Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Uplink Power Control Enhancement for 802.16e OFDMA PHY**
Date Submitted	**2004-8-15**
Source(s)	Jun Wu,Wenzhong Zhang, Mary Chion, Yonggang Fang, Keqiang Zhu, Irving Wang ZTE San Diego, 10105 Pacific Heights Blvd. San Diego, CA 92121 Voice: 858-554-0387 Fax: 858-554-0894 E-mail: jwu@ztesandiego.com, wzhang@ztesandiego.com
Re:	For consideration in Working Group Recirculation Ballot #14, on P802.16e.
Abstract	By adapting tile-based power control, the uplink performance in OFDMA system is enhanced in the NLOS environment.
Purpose	Adoption
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate text 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 and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures (Version 1.0) <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, if there is technical justification in the opinion of the standards-developing committee and provided the IEEE receives assurance from the patent holder that it will license applicants under reasonable terms and conditions for the purpose of implementing the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:r.b.marks@ieee.org> as early as possible, in written or electronic form, of any patents (granted or under application) that may cover technology that is under consideration by or has been approved by IEEE 802.16. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Uplink Power Control Enhancement for 802.16e OFDMA PHY

Jun Wu,Wenzhong Zhang, Mary Chion,
Yonggang Fang, Keqiang Zhu, Irving Wang
ZTE San Diego, Inc.

1. Introduction

The fast uplink power control is supported by using Fast tracking indication in the UL-MAP. The average received powers from all Subscriber Stations (SS) at the Base Station (BS) are kept at the same level through this mechanism. The uplink power control mechanism based on the SS average power works fine in LOS case.
However, in the NLOS environment,

1. The received power in different subcarriers may vary vastly due to the multipath effect.
2. The Inter-Carrier Interference (ICI) occurs due to frequency offset and the non- orthogonal nature on uplink.

Due to the difference of local oscillator and existence of Doppler shift, the frequency offsets of the received signals from different SSs are not coordinated. ICI occurs between two neighboring subcarriers that belong to different SSs.
As specified in the current standard, the Subscriber Stations (SS) shall be synchronized to the BS with a tolerance of maximum 2% of the subcarrier spacing. The adjacent subcarriers, which belong to two different SSs, may have the opposite-direction frequency shift, thus the ICI is caused by the summation of the frequency shifts of the signals from two SSs.
Therefore, strong power in a subcarrier may generate an ICI that destroys the reception of the weak signal in its adjacent subcarrier. This symptom is similar to that caused by near-far effect.
The ICI in NLOS case can be illustrated in a simple OFDMA system as shown in Figure 1. There are three SSs in this system, representing by green, red, blue colors, respectively. Each SS transmit in a tile that consists of 4 consecutive subcarriers by 3 OFDM symbols. Due to multipah effect, red signals are much stronger than their neighbors. The accumulated ICIs represented in black lines may hamper the reception of the blue signal at subcarrier 2 and green signal at subcarrier -3.

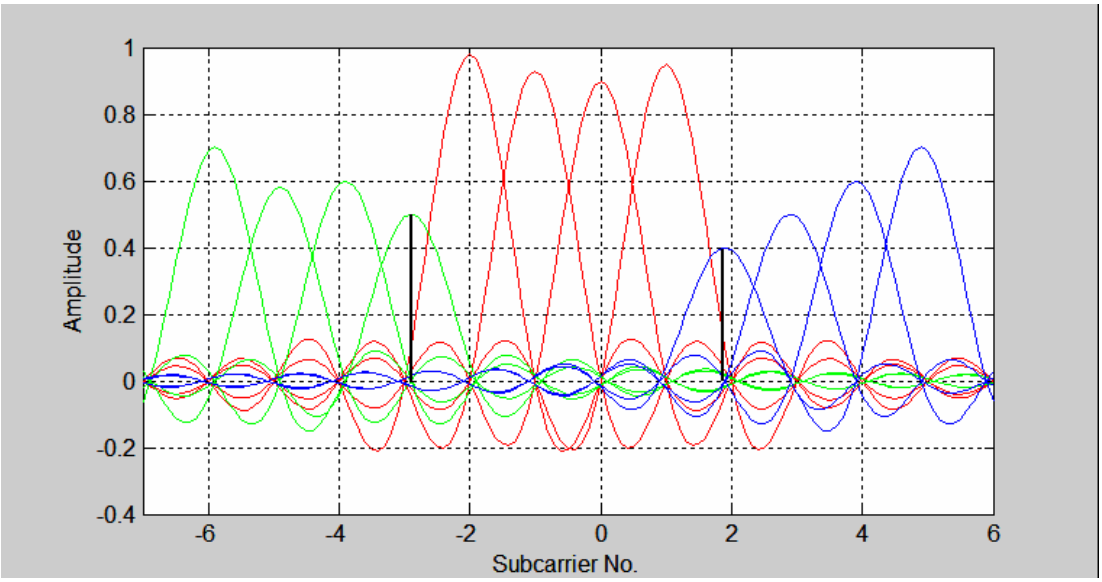

Fig.1 Received frequency-domain signal in Base Station

2. The Solution

Based on the analysis above, we propose the tile-based power control. The Base Station (BS) measures the average power of the tile, and then feeds back the adjustment command to the SS. The SS performs the power adjustment in digital domain. This accurate uplink power control eliminates the near-far effect in OFDMA system.

3. Performance

The performance is evaluated by simulation. The simulation parameters follow the OFDMA uplink PHY in 802.16 2004. Assume that the 70 users communicate with BS simultaneously, and each user occupies one subchannel with ½ convolutional coded 16QAM. The two static multipath channel models are randomly assigned to the 69 users except the user 1, and the frequency offset of all the users are supposed to be the same (2% and 6% of subcarrier spacing). The user 1 is chosen as the target uplink user, whose channel model is SUI5. The uplink performance of user 1 is shown in Fig. 2 and Fig.3. The tile-based power control brings about 1.5dB gain at frequency offset 2%, and 2.5dB gain at frequency offset 6%, compared to the user-based power control only.

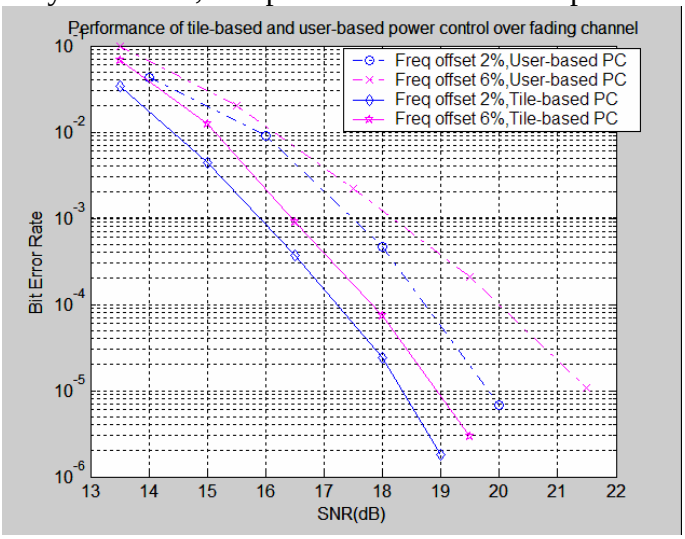

Fig.2 Bit error rate comparison of user-based and tile-based power control

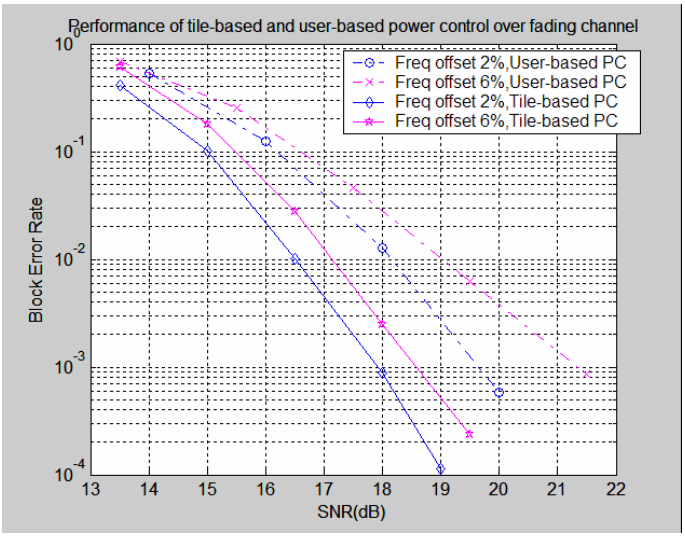

Fig.3 Block error rate comparison of user-based and tile-based power control

4. Proposed Text

8.4.5.4.3 Enhanced Power Control
When the UL enhance power control is used, an Enhanced Power Control IE is sent using the exteneded UIUC=15 with subcode 0x01. An UL enhanced power control IE is used to keep the power balance between tiles within one SS when some tiles reside in the deep fading. We divide the 420 tiles into 14 groups, each group has 30 tiles. The power control value is expressed in 1 bit and defined according to Table xxx.

The IE is unicasted to each SS. When used, the CID in the UL_MAP_IE() should be set to Basic CID of the SS .

Table xxx. Enhanced power control IE

Syntax	Size	Notes
Enhanced_Power_Control_IE(){		
Extended UIUC	4 bits	Enhanced Fast Power Control = 0x01
Length	4 bits	Length(n)=ceil((14+7*n)/8), n is integer between 1 to 16
Power Adjustment Group Bitmap	14 bits	Each bit indicates if there is a power adjustment in the current group. “1”- there are at least one tile need to adjust power;“0”- all the tiles in current group keep unchanged.
for (i=1; i<=n; i++) {		n=Number of tiles which need to be adjusted, 1<=n<=16
The flag for group changing	1 bit	“1”-the group changed;”0”- the group keep unchanged
Tile index within group	5 bits	The indexes of tile within each group
Power correction	1 bits	Power correction indication, 0: -3dB, 1: +3dB
}		
}		