Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Changes to IEEE 802.16a/D3. Method for determining the Cyclic Prefix used by an AP.**
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Re:	
Abstract	Changes suggested in IEEE 802.16a/D3 pertaining to Cyclic Prefix selection.
Purpose	This document is submitted in response for call for comments IEEE 802.16a/D3.
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1   Introduction

The following submission proposes a method for informing a Subscriber Unit of the Cyclic Prefix being used in a sector.

It is currently implied that a Subscriber Unit will automatically determine which CP is being used by the Access Point. This approach will add complexity for two reasons. First the SU will be required to scan the DL bursts and determine which CP is being used. There will be a need for additional logic to do this. Secondly the variable CP in the preamble will cause a synchronization correlator to be more complex. The correlation peak on the first CP portion of the preamble will vary from very small when CP=1/32 of the FFT size to quite large when CP=1/4 of the FFT size.

The system could be greatly simplified by simply setting the CP of the DL burst preamble and the first DL OFDM data symbol to the maximum _ of the FFT size. The DL Frame Prefix in the first OFDM data symbol would contain 2 extra data bits (padded to 8 for byte boundary) to indicate the CP to be used for all remaining DL data symbols as well as all UL bursts (preamble and data).

The added overhead of this approach would be minimal but the reduced implementation complexity and improved performance could be significant.

2   Proposed Changes

The following changes should be made to the 802.16a/D3 document.

If accepted, the wording would be added to state that the first OFDM symbol in the DL burst would have a fixed CP length of _ the FFT length. The following sections on the specified pages would also require change:

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8.3.4.1.2 Time domain description.

Inverse-Fourier-transforming creates the OFDM waveform; this time duration is referred to as the useful symbol time . A copy of the last samples is inserted before the useful symbol time, and is called the Cyclic Prefix (CP); its duration is denoted as a fraction of the useful symbol time. The two together are referred to as the symbol time . Figure 188 illustrates this structure. A cyclic extension of s is used to collect multipath, while maintaining the orthogonality of the tones. The transmitter energy increases with the length of the guard time while the receiver energy remains the same (the cyclic extension is discarded), so there is a dB loss in SNR.

Using a cyclic extension, the samples required for performing the FFT at the receiver can be taken anywhere over the length of the extended symbol. This provides multipath immunity as well as a tolerance for symbol time synchronization errors.
On initialization, a SS will determine the CP being used by reading the FCH message in the regular DL burst. Once a specific CP duration has been selected by the BS for operation on the DL, it should not be changed. Changing the CP would force all the SSs to resynchronize to the BS. The CP overhead fraction can be reduced by using larger FFT intervals (i.e. a larger FFT size). Larger FFT intervals do however, among other things, adversely affect the sensitivity of the system to phase noise of the oscillators. To facilitate a choice in this trade-off, the designed PHY provides for various FFT sizes.

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Table 219 OFDM DL Frame Prefix

Syntax	Size	Notes
DL_Frame_Prefix_Format() {		
Rate_ID	8 bits	
Length	8 bits	
CP	2 bits	
reserved	6 bits	
HCS	8 bits	
}		

The following are the fields of DL Frame Prefix:

Rate_ID

Field that defines the burst profile of the following burst. Encoding is specified in Table 213.

Length

Number of OFDM symbols (PHY payload) in the burst immediately following the FCH burst.

CP

Cyclic Prefix to be used for DL data symbols (other than the first), UL data symbols and UL preambles.
00 for CP=1/4 of FFT length or 64 samples
01 for CP=1/8 of FFT length or 32 samples
10 for CP=1/16 of FFT length or 16 samples
11 for CP=1/32 of FFT length or 8 samples

HCS

> An 8-bit Header Check Sequence used to detect errors in the DL Frame
> Prefix. The generator polynomial is $g(D)= D^8 +D^2 +D+1$

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8.3.4.6 Preamble structure

In the uplink, the data preamble consists of 2 times 128 samples preceded by a cyclic prefix whose length is the same as the cyclic prefix in the traffic mode. This preamble is referred to as the short preamble.

CP	128	128

Figure 199 Uplink data preamble structure

The first preamble in the downlink PHY transmission burst, as well the network entry (registration) preamble, consists of a CP and 4 times 64 samples followed by a CP and 2 times 128 samples. For downlink and registration preambles the CP shall always be set to the maximum 1/4 of the symbol length or 64 samples. This preamble is referred to as the long preamble.

CP=64	64	64	64	64	CP=64	128	128

Figure 200 Downlink and network entry preamble structure