Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Proposed Revision of TGm Frame Structure Rapporteur Group Output (C802.16m-08/118r1) regarding Coexistence**
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Re:	IEEE 802.16m-08/118r1 (“Proposed 802.16m Frame Structure Baseline Content Suitable for Use in the 802.16m SDD”)
Abstract	This contribution proposes to replace subclause 11.4.5 of IEEE C802.16m-08/118r1. As a result, 802.16 would not be required to sacrifice as much transmission time in the name of coexistence.
Purpose	To be discussed and adopted by TGm as a modification of subclause 11.4.5 of IEEE C802.16m-08/118r1.
Notice	
Release	
Patent Policy	

Proposed Revision of TGm Frame Structure Rapporteur Group Output (C802.16m-08/118r1) regarding Coexistence

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1 Introduction and Discussion

IEEE 802.16m-08/118r1 ("Proposed 802.16m Frame Structure Baseline Content Suitable for Use in the 802.16m SDD") [2] includes a subclause 11.4.5 on "Coexistence Support in Frame Structure." Included in 11.4.5 are three figures, along with associated text.

Figures 11.4-8 and 11.4-9 deal with coexistence between 802.16 TDD and another TDD system in an adjacent channel or cell. TDD systems are generally synchronized to avoid simultaneous BS and MS transmissions in adjacent channels or cells. For example, proposals have been made to apply this approach to address coexistence of 802.16m TDD with legacy 802.16 systems [3,4].

Subclause 11.4.5.2 of [2] ("Coexistence with UTRA LCR-TDD (TD-SCDMA)") includes the text

> *Coexistence between IEEE 802.16m TDD and UTRA LCR-TDD (TD-SCDMA) may be facilitated by inserting either idle symbols within the IEEE 802.16m frame or idle sub-frames. Figure 11.4-9 shows how coexistence between IEEE 802.16m with a 4:4 DL:UL ratio and TD-SCDMA can be facilitated.*

and also includes Fig.11.4-9 ("Alignment of IEEE 802.16m frame with UTRA LCR-TDD frame in TDD mode"). Fig.11.4-9 demonstrates how the 802.16 frame can be synchronized with an adjacent UTRA LCR-TDD frame to avoid simultaneous BS and MS transmissions.

A major drawback of Fig.11.4-9 is that the IEEE 802.16 system is shown to be idle for 333 μs around the DL-to-UL switch point and for 205.64 μs around the UL-to-DL switch point. This requires the 802.16 system to be idle over 10% of the time simply to address the coexistence issue. This contribution proposes an alternative text and table with much less idle time.

This 10% figure may be an underestimate, because the numbers in Fig.11.4-9 are questionable. In particular, it is not clear how the 333 μs at the DL-to-UL switch point was calculated. It is not a multiple of the presumed 102.82 μs symbol time, even allowing for extra 64.64 μs of idle time allocated per frame in Proposal-1. To emphasize the point, note that the figure shows 5000–333–205.64 = 4461.36 μs of transmission time. This would accommodate 43.39 102.82 μs symbols – not an integer number of them. It appears that the intent was to drop three symbols and add the extra 64.64 μs of idle time. In this case, the idle time at this switch point is 3*102.82 + 64.64 = 373.1 μs, not 333 μs.

Therefore, it appears that Fig.11.4-9 is suggesting 43 symbols per frame, 24 in the DL and 19 in the UL, with a total idle time in 578.74 μs. This means that the actual idle time of this proposal seems to be 11.6%.

The inefficiency in Fig.11.4-9 is due to three separate problems:

(1) Fig.11.4-9 forces 802.16 to idle during the TD-SCDMA DwPTS and UpPTS. These total 200 μs. However, there is no obvious coexistence value of forcing the 802.16 system to idle during these periods. DwPTS is a downlink interval for TD-SCDMA, and UpPTS is an uplink interval. The 802.16 system can safely transmit in parallel.

(2) Fig.11.4-9 requires excess 802.16 idle time at both the beginning and the end of both the 802.16 DL and UL

intervals. If the 802.16 DL is aligned with the start time of the adjacent system's DL, then no idle time need be introduced at the start of the DL. Some mismatch may still occur at the end.

(3) It appears that Fig.11.4-9 is following the subframe concept of Proposal-1, using a rigid grid of six-symbol subframes, each of which can include DL or UL but not both.

Considering these three points, the continuous DL duration in TD-SCDMA (in the 4:3 DL:UL example in Fig. 11.4-9, is 4*675+75 = 2775 μs. To calculate the number of 802.16 symbols that will fit, we need to know the symbol period. If we take, for example, the symbol duration of 102.82 μs, we can fit 27 DL symbols. [This would extend 1 μs into the 75 μs TD-SCDMA gap.] Likewise, the TD-SCDMA UL time, including he 75 μs gap reserved in TD-SCDMA for the DL-to-UL switch, is 3*675+125+75 = 2225 μs, long enough to hold 20 symbols of 102.82 μs, with 168.6 μs left over for gap time.

By this analysis, coexistence with TD-SCDMA can be achieved while using 47 symbols of 102.82 μs each, which keeps the 802.16 system busy for 4832.54 out to 5000 μs. The idle ratio is 3.3%.

The bottom line here is that Fig.11.4-9 allows 24 DL symbols and 19 UL symbols per frame. Correcting the three problems allows 27 DL symbols and 20 UL symbols per frame. This increases the throughput by 9.3% compared to Fig.11.4-9.

While the correction of (1) and (2) is straightforward, the correction of (3) would require a more flexible subframing structure. Since that is not a given, we could consider a coexistence solution that corrects for (1) and (2) but not (3), assuming the rigid six-symbol subframe. As shown in the figure below, this would recover two of the four symbols wasted in the method of Fig.11.4-9. The DL would include 27 symbols, but the UL would include only 18; two UL symbols would be lost to the subframe roundoff.

In IEEE 802.16m-08/118r1, Fig.11.4-8 is parallel to Fig.11.4-9 but addresses E-UTRA TDD (TD-LTE) as the adjacent system. The same remarks, including the unnecessary idle time during DwPTS and UpPTS, apply to this example. Due to the fact that the same principles apply to this case, it is perhaps not necessary to include both examples in the document.

Figure 11.4-7 addresses coexistence with E-UTRA FDD. The point of the figure is not entirely apparent. This contribution proposes to not discuss coexistence of adjacent FDD systems.

2 Proposed content of 11.4.5

11.4.5.1 Coexistence with UTRA LCR-TDD (TD-SCDMA) and E-UTRA TDD

Coexistence between IEEE 802.16m TDD and UTRA LCR-TDD (TD-SCDMA) may be facilitated by synchronizing and aligning the IEEE 802.16m and UTRA LCR-TDD frames. This is illustrated in Figure 11.4-9a for a special case: the legacy 802.16 TDD frame with 27:20 DL:UL symbol ratio and TD-SCDMA 4:3 DL:UL symbol ratio. This concept can be generalized to other DL:UL ratios. Note that the TTG shown here is that of the legacy system. It could be adjusted in 802.16m if, for instance, the TTG was chosen to be one symbol duration. This would not affect the concept.

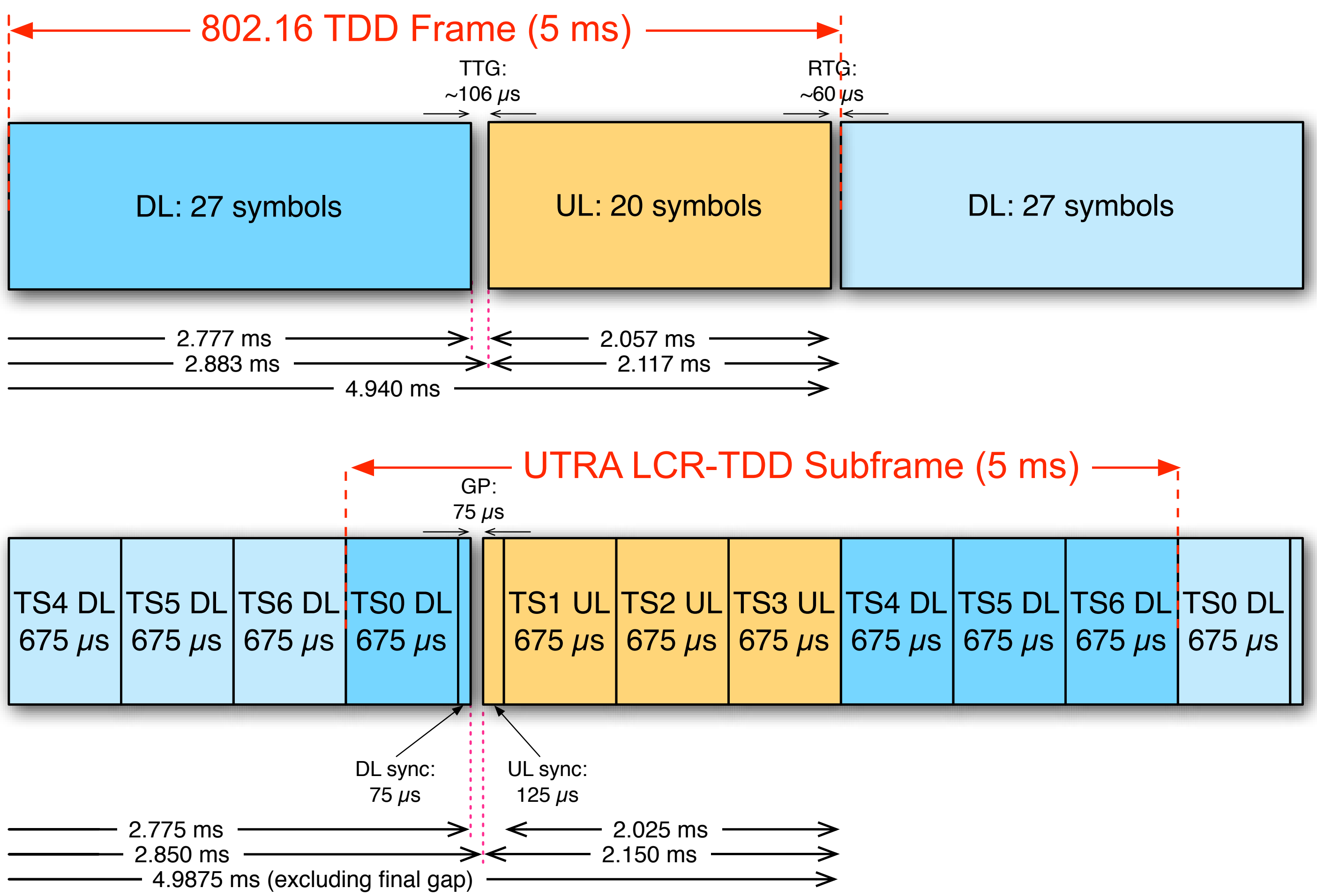

Figure 11.4-9a: Alignment of IEEE 802.16m TDD frame with UTRA LCR-TDD frame

Figure 11.4-9b illustrates the same coexistence scenario using a rigid subframe of six symbols, each of 102.82 μs duration.

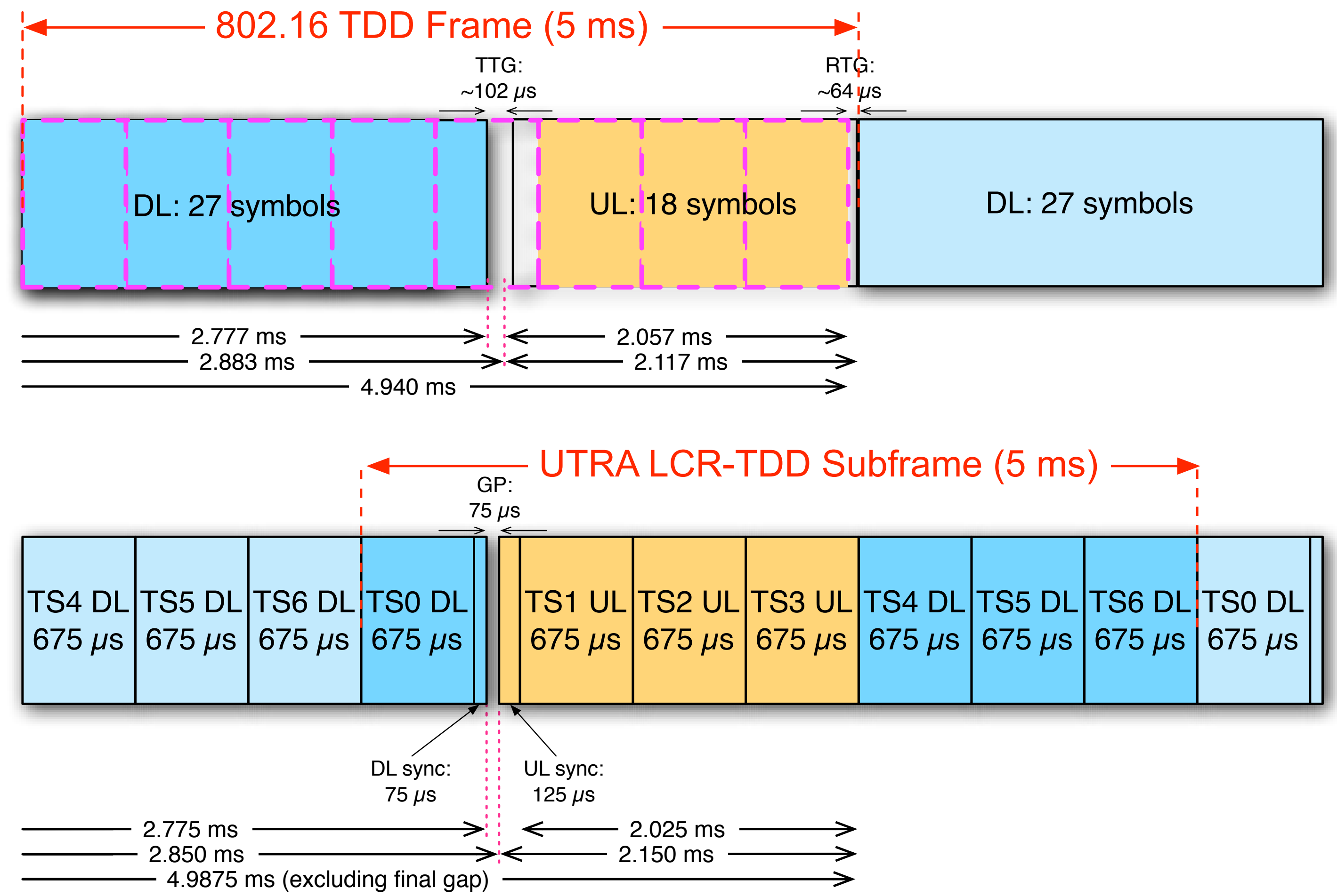

Figure 11.4-9b: Alignment of IEEE 802.16m TDD frame with UTRA LCR-TDD frame, assuming a rigid subframe of six symbols, 102.82 μs each

Coexistence between IEEE 802.16m TDD and E-UTRA TDD (TD-LTE) may be facilitated by the identical technique.

3 Conclusion and Recommendation

This contribution proposes to replace the content of subclause 11.4.5 of IEEE 802.16m-08/118r1 with subclause 2 of this contribution.

Using Fig. 11.4-9a, 802.16 would not, in this example, be required to sacrifice transmission time in the name of coexistence. However, this requires that the DL and UL be permitted to begin at arbitrary times, or with a granularity of one symbol. If 802.16m adopts a rigid allocation regime in which subframes can begin only on multiple of a fixed resource allocation unit, additional inefficiencies may result.

Table 1 summarizes the results.

Figure	DL Symbols	UL Symbols	Total Symbols	Symbols Lost	% of Symbols Lost
11.4-9a	27	20	47	0	0
11.4-9	24	19	43	4	8.51%
11.4-9b	27	18	45	2	4.26%

Table 1: Summary of results

4 References

[1] IEEE 802.16m-07/018r1 (“Proposed 802.16m Frame Structure Baseline Content Suitable for Use in the 802.16m SDD”), 802.16m Frame Structure Rapporteur Group

[2] IEEE 802.16m-07/002r4 (“IEEE 802.16m System Requirements”)

[3] IEEE C802.16m-07/263, “802.16m Frame Structure to Enable Legacy Support, Technology Evolution, and Reduced Latency,” Roger Marks, Lei Wang, Yair Bourlas, Srikanth Gummadi, Kenneth Stanwood.

[4] IEEE C802.16m-08/095r1, “An Evolved Frame Structure and the use of fractional OFDMA symbols,” Kiran Thakare, Per Ernström, S. Shawn Tsai.