

Project	IEEE 802.16 Broadband Wireless Access Working Group < http://ieee802.org/16 >	
Title	Open Loop Power Control Operation	
Date Submitted	2004-07-15	
Source(s)	<p>Panyuh Joo, Seungjoo Maeng, Jaeho Jeon, Soonyoung Yoon, Jeong-Heon Kim, Jaehyok Lee, Myungkwang Byun, Inseok Hwang, Jaehee Cho, Jiho Jang, Sanghoon Sung, Hoon Huh,</p> <p>Samsung Electronics Co. Ltd.</p> <p>Choongil Yeh, Hyuongsoo Lim, Yuro Lee, Jongee Oh, DongSeung Kwon, ETRI</p>	<p>panyuh@samsung.com</p> <p>lim@etri.re.kr</p>
Re:	Recirculation of P802.16 REVe/D3	
Abstract	Open loop power control operation is proposed to determine uplink transmit power	
Purpose	Adoption of suggested changes into P802.16e/D4	
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 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 and Procedures	<p>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."</p> <p>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>.</p>	

Problem Definition

In the current IEEE P802.16REVd/D5, the SS should automatically update transmit power when the SS transmits in region of Fast-feedback, Ranging, and CDMA allocation. The current transmitting power is computed by adding a correction term power, based on the change in used bandwidth and CINR threshold, to the last transmission. The changes in network interference levels may be handled by changing the CINR threshold table with a dedicated UCD message TLV.

However, there are two factors which are not managed in the current scheme. The one is change in the propagation loss due to mobility and packet scheduling. The other is an SS specific link level non-ideality such as channel selectivity, propagation differences between uplink and downlink (especially for FDD systems), channel measurement error, and channel report delay under high mobility condition. To cope with these impairments, SS specific power margin is required to achieve desired packet error rate. In this contribution, enhanced open loop power control formula is introduced, which can compensate these two degradation factors.

Proposed Solution

Propagation loss estimation

The change in propagation loss can be estimated by measuring the signal strength of preamble and/or pilot tones and then comparing it with transmitting power level. To get a better estimate, IIR filtering and linear interpolation can be applied. An example of implementation algorithm using DL preamble is shown as below (in dB scale)

$$\begin{aligned} L_{DL}(n) &= \alpha(P_{TX,DL,Preamble} - P_{RX,DL,Preamble}(n)) + (1-\alpha)L_{DL}(n-1) \text{ (IIR filtering)} \\ L_{UL}(n) &= L_{DL}(n) + \beta\{L_{DL}(n) - L_{DL}(n-1)\} \text{ (Linear interpolation)} \end{aligned}$$

where $L_{DL}(n)$, and $P_{RX,DL,Preamble}(n)$ are an estimated downlink propagation loss, a received preamble strength at n -th frame and $L_{UL}(n)$ is an estimated uplink propagation loss. The parameter α is an IIR filter coefficient and β is an offset considering time delay between uplink transmission slot and downlink preamble.

SS specific power offset estimation

The power offset for an SS-specific non-ideality can be estimated by observing the Ack/Nack of uplink burst. The specific algorithm can be described as follows (in dB scale).

$$\begin{cases} \text{Offset}_{perSS} = \text{Offset}_{perSS} + UP_STEP & \text{if NAK is received} \\ \text{Offset}_{perSS} = \text{Offset}_{perSS} - \frac{1}{1/ FER_{target} - 1} \cdot UP_STEP & \text{else if ACK is received} \\ \text{Offset}_{perSS} = \text{Offset}_{perSS} & \text{else where} \end{cases}$$

$$\begin{cases} \text{Offset}_{perSS} = \text{Offset_Bound}_{upper} & \text{if } \text{Offset}_{perSS} \geq \text{Offset_Bound}_{upper} \\ \text{Offset}_{perSS} = \text{Offset_Bound}_{lower} & \text{else if } \text{Offset}_{perSS} \leq \text{Offset_Bound}_{lower} \end{cases}$$

The operating parameters UP_STEP , $\text{Offset_Bound}_{upper}$, $\text{Offset_Bound}_{lower}$ are signaled by a UCD message TLV. The FER_{TARGET} is also handled by a UCD message if not defined in service level negotiation process.

Proposed power adjustment formula

The proposed open loop power control algorithm can be summarized as follows,

$$P_{new} = P_{last} + (L_{UL,new} - L_{UL,last}) + 10 \cdot \log_{10}(B_{new}/B_{last}) + C/N_{new} - C/N_{last} + \text{Offset}_{perSS}$$

where B_{new}/B_{last} is the ratio of change in used bandwidth. Comparing the Eq. (134) in P802.16REVd/D5, correction terms for propagation loss difference and SS-specific power offset are added.

Suggested text changes to 16.e standard

8.4.10.3 Power Control

[Modify the text describing the Eq. (134):]

To maintain at the BS a power density consistent with the modulation and FEC rate used by each SS, the BS may change the SS TX power as well as the SS assigned modulation and FEC rate. There are, however, situations where the SS should automatically update its TX power, without being explicitly instructed by the BS. This happens when the SS transmits in region marked by UIUC=0, UIUC=12 or UIUC=14. In all these situations the SS shall use a temporary a TX power value set according to the formula (in dB),

~~$$P_{new} = P_{last} + (C/N_{new} - C/N_{last}) - (\log_{10}(R_{new}) - \log_{10}(R_{last})) \quad (134)$$~~

$$P_{new} = P_{last} + (L_{new} - L_{last}) + (C/N_{new} - C/N_{last}) - (10\log_{10}(R_{new}) - 10\log_{10}(R_{last})) + Offset_{perSS} \quad (134)$$

Where,

P_{new} is the temporary TX Power

P_{last} is the last used TX Power. When any power control message is arrived and the TX Power is updated based on the message before new transmission, P_{last} is the updated TX Power.

L_{new} is the estimated current UL propagation loss

L_{last} is the estimated last UL propagation loss. When any power control message is arrived and the TX Power is updated based on the message before new transmission, L_{last} is the value of the estimated UL propagation loss when the TX Power is updated.

C/N_{new} is the normalized C/N of new modulation/FEC rate instructed by the UIUC

C/N_{last} is the normalized C/N of the last used modulation/FEC rate

R_{new} is the number of repetitions for the new modulation/FEC rate instructed by the UIUC

R_{last} is the number of repetitions on the last used modulation/FEC rate

$Offset_{perSS}$ is the correction term for SS-specific power offset.

The power offset for an SS-specific non-ideality shall be estimated by observing the Ack/Nack of uplink burst. The specific algorithm is described as follows (in dB). The initial value of $Offset_{perSS}$ is '0'.

$$\begin{cases} Offset_{perSS} = Offset_{perSS} + UP_STEP & \text{if NAK is received} \\ Offset_{perSS} = Offset_{perSS} - \frac{1}{1/ FER_{target} - 1} \cdot UP_STEP & \text{else if ACK is received} \\ Offset_{perSS} = Offset_{perSS} & \text{elsewhere} \end{cases} \quad (aaa)$$

$$\begin{cases} Offset_{perSS} = Offset_Bound_{upper} & \text{if } Offset_{perSS} \geq Offset_Bound_{upper} \\ Offset_{perSS} = Offset_Bound_{lower} & \text{else if } Offset_{perSS} \leq Offset_Bound_{lower} \end{cases} \quad (bbb)$$

Where,

UP_STEP is the adjustment step

FER_{TARGET} is the target frame error rate

$Offset_Bound_{upper}$ is the upper bound of power offset adjustment

$Offset_Bound_{lower}$ is the lower bound of power offset adjustment

The operating parameters UP_STEP , FER_{TARGET} , $Offset_Bound_{upper}$, $Offset_Bound_{lower}$ are signaled by a dedicated UCD message TLV. The default normalized C/N values per modulation are given by Table 332. These values may be overridden by the BS by using a dedicated UCD message TLV. The minimum step size and accuracy of the RF transmit power level shall satisfy the transmitter requirements in Section 8.4.12.1.

11.3.1 UCD channel encodings

[Add the following rows to Table 351 – UCD PHY-specific channel encodings – WirelessMAN-OFDMA:]

<u>Name</u>	<u>Type (1 byte)</u>	<u>Length</u>	<u>Value</u>
<u>SS-specific power offset adjustment step</u>	<u>www</u>	<u>1</u>	<u>Unsigned in units of 0.01 dB</u>
<u>Target frame error rate of UL burst transmission</u>	<u>xxx</u>	<u>1</u>	<u>Unsigned integer of $-10 \cdot \log_{10}(\text{FER}_{\text{target}})$</u>
<u>Minimum level of power offset adjustment</u>	<u>yyy</u>	<u>1</u>	<u>Signed in units of 0.1 dB</u>
<u>Maximum level of power offset adjustment</u>	<u>zzz</u>	<u>1</u>	<u>Signed in units of 0.1 dB</u>