Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
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Re:	
Abstract	Clarification on STC data mapping for Optional Zones
Purpose	Adoption of proposed changes into P802.16e ~~Crossed-out indicates deleted text,~~ underlined blue indicates new text change to the Standard
Notice	
Release	
Patent Policy and Procedures	

Clarification on STC Data Mapping for Optional Zones

1. Introduction

Current draft standard features several MIMO techniques in a form of transmission matrix for each optional permutation zones [1]. Since the mapping of data subcarriers for each transmission matrix in STC/MIMO zones is different from that in the regular SISO zones, allocation of data subchannels for STC/MIMO zones is different from that of SISO zones. It gets more complicated when the system employs CTC and there is pilot puncturing, e.g., 3, 4 Tx for DL and 2 Tx for UL. The current draft standard, however, is not clear on these issues.

In this document, the notion of data subchannel allocation and subcarrier mapping for two basic transmission matrices (TD and SM) in two optional zones (band AMC and optional FUSC permutations) are clarified. In addition, pilot puncturing processes are described with an example.

2. Specific Text Changes

[Modify the text from line 41—46 on page 410 of [1] as follows]

------------------ ***Start of Text Change*** --

In Figure 251a the STC encoder operates on input data symbols sequentially and distributes the antenna specific data symbols to each antenna path. The block of subcarrier mapping and PR~~D~~BS function denotes data truncation or puncturing, if needed, pilot insertion, IFFT input packing and each subcarrier multiplied by the factor $2^*(1/2\text{-}w_k)$ according to the subcarrier index k in 8.4.9.4.1. The data truncation for CTC or the puncturing for CC encoder shall be required for 3 Tx and 4 Tx BS for the optional AMC and the optional FUSC zones in the downlink, and required for 2 Tx for the optional AMC and the optional PUSC in the uplink.

------------------ ***End of Text Change*** --

[Replace the text from line 1—18 on page 414 of [1] with the following:]

------------------ ***Start of Text Change*** --

8.4.8.3.1.2 Allocation of data subchannels and subcarriers

8.4.8.3.1.2.1 STC Mapping for Optional AMC Permutation

For the optional AMC permutation in STC zone, the data subchannels shall take 2x6 (2 bins for 6 symbols) format. The subcarrier permutation represented by equation (112) in 8.4.6.3 shall not be applied for the optional AMC permutation within STC zones.

For 2-antenna matrix A in 8.4.8.3.3, STC encoded data symbols shall be time mapped starting over the first 2 OFDMA symbols. The mapping starts at the lowest numbered subcarriers of lowest slot and continues in an ascending manner in subchannels first and then proceeds to the next two symbols in time. An illustration of the mapping rule for the antenna #0 is shown in Figure 251h, assuming 2 Tx with Matrix A for a block of 2 slots.

Antenna #0

s_0	? s_1^*	s_{32}	? s_{33}^*	s_{64}	? s_{65}^*
PILOT	NULL	s_{34}	? s_{35}^*	s_{66}	? s_{67}^*
s_2	? s_3^*	s_{36}	? s_{37}^*	s_{68}	? s_{69}^*
s_4	? s_5^*	s_{38}	? s_{39}^*	s_{70}	? s_{71}^*
s_6	? s_7^*	s_{40}	? s_{41}^*	PILOT	NULL
s_8	? s_9^*	s_{42}	? s_{43}^*	s_{72}	? s_{73}^*
s_{10}	? s_{11}^*	s_{44}	? s_{45}^*	s_{74}	? s_{75}^*
s_{12}	? s_{13}^*	PILOT	NULL	s_{76}	? s_{77}^*
s_{14}	? s_{15}^*	s_{46}	? s_{47}^*	s_{78}	? s_{79}^*
s_{16}	? s_{17}^*	s_{48}	? s_{49}^*	s_{80}	? s_{81}^*
PILOT	NULL	s_{50}	? s_{51}^*	s_{82}	? s_{83}^*
s_{18}	? s_{19}^*	s_{52}	? s_{53}^*	s_{84}	? s_{85}^*
s_{20}	? s_{21}^*	s_{54}	? s_{55}^*	s_{86}	? s_{87}^*
s_{22}	? s_{23}^*	s_{56}	? s_{57}^*	PILOT	NULL
s_{24}	? s_{25}^*	s_{58}	? s_{59}^*	s_{88}	? s_{89}^*
s_{26}	? s_{27}^*	s_{60}	? s_{61}^*	s_{90}	? s_{91}^*
s_{28}	? s_{29}^*	PILOT	NULL	s_{92}	? s_{93}^*
s_{30}	? s_{31}^*	s_{62}	? s_{63}^*	s_{94}	? s_{95}^*

s Data Subcarrier

PILOT Pilot Subcarrier

NULL Null Subcarrier reserved for Ant #1 Pilot

Figure 251h -- Data mapping in the optional AMC Zone with 2 Tx antenna and Matrix A

For 2-antenna vertically encoded matrix B in the optional AMC permutation, modulated data symbols shall be sequentially mapped for two transmit antennas along the subcarriers of the first symbol. The mapping continues in an ascending manner in subchannels first and then proceeds to the next symbol in time. An illustration of the mapping rule for the antenna #0 is shown in Figure 251i, assuming 2 Tx with vertically encoded matrix B for a block of 2 slots. Figure 251i also shows the mapping rule for 2-antenna horizontally encoded matrix B in the optional AMC permutation, where each encoded stream is separately mapped to the corresponding antenna.

Antenna #0
with Vertical Encoding

s_{0}	s_{32}	s_{64}	s_{96}	s_{128}	s_{160}
PILOT	NULL	s_{66}	s_{98}	s_{130}	s_{162}
s_{2}	s_{34}	s_{68}	s_{100}	s_{132}	s_{164}
s_{4}	s_{36}	s_{70}	s_{102}	s_{134}	s_{166}
s_{6}	s_{38}	s_{72}	s_{104}	PILOT	NULL
s_{8}	s_{40}	s_{74}	s_{106}	s_{136}	s_{168}
s_{10}	s_{42}	s_{76}	s_{108}	s_{138}	s_{170}
s_{12}	s_{44}	PILOT	NULL	s_{140}	s_{172}
s_{14}	s_{46}	s_{78}	s_{110}	s_{142}	s_{174}
s_{16}	s_{48}	s_{80}	s_{112}	s_{144}	s_{176}
PILOT	NULL	s_{82}	s_{114}	s_{146}	s_{178}
s_{18}	s_{50}	s_{84}	s_{116}	s_{148}	s_{180}
s_{20}	s_{52}	s_{86}	s_{118}	s_{150}	s_{182}
s_{22}	s_{54}	s_{88}	s_{120}	PILOT	NULL
s_{24}	s_{58}	s_{90}	s_{122}	s_{152}	s_{184}
s_{26}	s_{56}	s_{92}	s_{124}	s_{154}	s_{186}
s_{28}	s_{60}	PILOT	NULL	s_{156}	s_{188}
s_{30}	s_{62}	s_{94}	s_{126}	s_{158}	s_{190}

Antenna #0
with Horizontal Encoding

s_{0}^{0}	s_{16}^{0}	s_{32}^{0}	s_{48}^{0}	s_{64}^{0}	s_{80}^{0}
PILOT	NULL	s_{33}^{0}	s_{49}^{0}	s_{65}^{0}	s_{81}^{0}
s_{1}^{0}	s_{17}^{0}	s_{34}^{0}	s_{50}^{0}	s_{66}^{0}	s_{82}^{0}
s_{2}^{0}	s_{18}^{0}	s_{35}^{0}	s_{51}^{0}	s_{67}^{0}	s_{83}^{0}
s_{3}^{0}	s_{19}^{0}	s_{36}^{0}	s_{52}^{0}	PILOT	NULL
s_{4}^{0}	s_{20}^{0}	s_{37}^{0}	s_{53}^{0}	s_{68}^{0}	s_{84}^{0}
s_{5}^{0}	s_{21}^{0}	s_{38}^{0}	s_{54}^{0}	s_{69}^{0}	s_{85}^{0}
s_{6}^{0}	s_{22}^{0}	PILOT	NULL	s_{70}^{0}	s_{86}^{0}
s_{7}^{0}	s_{23}^{0}	s_{39}^{0}	s_{55}^{0}	s_{71}^{0}	s_{87}^{0}
s_{8}^{0}	s_{24}^{0}	s_{40}^{0}	s_{56}^{0}	s_{72}^{0}	s_{88}^{0}
PILOT	NULL	s_{41}^{0}	s_{57}^{0}	s_{73}^{0}	s_{89}^{0}
s_{9}^{0}	s_{25}^{0}	s_{42}^{0}	s_{58}^{0}	s_{74}^{0}	s_{90}^{0}
s_{10}^{0}	s_{26}^{0}	s_{43}^{0}	s_{59}^{0}	s_{75}^{0}	s_{91}^{0}
s_{11}^{0}	s_{27}^{0}	s_{44}^{0}	s_{60}^{0}	PILOT	NULL
s_{12}^{0}	s_{28}^{0}	s_{45}^{0}	s_{61}^{0}	s_{76}^{0}	s_{92}^{0}
s_{13}^{0}	s_{29}^{0}	s_{46}^{0}	s_{62}^{0}	s_{77}^{0}	s_{93}^{0}
s_{14}^{0}	s_{30}^{0}	PILOT	NULL	s_{78}^{0}	s_{94}^{0}
s_{15}^{0}	s_{31}^{0}	s_{47}^{0}	s_{63}^{0}	s_{79}^{0}	s_{95}^{0}

s Data Subcarrier PILOT Pilot Subcarrier NULL Null Subcarrier reserved for Ant #1 Pilot

(s_{x}^{0} : 0th stream, STC coded Symbol)

Figure 251i -- data mapping in the optional AMC Zone with 2 Tx antenna and Matrix B

For 3, 4-antenna matrix A and matrix B in 8.4.8.3.4 and 8.4.8.3.5, STC encoded data symbols shall be mapped at two adjacent subcarriers over two OFDMA symbols. When the subcarrier pair (over two symbols) at frequency k+1 is allocated to pilots for antenna #0 or #1 and the pair at frequency k+2 is allocated to pilots for antenna #2 or #3, then the pair at frequency k+3 shall be jointly encoded with the pair at frequency k. This is illustrated in Figure 251j, where blocks of 2 convolutional coded (CC) slots and convolutional turbo coded (CTC) slots are separately shown. The mapping starts at the lowest numbered subcarriers of the lowest slot and continues in an ascending manner in subchannels first and then proceeds to the next two symbols in time.

For 3 and 4 antenna vertically/horizontally encoded matrix C in the optional AMC permutation, the same mapping rule for 2-antenna vertically/horizontally encoded matrix B shall be applied on the same frequency-time block with the 3,4 antenna pilot pattern.

Antenna #0 with CC

s_0	? s_1^*	s_{32}	? s_{33}^*	s_{64}	? s_{65}^*
PILOT	NULL	NULL	NULL	NULL	NULL
NULL	NULL	s_{36}	? s_{37}^*	s_{68}	? s_{69}^*
s_4	? s_5^*	NULL	NULL	NULL	NULL
NULL	NULL	s_{40}	? s_{41}^*	PILOT	NULL
s_8	? s_9^*	NULL	NULL	NULL	NULL
NULL	NULL	s_{44}	? s_{45}^*	NULL	NULL
s_{12}	? s_{13}^*	PILOT	NULL	s_{76}	? s_{77}^*
NULL	NULL	NULL	NULL	NULL	NULL
s_{16}	? s_{17}^*	s_{48}	? s_{49}^*	s_{80}	? s_{81}^*
PILOT	NULL	NULL	NULL	NULL	NULL
NULL	NULL	s_{52}	? s_{53}^*	s_{84}	? s_{85}^*
s_{20}	? s_{21}^*	NULL	NULL	NULL	NULL
NULL	NULL	s_{56}	? s_{57}^*	PILOT	NULL
s_{24}	? s_{25}^*	NULL	NULL	NULL	NULL
NULL	NULL	s_{60}	? s_{61}^*	NULL	NULL
s_{28}	? s_{29}^*	PILOT	NULL	s_{92}	? s_{93}^*
NULL	NULL	NULL	NULL	NULL	NULL

Antenna #0 with CTC

s_0	? s_1^*	s_{28}	? s_{29}^*	s_{56}	? s_{57}^*
PILOT	NULL	NULL	NULL	NULL	NULL
NULL	NULL	s_{32}	? s_{33}^*	s_{60}	? s_{61}^*
NULL	NULL	NULL	NULL	NULL	NULL
s_4	? s_5^*	s_{36}	? s_{37}^*	PILOT	NULL
NULL	NULL	NULL	NULL	NULL	NULL
s_8	? s_9^*	s_{40}	? s_{41}^*	s_{64}	? s_{65}^*
NULL	NULL	PILOT	NULL	NULL	NULL
s_{12}	? s_{13}^*	NULL	NULL	s_{68}	? s_{69}^*
NULL	NULL	NULL	NULL	NULL	NULL
PILOT	NULL	s_{44}	? s_{45}^*	s_{72}	? s_{73}^*
NULL	NULL	NULL	NULL	NULL	NULL
s_{16}	? s_{17}^*	s_{48}	? s_{49}^*	s_{76}	? s_{77}^*
NULL	NULL	NULL	NULL	PILOT	NULL
s_{20}	? s_{21}^*	s_{52}	? s_{53}^*	NULL	NULL
NULL	NULL	NULL	NULL	NULL	NULL
s_{24}	? s_{25}^*	PILOT	NULL	s_{80}	? s_{81}^*
NULL	NULL	NULL	NULL	NULL	NULL

s	Data Subcarrier	PILOT	Pilot Subcarrier
NULL	Null Subcarrier reserved for Ant #2,3 data	NULL	Null Subcarrier reserved for Ant #1,2,3 Pilot

Figure 251j -- Data mapping with CC in the optional AMC Zone with 4 Tx antenna and Matrix A

8.4.8.3.1.2.2 STC Mapping for Optional FUSC Permutation

For the optional FUSC permutation in STC zone, the data subchannels shall be allocated for two consecutive OFDMA symbols. For 2-antenna matrix A in 8.4.8.3.3, STC encoded data symbols shall be time mapped over two OFDMA symbols. The mapping starts at the lowest numbered subcarriers of lowest slot and continues in an ascending manner in subchannels first and then, if needed, proceeds to the next two symbols in time.

For 2-antenna vertically encoded matrix B in 8.4.8.3.3 for the optional FUSC permutation, the data subchannels shall be allocated for two consecutive OFDMA symbols and the modulated data symbols shall be sequentially mapped for two transmit antennas along the subcarriers in the symbol. The mapping continues in an ascending manner in subchannels first and then proceeds to the next symbol in time. For 2-antenna horizontally encoded matrix B in 8.4.8.3.3 each encoded stream is separately mapped to the corresponding antenna.

For 3 and 4 antenna matrix A and matrix B in 8.4.8.3.4 and 8.4.8.3.4 for the optional FUSC permutation, STC encoded data symbols shall be mapped at two logical subcarriers over two OFDMA symbols. When the subcarrier pair (over two symbols) at logical frequency k+1 is allocated to pilots for antenna #0 or #1 and the pair at logical frequency k+2 is allocated to pilots for antenna #2 or #3, then the pair at logical frequency k+3 shall be jointly encoded with the pair at logical frequency k. The mapping starts at the lowest numbered subcarriers of the lowest slot and continues in an ascending manner in subchannels first and then proceeds to the next two symbols in time if needed. Data puncturing for CC or truncation for CTC shall be performed in a similar manner as in the optional AMC zone.

For 3 and 4 antenna vertically/horizontally encoded matrix C in the optional FUSC permutation, the same mapping rule for 2-antenna vertically/horizontally encoded matrix B shall be applied on the same frequency-time block with the 3,4 antenna pilot pattern

A mapping example of a downlink burst for the optional FUSC using 4 antenna transmission is provided in the following:
Parameters are :
ID_CELL = 1, Symbol index m=0 (first symbol in STC zone), subchannel index = 0, The number of subchannel = 1, 1024 FFT,

The indices of 48 data subcarriers in subchannel #0 for the optional FUSC are

3	23	46	58	79	104	121	132	156	170	196	215	231	245
254	273	293	316	328	349	374	391	402	426	440	466	485	501
515	524	543	563	586	598	619	644	661	672	696	710	736	755
771	785	794	813	833	856								

If Convolutional Coding is used for 4 Tx antennas, data tones at subcarrier indices = {245,254,515,524,785,794} shall be punctured for additional pilots. If Convolutional Turbo Coding is used for 4 Tx antennas, the last 6 of 48 data tones shall be first truncated and the remaining 42 data tones shall be mapped at the following indices:,

3	23	46	58	79	104	121	132	156	170	196	215	231	273
293	316	328	349	374	391	402	426	440	466	485	501	543	563
586	598	619	644	661	672	696	710	736	755	771	813	833	856

8.4.8.3.1.2.3 Burst Packing of Spatial Multiplexed Streams with CTC H-ARQ

For multiple spatial rate transmission and H-ARQ CTC, the packet shall be formed by concatenating multiple Nep/Nsch FEC codewords together. For the case of vertical encoding (number of layers=1), there shall be only 1 CRC check at the end of the last codeword. The first block is of size Nep and the second block of size Nep-16 bits. For the case of horizontal encoding (number of layers >1), each burst shall be a separate Nep/Nsch pair with separate CRC. The randomization seed shall be reset for all of the Nep/Nsch pairs in the combined codword. Figure 251k shows an example of vertically encoded rate 2 with CTC H-ARQ transmission.

----------------- ***End of Text Change*** --

[Replace the text from line 42—49 on page 426 of [1] with the following:]

----------------- ***Start of Text Change*** --

8.4.8.4.2 Allocation of data subchannels

For the optional PUSC permutation with matrix A in 8.4.8.3.3, the data subchannels shall be allocated for two consecutive slots in time. As can be seen in Figure 251l, STC encoded data symbols shall be time mapped over two OFDMA symbols. The mapping starts at the lowest numbered subcarriers of lowest slot and continues in an ascending manner in subchannels first and then proceeds to the next two symbols in time.

For 2-antenna matrix B in the optional PUSC permutation, modulated data symbols shall be sequentially mapped for two transmit antennas along the subcarriers in the symbol. The mapping continues in an ascending manner in subchannels first and then proceeds to the next symbol in time.

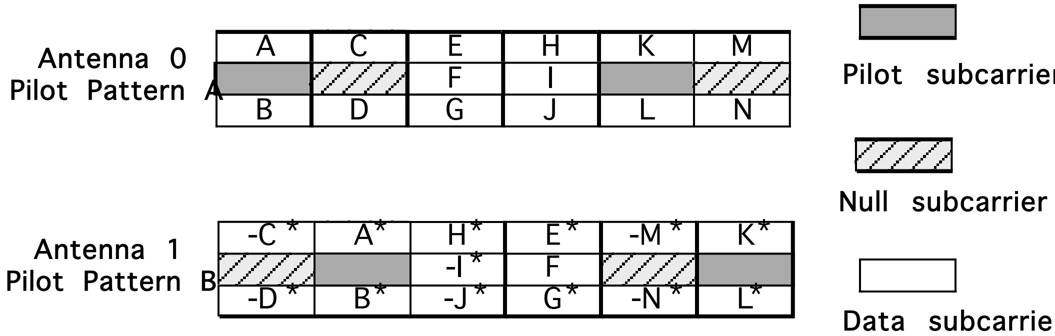

Figure 251l — Uplink data mapping for 2-antenna SS with matrix A for the optional PUSC permutation

For the uplink optional AMC permutation with matrix A and B, the data subchannels shall take 1x6 (1 bin for 6 symbols) format. The subcarrier permutation represented by equation (112) in 8.4.6.3 shall not be applied for the uplink optional AMC permutation with matrix A and B. The data mapping rule is identical to that for the downlink AMC permutation with 2 antennas.

----------------- *End of Text Change* ---

References

[1] IEEE P802.16e/D6 Air Interface for Fixed and Mobile Broadband Wireless Access Systems – Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands

[2] IEEE P802.16-REVd/D5-2004 Draft IEEE Standards for local and metropolitan area networks part 16: Air interface for fixed broadband wireless access systems