Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Common SYNC Symbol for OFDMA**
Date Submitted	**2004-08-31**

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Re:	Response to Recirculation Ballot #14c
Abstract	Propose a common Sync symbol to enhance initial cell search and facilitate fast cell search for handover
Purpose	To incorporate the changes here proposed into the 802.16e D5 draft.
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Common SYNC Symbol for OFDMA

1 Introduction

In this contribution, we propose to introduce a common SYNC symbol in addition to the existing cell specific preamble. The common SYNC symbol uses a common PN sequence for all BSs and it is known to all MSSs, furthermore, such a common symbol possesses a time repetition structure, it allows facilitating the frame synchronization at cell edge and fine tuning for time and frequency synchronization including the frequency offset correction, the existing cell specific preamble (legacy preamble) can be used for the IDcell/segment identification and verification during the cell search or initial access.

2 Proposed Solution

The proposed design approach is to re-use the preamble structure (legacy preamble) defined IEEE802.16-2004 to provide basic preamble functionality and to achieve backward compatibility. An additional common SYNC symbol is introduced in the DL frame; such a common SYNC symbol is allocated at a fixed position and the last symbol in the DL frame, ~~with N_{COMMON_FFSET} symbol offset to the preamble,~~ in every N_{COMMON_CYCLE} frames. It possesses the following properties:

1. The structure is a 2-time repetition in time domain and only even sub-carriers are used in frequency domain.
2. Its location is identical across the network.
3. Its presence and location are deterministic.
4. The sequence of common SYNC symbol has a very low PAPR value.

~~The exact location of common SYNC symbol N_{COMMON_FFSET} is **TBD**, a post-amble (the last symbol of DL frame) can be identified as location assignment.~~

The presence cycle of the common SYNC symbol N_{COMMON_CYCLE} can be determined by the frame duration and common SYNC symbol periodicity in real time, see Table 1, in addition, such a common SYNC symbol can be assigned in very frame.

Table 1 N_{COMMON_CYCLE} Time Interval vs. Frame Length

N_{COMMON_CYCLE}	**Common SYNC Time Interval (ms)**						
Frame Duration (ms)	4	8	10	20	40	60	120
2.0	~~2~~	4	~~6~~	~~10~~	~~20~~	~~30~~	~~60~~
2.5	-	~~2~~	4	~~8~~	~~16~~	~~24~~	~~48~~
4.0	-	~~2~~	~~2~~	4	~~10~~	~~14~~	~~30~~
5.0	-	-	~~2~~	4	~~8~~	~~12~~	~~24~~
8.0	-	-	-	~~2~~	4	~~6~~	~~14~~
10.0	-	-	-	~~2~~	4	~~6~~	~~12~~
12.5	-	-	-	-	~~2~~	4	~~8~~
20.0	-	-	-	-	~~2~~	~~3~~	6

Comment: The overhead vs. N_{COMMON_CYCLE} is listed in the Table 2: (5ms frame, DL:UL=2:1, DL=27, UL=15)

Table 2 Example of overhead for Common SYNC Symbol

N_{COMMON_CYCLE}	1	2	3	4	8	10	15	20
Overhead (%)	3.70	1.85	1.23	0.93	0.46	0.37	0.25	0.19

Proposed Text

Add section 8.4.6.1.1.1 and 8.4.6.1.1.2

----------Start text ----------

8.4.6.1.1.1 Common SYNC Symbol

In every ~~N_{COMMON_CYCLE} (TBD)~~ fourth downlink transmission frame, ~~N_{COMMON_FFSET} (TBD) symbols after the preamble~~ the last OFDM symbol is the common SYNC symbol; it can be transmitted by the BSs in the1024/515/128 FFT modes by antenna 0. The mapping of the common SYNC sequence to the common SYNC symbol sub-carrier is defined by using the following formula:

$$\text{Common\_SYNC\_Carrier\_Set} = N_{LEFT\text{-}FFT} + 2k - 1$$

where:

k is the number of the running index $1 \ldots (N_{FFT} - N_{LEFT\text{-}FFT} - N_{RIGHT\text{-}FFT} - 1)/2$

$N_{LEFT\text{-}FFT}$ is the number of guard sub-carriers of the left band of FTT size N_{FFT}, $N_{RIGHT\text{-}FFT}$ is the guard sub-carriers of the left band, the value of $N_{LEFT\text{-}FFT}$ and $N_{RIGHT\text{-}FFT}$ for 1024/515/128 FFT modes are listed in Table 309b/c/d, and the DC carrier shall always be zeroed.

The common SYNC symbol is defined by frequency domain as shown in Figure xxxx, the time domain illustration is shown in Figure yyyy.

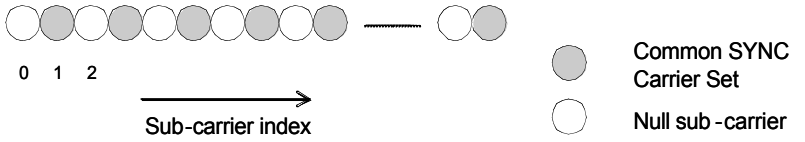

Figure xxxx Common SYNC Symbol Structure (Frequency Domain)

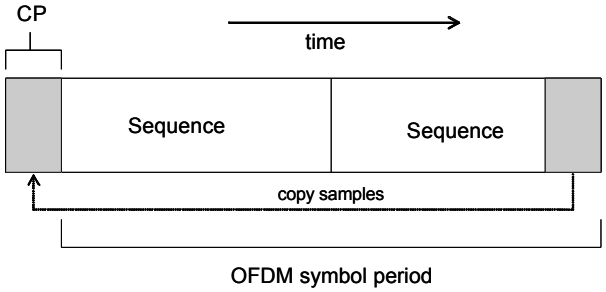

Figure yyyy Common SYNC Symbol Structure (Time Domain)

The same common SYNC symbol is transmitted by al BSs across the network synchronously.

~~If the sequence is not defined in section 8.4.6.1.1.2, then first_*k* elements of Table 246 shall be used to modulate the DL preamble sub-carriers.~~

8.4.6.1.1.2 Common SYNC Symbol Sequence

The common SYNC sequences ~~(TBD)~~ are listed in Table xxx.

Table xxx Common SYNC Sequence ~~(place holder for the sequence)~~

N_{FFT}	Sequence	PAPR (dB)
1024	473A0B21CE9537F3A0B20316AC873A0B21CE95378C5F4DFCE9537F3A0B21CE9537F3A0B20316AC80C5F4DE316AC873A0B20316AC800	3.32
512	5642862D90FE75642862A6F018B642862D90FE749BD79D590FE740	3.17
128	590A18B643F9D0	2.89

----------End text ----------