Preamble of OFDM Subchannelization

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Purpose:

[Only changing preamble of 802.16a/D6]

Preambles of OFDM Sub-channelization

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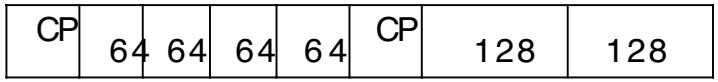
Design criterions of preamble for OFDM system

- 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.

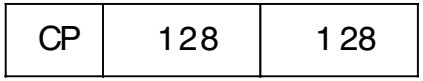
Current HIPERMAN preamble and training sequence

- 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}*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 ,0,0 ,-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}*sqrt(2)*sqrt(2)

• 256 OFDM sub-channelization in HIPERMAN

- Sub-channel allocation:

  Sub-channel 1: {-100,…,-89},{-50,...,-39},{1,...13},{51,...,63}
  Sub-channel 2: {-88,…,-76},{-38,...,-26},{14,...,25},{64,...,75}
  Sub-channel 3: {-75,…,-64},{-25,...,-14},{26,...,38},{76,...,88}
  Sub-channel 4: {-63,…,-51},{-13,...,-1},{39,...,50},{89,...,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-channel4)

  Case 3 : Original OFDM

•256 OFDM sub-channelization in IEEE 802.16aD6

- previous sub-channel allocation in HIPERMAN:

  Sub-channel 1: {**−100,...,−89**}, {-50,...,-39}, {1,...13}, {**51,...,63**}
  Sub-channel 2: {**−88,...,−76**}, {**−38,...,−26**}, {**14,...,25**}, {**64,...,75**}
  Sub-channel 3: {**−75,...,−64**}, {**−25,...,−14**}, {**26,...,38**}, {**76,...,88**}
  Sub-channel 4: {**−63,...,−51**}, {-13,...,-1}, {39,...,50}, {**89,...,100**}

- New sub-channel allocation in D6

  Sub-channel 1: {**−88,...,−76**},{-50,...,-39},{1,...13},{**64,...,75**}
  Sub-channel 2: {**−63,...,−51**},{**−25,...,−14**},{**26,...,38**},{**89,...,100**}
  Sub-channel 3: {**−100,...,−89**},{**−38,...,−26**},{**14,...,25**},{**51,...,63**}
  Sub-channel 4: {**−75,...,−64**},{-13,...,-1},{39,...,50},{**76,...,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 P1subch(-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.

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

-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														
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

}*sqrt(2)*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.

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

-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

}*sqrt(2)*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 subchannel	PAPR(dB) of old subchannel
1	3.1335dB	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.

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

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