

Preamble of OFDM Subchannelization

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[Only changing preamble of 802.16a/D6]

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Preambles of OFDM Sub-channelization

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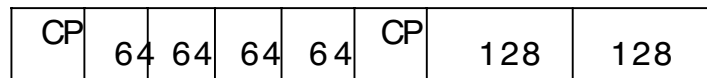
Design criteria of preamble for OFDM system

- Low PAPR
- Suitable for parameter estimation
 - Timing : need Good correlation properties
 - Frequency offset estimation(wide range ,fast , accurate)
 - Channel estimation
- Low computational complexity and low overhead.

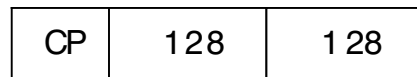
Current HIPERMAN preamble and training sequence

- 256 OFDM mode

➤ long preamble: consists of a CP followed by 4 times 64 samples followed by a CP and 2 times 128 samples



➤ short preamble :same as the second part of long preamble



➤ The training sequence corresponding to the preamble

The first part of long preamble:

$$S(-100:100) = \{+1+j, 0, 0, 0, +1+j, 0, 0, 0, +1+j, 0, 0, 0, +1-j, 0, 0, 0, -1+j, 0, 0, 0, +1+j, 0, 0, 0, \\ +1+j, 0, 0, 0, +1+j, 0, 0, 0, +1-j, 0, 0, 0, -1+j, 0, 0, 0, +1+j, 0, 0, 0, +1+j, 0, 0, 0, \\ +1+j, 0, 0, 0, +1-j, 0, 0, 0, -1+j, 0, 0, 0, +1-j, 0, 0, 0, +1-j, 0, 0, 0, +1-j, 0, 0, 0, \\ -1-j, 0, 0, 0, +1+j, 0, 0, 0, -1+j, 0, 0, 0, -1+j, 0, 0, 0, -1+j, 0, 0, 0, +1+j, 0, 0, 0, \\ -1-j, 0, 0, 0, 0, 0, 0, 0, -1-j, 0, 0, 0, +1-j, 0, 0, 0, +1+j, 0, 0, 0, -1-j, 0, 0, 0, -1+j, \\ 0, 0, 0, +1-j, 0, 0, 0, +1+j, 0, 0, 0, -1+j, 0, 0, 0, +1-j, 0, 0, 0, -1-j, 0, 0, 0, +1+j, \\ 0, 0, 0, -1+j, 0, 0, 0, -1-j, 0, 0, 0, +1+j, 0, 0, 0, +1-j, 0, 0, 0, -1-j, 0, 0, 0, +1-j, \\ 0, 0, 0, +1+j, 0, 0, 0, -1-j, 0, 0, 0, -1+j, 0, 0, 0, -1+j, 0, 0, 0, -1-j, 0, 0, 0, +1-j, \\ 0, 0, 0, -1+j, 0, 0, 0, -1-j, 0, 0, 0, +1+j\} * \sqrt{2} * \sqrt{2}$$

The short preamble or second part of long preamble

$$P(-100:100) = \{-1, 0, 1, 0, 1, 0, 1, 0, 1, 0, -1, 0, -1, 0, 1, 0, -1, 0, 1, 0, -1, 0, -1, 0, 1, 0, -1, 0, \\ 1, 0, -1, 0, 1, 0, -1, 0, 1, 0, -1, 0, 1, 0, 1, 0, -1, 0, 1, 0, -1, 0, -1, 0, -1, 0, 1, 0, -1, 0, -1, 0, \\ -1, 0, 1, 0, 1, 0, -1, 0, 1, 0, 1, 0, 1, 0, -1, 0, 1, 0, 1, 0, -1, 0, -1, 0, -1, 0, 1, 0, 1, 0, \\ 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, -1, 0, -1, 0, 1, 0, -1, 0, -1, 0, 1, 0, 1, 0, 1, 0, -1, 0, \\ 1, 0, 1, 0, 1, 0, -1, 0, -1, 0, -1, 0, -1, 0, -1, 0, 1, 0, -1, 0, -1, 0, -1, 0, -1, 0, -1, 0, \\ -1, 0, 1, 0, 1, 0, 1, 0, -1, 0, 1, 0, -1, 0, 1, 0, 1, 0, 1, 0, -1, 0, -1, 0, -1, 0, \\ -1, 0, -1, 0, -1, 0, 1, 0, -1, 0, -1, 0, -1, 0, -1, 0, 1, 0, -1, 0, 1, 0, -1, 0, -1, 0, -1, 0\} * \sqrt{2} * \sqrt{2}$$

• 256 OFDM sub-channelization in HIPERMAN



Sub-channel allocation:

Sub-channel 1: $\{-100, \dots, -89\}, \{-50, \dots, -39\}, \{1, \dots, 13\}, \{51, \dots, 63\}$

Sub-channel 2: $\{-88, \dots, -76\}, \{-38, \dots, -26\}, \{14, \dots, 25\}, \{64, \dots, 75\}$

Sub-channel 3: $\{-75, \dots, -64\}, \{-25, \dots, -14\}, \{26, \dots, 38\}, \{76, \dots, 88\}$

Sub-channel 4: $\{-63, \dots, -51\}, \{-13, \dots, -1\}, \{39, \dots, 50\}, \{89, \dots, 100\}$



Usage of sub-channel

Case 1: Use one sub-channel, which is one of four sub-channels

Case 2: Use two sub-channels, (sub-channel 1 and sub-channel 3) or
(sub-channel 2 and sub-channel 4)

Case 3 : Original OFDM

•256 OFDM sub-channelization in IEEE 802.16aD6

➤ previous sub-channel allocation in HIPERMAN:

Sub-channel 1: $\{-100, \dots, -89\}$, $\{-50, \dots, -39\}$, $\{1, \dots, 13\}$, $\{51, \dots, 63\}$

Sub-channel 2: $\{-88, \dots, -76\}$, $\{-38, \dots, -26\}$, $\{14, \dots, 25\}$, $\{64, \dots, 75\}$

Sub-channel 3: $\{-75, \dots, -64\}$, $\{-25, \dots, -14\}$, $\{26, \dots, 38\}$, $\{76, \dots, 88\}$

Sub-channel 4: $\{-63, \dots, -51\}$, $\{-13, \dots, -1\}$, $\{39, \dots, 50\}$, $\{89, \dots, 100\}$

➤ New sub-channel allocation in D6

Sub-channel 1: $\{-88, \dots, -76\}$, $\{-50, \dots, -39\}$, $\{1, \dots, 13\}$, $\{64, \dots, 75\}$

Sub-channel 2: $\{-63, \dots, -51\}$, $\{-25, \dots, -14\}$, $\{26, \dots, 38\}$, $\{89, \dots, 100\}$

Sub-channel 3: $\{-100, \dots, -89\}$, $\{-38, \dots, -26\}$, $\{14, \dots, 25\}$, $\{51, \dots, 63\}$

Sub-channel 4: $\{-75, \dots, -64\}$, $\{-13, \dots, -1\}$, $\{39, \dots, 50\}$, $\{76, \dots, 88\}$

➤ Usage of new sub-channel

Case 1: Use one sub-channel, which is one of four sub-channels

Case 2: Use two sub-channels, (sub-channel 1 and 2) or
(sub-channel 3 and 4)

Case 3: Use of OFDM symbol as on channel.

➤ **Currently the Preamble of OFDM sub-channel is,**

➤ **If in the UL, if the allocation spans less than the whole OFDM symbol (i.e. when sub-channelization is used), the preamble carriers that do not fall within the sub-channels allocated shall not be transmitted.**

➤ **In current IEEE80216aD6, the two preamble for OFDM sub-channelization P1 subch(-100:100) and P2subch (-100:100) are not suitable for new subchannel allocation.**

Old preamble for OFDM subchannelization

For case 1: the preamble carriers that do not fall within the subchannels allocated shall not be transmitted.

$$P_{1\text{subch}}(-100:100)=\{$$

-1	0	1	0	1	0	-1	0	-1	0	-1	0		[-100:-89] subch1	
-1	0	-1	0	-1	0	1	0	-1	0	1	0	1	[-88:-76] subch2	
0	-1	0	-1	0	1	0	-1	0	-1	0	-1		[-75:-64] subch3	
0	-1	0	1	0	1	0	-1	0	-1	0	-1	0	[-63:-51] subch4	
1	0	1	0	1	0	-1	0	1	0	-1	0		[-50:-39] subch1	
-1	0	1	0	-1	0	-1	0	1	0	-1	0	-1	[-38:-26] subch2	
0	-1	0	1	0	-1	0	-1	0	1	0	1		[-25:-14] subch3	
0	1	0	1	0	1	0	-1	0	1	0	-1	0	[-13:-1] subch4	
0	1	0	-1	0	1	0	1	0	-1	0	-1	0	[1:13] subch1	
1	0	-1	0	-1	0	1	0	1	0	1	0		[14:25] subch2	
-1	0	1	0	1	0	1	0	-1	0	-1	0	-1	[26:38] subch3	
0	1	0	-1	0	1	0	1	0	-1	0	-1		[39:50] subch4	
0	-1	0	-1	0	-1	0	-1	0	1	0	-1	0	[51:63] subch1	
1	0	-1	0	1	0	1	0	1	0	-1	0		[64:75] subch2	
	-1	0	1	0	1	0	1	0	1	0	-1	0	1	[76:88] subch3
0	-1	0	-1	0	-1	0	-1	0	1	0	-1		[89:100] subch4	

$$\}*\text{sqrt}(2)*\text{sqrt}(2)$$

Old preamble for OFDM subchannelization

- For case 2: the preamble carriers that do not fall within the sub-channels allocated shall not be transmitted.

$P_{2\text{subch}}(-100:100)=\{$

-1	0	1	0	1	0	-1	0	1	0	-1	0		[-100:-89]	subch1+subch3
-1	0	-1	0	1	0	-1	0	1	0	-1	0	1	[-88:-76]	subch2+subch4
0	-1	0	1	0	1	0	1	0	1	0	1		[-75:-64]	subch1+subch3
0	-1	0	1	0	-1	0	1	0	1	0	-1	0	[-63:-51]	subch2+subch4
1	0	1	0	1	0	-1	0	-1	0	-1	0		[-50:-39]	subch1+subch3
-1	0	-1	0	1	0	1	0	-1	0	1	0	-1	[-38:-26]	subch2+subch4
0	-1	0	1	0	1	0	-1	0	-1	0	-1		[-25:-14]	subch1+subch3
0	-1	0	1	0	-1	0	1	0	1	0	-1	0	[-13:-1]	subch2+subch4
0														
0	1	0	1	0	1	0	-1	0	1	0	1	0	[1:13]	subch1+subch3
1	0	1	0	1	0	-1	0	1	0	1	0		[14:25]	subch2+subch4
-1	0	1	0	1	0	-1	0	1	0	1	0	-1	[26:38]	subch1+subch3
0	1	0	1	0	-1	0	-1	0	1	0	1		[39:50]	subch2+subch4
0	1	0	1	0	-1	0	1	0	-1	0	1	0	[51:63]	subch1+subch3
-1	0	-1	0	-1	0	-1	0	1	0	-1	0		[64:75]	subch2+subch4
-1	0	-1	0	-1	0	1	0	-1	0	-1	0	-1	[76:88]	subch1+subch3
0	1	0	1	0	1	0	-1	0	-1	0	-1		[89:100]	subch2+subch4

 $\}*\text{sqrt}(2)*\text{sqrt}(2)$

Analysis of sequences of current sub-channelization

➤ The PAPR is high,

subchann	PAPR(dB)
1	7.0053dB
2	7.6182dB
3	5.5073dB
4	5.6480dB
1+2	4.5574dB
2+4	6.2098dB.

➤ The current sequence **Optimised** for the preamble of 256 OFDM sub-channelization in HIPERMAN.

➤ **Sub-channels of IEEE 802.16aD6 should have additional optimal sequence.**

•PAPR of the proposal preamble

Subch.	PAPR(dB) of current subchann	PAPR(dB) of old subchanne
1	3.1335dB 2.922dB	7.0053dB
2	2.922dB	7.6182dB
3	2.922dB	5.5073dB
4	3.1335dB	5.6480dB
1+2(1+3)	3.1399dB	4.5574dB
3+4(2+4)	3.1066dB	6.2098dB.

•Max gain 4.7dB

Preamble optimized for New OFDM subchannelization

For case 1: the preamble carriers that do not fall within the subchannels allocated shall not be transmitted.

```

P1subch(-100:100)={  -1  0 -1  0  1  0  1  0 -1  0 -1  0      [-100:-89]  subch3
                    -1  0  1  0  1  0 -1  0 -1  0 -1  0 -1  [-88:-76]  subch1
                      0 -1  0 -1  0 -1  0 -1  0  1  0  1      [-75:-64]  subch4
                      0 -1  0  1  0 -1  0  1  0 -1  0  1  0  [-63:-51]  subch2
                      1  0 -1  0 -1  0  1  0 -1  0 -1  0      [-50:-39]  subch1
                      1  0  1  0 -1  0  1  0  1  0 -1  0  1  [-38:-26]  subch3
                      0 -1  0 -1  0  1  0  1  0  1  0  1      [-25:-14]  subch2
                      0  1  0 -1  0  1  0 -1  0  1  0 -1  0  [-13:-1]   subch4
                      0
                      0  1  0 -1  0  1  0 -1  0  1  0 -1  0  [1:13]    subch1
                    -1  0 -1  0 -1  0 -1  0  1  0  1  0      [14:25]   subch3
                    -1  0  1  0 -1  0 -1  0  1  0 -1  0 -1  [26:38]   subch2
                      0  1  0  1  0 -1  0  1  0  1  0 -1      [39:50]   subch4
                      0 -1  0  1  0 -1  0  1  0 -1  0  1  0  [51:63]   subch3
                    -1  0 -1  0  1  0  1  0  1  0  1  0      [64:75]   subch1
                      1  0  1  0  1  0  1  0 -1  0 -1  0  1  [76:88]   subch4
                      0  1  0  1  0 -1  0 -1  0  1  0  1      [89:100]  subch2
} *sqrt(2) *sqrt(2)

```

Preamble optimized for New OFDM subchannelization

- For case 2: the preamble carriers that do not fall within the sub-channels allocated shall not be transmitted.

```

Pzsubch(-100:100)={
    1  0 -1  0  1  0  1  0 -1  0  1  0      [-100:-89]    subch3+such4
    1  0  1  0  1  0  1  0 -1  0 -1  0 -1    [-88:-76]    subch1+subch2
    0  1  0  1  0  1  0 -1  0  1  0  1      [-75:-64]    subch3+such4
    0  1  0 -1  0  1  0  1  0  1  0  1  0    [-63:-51]    subch1+subch2
    1  0 -1  0  1  0  1  0 -1  0  1  0      [-50:-39]    subch1+subch2
   -1  0  1  0 -1  0  1  0  1  0  1  0  1    [-38:-26]    subch3+such4
    0 -1  0  1  0 -1  0  1  0 -1  0  1      [-25:-14]    subch1+subch2
    0 -1  0  1  0  1  0 -1  0 -1  0 -1  0    [-13:-1]     subch3+such4
    0
    0  1  0 -1  0 -1  0  1  0  1  0  1  0    [1:13]       subch1+subch2
   -1  0  1  0 -1  0 -1  0 -1  0  1  0      [14:25]     subch3+such4
   -1  0  1  0  1  0 -1  0 -1  0  1  0 -1    [26:38]     subch1+subch2
    0  1  0  1  0  1  0 -1  0 -1  0 -1      [39:50]     subch3+such4
    0  1  0 -1  0  1  0  1  0  1  0  1  0    [51:63]     subch3+such4
   -1  0  1  0 -1  0 -1  0 -1  0  1  0      [64:75]     subch1+subch2
   -1  0 -1  0 -1  0  1  0  1  0 -1  0  1    [76:88]     subch3+such4
    0  1  0 -1  0 -1  0  1  0  1  0  1      [89:100]    subch1+subch2
} *sqrt(2) *sqrt(2)

```

Conclusion :

- It is feasible to add just two additional sequences for the sub-Channelization
- Without any MAC overhead
- Lower PAPR