Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Uplink Power Control for FDD/H-FDD Duplexing**
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Re:	IEEE 802.16e D4 Draft
Abstract	The up link power control for FDD/H-FDD with MIMO and non-MIMO transmission. The added text is highlighted in green.
Purpose	To incorporate the changes here proposed into the 802.16e D5 draft.
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Uplink Power Control for FDD/H-FDD Duplexing

1 Introduction

The uplink power control for the macro-cell deployment is fundamental for the reduction of the other-cell interference generated by MSS. The up link power control is an even more difficult task for FDD than TDD due to the MSS has no *a prior* knowledge of the fast fading channel in the UL. The conventional closed loop power control technique can be employed in which BS detects the MSS transmission power and send the power control command to assist the MSS to track the UL channel fading.

In the OFDMA application, due to the construction of UL sub-channel, the fading to each individual user is dominated by flat temporal Rayleigh fading. And two additional difficulties arises: (1) a very large control time delay, such as 5ms frame makes the closely tracking and predict the fading channel very difficult, therefore the single power control step size for the MSS is not sufficient. (2) in the case of H-FDD, there is a transmit gap for the MSS, this makes the prediction even more difficult.

In this contribution, we propose multi-bit power control technique for UL MSS transmission for both FDD and H-FDD case, in addition, the multi-bit power control mechanism can be extended to the UL MIMO transmission.

2 Multi-bit Power Control

2.1 UL SIMO Power Control

The BS receiver measures the MSS transmission power, for the single antenna MSS transmission and multiple antenna BS reception case (SIMO), the BS measures the SIR_k values for the individual MSS at k^{th} frame the target SIR_{k+1} value for the k+1 frame can be generated by using prediction techniques (such as LMS linear predictor), we can set two power control threshold values $SIR_{THRESHOLD-1}$ and $SIR_{THRESHOLD-2}$.

Then a 2-bit power control command is generated based on the following rule (FDD case):

1. if $0 < SIR_{k+1} < SIR_{THRESHOLD-1}$ → then MSS transmits power DOWN with step size $\Delta 1$
2. if $-SIR_{THRESHOLD-2} < SIR_{k+1} < 0$ → then MSS transmits power UP with step size $\Delta 1$
3. if $SIR_{THRESHOLD-1} < SIR_{k+1}$ → then MSS transmits power DOWN with step size $\Delta 2$
4. if $SIR_{k+1} < -SIR_{THRESHOLD-2}$ → then MSS transmits power UP with step size $\Delta 2$

2.2 UL MIMO Power control

For the STTD transmission case, the 2-bit power control command is generated based on the following rule (FDD case):

1. The k^{th} frame SIR is measured as $SNR_k = \sum_{i}^{2} G_i^{\,2} \sum_{j=1}^{NRx} \left| h_{i,j} \right|^2$, $G_\Sigma = G_1 + G_2$ is the sum of the transmit power of MSS antenna 1 and MSS antenna 2.
2. The first power control bit is generated by predictor output SNR
   a. if $0 < SIR_{k+1} < SIR_{THRESHOLD-1}$ → then MSS transmits power DOWN with step size $\Delta 1$
   b. if $-SIR_{THRESHOLD-1} < SIR_{k+1} < 0$ → then MSS transmits power UP with step size $\Delta 1$
3. The second power control bit is generated to control G1 and G2 as:
   a. If $\sum_{j=1}^{NRx} \left| h_{1,j} \right|^2 > \sum_{j=1}^{NRx} \left| h_{2,j} \right|^2$; → then $G_1 = 0.9 G_\Sigma$ and $G_2 = 0.1 G_\Sigma$;

      else $G_2 = 0.9 G_\Sigma$ and $G_1 = 0.1 G_\Sigma$

2.3 Advantages of UL power control

The advantage of the fast closed loop power in the UL is to minimize the other cell interference and to manage the UL QoS performance. The benefit for the uplink power control is shown Figure 1 and Figure 2.

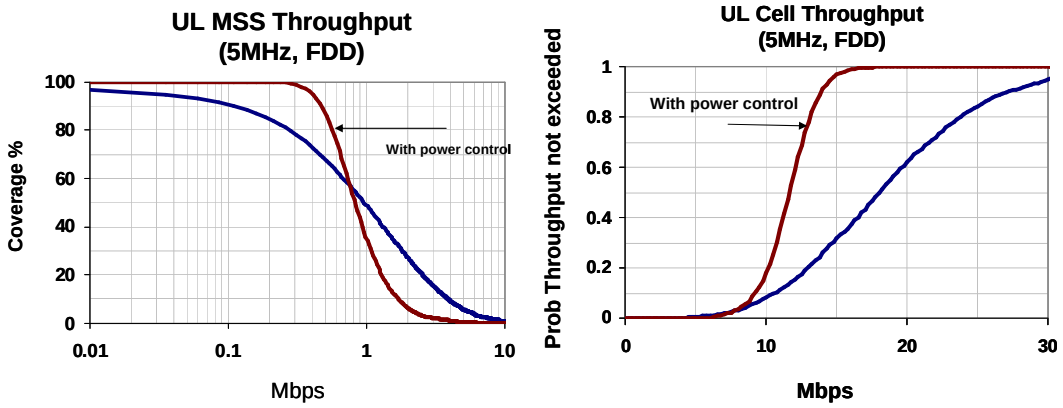

Figure 1 UL Cell and per MSS throughput with and without power control

3 Proposed Text

Insert the following text in section 8.4.5.4.16

---------- Start Text ----------

Table zzzz Enhanced Power Control IE

SYNTAX	SIZE	NOTE
Enhancement_Power_Control_IE() {		
Extended UIUC	4 bits	
MSS Transmit antenna index	1 bit	0- single transmit, 1- two transmit
Power adjustment	2 bits	
}		

MSS Transmit antenna index=0; the rule is described in section 2.1
MSS Transmit antenna index=1; the rule is described in section 2.2

---------- End Text ----------