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Re:	Call for Comments on contribution C802.16-08/118r1 – the proposed SDD text on frame structure from the Rapporteur's Group	
Abstract	This contribution proposes to support multiple CP in 16m system.	
Purpose	To be discussed and accepted by TGm into 16m SDD baseline document.	
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A Proposal for Supporting Multiple CP in 16m Frame Structure

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Introduction

In this contribution, we propose to support multiple CP length in the 16m system. We also suggest a text proposal to be included in 802.16m SDD baseline document.

Problem Statement

As we all know, even though there are four types of CP length (1/4Tu, 1/8Tu, 1/16Tu, 1/32Tu) to be defined in the current IEEE802.16e-2005 standard, only one type of CP length can be used by WirelssMAN-OFDMA reference system, which is specified by WiMAX Mobile System Profile as 1/8Tu. Here, Tu means the useful OFDM symbol time based on 10.94 kHz subcarrier spacing.

Some contributions suggest to use only this CP length (1/8Tu) in the 16m system, which is described as proposal-1 of OFDMA parameters for IEEE 802.16m in the rapporteour's report Contribution C802.16-08_118r1. Obviously, it is not suitable to use only one type of CP length for different deployment scenarios. For example, in the scenario with severe multipath (i.e. larger delay spread), longer CP should be used to eliminate the ISI and ICI. But simple scenario with fewer multipath only requires short CP in order to reduce overhead and transmission power. The following table lists all the channel models and corresponding maximum delay spread which are suggested by IEEE 802.16m-08/004 802.16m EVM document.

Table 1 – Wireless Channel Model suggested by 802.16m EMD document

Channel Model	Max. Delay Spread (ns)
Indoor Hotspot (LOS)	130
Indoor Hotspot (NLOS)	215
Rural Macrocell (LOS)	235
Indoor Small Office	250
Rural Macrocell (NLOS)	420
Urban Microcell (LOS)	460
Outdoor to Indoor	585
Urban Microcell (NLOS)	615
Suburban Macrocell	770
Urban Macrocell	1845
Vehicular A	2510
Modified Vehicular A	2620
Urban Microcell (Bad)	2800
Pedestrian B	3700
Modified Pedestrian B	3870
Urban Macrocell (Bad)	7100

And the CP length defined by current legacy system is a fraction of useful symbol time. But actually the CP duration is independent of the useful symbol time, especially in current legacy system where the useful symbol

time changes between different sampling frequency sets. In other words, based on the CP definition in the current legacy system, for a given deployment environment, the CP length will vary with the channel bandwidth which is used by the system. The following table lists the CP length used by the legacy system.

Table 2 – CP Length used by the legacy system

Channel Bandwidth (MHz)	5/10	7/14	8.75
Sampling Frequency (MHz)	11.2	8	10
Subcarrier Spacing (kHz)	10.94	7.8	9.76
Useful Symbol Time (us)	91.4	128.2	102.46
CP (1/8Tu, us)	11.42	16.025	12.81

Based on table-1 and table-2, we make three examples to show the problems caused by the proposal-1 of OFDMA parameters of 16m in C80216m-08_118r1. In the first example, the bad urban macrocell is selected as the deployment scenario where the maximum delay spread is 7.1us. If the operator deploys the 16m system with 10MHz channel bandwidth, 4.15% of total transmission resource will be wasted. For the 16m system with 7MHz and 8.75MHz channel bandwidth, 6.07% and 4.91% of total transmission resource will be wasted, respectively. In the second example, the indoor hotspot with LOS is selected as the deployment scenario where the maximum delay spread is 0.13us. In the third example, the urban microcell with NLOS is seleced where the maximum delay spread is 0.615us. The following table gives the comparison of the wasted transmission resource among the systems with different channel bandwidth, which use only one type of CP length.

Table 3 - Comparison of wasted transmission resource

	Bad Urban Macrocell	Indoor Hotspot with LOS	Urban Microcell with NLOS
5/10MHz	4.15%	10.84%	10.37%
7/14MHz	6.07%	10.81%	10.48%
8.75MHz	4.91%	10.9%	10.49%

Obviously, only one type of CP length can not be appropriately applied to different deployment scenarios.

Some other contributions propose that other three types of CP length can be also used for 16m system which is based on OFDMA numerology of legacy system. Even though there are different types of CP length which can be used for different scenarios of 16m system, the second problem mentioned above still exists, i.e. for a given deployment scenario, the 16m systems with different channel bandwidth have different CP length and different transmission efficiency.

Table 4 - all the types of CP length for different channel bandwidth based on legacy OFDMA numerology

	5/10MHz	7/14MHz	8.75MHz
CP – 1/4Tu	22.84us	32.05us	25.62us
CP – 1/8Tu	11.42us	16.025us	12.81us
CP – 1/16Tu	5.71us	8.01us	6.4us
CP – 1/32Tu	2.85us	4.0us	3.2us

Besides the above problems, a new problem has to be faced by the basic frame structure-1 in C80216m-

08_118r1 which is closely related to legacy OFDMA numerology, i.e. the switching point alignment between 16m system with legacy supporting and 16m-only system. Based on the basic frame structure-1 in C80216m-118r1, there are two possible cases to be defined for supporting multiple CP in 16m system. One is the 16m system with legacy supporting uses 1/8Tu in the “legacy zone” and uses a new CP in the “16m zone”. The other is the 16m system with legacy supporting uses only 1/8Tu, and the 16m-only system uses a new CP.

For the first case, the whole framework of basic frame structure proposal-1 will be broken down. One frame of 5ms will not be composed of 48 OFDM symbols since two types of symbol duration with different CP exist in one frame.

For the second case, it is difficult to keep the switching point aligned between 16m system with legacy system and 16m-olny system to avoid the DL and UL transmission interference, since they have different OFDM symbol duration. Even though a solution can be found to keep the switching point alignment, the cost is the switching point is fixed and for different channel bandwidth dedicated solutions have to be proposed which is not a general way for all the 16m systems. The following table shows the number of OFDM symbols in one frame of 5ms for different CP length.

Table 5 – the number of OFDM symbols in one frame based on legacy numerology

	5/10MHz	7/14MHz	8.75MHz
1/4Tu	43	31	39
1/8Tu	48	34	43
1/16Tu	51	36	45
1/32Tu	53	37	48

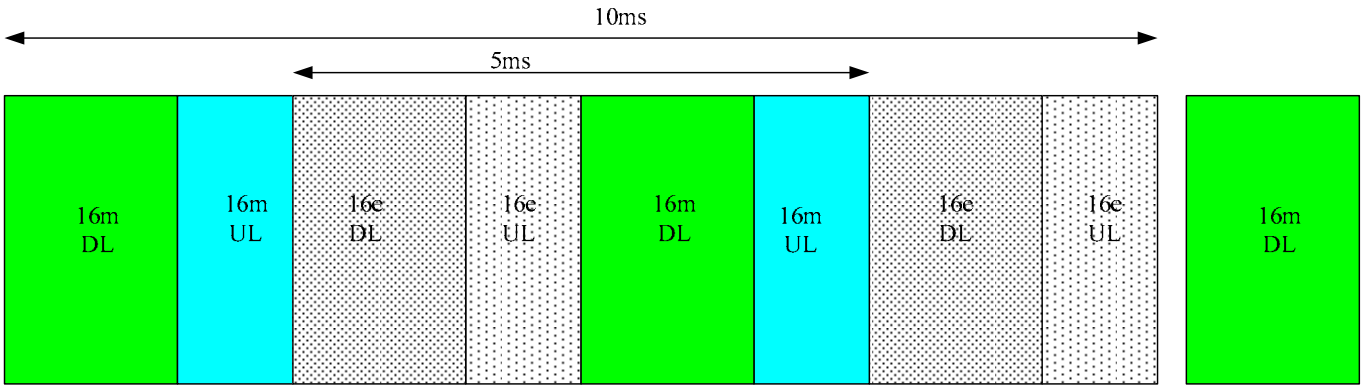
Proposed Solution

According to the above analysis, we propose to use a set of CP length for different scenario and all the channel bandwidth as follows.

Short CP: 2.5us
Normal CP: 10us
Long CP: 15us

These three types of CP are used by 16m system with legacy supporting and 16m-only system for all the channel bandwidth. The CP length can be configured frame by frame.

With TDM mode, 16m system with legacy supporting can use the legacy CP in “legacy zone” and the new CP in “16m zone”. The following shows an example of 16m frame structure with legacy supporting. 16e/16m DL/UL subframe is defined as 0.5ms, 1.0ms, 1.5ms, 2ms, 2.5ms, or 3ms. In this case, “legacy zone” is allocated as a whole which will not cause DL-UL switching point unaligned.



Text Proposal for 802.16m SDD

[To add the following text proposal in C802.16m-08_118r1:]

11.3 OFDMA Parameters
The OFDMA parameters for the IEEE 802.16m are specified as follows:

The following three types of CP length are defined for 16m system with legacy system and 16m-only system. The CP length can be configured frame by frame.

Short CP: 2.5us
Normal CP: 10us
Long CP: 15us

Reference

[1] C80216m-08_118r1 Frame Structure Rapporteur Report
[2] IEEE 80216m-08_004 802.16m EMD