| Source: | Voice: (613)-763-1315  
Fax: (613)-765-7723 | wentong@nortelnetworks.com |
|---------|---------------------------------------------------|--------------------------|
| Nortel Networks  
3500 Carling Avenue  
Ottawa, ON. K2H 8E9  
CANADA | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
| Jason Hou, Jing Wang, Sean Cai, Dazi Feng, Yonggang Fang | Voice: 858-554-0387  
Fax: 858-554-0894 | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
| ZTE San Diego Inc.  
10105 Pacific Heights Blvd.  
San Diego, CA 92121  
USA | Voice: 408-731-2870  
Fax: 408-387-5099 | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
| Jeff.Zhuang@motorola.com  
Xiangyang (Jeff) Zhuang, Kevin Baum, Fred Vook, Vijay Nangia, Mark Cudak | Voice: 858-554-0387  
Fax: 858-554-0894 | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
| Jason Hou, Jing Wang, Sean Cai, Dazi Feng, Yonggang Fang | Voice: 858-554-0387  
Fax: 858-554-0894 | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
| ZTE San Diego Inc.  
10105 Pacific Heights Blvd.  
San Diego, CA 92121  
USA | Voice: 408-731-2870  
Fax: 408-387-5099 | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
| Jeff.Zhuang@motorola.com  
Xiangyang (Jeff) Zhuang, Kevin Baum, Fred Vook, Vijay Nangia, Mark Cudak | Voice: 858-554-0387  
Fax: 858-554-0894 | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
| Jason Hou, Jing Wang, Sean Cai, Dazi Feng, Yonggang Fang | Voice: 858-554-0387  
Fax: 858-554-0894 | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
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San Diego, CA 92121  
USA | Voice: 408-731-2870  
Fax: 408-387-5099 | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
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Xiangyang (Jeff) Zhuang, Kevin Baum, Fred Vook, Vijay Nangia, Mark Cudak | Voice: 858-554-0387  
Fax: 858-554-0894 | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
| Jason Hou, Jing Wang, Sean Cai, Dazi Feng, Yonggang Fang | Voice: 858-554-0387  
Fax: 858-554-0894 | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
| ZTE San Diego Inc.  
10105 Pacific Heights Blvd.  
San Diego, CA 92121  
USA | Voice: 408-731-2870  
Fax: 408-387-5099 | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
| Jeff.Zhuang@motorola.com  
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Fax: 858-554-0894 | jhou@ztesandiego.com  
jwang@ztesandiego.com  
scai@ztesandiego.com  
dfeng@ztesandiego.com  
yfang@ztesandiego.com |
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 \( N_{\text{COMMON FFSET}} \) symbol offset to the preamble, in every \( N_{\text{COMMON CYCLE}} \) 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 \( N_{\text{COMMON FFSET}} \) 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 \( N_{\text{COMMON CYCLE}} \) 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>
<thead>
<tr>
<th>( N_{\text{COMMON CYCLE}} )</th>
<th>Common SYNC Time Interval (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame Duration (ms)</td>
<td>4</td>
</tr>
<tr>
<td>2.0</td>
<td>2</td>
</tr>
<tr>
<td>2.5</td>
<td>-</td>
</tr>
<tr>
<td>4.0</td>
<td>-</td>
</tr>
<tr>
<td>5.0</td>
<td>-</td>
</tr>
<tr>
<td>8.0</td>
<td>-</td>
</tr>
<tr>
<td>10.0</td>
<td>-</td>
</tr>
<tr>
<td>12.5</td>
<td>-</td>
</tr>
<tr>
<td>20.0</td>
<td>-</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>( N_{\text{COMMON CYCLE}} )</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>8</th>
<th>10</th>
<th>15</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead (%)</td>
<td>3.70</td>
<td>1.85</td>
<td>1.23</td>
<td>0.93</td>
<td>0.46</td>
<td>0.37</td>
<td>0.25</td>
<td>0.19</td>
</tr>
</tbody>
</table>
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 the 1024/515/128 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:

\[
\text{Common\_SYNC\_Carrier\_Set} = N_{LEFT\_FFT} + 2k - 1
\]

where:

- \( k \) is the number of the running index \( 1 \ldots (N_{FFT} - N_{LEFT\_FFT} - N_{RIGHT\_FFT} - 1)/2 \)
- \( N_{LEFT\_FFT} \) is the number of guard sub-carriers of the left band of FFT size \( N_{FFT} \), \( N_{RIGHT\_FFT} \) is the guard sub-carriers of the left band, the value of \( N_{LEFT\_FFT} \) and \( N_{RIGHT\_FFT} \) 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.

The same common SYNC symbol is transmitted by all 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>
<thead>
<tr>
<th>N&lt;sub&gt;FFT&lt;/sub&gt;</th>
<th>Sequence</th>
<th>PAPR (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1024</td>
<td>473A0H21CE9527F3A0B20316AC873A0B21CE9527FKSFDFCE9527F3A0B20316AC80C5F4DE316AC873A0B20316AC800</td>
<td>3.22</td>
</tr>
<tr>
<td>512</td>
<td>7642362D90FED7642362ADFO18B642862D90FED79D290FED740</td>
<td>3.12</td>
</tr>
<tr>
<td>128</td>
<td>290A18B6423F920</td>
<td>2.89</td>
</tr>
</tbody>
</table>

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