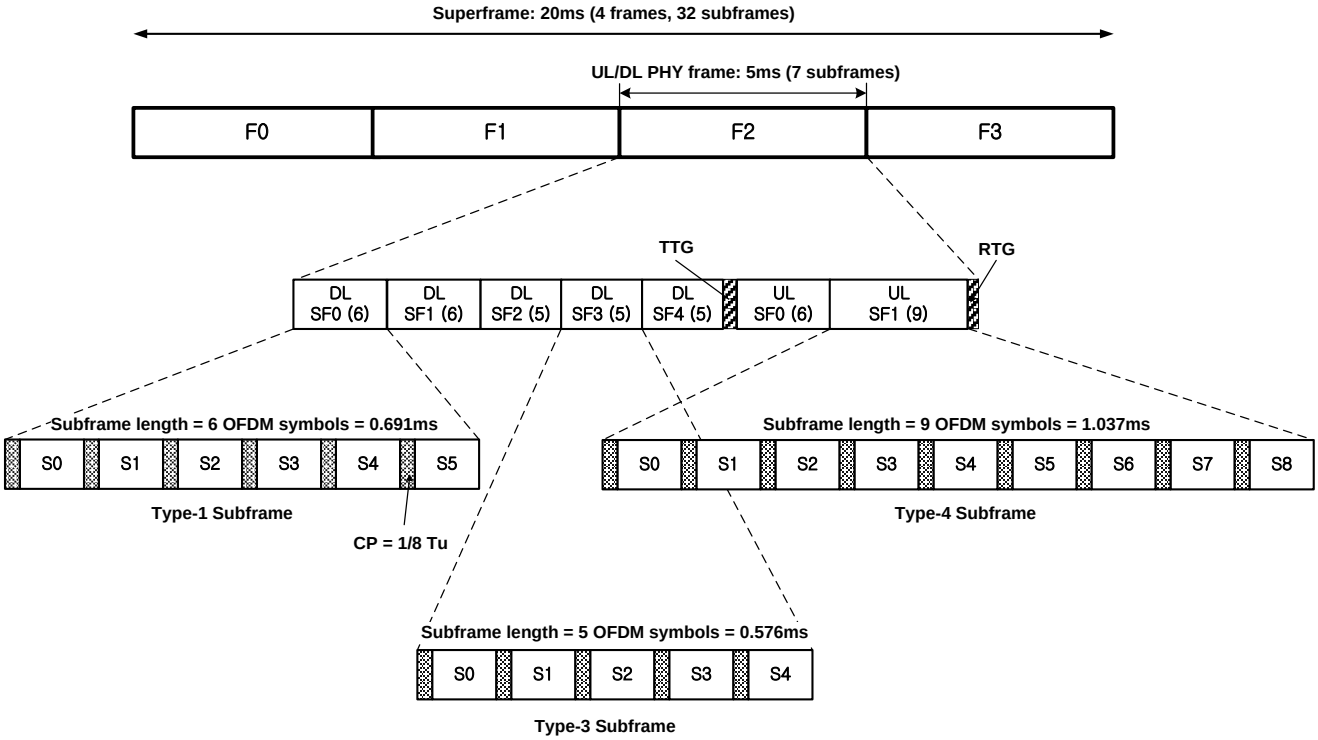

Figure xxx Frame Structure with type-1, type-3 and type-4 subframes in TDD duplex mode for 8.75 MHz channel bandwidths (CP=1/8 T_b)

[Remedy 4: Insert the following text and Figure after Figure 391 in page 17]

Figure yyy illustrates an example TDD frame structure with D:U = 4:2, which is applicable to the nomial channel bandwidth of 7MHz with G = 1/8. In Figure yyy the first DL subframe and all UL subframes are type-1 subframes, and the other DL subframes are type-2 subframes. TTG and RTG are 188µs and 60µs, respectively.

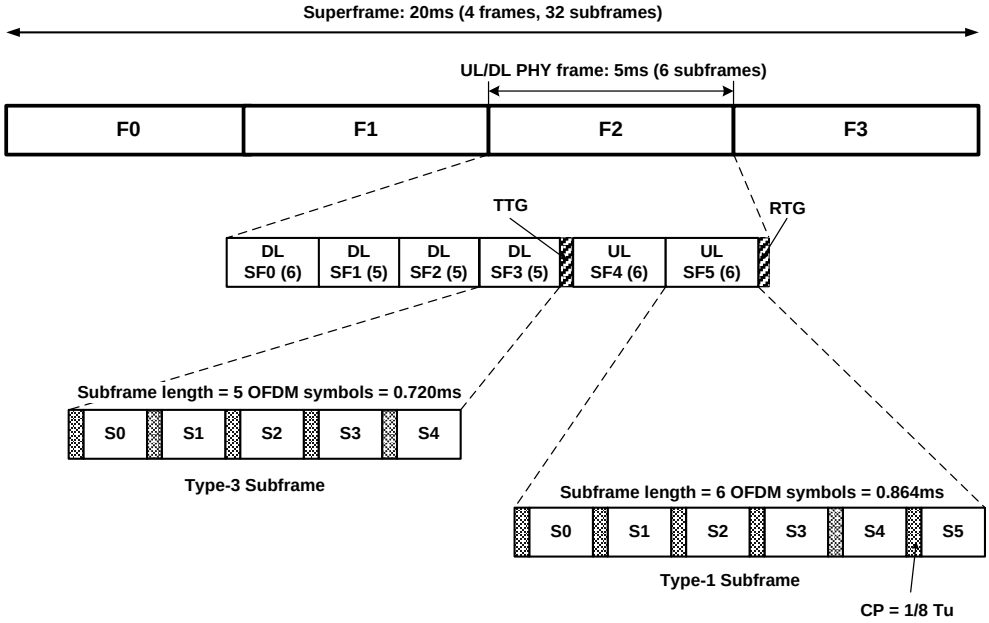

Figure yyy Frame Structure with type-1 and type-3 subframes in TDD duplex mode for 7 MHz channel bandwidths (CP=1/8 T_b)

5. References

[1] IEEE 802.16m-08/003r7, “The Draft IEEE 802.16m System Description Document.”

[2] IEEE 802.16m-09/0010, “IEEE 802.16m Amendment Working Document.”

[3] IEEE 802.16m-07/002r7, “IEEE 802.16m System Requirements.”

[4] WiMAX Plugfest 5 guideline, Dec 2007.