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Title	**CQICH Based UL Channel Sounding**
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Re:	Response to Sponsor Ballot call for comment
Abstract	Combined CQICH and uplink channel sounding
Purpose	To incorporate the changes here proposed into the 802.16e D6 draft.
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CQICH Based UL Channel Sounding

1 Introduction

Uplink channel sounding is required to support the closed-loop transmission strategies. In IEEE 802.16e/D5, a dedicated channel resource, the sounding zone, is allocated to enable uplink channel sounding. The sounding zone is a region of one or more OFDMA symbol intervals in the UL frame that is used by the MSS to transmit sounding signals to enable the BS to rapidly determine the channel response between the BS and the MSS. Since all CSIT capable MSSs need to do sounding, a significant overhead is introduced.

2 Proposed Solution

Since all active MSSs send CQICH messages to BS through CQICH channels, they can be reused for the purpose of uplink channel sounding in TDD system. However in order to obtain the channel response over the entire frequency band, sufficient sampling density crossing the entire band is required. In 802.16e/D5, the channel allocation for CQICH is the same as that for the uplink diversity channel. Based on such a channel allocation, there are only six tiles in each CQICH. To cover the whole band, uplink channel sounding should be done based on a number of CQICH channels from the same MSS. As a result, more time is required to complete the sounding. For CSIT capable MSS, the modified CQICH, sounding CQICH, should be adopted. With this new sounding CQICH, the uplink channel sounding procedure can be speeded up.

The solution proposed is a simple *reuse* both CQICH and UL sounding symbol structure and combined them into an integrated solution.

For PUSC, one UL sub-channel is constructed from 6 UL tiles, and each tile has 4 sub-carriers crossing 3 symbols. To generate the sounding CQICH, each UL tile is mapped into 4 sub-tiles and each sub-tile consists of one sub-carrier over 3 OFDM symbols as shown in Figure zzzz-a. Four sounding CQICH channels are generated by concatenating 4 UL sub-channels. Each sounding CQICH is composed of 24 sub-tiles from 24 tiles.

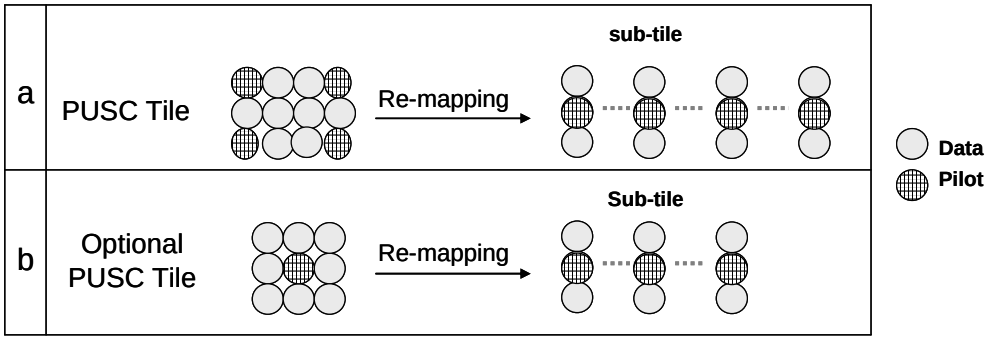

Figure zzz

For optional PUSC, one UL sub-channel is constructed from 6 UL tiles, and each tile has 3 sub-carriers crossing 3 symbols. To generate the sounding CQICH, each UL tile is partitioned into 3 sub-tiles and each sub-tile consists of one sub-carrier over 3 OFDM symbols as shown in Figure zzzz-b. Three sounding CQICH channels are generated by concatenating 4 UL sub-channels. Each sounding CQICH is composed of 24 sub-tiles from 24 tiles.

Since the number of pilot sub-carriers and the number of data sub-carriers are unchanged in each sounding CQICH channel compared to the regular CQICH channel, the same modulation scheme defined in 802.16e/D5 for FAST_FEEDBACK channels can be applied. Eight elements in each vector are mapped to 4 sub-tiles, starting from the first sub-tile to the last sub-tile See Figure X1 for PUSC and Figure X2 for optional PUSC.

For uplink MIMO capable MSS, STC using 2 antennas can be applied in the transmission of sounding CQICH channel.

For PUSC, one MIMO UL sub-channel is constructed from 6 MIMO UL tiles, and each MIMO tile has 4 sub-carriers crossing 3 symbols. To generate MIMO sounding CQICH, each UL tile is partitioned into 2 sub-tiles and each sub-tile consists of 2 sub-carriers over 3 OFDM symbols as shown in Figure vvvv. Two MIMO sounding CQICH channels are generated by concatenating 2 MIMO UL sub-channels. Each MIMO sounding CQICH is composed of 12 sub-tiles from

12 tiles. Two antennas shall use different pilot pattern. Figure X3 shows the construction of MIMO sounding CQICH channel and the data mapping strategy for two antennas.
For optional PUSC, one MIMO UL sub-channel is constructed from 3 MIMO UL tiles, and each MIMO tile has 3 sub-carriers crossing 6 symbols. To generate MIMO sounding CQICH, each UL tile is re-mapped into 3 sub-tiles and each sub-tile consists of 3 sub-carriers over 2 OFDM symbols. Three MIMO sounding CQICH channels are constructed by concatenating 4 MIMO UL sub-channels. Each MIMO sounding CQICH is composed of 6 sub-tiles from 6 tiles. Two antennas shall use different pilot pattern. Figure X4 shows the construction of MIMO sounding CQICH channel and the data mapping strategy for two antennas.

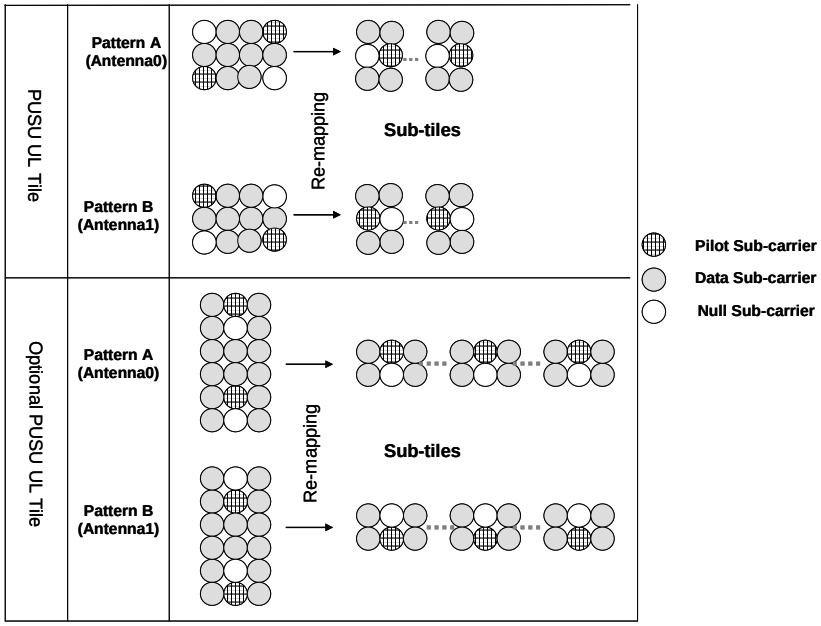

Figure vvvv

To cover the whole frequency band, measurement based on N sounding CQICH channels is required. For example, for the 2048 FFT size, there are 96 sounding frequency bands. For PUSC and optional PUSC, N=4, while for 2-antenna MIMO PUSC and 2-antenna MIMO optional PUSC, N=8.
Table AAA gives an example of the overhead introduced by a single MSS for uplink sounding covering the sounding zone containing maximum 96 sounding frequency bands (2048 FFT).

Table AAA

Non CQICH Reuse	96 Subcarriers
CQICH Reuse for PUSC (non-MIMO)	0 Subcarriers
CQICH Reuse for Optional PUSC (non-MIMO)	12 Subcarriers
CQICH Reuse for PUSC (MIMO)	0 Subcarriers
CQICH Reuse for Optional PUSC (MIMO)	12 Subcarriers

3 Proposed Text Change

Add the text in Section 8.4.6.2.7.1.

----------Start the Text ----------

For PUSC, to construct the sounding CQICH, each UL tile is re-mapped into 4 sub-tiles and each sub-tile consists of one sub-carrier over 3 OFDM symbols. Four sounding CQICH channels are constructed by concatenating 4 UL sub-channels. Each sounding CQICH is composed of 24 sub-tiles from 24 tiles.

For optional PUSC, to construct the sounding CQICH, each UL tile is partitioned into 3 sub-tiles and each sub-tile consists of one sub-carrier over 3 OFDM symbols. Three sounding CQICH channels are re-mapped by concatenating 4 UL sub-channels. Each sounding CQICH is composed of 24 sub-tiles from 24 tiles. The same modulation scheme defined in section ???? for FAST_FEEDBACK channels is used. Eight elements in each vector are mapped to 4 sub-tiles, starting from the first sub-tile to the last sub-tile See figure X1 for PUSC and figure X2 for optional PUSC.

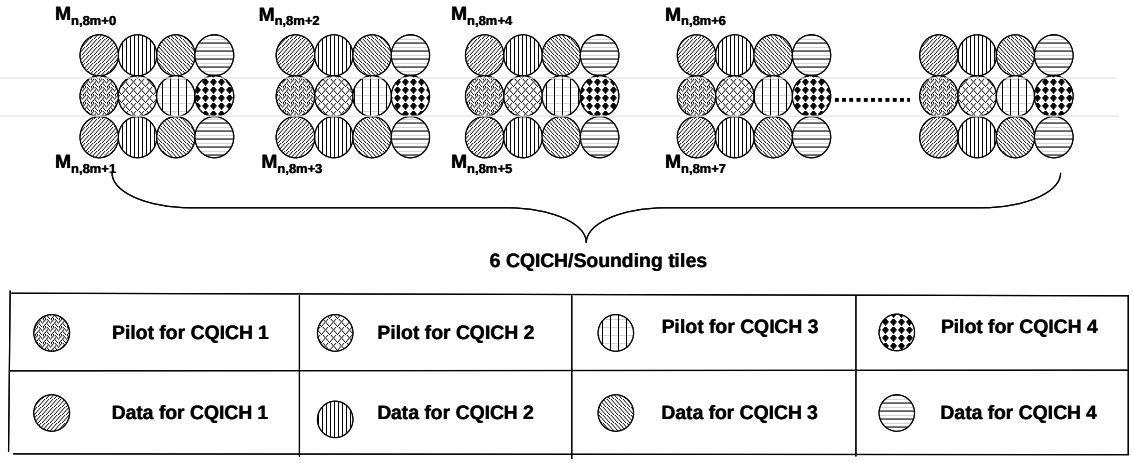

Figure X1

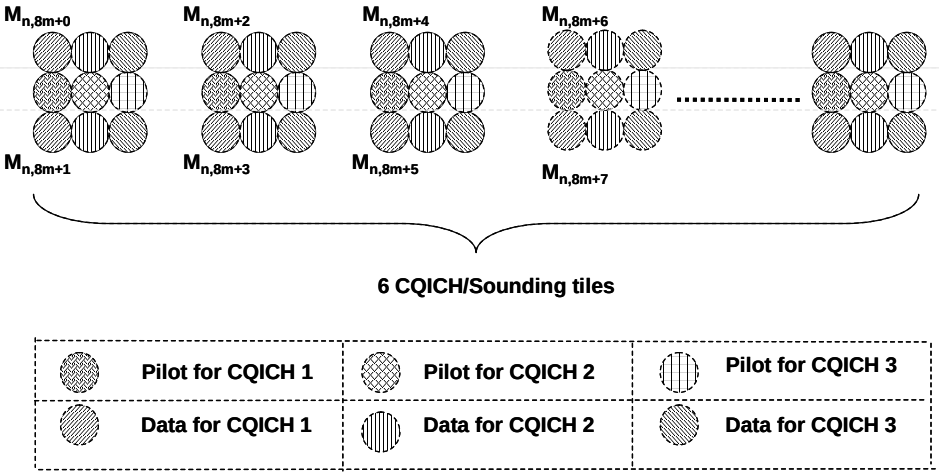

Figure X2

For uplink MIMO capable MSS, STC using 2 antennas can be applied in the transmission of sounding CQICH channel.

For PUSC, one MIMO UL sub-channel is constructed from 6 MIMO UL tiles, and each MIMO tile has 4 sub-carriers crossing 3 symbols. To generate MIMO sounding CQICH, each UL tile is re-mapped into 2 sub-tiles and each sub-tile consists of 2 sub-carriers over 3 OFDM symbols. Two MIMO sounding CQICH channels are constructed by concatenating 2 MIMO UL sub-channels. Each MIMO sounding CQICH is composed of 12 sub-tiles from 12 tiles. Two antennas shall use different pilot pattern. Figure X3 shows the construction of MIMO sounding CQICH channel and the data mapping strategy for two antennas.

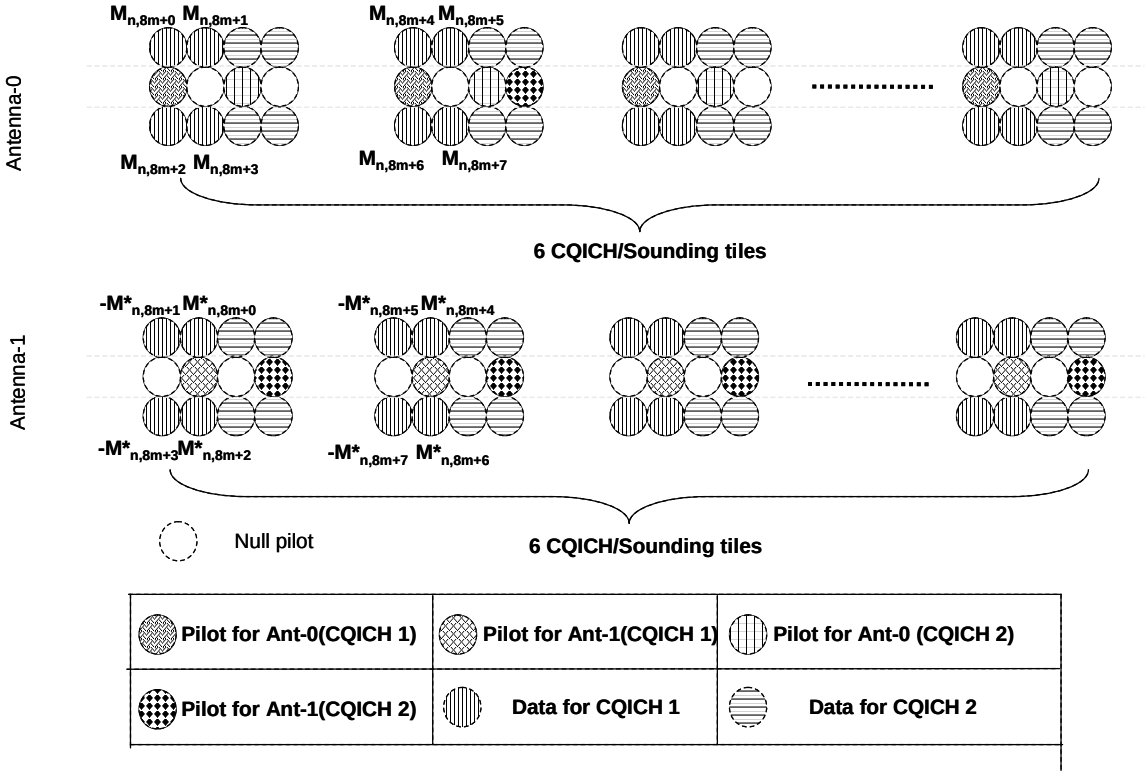

Figure X3

For optional PUSC, one MIMO UL sub-channel is constructed from 3 MIMO UL tiles, and each MIMO tile has 3 sub-carriers crossing 6 symbols. To generate MIMO sounding CQICH, each UL tile is re-mapped into 3 sub-tiles and each sub-tile consists of 3 sub-carriers over 2 OFDM symbols. Three MIMO sounding CQICH channels are constructed by concatenating 4 MIMO UL sub-channels. Each MIMO sounding CQICH is composed of 6 sub-tiles from 6 tiles. Two antennas shall use different pilot pattern. Figure X4 shows the construction of MIMO sounding CQICH channel and the data mapping strategy for two antennas.

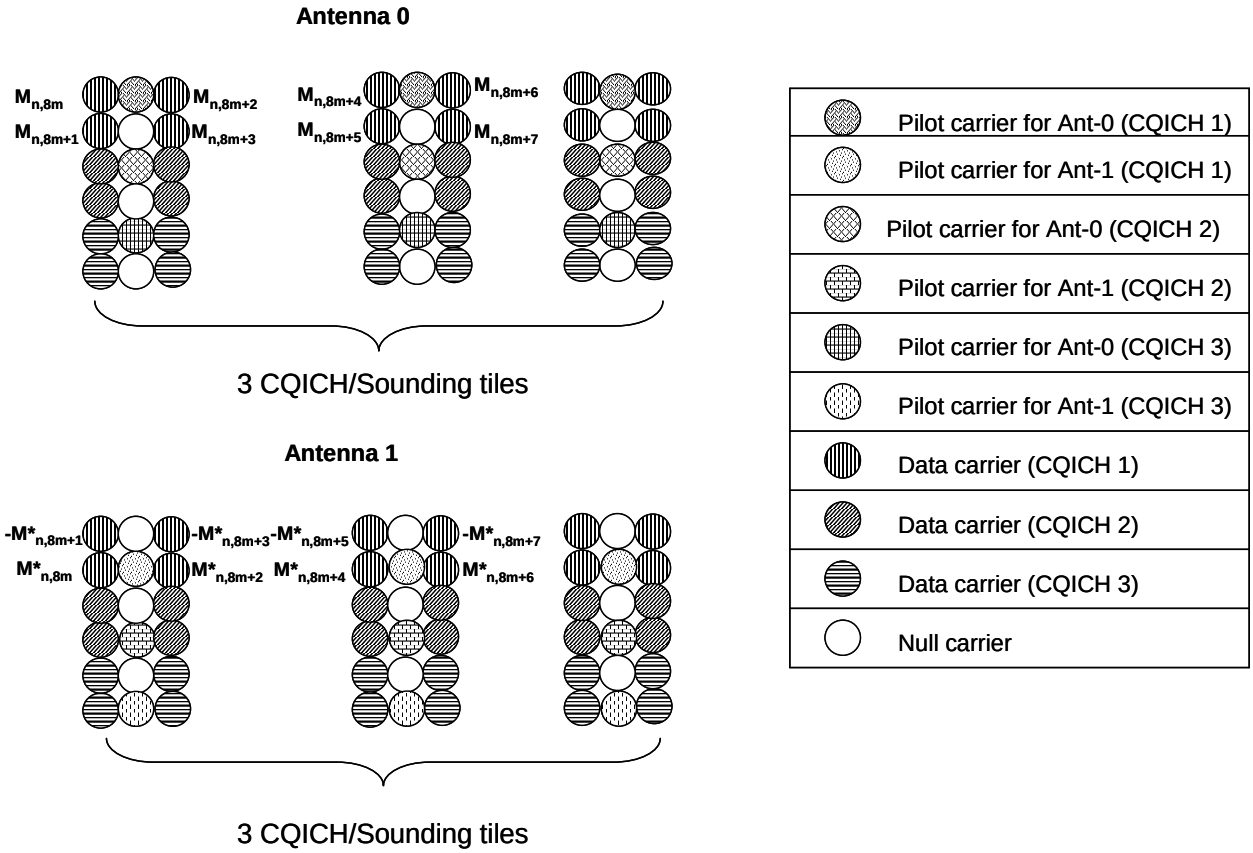

Figure X4

----------End the Text ----------