

Project	IEEE 802.16 Broadband Wireless Access Working Group < http://ieee802.org/16 >	
Title	Extended Cyclic Prefix for High-Mobility Support of IEEE 802.16m Frame Structure	
Date Submitted	2007-11-16	
Source(s)	Yu-Tao Hsieh, Lai-Hui Wang, Jen-Yuan Hsu, Pang-An Ting, Chi-Fang (Richard) Li ITRI	Voice: + 886 3 5915642 E-mail: richard929@itri.org.tw
Re:	IEEE 802.16m-07/047 – Responds to Call for Contributions on Project 802.16m System Description Document (SDD)	
Abstract	This contribution proposes a mechanism to improve system performance in high mobility environments with high-mobility zones in the new 802.16m frame structure.	
Purpose	For 802.16m discussion and adoption	
Notice	<i>This document does not represent the agreed views of the IEEE 802.16 Working Group or any of its subgroups. It represents only the views of the participants listed in the “Source(s)” field above. It is offered as a basis for discussion. It is not binding on the contributor(s), who reserve(s) the right to add, amend or withdraw material contained herein.</i>	
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE’s name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE’s sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.	
Patent Policy	The contributor is familiar with the IEEE-SA Patent Policy and Procedures: < http://standards.ieee.org/guides/bylaws/sect6-7.html#6 > and < http://standards.ieee.org/guides/opman/sect6.html#6.3 >. Further information is located at < http://standards.ieee.org/board/pat/pat-material.html > and < http://standards.ieee.org/board/pat >.	

Extended Cyclic Prefix for High-Mobility Support of IEEE 802.16m Frame Structure

*Yu-Tao Hsieh, Lai-Hui, Wang, Jen-Yuan Hsu,
Pang-An Ting , Chi-Fang (Richard) Li
ITRI*

Introduction

The 802.16m system requirements [1] describes the system performance demand for high speed environments. However, the WirelessMAN-OFDMA Reference system can support limited link performance under moderate to high speed scenarios. This contribution proposes new cyclic prefix (CP) options used by the new data zone in the 802.16m frame structure as shown in [2]. Based on the larger CP length, the inter-subcarrier interference (ICI) can be significantly reduced with low-complexity interference cancellation techniques. This will improve data reception in high-mobility applications.

Frame structure with high-mobility support

In the proposed frame structures for high mobility environments for IEEE 802.16m, a new DL/UL data zone is appended at the end of conventional DL/UL zones as shown in Figure 1 [2]. The proposed frame structure is compatible with the legacy system and is configured to increase the system performance under high-mobility applications with the advanced mode Greenfield DL/UL zones. It is well known that the system link error rate deteriorates dramatically in the WirelessMAN-OFDMA Reference system for high levels of modulation and coding schemes when the user velocity is very high (e.g. 300 km/hr). In this case the ICI resulting from neighboring data subcarriers dominates AWGN, thus complicated techniques performed subcarrier-by-subcarrier for ICI mitigation are usually required to decrease the interference. However, the ICI can be significantly decreased in time domain with much less complexity and then the system can operate under much

higher speed environments than expected for the WirelessMAN-OFDMA Reference system. This goal is achieved through the use of sample repetition of the cyclic prefix portion in each OFDMA symbol. The burden of complexity and power for the receiver design can be also greatly relieved without degrading the system performance.

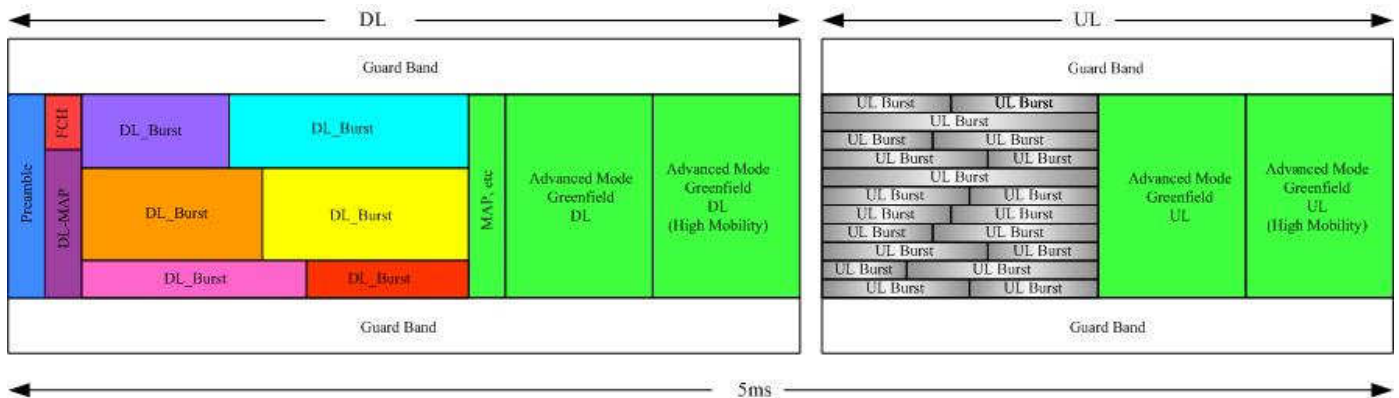


Figure 1. OFDMA frame structure for IEEE 802.16m with high-mobility support

ICI cancellation using cyclic prefix

Conventional ICI cancellation techniques rely on complicated MMSE or multistage interference cancellation approaches to estimate and mitigate the interference. In the WirelessMAN-OFDMA Reference system, it can be shown that the system can operate and maintain data transmission under very high mobility scenarios (e.g., 300 km/hr or above) with QPSK only. This will greatly complicate the receiver design and the power consumption will become very critical for the mobile units. We suggest using larger CP length than that defined in the WirelessMAN-OFDMA Reference system such that a robust and simple ICI cancellation approach can be employed in the receiver. The user mobility can be increased significantly with little system performance. The rationale for the use of larger CP length is that we take advantage of the repetitive characteristic of the CP samples to estimate and mitigate the ICI estimates. The capability of ICI cancellation increases with the available repetitive samples obtained from the CP.

Simulation results

We show the uncoded BER comparisons with various CP lengths for 16 QAM and 64 QAM, respectively for the PUSC permutation zone. The channel bandwidth is 10 MHz and the FFT size is 1024 points. The ITU Vehicular-A channel model is employed as the multipath channel. The channel state information (CSI) is assumed ideal without channel estimation error. As we can see in Figures 3 and 4, when the user velocity is set at 300 km/hr (denoted by VA300), the system performance is dominated by the ICI and exhibits error floors for the SNR range larger than 15dB without ICI cancellation techniques. On the other hand, the proposed ICI cancellation algorithm can improve the performance by at least 8 dB with different CP lengths of 512 points (1/2 FFT size), and 768 points (3/4 FFT size). Finally, when a CP length with 100% FFT size (1024 samples) is available, we can achieve the ICI-free performance even at SNR= 40 dB. Note that in cases of CP lengths of 768 and 1024, the proposed algorithm performs better than the static scenario (denoted by VA0) in some SNR ranges. This is due to the energy combining effect by use of repetitive samples, i.e., the CP portion, in the purposed algorithm for ICI cancellation. Thus the purposed algorithm is able to cancel the ICI and improve the signal power at the same time.

Conclusion

We suggest use of CP lengths larger than one fourth the FFT size for high-mobility data zone (such as 1/2, 3/4, or equal length of the FFT size) with other system configurations unchanged. The system performance will be improved significantly with minor receiver complexity under high speed (e.g. 300 km/hr) scenarios.

References

- [1] M. Cudak, "802.16m System Requirements, " IEEE 802.16m-07/002r4
- [2] R.-J. Chen, *et al*, "OFDMA Frame Structures with Scalable Bandwidth and High-Mobility Support for IEEE 802.16m, " IEEE 802.16m-07/295r1.

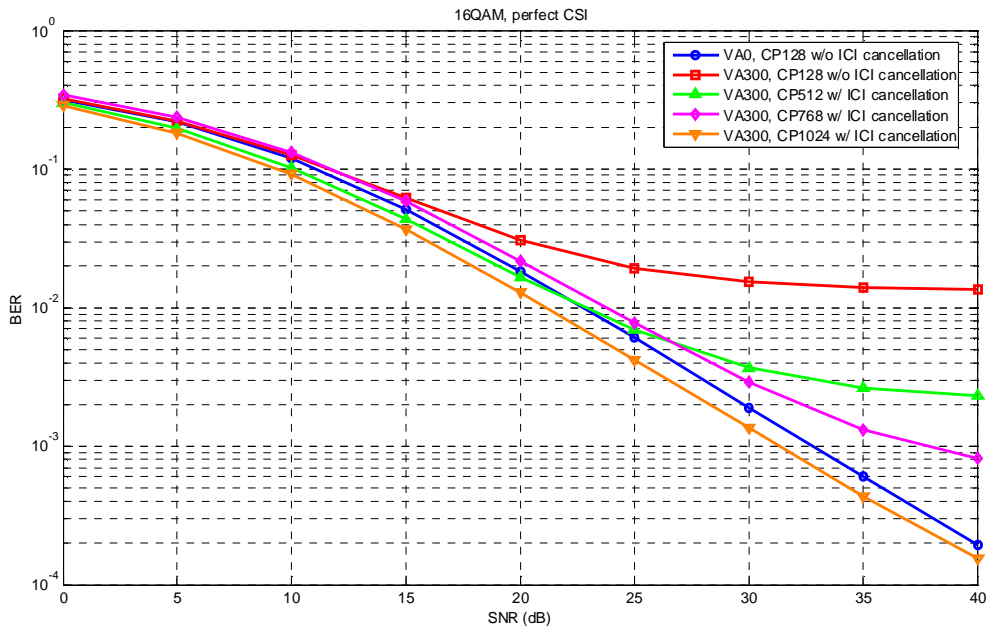


Figure 3. Performance comparison with various CP lengths for 16 QAM

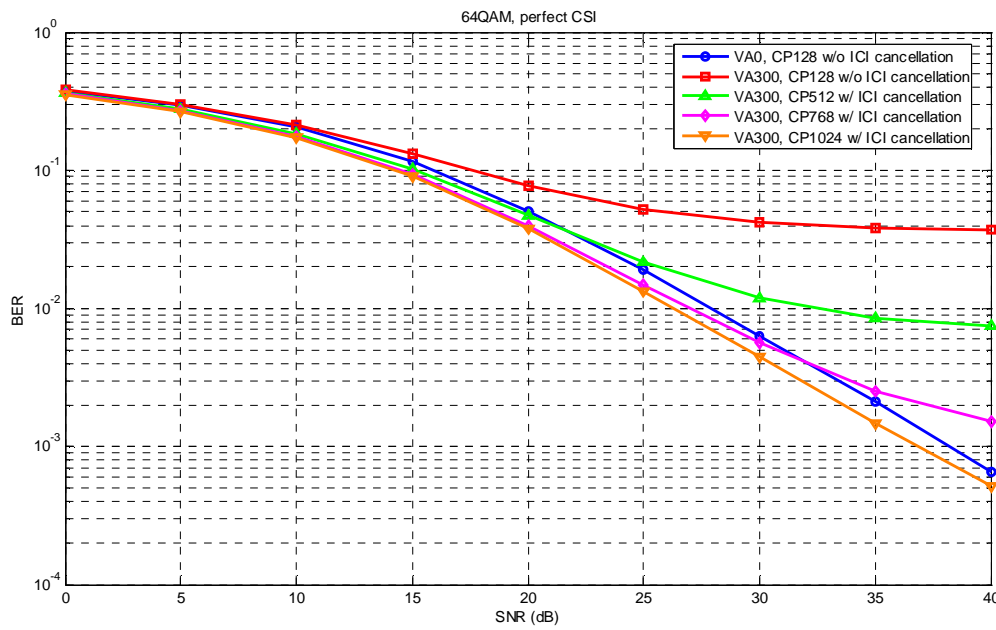


Figure 4. Performance comparison with various CP lengths for 64 QAM