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Title	**Ambiguity in PHY layer §8.3 OFDM frequency and timing requirements**
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Re:	Response to call for comments IEEE P802.16-2004/Cor1-D1
Abstract	Correction of inconsistencies for 802.16-2004 PHY §8.3 OFDM
Purpose	Resolving ambiguity in PHY layer §8.3 OFDM
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Ambiguity in PHY layer §8.3 OFDM frequency and timing requirements

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1 Statement of the problem

In section 8.3.12 "Frequency and timing requirements" of IEEE802.16-2004 it is stated that the symbol clock frequency of the subscriber station (SS) "shall be synchronized **and** locked to the BS with a tolerance of maximum 2% of the subcarrier spacing". The wording here is ambiguous.

The subcarrier spacing is defined as follows:

$$\Delta f = F_s / N_{FFT}$$

with $F_S = floor(n * BW / 8000) * 8000$

F_s = sampling frequency, n = sampling factor = $8/7$, BW = nominal channel bandwidth

and N_{FFT} = number of FFT points

In the case of BW = 10 MHz, N_{FFT} = 256, a subcarrier spacing of

$$\Delta f = floor(n * BW / 8000) * 8000 \div N_{FFT} = 44.625 KHz$$

results. Two percent of this value corresponds to 892.5 Hz.

According to this tolerance the SS is allowed to transmit OFDM symbols with differences in duration as shown in Figure 1 with a Cyclic Prefix (CP) time of 1/4 of the “useful” symbol time assumed. The symbol time extension by the CP is 256/4 = 64 samples. The whole symbol is equivalent to 320 samples that correspond to symbol time $T_s = 28.011\mu$sec nominal.

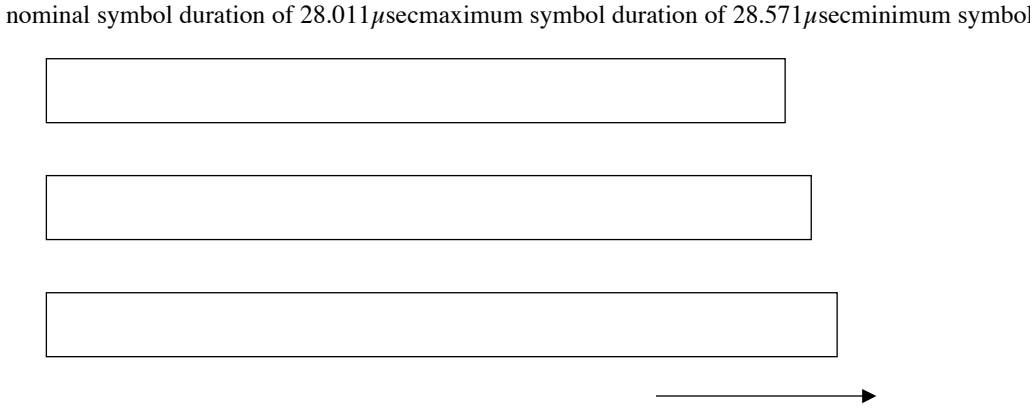

Figure 1: Possible differences in OFDM symbol duration

In a view of the Base Station receiver a nominal symbol duration of 28.011μsec is expected. An UL OFDM symbol with maximum symbol duration of 28.571μsec is 6.4 samples longer than the expected nominal symbol duration of 28.011μsec. A detection of the short preamble using time domain correlator principles would fail.

Moreover the term "locked" is ambiguous, making it unclear whether the term “synchronized” applies to the synchronization of the SS to the BS or to the synchronization between the symbol clock frequency and the center frequency at the SS.

2 Proposed solution

The above ambiguity could be solved by explicitly stating that the accuracy of the symbol clock frequency at the SS is guaranteed by its locking to center frequency at the SS, thereby exploiting the fact that through the requirement, that the symbol clock frequency and the center frequency are derived from a single reference at the BS, they have a fixed and predefined ratio.

3 Specific text changes

add sub-clause 8.3.12 and the following text in [1], starting page 44, line 9:

8.3.12 Frequency and timing requirements

Change the second paragraph in §8.3.12 as follows:

At the SS, ~~both~~ the transmitted center frequency ~~and the symbol clock frequency~~ shall be synchronized ~~and locked~~ to the BS with a tolerance of maximum 2% of the subcarrier spacing. Additionally the symbol clock frequency at the SS shall be locked to the center frequency at the SS which guarantees a relative tolerance for the symbol clock frequency at the SS of maximum 0.02*(subcarrier spacing)/(center frequency).

4 Reference

[1] draft for corrigendum IEEE P802.16-2004/Cor1-D1