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Re:	IEEE 802.16e D2 Draft
Abstract	This contribution proposes changes to OFDMA PHY description in the P802.16e D3 Draft
Purpose	To incorporate the changes here proposed into the P802.16e D3 draft.
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FFT to Channel Bandwidth Mapping for OFDMA

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Introduction

The current P802.16e D3 draft [1] proposes the FFT Channel Bandwidth mapping for OFDMA. As it is beneficial to provide at least a minimum of ~5-10 kHz sub carrier spacing for reducing ICI and phase-noise issues in mobile channels, this contribution proposes changes to the current FFT size to bandwidth mapping.

The current 802.16e D3 draft [1] also requires the OFDMA 2048 FFT (2k) mode to be mandatory in section 8.4. Requiring all MSS to implement the 2k mode is very difficult requirement from a cost and complexity perspective. However if the intent is for MSS to always use 2k mode as a means of synchronizing to the network during initial network entry for all MSS, even from that perspective we feel its not necessary as long as a search mechanism is implemented. Hence in this contribution we propose to remove this requirement.

Minimum Sub-carrier Spacing

The current OFDMA specification maps FFT sizes to channel bandwidths in the following manner.

- 512 FFT for 5MHz and less
- 1024 FFT for 10MHz and less

It also does not assign BWs for the 128 FFT.

Now this means that one could use the 1024 FFT for a 5MHz channel or even a 1.25 MHz channel if so desired. This essentially means that, if one uses a 1024 FFT in a 1.25MHz channel the sub carrier spacing will be around ~1.2kHz. An earlier contribution [2] made to 802.16 shows that larger the subcarrier spacing the better the phase-noise immunity becomes. So it is more preferable to keep a sufficiently larger subcarrier spacing and try to maintain it across most of the channel bandwidths by assigning ranges for each FFT size.

Also ICI as result of mobility increases as sub carrier spacing decreases. For example at 120Km/h, 5.8Ghz carrier, and 10Khz sub carrier spacing, the ICI is -20dB (enough for 16QAM, marginal for 64QAM), and for sub carrier spacing 5Khz it is 14dB (enough for QPSK, marginal for 16QAM). As a rule of thumb, every ratio of 2 in sub carrier spacing contributes 6dB to ICI, and reduces the constellation by one step (64QAM->16QAM->QPSK).

Also the standard requirement is for frequency error to be 0.2% of carrier spacing, so this requirement becomes very stringent when sub carrier spacing is small (for 10Khz the requirement is 200Hz). In general it would be more difficult to acquire initial frequency synchronization with the BS (actually, according to our current knowledge, it will take x2 time (/MIPS) with 5Khz than 10Khz, so affects HO/Scanning processes), and it would also be more difficult to track the frequency once it is acquired. This may cause the re-tuning to the BS more frequently.

Finding the channel bandwidth and FFT size

When an MSS enters a network for the very first time, it can use a search scheme to lookup all the supported channel bandwidths and FFT sizes to detect the channel to acquire on the DL. However such a scheme may incur some delay in channel acquisition. However this time may be tolerable as an MSS is entering the network for the very first time. For subsequent entries it can remember the last entered network channel widths and FFT sizes and optimize its search to quickly reacquire the same channel.

As this is purely an implementation optimization, further specification is not necessary in the P802.16e draft to support this feature. However it does obviate the need for a mandatory FFT size to be supported by all MSS. BS are free to choose the appropriate FFT size based on the channel widths deployed and the MSS will be dynamically able to acquire the DL through such a scanning and search as suggested here.

Related Comments

Comment 397 and 400 also proposes the same recommendation as this contribution in terms of FFT size to BW mapping.

Changes Proposed

In section 8.4.1 replace the following text

"The mandatory OFDMA PHY mode that shall be supported by all SS is based on a 2048-FFT. Other FFT sizes may optionally be employed as well. These FFT sizes are scalable to the channel BW in which they are being used, i.e., 512- FFT for 5 MHz channel BW or less and 1024-FFT for 10 MHz channel BW or less.
"

With the following text

"The OFDMA PHY mode based on at least one of the appropriate FFT sizes 2048, 1024, 512 and 128 shall be supported based on the channel bandwidths supported. The Table 1 shows the recommended FFT sizes for the various channel bandwidths for mobile operation, where there is a need to keep a relatively constant and larger subcarrier spacing (minimum ~5-10kHz). For fixed mode of operation the 2048 FFT mode may be used in additional channel widths if the sub-carrier spacing requirements are less stringent.

Channel Bandwidth Ranges (MHz)	>14 to 28	>7 to 14	>2.5 to 7	<=2.5
FFT size	2048-FFT	1024-FFT	512-FFT	128-FFT

Table 1: FFT size to channel bandwidth mapping for mobile operation

The MSS shall implement a scanning and search mechanism to detect the DL signal when performing initial network entry and this shall include dynamic detection of the FFT size and the channel bandwidth employed by the BS. The exact algorithms employed are implementation specific but shall include optimizations for reducing channel acquisition times in network re-entry situations.
"

References

[1] IEEE P802.16e/D3, June 2004
[2] IEEE 802.16.3c-01/49, "Performance Aspects of OFDM PHY proposal", Tal Kaitz, March 2001