

Multiple CPs for 16m downlink OFDM frame structure

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Purpose:

To be discussed and adopted by TGM for the 802.16m SDD.

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Background

- Two CP sizes are supported in SDD
 - Normal CP: $T_g = 1/8 T_u = 11.43\mu\text{s}$
 - Short CP: $T_g = 1/16 T_u = 5.71\mu\text{s}$
- Normal CP ($T_g = 11.43\mu\text{s}$) is not long enough for MBS
 - Propagation delay $\approx 3.33\mu\text{s}/\text{km}$
 - $T_g = 11.43\mu\text{s} \approx 3.43\text{km}$
 - For SFN, the delay profile has a long tail, the energy beyond $11.43\mu\text{s}$ is non-negligible → Inter-symbol interference
- Short CP ($T_g = 5.71\mu\text{s}$) is not short enough for femto-cell deployment
 - Typical delay spread of indoor environment is $< 1\mu\text{s}$
 - 51 OFDM symbols per frame
 - Subframe timing not aligned with systems with normal CP
 - FDM/TDM with legacy systems on the subframe level becomes difficult
 - Difficulty in synchronizing the switching points for TDD with systems using different CPs

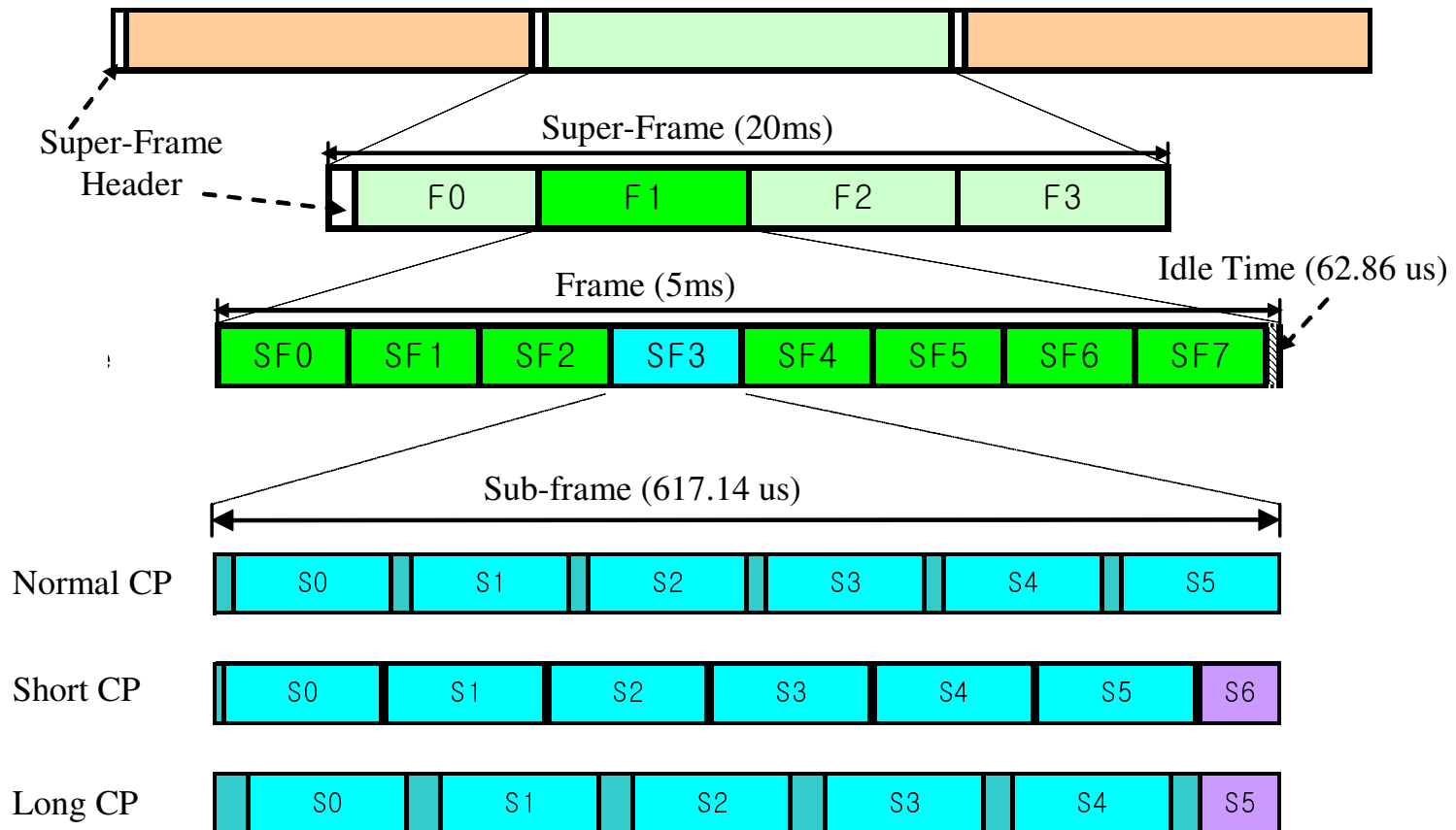
Multiple CP Design Criteria

- Short CP
 - Efficient support of indoor environment (Short CP < 5us)
- Normal CP
 - Same normal CP as in 16e for backward compatibility (Normal CP = 11.43us)
- Long CP
 - Efficient support of SFN operation for MBS
 - No inter-symbol interference for SFN transmission with 5km distance (Long CP > 16.7us)
- Subframes with different CPs are time-aligned
 - Support TDM/FDM with legacy systems at the subframe level
 - No additional provisioning needed for TDD switching points

Multiple CP proposal

- Short CP:
 - $T_g = 3.21\mu\text{s}$
 - Number of OFDM symbols per subframe
 - 6 OFDM symbols with $T_u = 91.43\mu\text{s}$
 - 1 OFDM symbol with $T_u = 45.71\mu\text{s}$
- Normal CP:
 - $T_g = 11.43\mu\text{s}$
 - Number of OFDM symbols per frame
 - 6 OFDM symbols with $T_u = 91.43\mu\text{s}$
- Long CP:
 - $T_g = 18.93\mu\text{s}$
 - 5 OFDM symbols with $T_u = 91.43\mu\text{s}$
 - 1 OFDM symbol with $T_u = 45.71\mu\text{s}$

Frame structure with multiple CPs



Proposed SDD text

11.3 OFDMA Parameters

Nominal Channel Bandwidth (MHz)		5		10		20	
Over-sampling Factor		28/25		28/25		28/25	
Sampling Frequency (MHz)		5.6		11.2		22.4	
OFDM Symbol Types		Full	Half	Full	Half	Full	Half
FFT Size		512	256	1,024	512	2,048	1,024
Sub-carrier Spacing (kHz)		10.94	21.88	10.94	21.88	10.94	21.88
OFDMA Useful Symbol Time T_u (μs)		91.43	45.71	91.43	45.71	91.43	45.71
CP Length T_{cp} (μs)	Short	3.21					
	Normal	11.43					
	Long	18.93					
Symbol Duration T_s (μs)	Short	94.64	48.92	94.64	48.92	94.64	48.92
	Normal	102.86	57.14	102.86	57.14	102.86	57.14
	Long	110.36	64.64	110.36	64.64	110.36	64.64

Table 11.3-1: OFDMA parameters for IEEE 802.16m

In addition to the full OFDM symbol, the proposed frame structure uses half OFDM symbol that consists of a CP with the same size and the useful symbol part with half the size of those of the full OFDM symbol, respectively. The proposed frame structure supports three different CP sizes: Short, Normal and Long.

Conclusion

- The proposed multiple CP design provides
 - Effective support for large cell / SFN deployments and femto-cells
 - Allow subframe level time alignment for systems with different CPs
- Proposed SDD text
 - As on page 6 of this contribution