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Title	**Considerations on the E-MBS in 802.16m : Pilot patterns for 1 and 2 MBS data streams**
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Re:	Call for Comments on Project 802.16m System Description Document (SDD), IEEE 802.16m-08/052 (DL PHY section)
Abstract	This contribution describes the pilot pattern design on the E-MBS in 802.16m.
Purpose	To be discussed and adopted by TGm for use in the IEEE 802.16m SDD
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Considerations on the E-MBS in 802.16m : Pilot patterns for 1 and 2 MBS data streams

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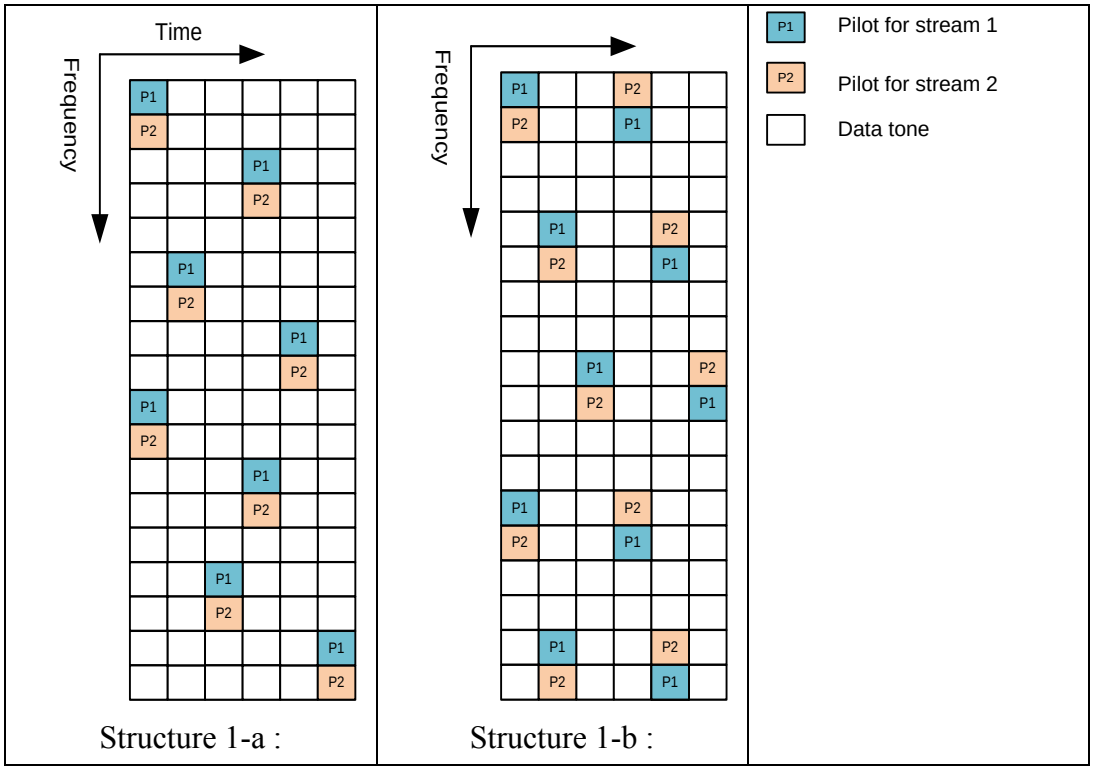
1 Introduction

In current SDD [1], E-MBS zone specific pilot pattern for MBSFN section needs to be specified.
The pilot structures/patterns should be supported up to two streams.

Unlike unicast pilot pattern, MBSFN pilot pattern shall be designed according to target inter site distance (ISD) since the MBS channel depends on ISD.
As seen in [2], rate-2 transmission is suitable for small cell transmission while rate-1 transmission is suitable for large cell transmission.
In this contribution, we optimize pilot pattern based on ISD. More specifically, we design rate-1 pilot pattern with 5km ISD channel while rate-2 pilot pattern with 1.5km ISD channel. Details of 1.5km and 5km ISD channel model are in section 5.

One more important assumption in pilot pattern design is MBS data multiplexing with unicast data.
In current SDD [1], multiplexing method is not clearly defined.
Depending on multiplexing method, optimal pilot pattern will be different.

2 E-MBS zone specific pilot proposals



Pilot Overhead 14.80%	Pilot Overhead 18.50%	

Figure 1. Pilot patterns for two streams in E-MBS with Pilot density of 14.80 and 18.50%

3 Simulation results

I. Window based channel estimation

A. Rate-1 pilot comparison

B. Rate-2 pilot comparison

II. Segment based channel estimation

A. Rate-1 pilot comparison

B. Rate-2 pilot comparison

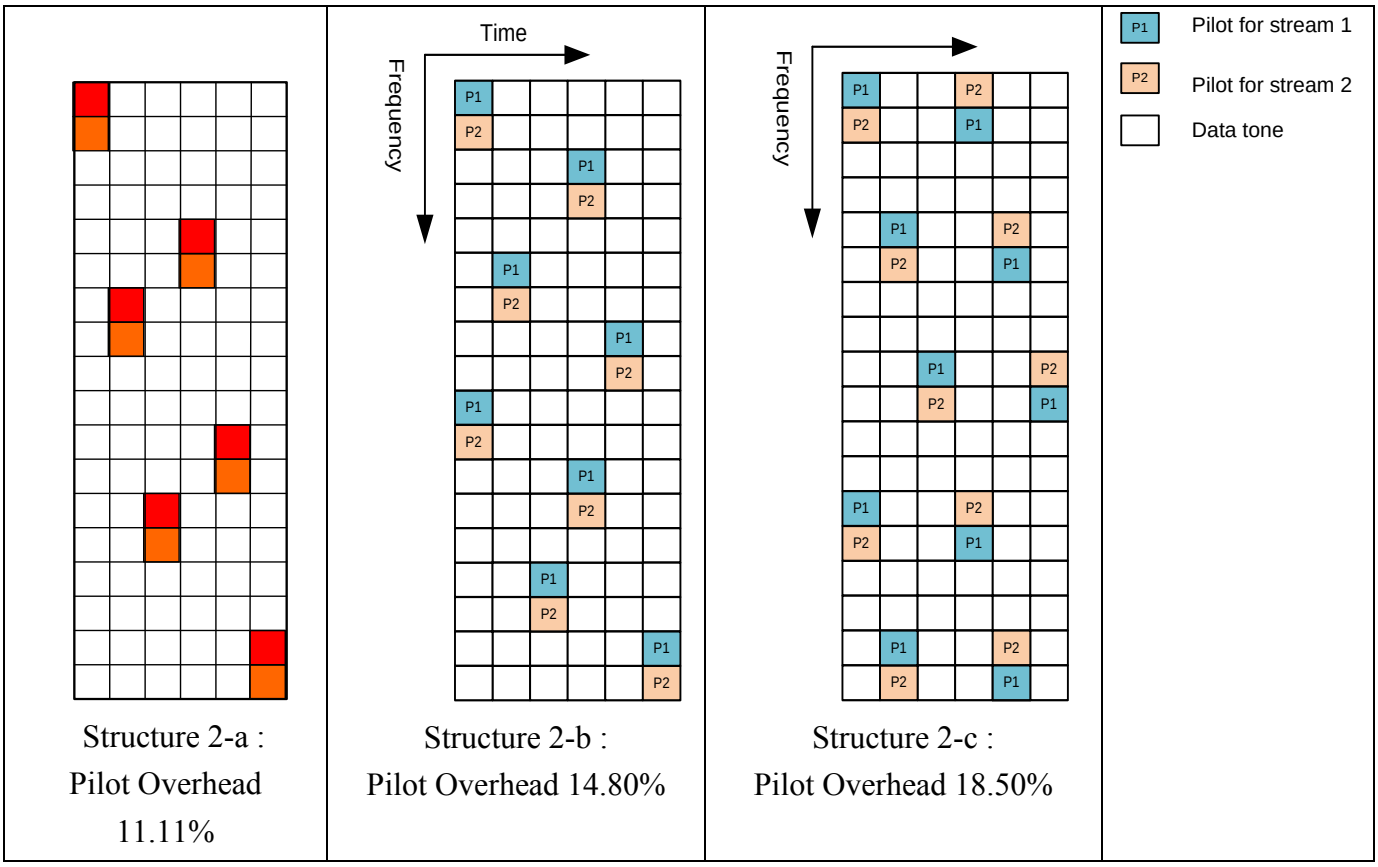


Figure 2. Performance comparison with three kinds of pilot types

4 Conclusion

Reference

[1] IEEE 802.16m-08/003r4 “The Draft IEEE 802.16m System Description Document”

[2] IEEE C80216m-08/1173r1 “Considerations on the E-MBS in 802.16m : Physical Structure and MIMO Support”

Text Proposal for the 802.16m SDD

Insert the proposed pilot pattern in line 19, page 80

Option 1: If TDM is adopted, following proposed text is used.

========== *Start of Proposed Text* ==========

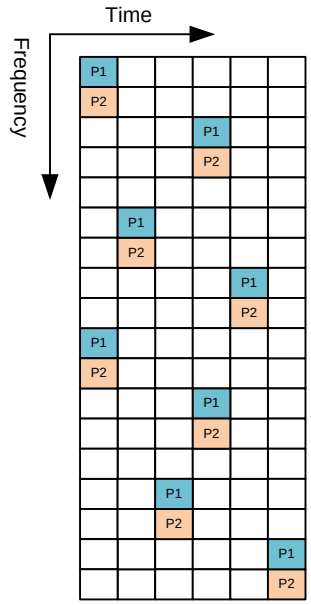


Figure xx E-MBS Zone Specific Pilot Pattern for 1 or 2 pilot streams

========== *End of Text Proposal* ==========

Option 2: If FDM is adopted, following proposed text is used.

========== *Start of Proposed Text* ==========

11.5.3.1 E-MBS zone specific pilot for MBSFN

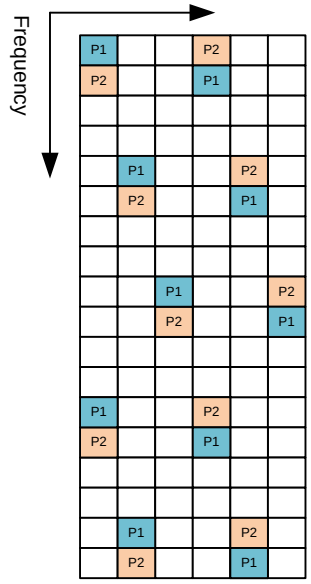


Figure xx E-MBS Zone Specific Pilot Pattern for 1 or 2 pilot streams

========== *End of Text Proposal* ==========

5 Appendix

Table 1 LLS Assumptions

OFDM parameters	10 MHz (1024 subcarriers)
Number of OFDM symbols per subframe	6
Data burst sizes/types	Tone-pair-based LDRU : Four LRUs
Permutation	Tone based LDRU
Number of total RU in one subframe	48
Number of Antennas & Antenna Configuration	2 transmitter, 2 receiver [2Tx,2Rx]
Transmission mode	Rate 1 transmission scheme : One stream pilot pattern - Rate-1, stream-1 scheme in Section 11.8.2.1.1.1 of SDD Two stream pilot pattern - Rate-1, stream-2 scheme (SFBC with/without precoding) in Section 11.8.2.1.1.1 of SDD

	Rate 2 transmission scheme : SM in Section 11.8.2.1.1.2 of SDD
Modulation/Coding	Code rate : 1/2, 3/4 with LTE FEC Modulation : For rate 1 simulation – QPSK, 16QAM For rate 2 simulation – 16QAM, 64QAM
Channel model	For rate 1 simulation – 5km ISD channel model For rate 2 simulation – 1.5km ISD channel model MS speed : [3km/hr, 30km/hr, 120km/hr]
Channel estimation	MMSE channel estimator (Wiener filter) is assumed, and channel statistics are assumed to be unknown at the receiver. - MMSE with three-PRU level CE ■ Segment based channel estimation for FDM with segment size 4PRU ■ Window based channel estimation for TDM [Additional note : For rate-1, stream-1 scheme in Section 11.8.2.1.1.1 of SDD for rate-1, the size of precoder cycling is 4PRU basis.]
MIMO detector	MRC for rate 1 scheme LMMSE for rate 2 scheme
Scenarios	Noise limited
Performance metrics:	a. Throughput vs. SNR with pilot overhead accounting and assuming perfect link adaptation b. MSE (mean squared error) vs. SNR; all simulations without HARQ c. Performance metric and simulation method: i. Run link level simulation for different MCS, which includes fading channel model, modulation/demodulation, encoding/decoding, channel estimation to generate long term PER versus SNR plots ii. Convert PER versus SNR plots to throughput versus SNR plots. Throughput is defined below. iii. Combine throughput versus SNR curves generated from different MCSs Throughput = (1-PER)*(number of information bits)/(subframe duration). The number of information bits is adjusted based on the MCS level in order to fit the information payload to the resource size of two LRUs as defined above.

Table 2 Channel model

ISD 1.5km		ISD 5.0km	
Delay (s)	Relative Power (dB)	Delay (s)	Relative Power (dB)
0	-11.4490628	0	-11.3740582
1.79E-07	-10.9084665	1.79E-07	-10.833462
3.57E-07	-8.3406372	3.57E-07	-10.081528
5.36E-07	-12.4633332	7.14E-07	-14.0803359

7.14E-07	-9.75337904	1.07E-06	-14.8582371
1.07E-06	-10.7559291	1.25E-06	-19.1945833
1.25E-06	-13.9563018	1.61E-06	-20.5965833
1.43E-06	-12.5029909	1.79E-06	-12.1561028
1.61E-06	-17.7370487	1.96E-06	-13.088364
1.79E-06	-15.1363444	2.14E-06	-12.3364301
1.96E-06	-22.2264545	2.50E-06	-14.8459521
2.14E-06	-16.3332827	2.68E-06	-22.4733333
2.32E-06	-23.8307264	2.86E-06	-17.1131391
2.50E-06	-17.2968504	3.04E-06	-21.4494854
2.68E-06	-17.1954007	3.39E-06	-14.8523521
2.86E-06	-16.0102646	3.57E-06	-13.8095188
3.04E-06	-24.1032045	3.75E-06	-14.3093888
3.21E-06	-23.0282251	4.11E-06	-18.3081967
3.39E-06	-22.457144	4.29E-06	-22.472301
3.57E-06	-18.5806309	4.46E-06	-18.0386208
3.75E-06	-18.0184926	4.64E-06	-23.4224441
3.93E-06	-22.7807536	5.00E-06	-24.8244441
4.11E-06	-18.5275394	5.18E-06	-21.7958355
4.29E-06	-21.9917747	5.89E-06	-24.4452598
4.46E-06	-18.8465526	6.07E-06	-26.7011941
4.64E-06	-23.4780931	7.50E-06	-19.6140022
4.82E-06	-18.6887037	7.68E-06	-19.0734059
5.00E-06	-20.6358428	7.86E-06	-18.321472
5.18E-06	-18.3215816	8.21E-06	-22.3202798
5.36E-06	-24.3514061	8.57E-06	-23.098181
5.54E-06	-19.8948111	8.75E-06	-27.4345273
5.71E-06	-23.1245407	9.11E-06	-28.8365273
5.89E-06	-19.4137505	9.29E-06	-25.8079187
6.07E-06	-21.2027588	1.00E-05	-28.4573429
6.25E-06	-21.2753119	1.09E-05	-22.2410927
6.43E-06	-22.3730786	1.11E-05	-21.7004964
6.61E-06	-21.9777622	1.13E-05	-20.9485625
6.79E-06	-21.569547	1.16E-05	-24.9473703
6.96E-06	-22.9610943	1.20E-05	-25.7252715
7.14E-06	-23.1938225	1.27E-05	-22.308965
7.32E-06	-24.6286689	1.29E-05	-22.9831694

7.50E-06	-24.3724159	1.30E-05	-22.2312354
7.68E-06	-27.727038	1.34E-05	-25.0013015
7.86E-06	-27.3749393	1.38E-05	-22.3834939
8.21E-06	-28.8094026	1.39E-05	-22.9928176
		1.41E-05	-22.92716
		1.45E-05	-21.8799534
		1.46E-05	-24.1578138
		1.48E-05	-22.0332653
		1.52E-05	-26.2023184
		1.55E-05	-22.7063434
		1.57E-05	-24.1089393
		1.59E-05	-24.0333418
		1.63E-05	-25.4039075
		1.66E-05	-24.1804962
		1.68E-05	-24.7882738
		1.70E-05	-24.1860396
		1.71E-05	-25.3108767
		1.73E-05	-23.2919693
		1.75E-05	-25.0343227
		1.77E-05	-29.4981878
		1.79E-05	-27.7912713
		1.80E-05	-26.0455696
		1.82E-05	-24.0305013
		1.84E-05	-24.1816707
		1.88E-05	-24.7911385
		1.89E-05	-25.6465326
		1.91E-05	-24.1521644
		1.95E-05	-29.8918585
		1.98E-05	-28.1160842
		2.00E-05	-24.4677523
		2.02E-05	-24.3288341
		2.04E-05	-23.3563092
		2.07E-05	-27.1878413
		2.09E-05	-28.3347599
		2.11E-05	-25.0545844
		2.13E-05	-25.5850098
		2.16E-05	-25.9340901

		2.18E-05	-26.3104614
		2.20E-05	-26.007297
		2.25E-05	-27.3900373
		2.27E-05	-25.8394243
		2.29E-05	-27.2724912
		2.41E-05	-28.6710005
		2.43E-05	-28.0417348
		2.45E-05	-28.5688624