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Re:	Call for contributions, IEEE P802.16e-2005 Sponsor Ballot
Abstract	This document suggests changes in TGe Draft Document IEEE 802.16e-2005 to define initial transmit power calculation during handover for OFDMA PHY
Purpose	Adopt into the current TGe working draft
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Initial Transmit Power Calculation during Handover and Power Control Mode Change for OFDMA PHY

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1 Introduction

The power control for the OFDMA PHY in the 802.16e standard has been designed with great consideration. However, the handover process defined in the standard, does not define a clear PC mechanism to be used during its execution. This fact may lead to unclear and/or unexpected MS behavior that may greatly degrade system performance. Moreover, the initial transmit power level during power control mode change from closed loop to open loop may be problematic in case of abnormal situation for example, pathloss values for downlink and uplink are different.

This contribution is aimed at expanding previous PC elements for use during the handover process and power control mode change, so as to clearly define a mandatory PC mechanism for use during this process.

The contribution is organized as follows: The motivation behind the changes are explained in the next section, followed by an explanation about the changes needed, and finally detailed text changes that need to be implemented.

2 Motivation for the Changes

According to section 8.4.5.4.21 in the standard, handover initiation may be performed using non-contention based Fast_Ranging_IE allocation by target BS. However, the standard does not indicate the initial transmit power in a Fast_Ranging_IE allocation. If the MS is to calculate this value using the open-loop power-control equations, it needs the noise and interference levels of the target BS. This information is only available at the MS if association has been performed with the specific target BS prior to handover initiation.

This contribution proposes a method for the calculation of the initial transmit power for MS transmission in Fast_Ranging_IE allocations, which is expected to expedite and prevent power control related errors in the handover process. A similar problem exists in the handover ranging mechanism, however it is not dealt with in this document so as not to impede on the vendor-specific implementation robustness of the ranging process.

Another needed change comes from the fact that according to section 8.4.10.3.2 in the standard, when the MS receives a PMC-RSP message from the BS to switch power control mode to open loop, the transmit power level at MS is recalculated using equation (138a) disregarding the last transmit power level used at closed loop power control mode. This may cause abrupt discontinuity of transmit power level at the instant of mode change from closed loop to open loop and can cause consecutive errors for subsequent uplink packets. Therefore, the Offset_SSperSS at the passive open loop power control should be modified to prevent the abrupt discontinuity of transmit power level during the power control mode change.

3 Initial transmit power calculation for handover

During a handover process, if the target BS allocates a Fast_Ranging_IE in the UL-MAP, it may also transmit the UL interference and noise level_IE in the same UL-MAP. This will provide the incoming MS the needed noise and interference measures, needed to calculate the open-loop transmit power using equation (138a), for its initial transmission in the Fast_Ranging_IE allocation. The UL_noise_and_interference_level_IE may include only the NI field that corresponds to the same zone that Fast_Ranging_IE points to (i.e. the UL zone in which MS shall transmit RNG-REQ).

The MS will use the target BS parameters in equation (138a), except for the $\text{Offset\_BS}_{\text{perSS}}$ parameter, which will be reused from the serving BS.

An MS, which is currently in closed loop power control or one not supporting open loop power control, should not use this method. Instead, the MS will use the following equation to calculate its initial transmit power at the target BS:

$$P_{TBS} = P_{last,SBS} - RSSI_{TBS} + RSSI_{last,SBS} + NI_{TBS} - NI_{last,SBS} + C/N_{TBS} - C/N_{last,SBS} + BS\_EIRP_{TBS} - BS\_EIRP_{SBS} - 10\log_{10}(R_{TBS}) + 10\log_{10}(R_{last,SBS})$$

If, for any reason, the MS does not have one of the parameters needed for the above equations, it will disregard Fast_Ranging_IE allocations and perform CDMA handover ranging with the target BS.

4 Initial transmit power calculation for open loop power control

In case of downlink/uplink imbalance (i.e. due to repeaters or measurement inaccuracies), the power control mode change from closed loop to open loop may cause severe problems. According to the current standard, when the MS receives PMC-RSP from BS to switch to open loop power control, the transmit power level at MS is recalculated using equation (138a) disregarding the last transmit power level used at the closed loop power control mode. This may cause abrupt discontinuity of transmit power level between closed loop and open loop during power control mode change, and therefore errors are inevitable for subsequent uplink packets. In this contribution, the value for Offset_SSperSS at the passive open loop power control is addressed and is modified as followings:

$$\text{Offset\_SSperSS} = P_{Tx,CL\_last} - P_{Tx,OL\_init} + C/N_{OL\_init} - 10\log10(R_{OL\_init}) - C/N_{CL\_last} + 10\log10(R_{CL\_last})$$

where, $P_{Tx,OL\_init} = L_{OL\_init} + C/N_{OL\_init} + NI_{OL\_init} - 10\log10(R_{OL\_init})$

The Offset_SSperSS can be rewritten as

$$\text{Offset\_SSperSS} = P_{Tx,CL\_last} - (L_{OL\_init} + NI_{OL\_init}) - C/N_{CL\_last} + 10\log10(R_{CL\_last})$$

Note that the above OffsetSSperSS shall be calculated only once during the power control mode change from closed loop to open loop. Therefore the OffsetSSperSS value will remain constant unless other power control mode change is executed. In normal cases, the OffsetSSperSS with the modification above will be zero. Because the last transmit power level used for closed loop power control will be the same as the initial transmit power level for open loop power control under the assumption of perfect power control. However, in the abnormal case such that downlink/uplink imbalance exists, the OffsetSSperSS can be a bias at MS to compensate the imbalance.

Note also that although Offset_BSperSS is not present in the above equations, it is used in the final $P_{Tx,OL}$ calculation.

5 Detailed Text Changes

[Add the following subclause 8.4.10.3.2.2]

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During handover, the target BS may provide BW allocation information to the MS using Fast_Ranging_IE to send an RNG-REQ message. In this case, the target BS shall also transmit the UL_noise_and_interference_level_IE in the same frame in which the OFDMA_Fast_Ranging_IE is transmitted. This UL_noise_and_interference_level_IE shall include at least the NI field that corresponds to the same zone that Fast_Ranging_IE points to (i.e. the UL zone in which the MS may transmit RNG-REQ). In turn, the MS shall calculate the initial transmit power at the target BS as follows:

1. If the MS is in open loop power control mode with serving BS, then equation (138a) of section 8.4.10.3.2 shall be used. In this calculation, the MS will reuse $offset\_BS_{perSS}$ from its serving BS, while all other equation parameters will be target BS related.

2. If the MS is in closed loop power control mode with serving BS, then the following equation shall be used:

$$P_{TBS} = P_{last,SBS} - RSSI_{TBS} + RSSI_{last,SBS} + NI_{TBS} - NI_{last,SBS} + C/N_{TBS} - C/N_{last,SBS} + BS\_EIRP_{TBS} - BS\_EIRP_{SBS} - 10log_{10}(R_{TBS}) + 10log_{10}(R_{last,SBS}) \quad (138e)$$

Where:

$P_{last,SBS}$	MS transmit power level of the last transmission to the SBS [dBm].
P_{TBS}	Initial MS transmit power level (dBm) to be used in subsequent HO-ranging or Fast_Ranging_IE allocation transmissions to the TBS.
$RSSI_{last,SBS}$	DL RSSI at MS of the SBS preamble, used to derive Tx power of last transmission at the SBS [dBm].
$RSSI_{TBS}$	DL RSSI of the TBS preamble, measured by the MS [dBm].
$NI_{last,SBS}$	Combined noise+interference known at time of last transmission at the SBS [dBm].
NI_{TBS}	Combined noise+interference at the TBS [dBm].
$C/N_{last,SBS}$	Carrier-to-noise level for assigned UL MCS of last transmission at the SBS [dB].
C/N_{TBS}	Carrier-to-noise level for UL MCS derived from the UIUC assigned to the Fast_Ranging_IE allocation at the TBS [dB].
BS_EIRP_{SBS}	SBS maximum equivalent isotropic transmit power (from DCD) [dBm].
BS_EIRP_{TBS}	TBS maximum equivalent isotropic transmit power (from DCD settings in MOB_NBR-ADV) [dBm].
$R_{last,SBS}$	Repetition factor of assigned UL MCS of last transmission at the SBS.
R_{TBS}	Repetition factor of assigned UL MCS at the TBS.

3. If the MS does not have one of the parameters needed for the above calculations (open loop or closed loop), it will disregard Fast_Ranging_IE allocations and perform CDMA handover ranging with the target BS.

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[Modify the table 109v and the following text in 6.3.2.3.58]

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Table 109v-PMC_REQ message format

Syntax	Size	Notes
PMC_REQ message format{	—	—
Management Message Type = 63	8 bits	Type = 63
Power control mode change	2 bits	0b00: Closed loop power control mode 0b01: ~~reserved~~ Open loop power control passive mode with Offset_SSperSS retention 0b10: Open loop power control passive mode with Offset_SSperSS reset 0b11: Open loop power control active mode

UL Tx power	8 bits	UL Tx power level for the burst that carries this header (11.1.1). When the Tx power is different from slot to slot, the maximum value is reported.
Confirmation	1 bit	0: Request 1: Confirmation
Reserved	5 bits	Shall be set to zero
}	—	—

CID shall be the basic CID of MS. MS shall generate the PMC_REQ message including the following parameters:

Power control mode change

0b00: Closed loop power control mode
0b01: Open loop power control passive mode with Offset_SSperSS retention
0b10: Open loop power control passive mode with Offset_SSperSS reset
0b11: Open loop power control active mode

UL Tx power

UL Tx power level for the burst that carries this header (11.1.1). When the Tx power is different from slot to slot, the maximum value is reported.

Confirmation

0: MS requests to change the power control mode.
1: MS confirms the receipt of PMC_RSP from BS.

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[Modify the table 109w and the following text in 6.3.2.3.59]

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Table 109w-PMC_RSP message format

Syntax	Size	Notes
PMC_RSP message format{	—	—
Management Message Type = 64	8 bits	Type = 64
Power control mode change	2 bits	0b00: Closed loop power control mode 0b01: ~~reserved~~ Open loop power control passive mode with Offset_SSperSS retention 0b10: Open loop power control passive mode with Offset_SSperSS reset 0b11: Open loop power control active mode
Start frame	6 bits	6 LSBs of frame number when the indicated power control mode is activated. When it is same with the current frame number, the mode change shall be applied from the current frame.
If (Power control mode change==0b00) {		
Power adjust	8 bits	Signed integer, which expresses the change in power level (in multiples of 0.25 dB) that the MS shall apply to its current transmission power. When subchannelization is employed, the subscriber shall interpret the power offset adjustment as a required change to the transmitted power density.
} else {	—	—
Offset_BSperMS	8 bits	Signed integer, which expresses the change in power level (in multiples of 0.25 dB) that the MS shall apply to the open loop power control formula in 8.4.10.3.2.
}	—	—
}	—	—

CID shall be the basic CID of MS. ~~MS~~BS shall generate the PMC_RSP message including the following parameters:

Power control mode change

0b00: Closed loop power control mode
0b01: ~~Reserved~~ Open loop power control passive mode with Offset_SSperSS retention
0b10: Open loop power control passive mode with Offset_SSperSS reset
0b11: Open loop power control active mode

Start frame

6 LSBs of frame number when the indicated power control mode is activated. When it is same with the current frame number, the mode change shall be applied from the current frame.

Power adjust

Signed integer, which expresses the change in power level (in multiples of 0.25 dB) that the MS shall apply to its current transmission power. When subchannelization is employed, the subscriber shall interpret the power offset adjustment as a required change to the transmitted power density.

Offset_BSperMS

Signed integer, which expresses the change in power level (in multiples of 0.25 dB) that the MS shall apply to the open loop power control formula in 8.4.10.3.2.

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[Modify the following text in 8.4.10.3.2]

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Passive Uplink open loop power control:

In passive uplink open loop power control with Offset_SSperSS reset (i.e., 'Power control mode change = 0b10' indicated by PMC_REQ/RSP message), the SS will set Offset_SSperSS to zero and modify the TX power value using Equation (138a).

In passive uplink open loop power control with Offset_SSperSS retention (i.e., 'Power control mode change =0b01' indicated by PMC_REQ/RSP message), the SS shall set Offset_SSperSS as described below in the event of power control mode change from closed loop to open loop, and modify the TX power value using Equation (138a).

$$\text{Offset\_SSperSS} = P_{Tx,CL\_last} - (L_{OL\_init} + NI_{OL\_init}) - C/N_{CL\_last} + 10\log10(R_{CL\_last})$$

Where:

$P_{Tx\_CL\_last}$	MS transmit power level used in the last transmission in closed loop power control mode.
L_{OL_init}	Path-loss value estimated at MS during power control mode change from closed loop to open loop.
NI_{OL_init}	Latest NI value transmitted in UL_noise_and_interference_level_IE prior to mode change to open loop power control.
C/N_{CL_last}	Normalized C/N according to modulation & FEC used in the last transmission in closed loop power control mode.
R_{CL_last}	Repetition factor for the modulation & FEC scheme used in the last transmission in closed loop power control mode.

The above Offset_SSperSS shall be calculated only once during the power control mode change from closed loop to open loop. Therefore the Offset_SSperSS value will remain constant unless other power control mode change is executed.

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6 References

[1] IEEE P802.16-2004.
[2] IEEE P802.16e-2005.