Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Clean-up of TTG/RTG and Irregular Subframe in IEEE 802.16mSDD and Amendment Working Document**
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Re:	IEEE 802.16m-08/052, "Call for Comments and Contributions on Project 802.16m System Description Document (SDD)". • Target topic: Call for Comment on the SDD draft (IEEE 802.16m-08/003r6; Section 11.3, 11.4, 11.5, 11.6). IEEE 802.16m-08/053r1, "Call for Comments and Contributions on Project 802.16m Amendment Working Document". • Target topic: Call for Comment on Amendment Working Document Text (IEEE 802.16m-08/050; Section 15.3.2, 15.3.3, 15.3.5).
Abstract	The contribution proposes to change TTG/RTG lengths and irregular subframe structure defined in the current 802.16m SDD draft and Amendment working document, in order that 802.16m BS shall smoothly support a mix of 802.16m and legacy MSs on the same RF carrier.
Purpose	To be discussed and adopted by TGm for the 802.16m SDD and Amendment Working Document.
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Clean-up of TTG/RTG and Irregular Subframe in IEEE 802.16m SDD and Amendment Working Document

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1. Problem Statement and Suggested Remedy

In the current draft of 802.16m SDD [1] and Amendment working document [2], TTG and RTG are secured in the following way:

- TTG
  - By puncturing the last one OFDMA symbol in the last DL subframe
  - Hence, its length is fixed to one OFDMA symbol time.
- RTG
  - An idle time in a frame is utilized for RTG.

However, such way has a problem that TTG/RTG is not compatible with legacy system, i.e. not the same lengths as defined in WiMAX Forum Mobile System Profile, R1.0 [3]. The TTG/RTG lengths in 802.16m SDD [1] and in WiMAX Profile R1.0 [3] are listed up and compared in the table below.

Bandwidth (MHz)	TTG (μs)		RTG (μs)	
	SDD (1symbol)	WiMAX R1.0	SDD (idle time)	WiMAX R1.0
5/10/20	102.857	105.714	62.86	60
8.75	115.2	87.2	46.4	74.4
7	144	188	104	60

We can see a large difference in the TTG/RTG values between the two documents. Such difference has a direct impact on legacy support operation at 802.16m BS. To solve this problem, we suggest the following changes to both 802.16m SDD draft [1] and Amendment working document [2]:

- Change the lengths of TTG and RTG to the same values defined in WiMAX Profile R1.0.
- Change *6-symbol subframe with idle symbol* (type-1 short subframe) to *5-symbol subframe*
  - It is noted that to allow TTG with a different length from one symbol time, 5-symbol subframe is need to be defined.

2. Proposed Text Changes in IEEE 802.16m SDD [1]

[Remedy 1: Replace Table 2 in page 60 with the following Table]

Nominal Channel Bandwidth (MHz)			5	7	8.75	10	20
Over-sampling Factor			28/25	8/7	8/7	28/25	28/25
Sampling Frequency (MHz)			5.6	8	10	11.2	22.4
FFT Size			512	1024	1024	1024	2048
Sub-Carrier Spacing (kHz)			10.937500	7.812500	9.765625	10.937500	10.937500
Useful Symbol Time T_u (μs)			91.429	128	102.4	91.429	91.429
Cyclic Prefix (CP) T_g=1/8 T_u	Symbol Time T_s (μs)		102.857	144	115.2	102.857	102.857
	FDD	Number of OFDM symbols per Frame	48	34	43	48	48
		Idle time (μs)	62.86	104	46.40	62.86	62.86
	TDD	Number of OFDM symbols per Frame	47	33	42	47	47
		TTG (μs)	105.714	188	87.2	105.714	105.714
		RTG (μs)	60	60	74.4	60	60
Cyclic Prefix (CP) T_g=1/16 T_u	Symbol Time T_s (μs)		97.143			97.143	97.143
	FDD	Number of OFDM symbols per Frame	51			51	51
		Idle time (μs)	45.71			45.71	45.71
	TDD	Number of OFDM symbols per Frame	50			50	50
		TTG (μs)	97.143			97.143	97.143
		RTG (μs)	45.71			45.71	45.71

Table 2 OFDMA parameters for IEEE 802.16m

[Remedy 2: Change the text from line 19 on the page 60 to line 1 on the page 61, in 11.4.1., as follows:]

There are ~~two~~ three types of subframes ~~depending on the size of cyclic prefix~~: 1) the type-1 subframe which consists of six OFDMA symbols, and 2) the type-2 subframe that consists of seven OFDMA symbols, and 3) the type-3 subframe which consists of five OFDMA symbols. ~~In both subframe types, some of symbols may be idle symbols.~~

[Remedy 3: Change the text from line 17 to 20 on the page 61, in 11.4.1.1., as follows:]

Figure 25 illustrates an example TDD frame structure with DL to UL ratio of 5:3. Assuming OFDMA symbol duration of 102.857μs and a CP length of 1/8 Tu, the lengths of type-1 subframe and type-3 subframe ~~is~~ are 0.617 ms and 0.514 ms, respectively. In Figure 25, the last DL subframe, i.e., DL SF4, is a type-~~1~~3 ~~short~~ subframe ~~whose last OFDMA symbol is an idle symbol to accommodate the gap required to switch from DL to UL.~~

[Remedy 4: Replace Figure 25 in page 62 with the following Figure]

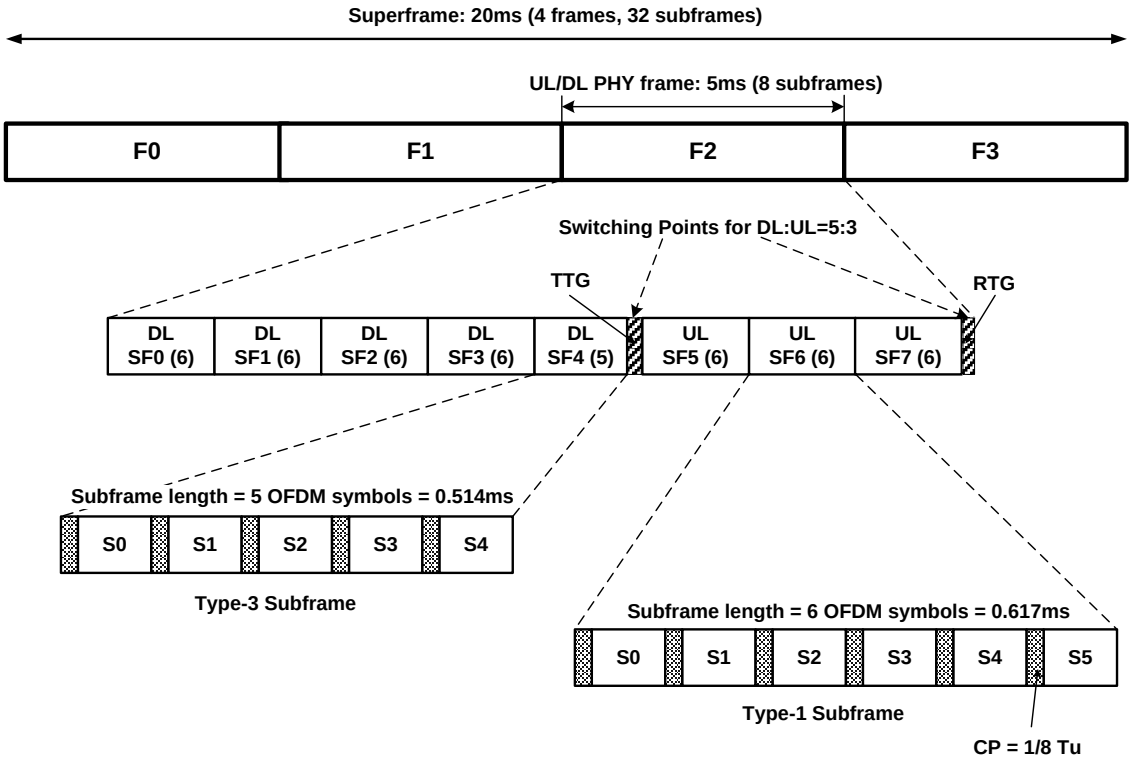

Figure 25 Frame Structure with type-1 and type-3 subframes in TDD duplex mode (CP=1/8T_u)

[Remedy 5: Change the text from line 3 to 9 on the page 63, in 11.4.1.2., as follows:]

For nominal channel bandwidths of 5, 10, and 20 MHz, an IEEE 802.16m frame for a CP of 1/16 Tu shall have five type-1 subframes and three type-2 subframes for FDD, and six type-1 subframes and two type-2 subframes for TDD.

[Remedy 6: Replace Figure 27 in page 63 with the following Figure]

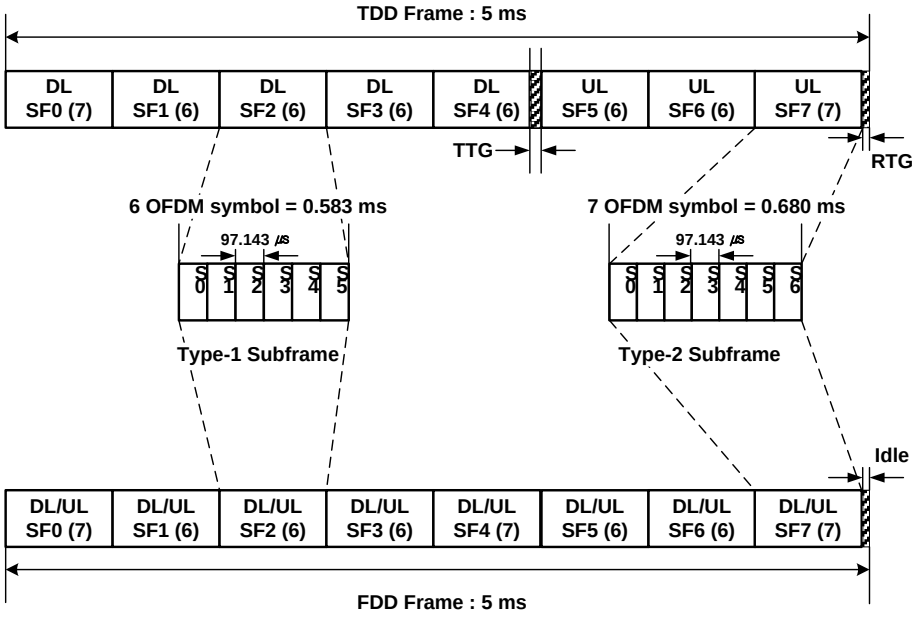

Figure 27 TDD and FDD Frame Structure with CP of 1/16 T_u (DL to UL ratio of 5:3)

[Remedy 7: Change the text from line 6 to 11 on the page 74, in 11.5.1., as follows:]

A physical resource unit (PRU) is the basic physical unit for resource allocation that comprises P_{sc} consecutive subcarriers by N_{sym} consecutive OFDMA symbols. P_{sc} is 18 subcarriers and N_{sym} is 6 OFDMA symbols for type-1 subframes, ~~and~~ N_{sym} is 7 OFDM symbols for type-2 subframes, and N_{sym} is 5 OFDMA symbols for type-3 subframes. A logical resource unit (LRU) is the basic logical unit for distributed and localized groups. A LRU is 18*6 subcarriers for type-1 subframes, ~~and~~ 18*7 subcarriers for type-2 subframes, and 18*5 subcarriers for type-3 subframes. Note that the LRU includes in its numerology the number of pilots that are used in a PRU, and may include control information.

[Remedy 8: Change the text from line 5 to 6 on the page 75, in 11.5.2.1., as follows:]

Each PRU contains pilot and data subcarriers. The number of used pilot and data subcarriers depends on MIMO mode, rank and number of multiplexed AMS as well as the type of the subframe, i.e., type-1, ~~or~~ type-2, or type-3.

[Remedy 9: Change the text from line 4 to 6 on the page 80, in 11.5.3., as follows:]

The pilot pattern of the type-3 subframe ~~consisting of 5 OFDM symbols~~ is obtained by deleting the third OFDM

symbol of the type-1 subframe. The pilot pattern of the type-2 subframe is obtained by adding the third OFDM symbol of the type-1 subframe to the end of the type-1 subframe.

[Remedy 10: Change the text from line 7 to 9 on the page 82, in 11.6.2.1, as follows:]

The number of used pilot and data subcarriers depends on MIMO mode, rank and number of multiplexed AMS and the type of resource allocation, i.e., distributed or localized resource allocations as well as the type of the subframe, i.e., type-1, ~~or~~ type-2, or type-3.

3. Proposed Text Changes in Amendment Working Document [2]

[Remedy 1: Replace Table 647 in page 12 with the following Table]

Table 647 – OFDMA parameters

The nominal channel bandwidth, *BW* (MHz)			5	7	8.75	10	20
Sampling factor, *n*			28/25	8/7	8/7	28/25	28/25
Sampling frequency, F_s (MHz)			5.6	8	10	11.2	22.4
FFT size, N_{FFT}			512	1024	1024	1024	2048
Subcarrier spacing, Δf (kHz)			10.94	7.81	9.77	10.94	10.94
Useful symbol time, T_b (μs)			91.4	128	102.4	91.4	91.4
CP ratio, *G* = 1/8	OFDMA symbol time, T_s (μs)		102.857	144	115.2	102.857	102.857
	FDD	Number of OFDMA symbols per 5ms frame	48	34	43	48	48
		Idle time (μs)	62.86	104	46.40	62.86	62.86
	TDD	Number of OFDMA symbols per 5ms frame	47	33	42	47	47
		TTG (μs)	105.714	188	87.2	105.714	105.714
		RTG (μs)	60	60	74.4	60	60
CP ratio, *G* = 1/16	OFDMA symbol time, T_s (μs)		97.143	[TBD]	[TBD]	97.143	97.143
	FDD	Number of OFDMA symbols per 5ms frame	51	[TBD]	[TBD]	51	51
		Idle time (μs)	45.71	[TBD]	[TBD]	45.71	45.71
	TDD	Number of OFDMA symbols per 5ms frame	50	[TBD]	[TBD]	50	50
		TTG (μs)	97.143	[TBD]	[TBD]	97.143	97.143
		RTG (μs)	45.71	[TBD]	[TBD]	45.71	45.71
Number of Guard Sub-Carriers		Left	40	80	80	80	160
		Right	39	79	79	79	159
Number of Used Sub-Carriers			433	865	865	865	1729
Number of Physical Resource Blocks (18x6)			24	48	48	48	96

[Remedy 2: Change the text from line 36 to 41 on the page 14, in 15.3.3.1., as follows:]

There are ~~two~~ three types of subframes ~~depending on the size of cyclic prefix~~:

1) the type-1 subframe which consists of six OFDMA symbols, ~~and~~

2) the type-2 subframe that consists of seven OFDMA symbols, and

3) the type-3 subframe which consists of five OFDMA symbols. ~~In both subframe types, some of symbols may be idle symbols.~~

[Remedy 3: Change the text from line 46 to 48 on the page 16, in 15.3.3.2.2., as follows:]

Figure 391 illustrates an example TDD frame structure with D:U = 5:3, which is applicable to the nominal channel bandwidths of 5, 10, and 20 MHz with G = 1/8. In Figure 391 the last DL subframe, i.e. DL SF4, is a type-3 subframe and the other subframes are type-1 subframes.

[Remedy 4: Replace Figure 391 in page 17 with the following Figure]

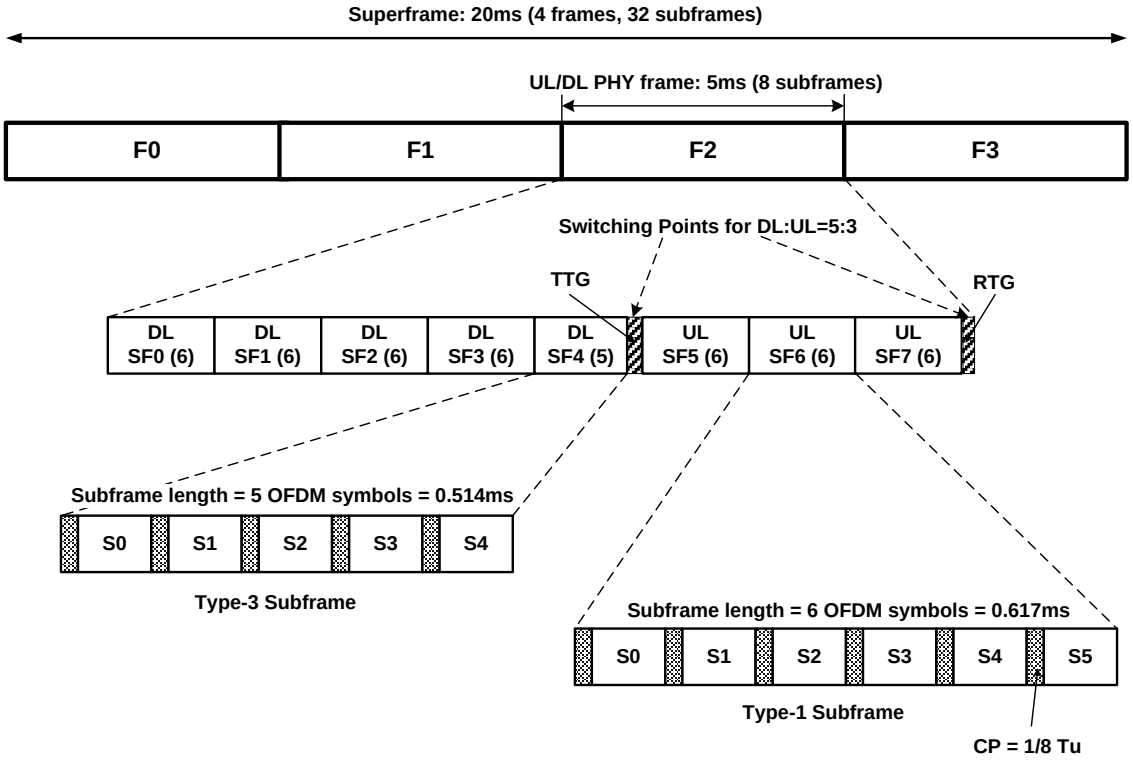

Figure 391 Frame Structure with type-1 and type-3 subframes in TDD duplex mode

for 5, 10, 20 MHz channel bandwidths (CP=1/8 T_b)

[Remedy 5: Change the text from line 41 to 55 on the page 17, in 15.3.3.3., as follows:]

For channel bandwidths of 5, 10, and 20 MHz, a FDD frame shall have five type-1 subframes and three type-2 subframes, and a TDD frame shall have six type-1 subframes and two type-2 subframes.

In the TDD frame, the first and last subframes within each frame shall be type-2 subframes. ~~The last OFDMA symbol in a type-2 subframe preceding a DL to UL switching point shall be an idle symbol, which is used to accommodate the gap required to switch from DL to UL.~~

[Remedy 6: Replace Figure 392 in page 18 with the following Figure]

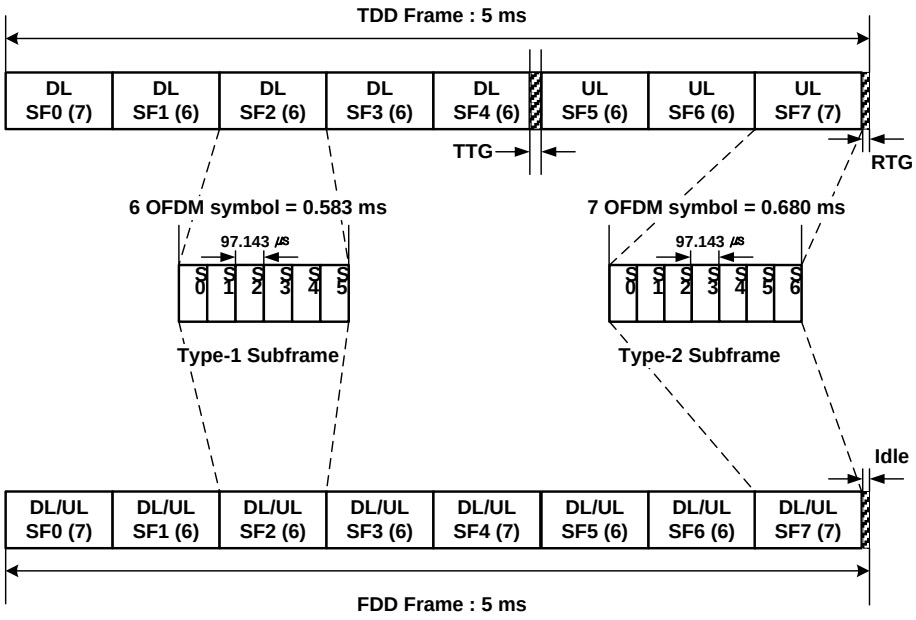

Figure 392 TDD and FDD Frame Structure with CP of 1/16 T_b (DL to UL ratio of 5:3)

[Remedy 7: Change the text from line 32 to 39 on the page 23, in 15.3.5.1., as follows:]

A physical resource unit (PRU) is the basic physical unit for resource allocation that comprises P_{sc} consecutive subcarriers by N_{sym} consecutive OFDMA symbols. P_{sc} is 18 subcarriers and N_{sym} is 6 OFDMA symbols for type-1 subframes, ~~and~~ N_{sym} is 7 OFDM symbols for type-2 sub frames, and N_{sym} is 5 OFDMA symbols for type-3 subframes. A logical resource unit (LRU) is the basic logical unit for distributed and localized resource allocations. A LRU is $P_{sc} \cdot N_{sym}$ subcarriers for type-1 subframes, ~~and~~ type-2 subframes, and type-3 subframes. The LRU includes the pilots in (ref. TBD) that are used in a PRU. The effective number of subcarriers in an

LRU depends on the number of allocated pilots.

4. References

[1] IEEE 802.16m-08/003r6, “The Draft IEEE 802.16m System Description Document”

[2] IEEE 802.16m-08/050, “IEEE 802.16m Amendment Working Document”

[3] WiMAX Forum™ Mobile System Profile, Release 1.0 Approved Specification (Revision 1.4.0: 2007-05-02)