Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Pilot Allocation for High-Speed Zone in 802.16m**
Date Submitted	**2007-11-07**
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Re:	IEEE 802.16m-07/040 - Call for Contributions on Project 802.16m System Description Document
Abstract	A pilot allocation method to reduce the intercarrier interference effect for high-speed conditions
Purpose	To contribute the proposal of pilot design in high-speed zone into the 802.16m SDD
Notice	
Release	
Patent Policy	

Pilot Allocation for High-Speed Zone in 802.16m

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Introduction

For 802.16m, one of the targets aims at high-mobility application with a velocity up to 350km/hr. Under such a high-speed environment, the inter-carrier interference (ICI) caused by Doppler spread is serious and may dominate the system performance for a large signal to noise power ratio (SNR). In 802.16e, the problem we address is the performance of pilot-aided channel estimation will be bounded by the ICI even though in a high SNR circumstance.

There are many methods to reduce the ICI effect. Either use a high-complexity equalizer [1] or design a modulation scheme with the mechanism of ICI self cancellation [2]. The deficiency of the former is high complexity for ICI reduction while the deficiency of the latter is half data efficiency remained. In the contribution, we want to design a pilot scheme for channel estimation to reduce the ICI effect without additional complexity. In [2], the authors modulate one data symbol onto two adjacent subcarriers anti-polar. In our proposal, we only modulate pilots rather than all data symbols onto two adjacent subcarriers anti-polar. We can prove that the proposed pilot scheme allows not only less efficiency loss but also prominent ICI self cancellation for channel estimation. So, in the contribution, we propose a new clustered pilot allocation scheme for the new high-speed zone in 802.16m to improve the performance of channel estimation.

Proposed pilot allocation scheme and performance

Figure 1 describes the pilot scheme we want to propose and a conventional equispaced pilot scheme. The phase difference between the adjacent pilots for all pilot pairs is set to q_d. The simulation parameters are listed in Table 1. Figure 2 shows the performance comparison between the conventional scheme and the clustered scheme under the cases of speed of 100, 200, and 300km/hr. The parameter of x axis is q_d with a unit of p/32 and the parameter of y axis is the mean square error (MSE) of channel impulse response measured in dB. As we can see, the performance of the conventional scheme is almost not affected by the phase difference and the MSE are roughly equal to -23.5, -27, and -35dB for speeds of 300, 200, and 100km/hr, respectively. By contrast, the performance of the proposed clustered scheme is sensitive to the phase difference. From the figure, the optimal performance occurs when q_d □ p and the MSE of channel impulse response is better than in the conventional scheme by about 10 dB for these speeds.

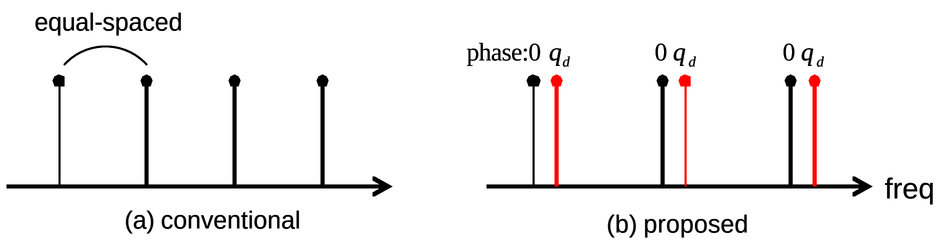

Figure 1. Conventional and proposed pilot patterns

Table 1. Simulation parameters

Carrier frequency	2.5GHz
Subcarrier spacing	10.94kHz
Channel model	ITU-VA + Jakes
FFT size	1024
Guard Interval	1024/8=128
RX speed	100, 200, 300 km/hr
Channel length of RX	64
Pilot number	2*64=128
Pilot power boosting	No
AWGN	No
Guard band	No
Channel estimation performance indicator	mean square error (MSE) of channel impulse response (CIR)

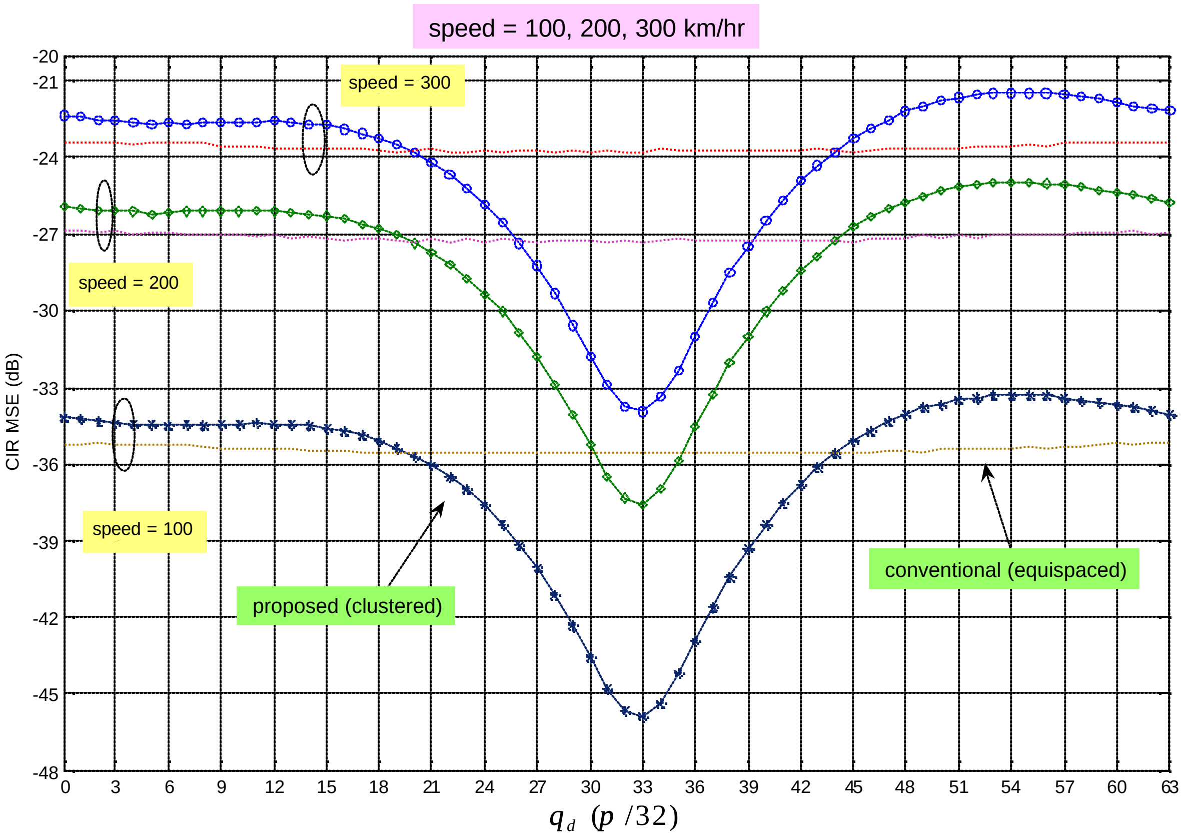

Figure 2 Performances for different velocities

Proposed pilot allocation for SISO in high-speed zone

Figure 3 shows the pilot location of one cluster in the downlink PUSC in 802.16e. The structure of the proposed high-speed zone in 802.16m is the same as in the downlink PUSC in 802.16e except for pilot allocation. Figure 4 shows the proposed pilot location of one cluster in the new downlink high-speed zone in 802.16m. We arrange the pilots to be adjacent two by two to improve the performance of channel estimation by ICI self cancellation. By modulating the two adjacent pilots anti-polar, we have the near ICI-free performance without cancelling the ICI on each pilot.

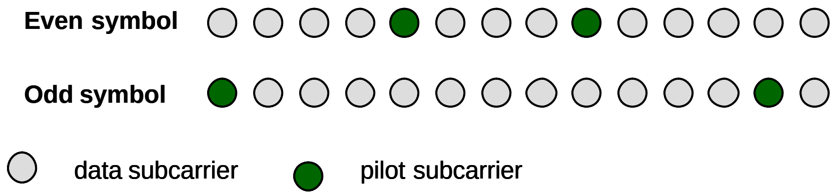

Figure 3. Cluster structure for donwlink PUSC in 802.16e

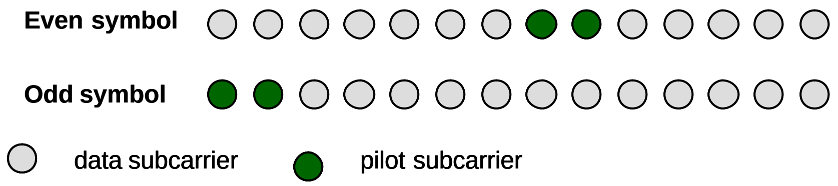

Figure 4. Proposed cluster structure for the high-speed zone in 802.16m

Proposed pilot allocation for MIMO (2x2) in high-speed zone

Figure 5 illustrates the pilot location of one cluster in the downlink STC PUSC using two antennas in 802.16e. Based on this structure, Figure 6 illustrates the proposed pilot location of one cluster in the new downlink high-speed zone using two antennas in 802.16m.

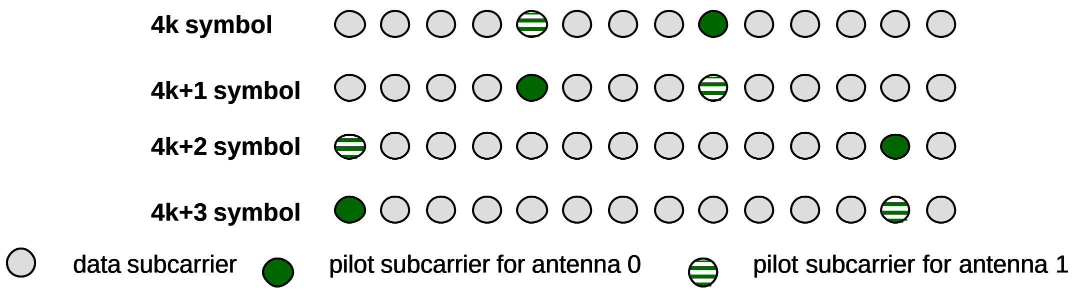

Figure 5. Cluster structure for STC PUSC using 2 antennas in 802.16e

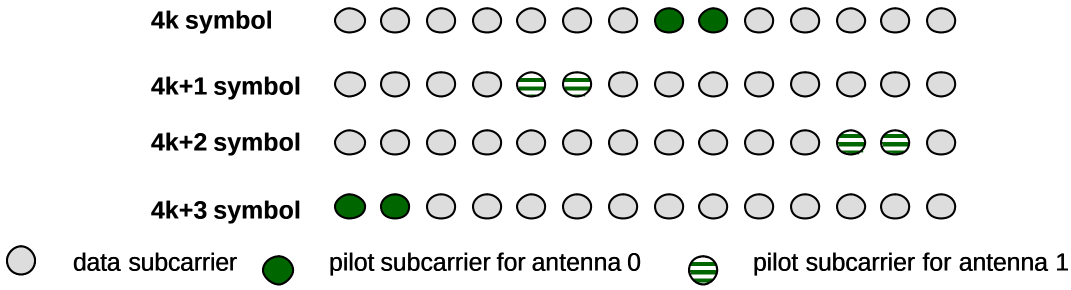

Figure 6. Proposed cluster structure for the high-speed zone using 2 antennas in 802.16m

Proposed pilot modulation in high-speed zone

In 802.16e, the power of pilot subcarriers is boosted 2.5dB over that of data subcarriers. In addition, both pilot and data subcarriers are modulated/re-modulated by a PRBS (Pseudo Random Binary Sequence) with the polynomial $x^{11} + x^{9} + 1$. In the proposal, however, we need the two adjacent pilots with an anti-polar phase to enable the mechanism of ICI self cancellation. Therefore, in the contribution, we modulate the pilots by the same strategy as in 802.16e except that the second pilots of each adjacent pair are modulated with negative value of the first ones.

Proposed SDD Text

[Chapter] Physical Layer

………

[Section] Frame Structure

………

[Subsection] High-Speed Zone

The structure of the high-speed zone is the same as in the downlink PUSC in 802.16e except for pilot allocation. The pilots are arranged adjacent two by two as shown in Figure 4 and Figure 6 for using one and two antennas, respectively. Moreover, the pilots are modulated by a PRBS with the polynomial $x^{11} + x^{9} + 1$ as in 802.16e except that the second pilots of each adjacent pair are modulated with negative value of the first ones.

[Other additions]

………

Reference

[1] X. Cai and G. B. Giannakis, “Bounding performance and suppressing intercarrier interference in wireless mobile OFDM,” IEEE Transactions on Communications, vol. 51, no. 12, pp. 2047-2056, Dec. 2003

[2] Y. Zhao and S. G. Haggman, “Intercarrier interference self-cancellation scheme for OFDM mobile communication systems,” IEEE Transactions on Communications, vol. 49, no. 7, pp. 1185-1191, July 2001