Multiple CPs for 16m downlink OFDM frame structure

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Base Contribution:
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Purpose:
To be discussed and adopted by TGm for the 802.16m SDD.

Background

- Two CP sizes are supported in SDD
  - Normal CP: Tg = 1/8 Tu = 11.43us
  - Short CP: Tg = 1/16 Tu = 5.71us
- Normal CP (Tg = 11.43us) is not long enough for MBS
  - Propagation delay ≈ 3.33us/km
  - Tg = 11.43us ≈ 3.43km
    - For SFN, the delay profile has a long tail, the energy beyond 11.43us is non-negligible ➔ Inter-symbol interference
- Short CP (Tg = 5.71us) is not short enough for femto-cell deployment
  - Typical delay spread of indoor environment is < 1us
  - 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

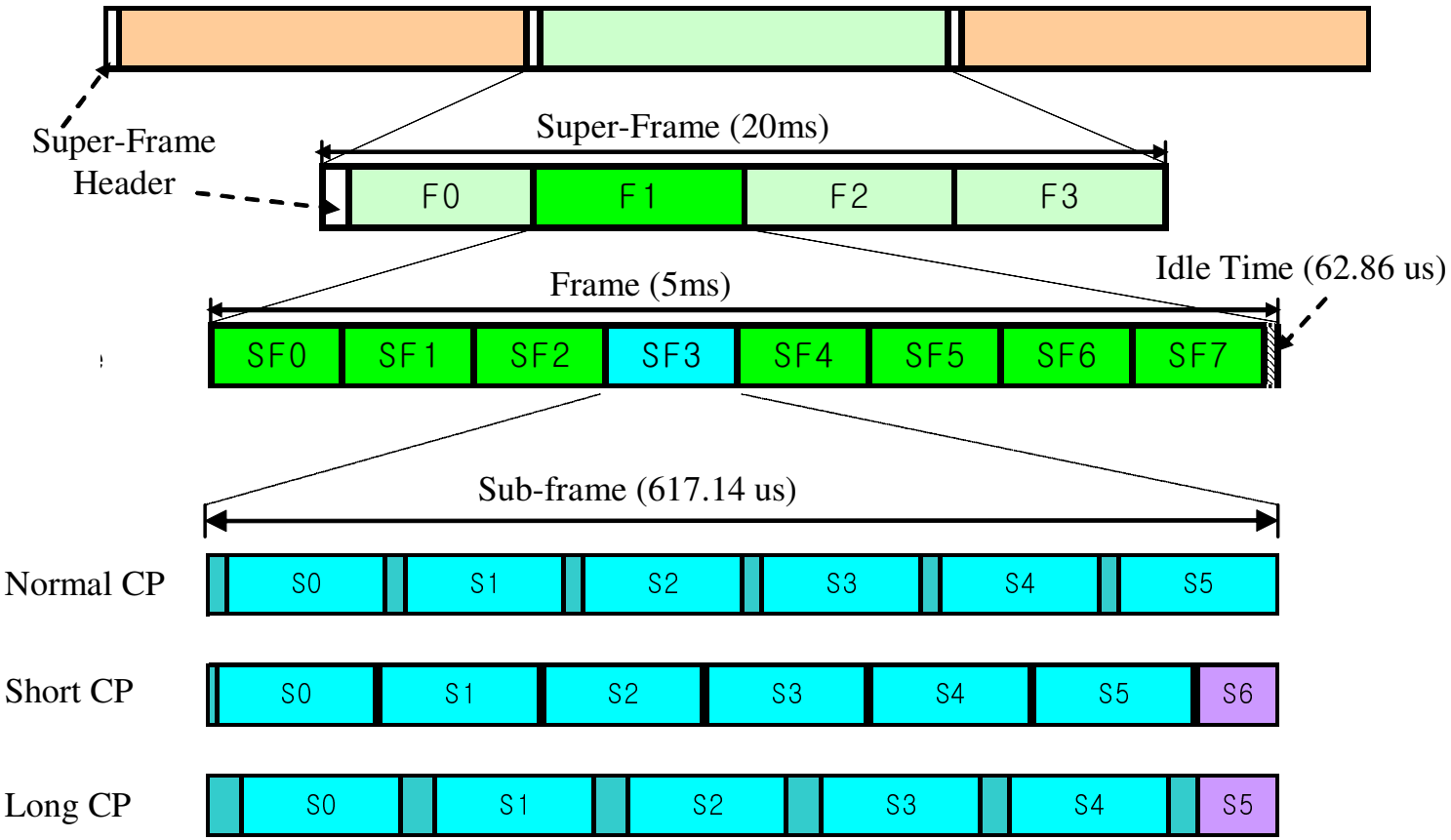
Multiple CP Design Criteria

- 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:
  - Tg = 3.21us
  - Number of OFDM symbols per subframe
    - 6 OFDM symbols with Tu = 91.43us
    - 1 OFDM symbol with Tu = 45.71us
- Normal CP:
  - Tg = 11.43us
  - Number of OFDM symbols per frame
    - 6 OFDM symbols with Tu = 91.43us
- Long CP:
  - Tg = 18.93us
    - 5 OFDM symbols with Tu = 91.43us
    - 1 OFDM symbol with Tu = 45.71us

Frame structure with multiple CPs



Proposed SDD text

11.3 OFDMA Parameters

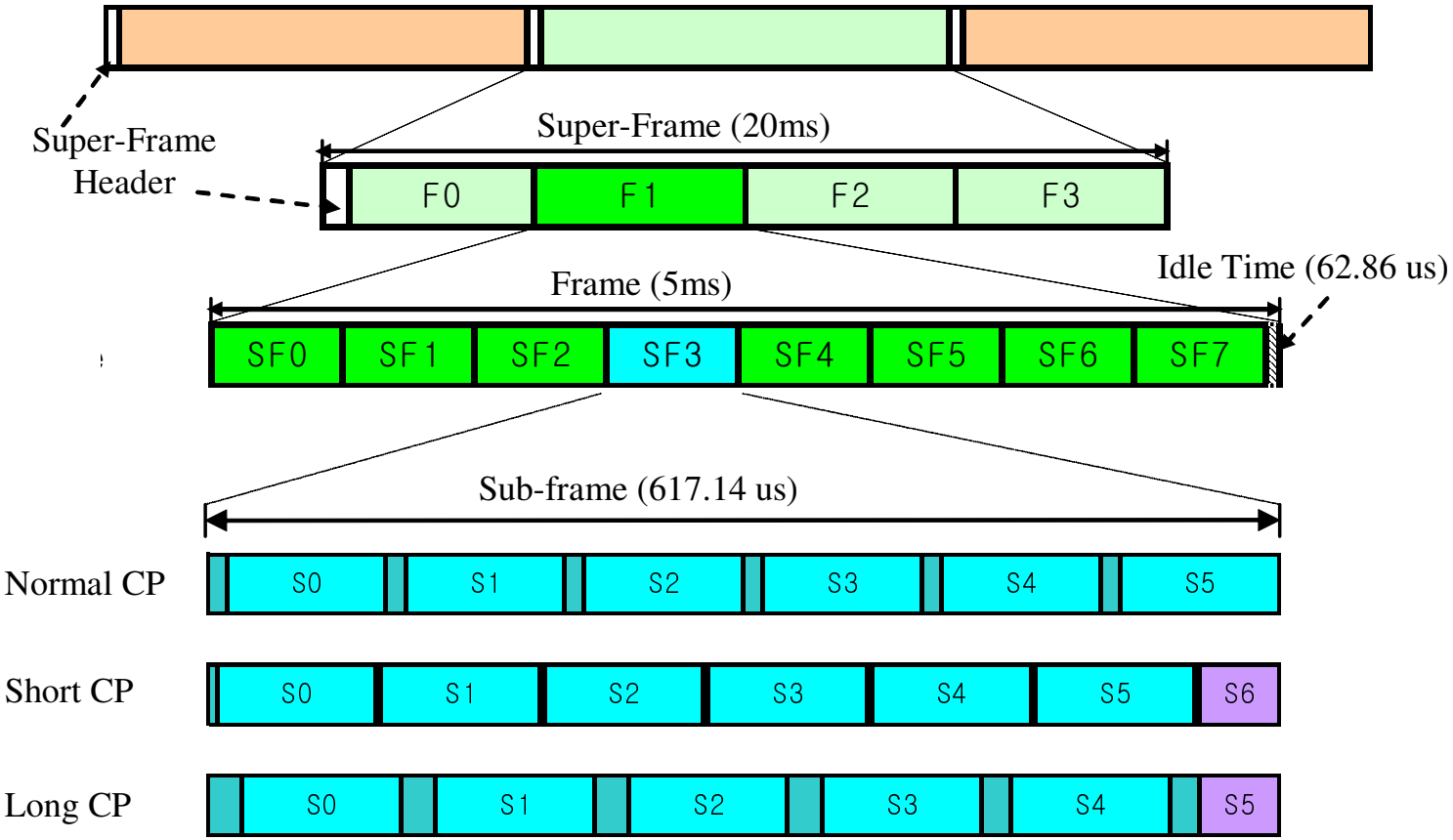
Nominal Channel Bandwidth (MHz)		5		10		20	
Over-sampling Factor		28/25		28/25		28/25	
Sampling Frequency (MHz)		5.6		11.2		22.4	
OFDM Symbol Types		Full	Half	Full	Half	Full	Half
FFT Size		512	256	1,024	512	2,048	1,024
Sub-carrier Spacing (kHz)		10.94	21.88	10.94	21.88	10.94	21.88
OFDMA Useful Symbol Time Tu (μs)		91.43	45.71	91.43	45.71	91.43	45.71
CP Length Tcp (μs)	**Short**	3.21					
	Normal	11.43					
	Long	18.93					
Symbol Duration Ts (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.

Proposed SDD text

- Section 11.4.1 (Replace Figure 17 with the following figure)



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 & 7 of this contribution