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Re:	IEEE P802.16e/D4-2004	
Abstract	In this contribution, the bit-by-bit definition of the PHY Profile ID in the NBR-ADV is proposed	
Purpose	Review and Adopt the suggested changes into P802.16e/D4	
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PHY Profile ID

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1. Introduction

The IEEE 802.16 standard has many options, which should be specified in either DCD/UCD or NBR-ADV mainly using bandwidth consuming TLV encoded information formats. Reducing the overhead of the broadcast messages is especially critical since these messages are encoded using the most robust coding scheme like 1/12 QPSK in OFDMA systems. This contribution introduces an identifier called 'PHY Profile ID' to reduce the overhead of NBR-ADV message by aggregating a set of essential key physical layer feature descriptors of neighboring base stations ~~such as FFT sizes, bandwidths, and channel numbers.~~ like FA indices. Currently, the 16-bit-long space is reserved for PHY Profile ID in the NBR-ADV message. This contribution proposes the bit-by-bit definition of the PHY Profile ID and the corresponding text changes in the current IEEE 802.16e standard draft.

Additionally, it proposes new values that can be specified in the DCD and hence in the NBR-ADV messages to ease the acquisition process at handover.

2. Definition of PHY Profile IDs

A. Components of PHY Profile ID

A PHY Profile ID of a BS has five components, which are the co-location indicator bit, the FA Configuration Indicator bit, ~~the FFT size, the BW~~ the Time/Frequency Synchronization Indicator, the BS EIRP Indicator, the DCD/UCD Reference Indicator, the FA Index Indicator, and the FA ~~number~~ Index of which the BS uses. Although the bit-by-bit values of PHY Profile ID are defined only for OFDMA systems in this contribution, the definition of PHY Profile ID for SC, SCa, and OFDM systems can be extended as some of TLV encoded information are PHY-specific.

i.   Co-located FA Indicator

In the current IEEE 802.16e system, the multiple FA (frequency assignment) – while maintaining the concept that a BS has only one FA, a group of co-located BSs has multiple channels – system can invoke the ambiguity when an MSS scans the neighbor BSs if there is no indicator that makes the MSS recognize that the listed BS is co-located with the serving BS (the one that the MSS is connected to at the synchronized FA) and scanning it is not necessary. In order to eliminate this ambiguity, the BS broadcasting the NBR-ADV should inform the mobile of which BSs are co-located

with the serving BS.

ii.   FA Configuration Indicator

This bit indicates that the BS has the same FA configuration as the serving BS, if it is set 1. This bit facilitates the load balancing procedure for the MSS in idle mode.

iii.   ~~FFT Size~~

~~IEEE 802.16 OFDMA network elements can have one of four different FFT sizes: 2048, 1024, 512, and 128. Although the FFT size is not an element listed in either DCD/UCD or NBR-ADV, the FFT size should be listed to facilitate the handover between the BSs having different sizes. (This kind of handover can take place in case of Macro/Micro BS deployment scenarios.)~~

iv.   ~~Bandwidth~~

~~For the same reason why the FFT size should be listed in the PHY Profile ID at the NBR-ADV, the bandwidth of the channel that the BS uses is also necessary. The bandwidth options in the current standard are 20, 10, 5, 1.25, 17.5, 8.75, 28, 14, and 7 MHz from the profiles defined IEEE 802.16d/D5. 4.375 and 1.09375 MHz are added as additional bandwidth options.~~

iii.   ~~v.~~ FA (Frequency Assignment) ~~Number~~Index

The current standard distinguishes channels by the DL physical center frequency, which is 32 bit long and obviously takes a huge overhead. Although reducing the overhead by introducing ~~a channel number of index~~ an index of the occupying channel (FA Index) would be strongly desired, the definition of the FA ~~numbers~~index in the unlicensed band may not be feasible due to a huge extent of eligible frequency bands.

This field would be valid only for a BS operating in the licensed band. In the licensed band, the eligible band is reasonably limited so that the distinction between channels by a several bit long ~~channel number~~FA Index is practicable. Since even the licensed bands for IEEE 802.16 is yet not defined, the bit-by-bit definition of an FA ~~numbers~~ Index cannot be established at this time. When we consider the gain achieved by the proposed scheme, it is reasonable to reserve ~~7~~8 bits for the FA number. For unlicensed bands, expressing the DL center frequency is possible by using a TLV encoded information if necessary.

iv.   Time/Frequency Synchronization Indicator

The Time/Frequency Synchronization Indicator is intended to shorten MSS synchronization time to to the target BS, by allowing it to rely on time and frequency offset

information obtained from the downlink of the serving BS. If time synchronization is indicated then the downlink frames transmitted by the serving BS and the target BS shall be synchronized to a level of at least 1/8 cyclic prefix length. If frequency synchronization is indicated, then the BS reference clocks shall be synchronized to a level that yields RF center frequency offset of no more than 4% of the OFDMA carrier spacing of the target BS. If the target BS and serving BS have different RF center frequencies, the definition applies to the serving BS center frequency after multiplication by the ratio of nominal center frequencies. I.e.

$$\left| f_{\text{Target}} - f_{\text{Serving}} \cdot \frac{f_{\text{Target, Nominal}}}{f_{\text{Serving, Nominal}}} \right| \leq 4\% \cdot \text{TargetToneSpacing}$$

v.   **BS EIRP Indicator and (Optional) BS EIRP**

For the open loop power control as well as the power adjustment at the HO, the MSS needs to know the EIRP of the neighbor BS. Although the DCD informs of this information (hence, if different, it shall be broadcast through NBR-ADV), the overhead will be huge since it has to be encoded using a TLV format. Yet, since the length of the PHY Profile ID is limited to 16 bit long which is too short to accommodate the BS EIRP, one bit indicator is included in PHY Profile ID and an optional field for BS EIRP which is presented only if the bit is set. The (optional) BS EIRP is one byte long and expressed in a signed integer from -128 to 127 in units of dBm.

vi.   **DCD/UCD Reference Indicator**

If the serving BS includes a neighbor BS which has three sectors and the three sectors have one DCD/UCD setting which is different from that of the serving BS, the NBR-ADV shall iterate the same settings three times. Since these sectors can be ordered and following one another, if there is an indicator which informs that the reference of the DCD/UCD of the BS is that of the neighbor BS preceding it in the NBR-ADV, the size of the NBR-ADV can be greatly reduced. If this indicator is set 1, the reference of the DCD/UCD is that of the preceding neighbor BS in NBR-ADV. Otherwise, the DCD/UCD has the same parameters if not specified.

v.   **FA Index Indicator**

Only if this bit is set to 1, the FA Index follows the PHY Profile ID. In addition, if the FA Indicator is followed, the DL center frequency shall be omitted in the DCD/UCD difference TLV information.

A. Structure of PHY Profile ID

Item	Size	Notes
Co-located FA Indicator	**1 bit**	**If the BS (or FA) is co-located with the serving BS, this bit is set to 1.**
FA Configuration Indicator	**1 bit**	**If this bit is set 1, the BS has the same FA configuration (the same number of FAs as well as their frequencies) as the BS broadcasting this NBR-ADV.**
~~FFT Size~~	~~2 bits~~	~~0b00: 2048~~ ~~0b01: 1024~~ ~~0b10: 512~~ ~~0b11: 128~~
~~Bandwidth~~	~~4 bits~~	~~0b0000: 20 MHz~~ ~~0b0001: 10 MHz~~ ~~0b0010: 5 MHz~~ ~~0b0011: 1.25 MHz~~ ~~0b0100: 17.5 MHz~~ ~~0b0101: 8.75 MHz~~ ~~0b0110: 4.375 MHz~~ ~~0b0111: 1.09375 MHz~~ ~~0b1000: 28 MHz~~ ~~0b1001: 14 MHz~~ ~~0b1010: 7 MHz~~ ~~0b1011: 3.5 MHz~~ ~~0b1100~0b1111: Reserved for future bandwidth options~~
Time/Frequency Synchronization Indicator	**2 bits**	**00 = Unsynchronized** **0 1 = Time synchronization.**

		10 = Time and Frequency synchronization
		If time synchronization is indicated then the downlink frames transmitted by the serving BS and the Neighbor BS shall be synchronized to a level of at least 1/8 cyclic prefix length. If frequency synchronization is indicated, then the BS reference clocks shall be synchronized to a level that yields RF center frequency offset of no more than 4% of the OFDMA carrier spacing of the Neighbor BS.
BS EIRP Indicator	**1 bit**	**If this bit is set, the BS EIRP follows the PHY Profile ID.**
DCD/UCD Reference Indicator	**1 bit**	**1: The DCD/UCD settings of this neighbor BS are the same as those of the preceding neighbor BS unless the TLV information specifies.** **0: The DCD/UCD settings of this neighbor BS are the same as those of the serving BS unless the TLV information**

		specifies.
FA Index Indicator	1 bit	Only if this bit is set to 1, the FA Index follows the PHY Profile ID. In addition, if the FA Indicator is followed, the DL center frequency shall be omitted in the DCD/UCD difference TLV information.
Reserved	~~2~~1 bit	Reserved for future use
(Optional) FA ~~Number~~Index	~~7~~8 bits	TBD by the service provider

B. Benefits by introducing PHY Profile ID

The following table shows the overhead reduction achieved by introducing the PHY Profile ID. The overhead given when using TLV encoded information is compared to that using PHY Profile ID. It is assumed that the components should be expressed using separate TLV's (3 bytes required for ~~a FFT size and a bandwidth respectively~~each of two TLV's, and 6 bytes required for DL physical frequency). While computing the number of the required subchanels, I assume that the NBR-ADV message should be encoded using 1/12 QPSK and one subchannel is composed of 48 subcarriers.

Number of Neighbor BS	Overhead using TLV's		Overhead using PHY Mode ID	
	Bits	Subchannels	Bits	Subchannels
5	480	60	80	10
10	960	120	160	20
20	1920	240	320	40
40	3840	480	640	80
80	7680	960	1280	160

vii.   Recommended text changes in IEEE 802.16e/D4

[Modify Table 106d as the following]

Syntax	Size	Notes
MOB_NBR-ADV_Message Format(){		
Management Message Type =49	8 bits	
Operator ID	24 bits	Unique ID assigned to the operator
Configuration Change Count	8 bits	Change count for this message
N_NEIGHBORS	8 bits	The count of the unique combination of Neighbor BS ID and Preamble Index and DCD

For (j=0; j< N_NEIGHBORS; j++){		
Length	8 bits	Length of message information within N_NEIGHBORS loop in bytes
Neighbor BS ID	24 bits	The least significant 24 bits of the Base Station ID parameter in the DL-MAP message of Neighbor BS.
~~Preamble Index~~	~~8 bits~~	~~SCa and OFDMA PHY specific only~~
PHY Profile ID	~~16~~8 bits	~~TBD~~ Aggregated IDs of Co-located FA Indicator, FA Configuration Indicator, FFT size, Bandwidth, Operation Mode of the starting subchannelization of a frame, and Channel Number
if (FA Index Indicator == 1){		
~~(Optional)~~ FA Index	8 bits	~~TBD by the service provider or some governmental body like FCC~~ This field, Frequency Assignment Index, is present only the FA Index Indicator in PHY Profile ID is set. Otherwise, the neighbor BS has the same FA Index or the center frequency is indicated using the TLV encoded information.
}		
if (BS EIRP Indicator == 1) {		
~~(Optional)~~ BS EIRP	8 bits	Signed Integer from -128 to 127 in unit of dBm This field is present only if the BS EIRP indicator is set in PHY Profile ID. Otherwise, the BS has the same EIRP as the serving BS.
}		
Preamble Index	8 bits	SCa and OFDMA PHY specific only
HO Process Optimization	8 bits	
DCD Configuration Change Count	8 bits	This represents the Neighbor BS current DCD configuration change count
UCD Configuration Change Count	8 bits	This represents the Neighbor BS current UCD configuration change count
TLV Encoded Neighbor information	variable	TLV specific
}		
}		

[Add the following description of PHY Profile ID below Table 92d]

PHY Profile ID – ~~TBD~~The PHY Profile ID is the aggregate ID's including the Co-located FA Indicator bit, the FA Configuration indicator bit, ~~the FFT size, the Bandwidth,~~ Time/Frequency Synchronization Indicator, BS EIRP Indicator, DCD/UCD Reference Indicator, FA Index Indicator, and the FA (Frequency Assignment) number. For systems using OFDMA, the bit-by-bit definition of the PHY Profile ID is shown in Table xxx. The ID for systems using other than OFDMA is TBD. If the Co-located FA Indicator bit is set, the following field of the NBR-ADV element including Preamble Index, HO Process Optimization, DCD/UCD Configuration Change Count, and TLV Encoded Neighbor Information may be omitted.

~~(Optional)~~ FA Index – Only if the FA Index Indicator bit in the PHY Profile ID is set to 1, the FA Index follows the PHY Profile ID. In addition, if the FA Indicator is followed, the DL center frequency shall be omitted in the DCD/UCD difference TLV information. The bit-by-bit definition

shall be determined by a service provider or a governmental body like FCC.

(Optional) BS EIRP – The neighbor BS EIRP is listed in a signed integer form from -128 to 127 in units of dBm. This field shall be omitted if the BS EIRP Indicator bit in PHY Profile ID is set zero.

Item	Size	Notes
Co-located FA Indicator	1 bit	If the BS (or FA) is co-located with the serving BS, this bit is set to 1.
FA Configuration Indicator	1 bit	If this bit is set 1, the BS has the same FA configuration (the same number of FAs as well as their frequencies) as the BS broadcasting the NBR-ADV.
~~FFT Size~~	~~2 bits~~	~~0b00: 2048~~ ~~0b01: 1024~~ ~~0b10: 512~~ ~~0b11: 128~~
~~Bandwidth~~	~~4 bits~~	~~0b0000: 20 MHz~~ ~~0b0001: 10 MHz~~ ~~0b0010: 5 MHz~~ ~~0b0011: 1.25 MHz~~ ~~0b0100: 17.5 MHz~~ ~~0b0101: 8.75 MHz~~ ~~0b0110: 4.375 MHz~~ ~~0b0111: 1.09375 MHz~~ ~~0b1000: 28 MHz~~ ~~0b1001: 14 MHz~~ ~~0b1010: 7 MHz~~ ~~0b1011: 3.5 MHz~~ ~~0b1100~0b1111: Reserved for future bandwidth options~~
Time/Frequency Synchronization Indicator	2 bits	00 = Unsynchronized 01 = Time synchronization. 10 = Time and Frequency synchronization If time synchronization is indicated then the downlink frames transmitted by the serving BS and the Neighbor BS shall be synchronized to a level of at least 1/8

		cyclic prefix length. If frequency synchronization is indicated, then the BS reference clocks shall be synchronized to a level that yields RF center frequency offset of no more than 4% of the OFDMA carrier spacing of the Neighbor BS.
BS EIRP Indicator	1 bit	If this bit is set, the BS EIRP follows the PHY Profile ID.
DCD/UCD Reference Indicator	1 bit	1: The DCD/UCD settings of this neighbor BS are the same as those of the preceding neighbor BS unless the TLV information specifies. 0: The DCD/UCD settings of this neighbor BS are the same as those of the serving BS unless the TLV information specifies.
FA Index Indicator	1 bit	Only if this bit is set to 1, the FA Index follows the PHY Profile ID. In addition, if the FA Indicator is followed, the DL center frequency shall be omitted in the DCD/UCD difference TLV information.
Reserved	1 bit	Reserved for future use

Table xxx The bit-by-bit definition of PHY Profile ID of the BS using OFDMA

[Add the following entries to table 356]

Name	Type	Length	Value	PHY scope
FA Index	~~??~~21	1	To be determined by a service provider or a governmental body like FCC after the licensed band is determined. If this TLV is present in the DCD message, the DL center frequency can be omitted in the message.	OFDMA

Name	Type	Length	Value	PHY scope
Phy Mode ID	~~??~~22	2	Refer to table xxx Phy Mode ID fields description	OFDMA

Item	Size	Notes
Bandwidth	7 bits	Channel BW in units of 125Khz.
FFT Size	3bits	0b000: 202448

		0b001: 1024
		0b010: 512
		0b011: Reserved
		0b100: 128
		0b111 – 0b101: reserved for future FFT size use.
Cycle prefix (CP)	2 bits	00 =
		01 = 1/8
		10 = 1/16
		11 = 1/32
Frame duration code	4 bits	0000 = 2.5 ms
		0001 = 4 ms
		0010 = 5 ms
		0011 = 8 ms
		0100 = 10 ms
		0101 = 12.5 ms
		0110 = 20 ms
		1111-0111 = reserved

Table xxx – Phy Mode ID fields description

[Add the following text in section 3.74]

3.74 Frequency Assignment (FA):   A Frequency Assignment (FA) denotes a logical assignment of DL center frequency and channel bandwidth programmed to the BS.

3.75 FA Index: A network specific logical FA Index assignment. FA Index assignment is used in combination with operator specific configuration information provided to the MSS in a method outside the scope of this standard.