

# 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

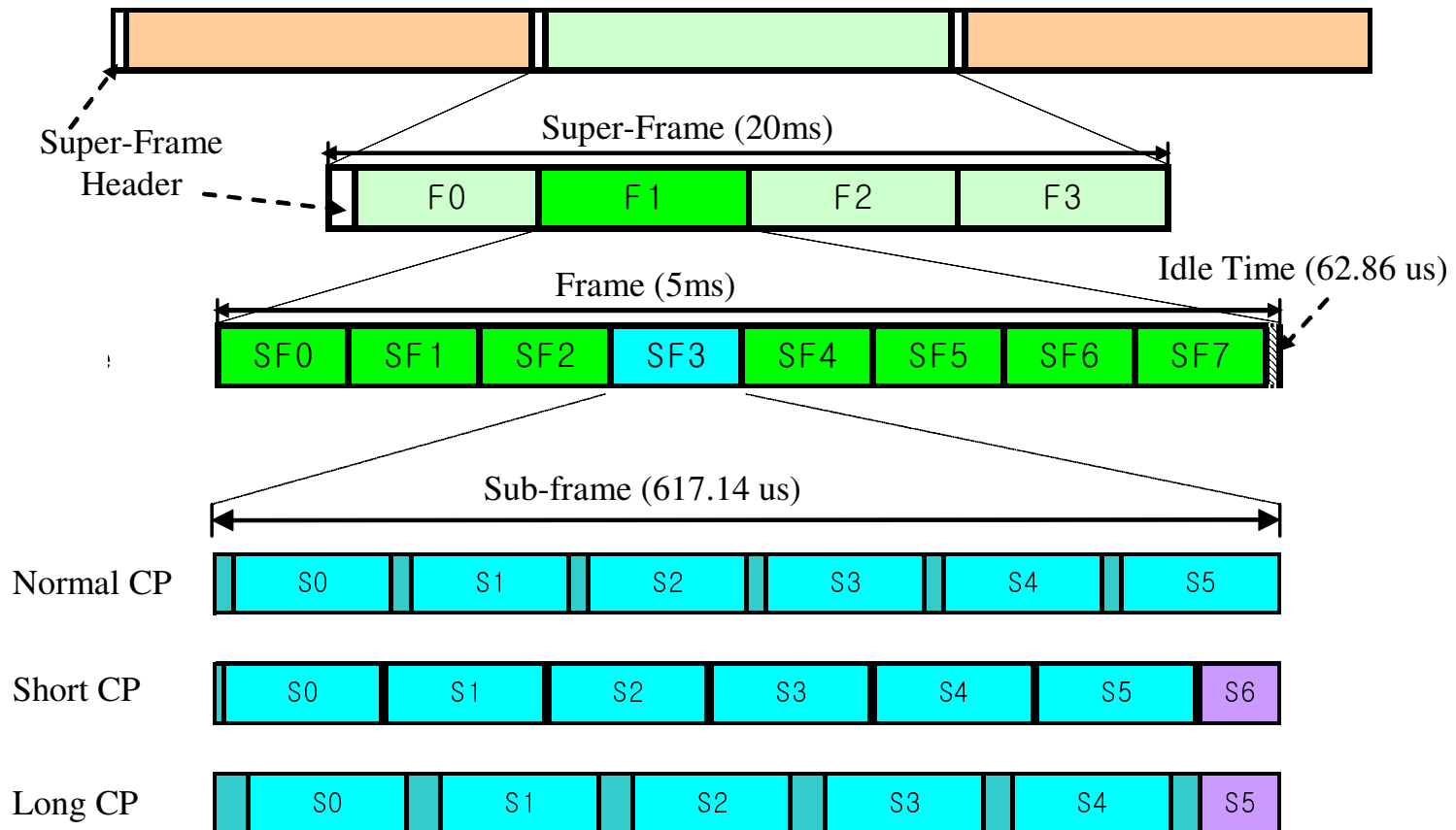
# Multiple CP Design Criteria

- 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

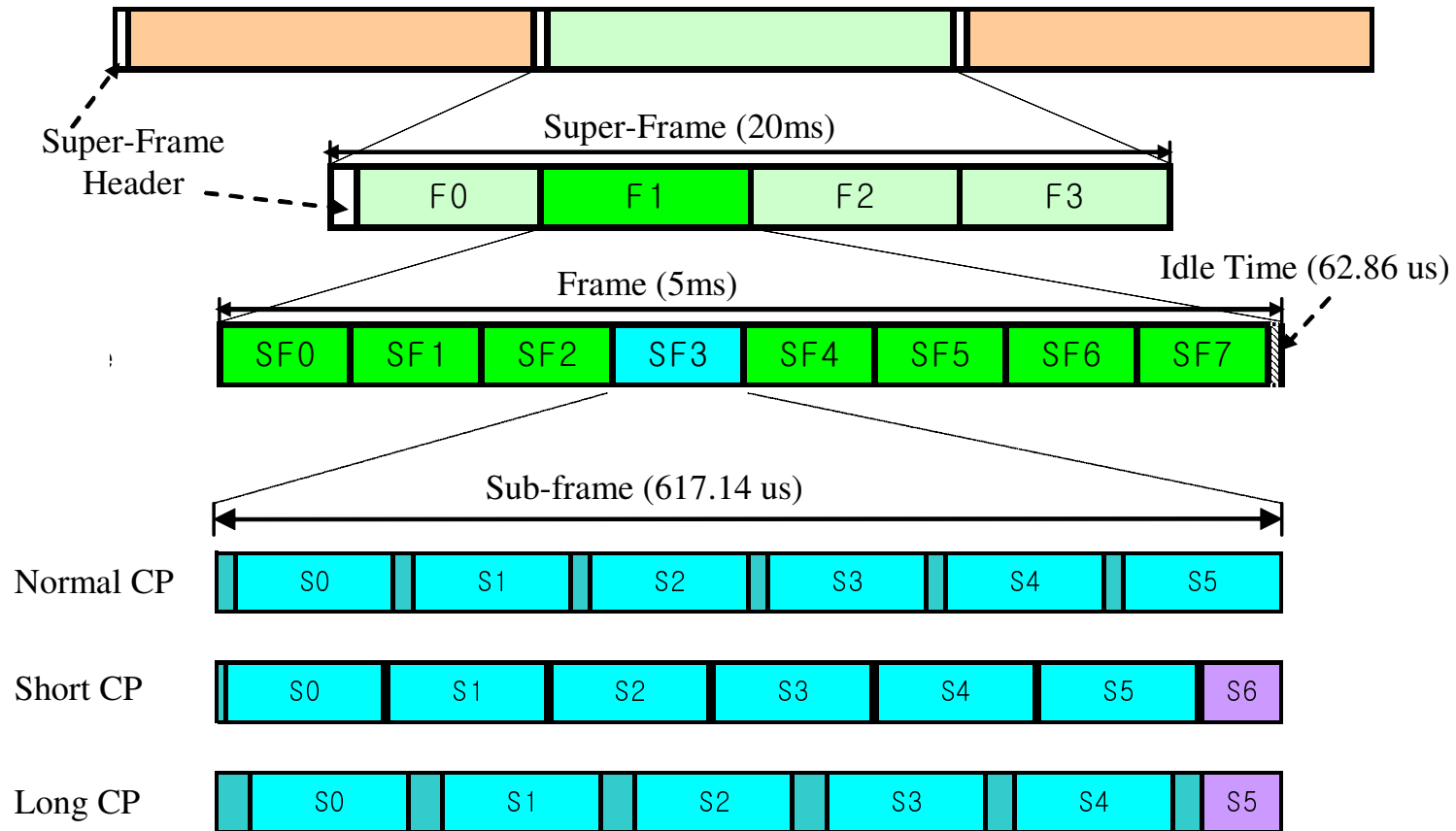
<b>Nominal Channel Bandwidth (MHz)</b>		5		10		20	
<b>Over-sampling Factor</b>		28/25		28/25		28/25	
<b>Sampling Frequency (MHz)</b>		5.6		11.2		22.4	
<b>OFDM Symbol Types</b>		Full	Half	Full	Half	Full	Half
<b>FFT Size</b>		512	256	1,024	512	2,048	1,024
<b>Sub-carrier Spacing (kHz)</b>		10.94	21.88	10.94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