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Re:	IEEE 802.16-REVe/D5a, BRC recirc
Abstract	Framework for Enabling Closed-loop MIMO for OFDMA
Purpose	Adoption of proposed changes into P802.16e, underlined blue indicates new text change to the Standard
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Framework for Enabling Closed-loop MIMO for OFDMA

1. Introduction

In this contribution, a framework which enables closed-loop MIMO (CL-MIMO) for OFDMA systems is provided. A suite of solutions is described in this document in order to cover various channel conditions and operational scenarios. The suite of solutions includes antenna selection, antenna grouping, vector/matrix codebooks, and direct channel coefficient feedback. It includes redefinition of CQICH feedback mechanism, the required changes of payload, and clarification of precoding operation and the necessary text changes on the relevant sections in the standard.

The organization of the contribution is shown as follows

2. MIMO Related Basic Capabilities

When SS reports its capabilities through the SBC_REQ message, it should be allowed to report all its MIMO capabilities, including closed-loop ones if any.

[Insert the following sections as indicated]

11.8.3.7.6 OFDMA SS Demodulator for MIMO Support

This field indicates the MIMO capability of OFDMA SS demodulator. A bit value of 0 indicates "not supported" while 1 indicates "supported".

Type	Length	Value	Scope
155	1	Bit #0 Two receive antennas Bit #1 Three receive antennas Bit #2 Four receive antennas Bit #3 Capable of transmit diversity Bit #4 Capable of spatial multiplexing Bit #5-#7 Always set to zero	SBC-REQ (See 6.3.2.3.23) SBC-RSP (See 6.3.2.3.24)

11.8.3.7.7 OFDMA SS Closed-Loop Feedback Demodulator for MIMO Support

This field indicates the closed-loop MIMO capability of OFDMA SS demodulator. A bit value of 0 indicates "not supported" while 1 indicates "supported".

Type	Length	Value	Scope
156	1	Bit #0 Capable of calculating precoding weight Bit #1 Capable of adaptive rate control Bit #2 Capable of calculating channel matrix Bit #3 Capable of antenna grouping Bit #4 Capable of antenna selection Bit #5 Capable of code book based precoding Bit #6 Capable of long term precoding Bit #7 Reserved.	SBC-REQ (See 6.3.2.3.23) SBC-RSP (See 6.3.2.3.24)

11.8.3.7.8 OFDMA SS Modulator for MIMO Support

This field indicates the MIMO capability of OFDMA SS modulator. A bit value of 0 indicates "not supported" while 1 indicates "supported".

Type	Length	Value	Scope
15~~5~~7	1	Bit #0 Two transmit antennas Bit #1 Capable of transmit diversity Bit #2 Capable of spatial multiplexing Bit #3 Capable of beamforming Bit #4 Capable of adaptive rate control Bit #5-#7 Always set to zero	SBC-REQ (See 6.3.2.3.23) SBC-RSP (See 6.3.2.3.24)

[End of 'Insert the following sections as indicated']

3. CQICH Signaling for CL-MIMO

In this section a three-bit feedback scheme using a half of CQICH is proposed. Each 3bit-MIMO Fast feedback consists of a half CQICH slot mapped in a manner similar to the mapping of ACK Channel. The 3-bit fast feedback slot uses QPSK modulation on the 24 data sub-carriers it contains, and can carry a data payload of 3 bits. Table 1 defines the mapping between the payload bit sequences and the subcarriers modulation for 3 bit payload.

Table 1—3bit-MIMO Fast-feedback channel subcarrier modulation

3 bit payload	Fast Feedback vector indices per Tile Even = {Tile(0), Tile(2),Tile(4)} or Odd = {Tile(1), Tile(3),Tile(5)}
0b000	0,0,0
0b001	1,1,1
0b010	2,2,2
0b011	3,3,3
0b100	4,4,4

0b101	5,5,5
0b110	6,6,6
0b111	7,7,7

[Modify Section 8.4.5.4.10.4 as indicated in the following]

8.4.5.4.10.4 ~~Optional~~ Enhanced FAST FEEDBACK Channels

Enhanced Fast feedback slots may be individually allocated to an MSS for transmission of PHY related information that requires fast response from the MSS. The allocations are done either in a unicast manner through the FAST_FEEDBACK MAC subheader (see 6.3.2.2.6), or through the CQICH_Control IE() (see 6.3.2.3.43.5), or through the CQICH_Alloc_IE() (see 8.4.5.4.12), or through the CQICH_Enhanced_Alloc_IE() (see 8.4.5.4.12.1), or through the MIMO Compact DL-MAP IE() (see 6.3.2.3.43.6.7), and the transmission takes place in a specific UL region designated by UIUC = 0.

Each enhanced 3bit-MIMO Fast-feedback slot consists of 1/2 OFDMA slots mapped in a manner similar to the mapping of ACK Channel. An enhanced Fast-feedback slot uses QPSK modulation on the 24 data sub-carriers it contains, and can carry a data payload of 3 bits. Table xxx defines the mapping between the payload bit sequences and the subcarriers modulation.

Table xxx—3bit-MIMO Fast-feedback channel subcarrier modulation

3 bit payload	Fast Feedback vector indices per Tile Even = {Tile(0), Tile(2),Tile(4)} or Odd = {Tile(1), Tile(3),Tile(5)}
0b000	0,0,0
0b001	1,1,1
0b010	2,2,2
0b011	3,3,3
0b100	4,4,4
0b101	5,5,5
0b110	6,6,6
0b111	7,7,7

Each enhanced Fast-feedback slot consists of 1 OFDMA slots mapped in a manner similar to the mapping of normal uplink data. An enhanced Fast-feedback slot uses QPSK modulation on the 48 data sub-carriers it contains, and can carry a data payload of 6 bits. Table 296a defines the mapping between the payload bit sequences and the subcarriers modulation.

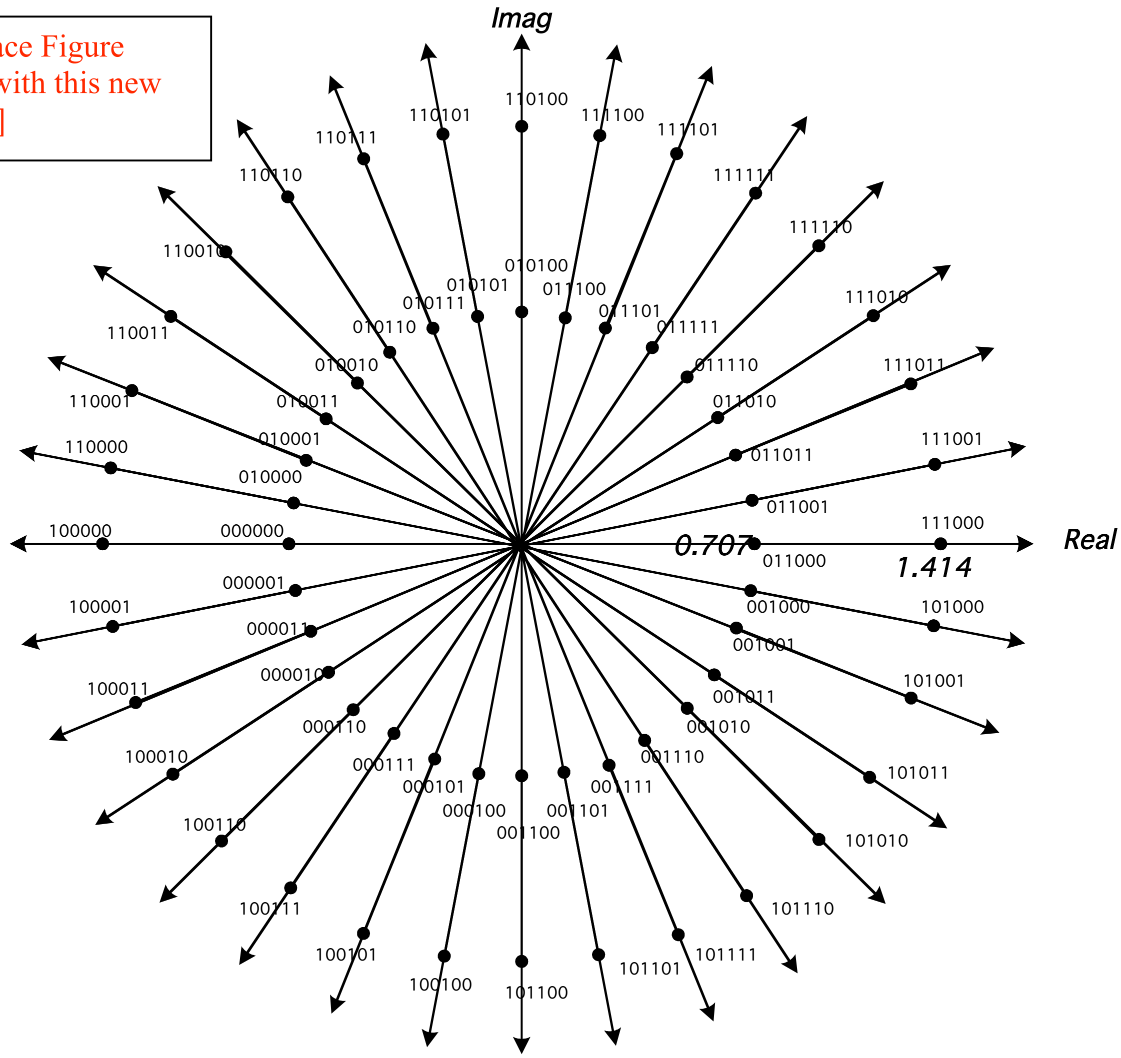
[Modify Section 8.4.5.4.10.6 as suggested in the following]

8.4.5.4.10.6 Fast MIMO Feedback of Quantized Precoding Weight for Enhanced FAST_FEEDBACK Channel

When the FAST_FEEDBACK subheader Feedback Type field is '01' or '10', or the CQI Feedback Type field in the MIMO Compact DL-MAP IE() (see 6.3.2.3.43.6.7) is 011, or the CQI Feedback Type field in CQICH_Enhanced_Alloc_IE() (see 8.4.5.4.15~~1.2.1~~) is 011, the MSS shall report the MIMO coefficient the BS should use for best DL reception ~~(see 8.4.8.1.6)~~. The mapping for the complex weights is shown in Figure 231c, and the SS shall construct the 6 CQI bits with 0 as the MSB and the mapped code as the remaining LSBs. For this type of feedback, if *N* is the number of BS transmit antennas, then *(N-1)* CQICH shall be allocated to the SS and SS shall report the desired antenna weights of antenna 1 through *N-1* based on antenna 0.

Figure 231c - Mapping of MIMO coefficients for quantized precoding weight for enhanced fast MIMO feedback payload bits

[Replace Figure 231c with this new figure]



[Replace Section 8.4.5.4.10.7 with the following]

8.4.5.4.10.7 MIMO Mode Feedback for Enhanced FAST_FEEDBACK channel

When the enhanced FAST FEEDBACK channel is employed, the SS may report the MIMO mode feedback on the assigned CQICH when the FAST_FEEDBACK subheader Feedback Type field is '00', or the CQI Feedback Type field in the MIMO Compact DL-MAP IE() (see 6.3.2.3.43.6.7) is 000, 001, or 010, or the CQI Feedback Type field in CQICH_Enhanced_Alloc_IE() (see 8.4.5.4.15) is 000, 001, or 010. The encoding of payload bits is shown in Table 296d.

Table 296d —Encoding of payload bits for MIMO Mode Feedback with Enhanced FAST FEEDBACK Channel

Value	**Description**
0b101000	STTD and PUSC/FUSC permutation

0b101001	STTD and adjacent-subcarrier permutation
0b101010	SM and PUSC/FUSC permutation
0b101011	SM and adjacent-subcarrier permutation
0b101100	Hybrid and PUSC/FUSC permutation
0b101101	Hybrid and adjacent-subcarrier permutation
0b101110-0b110110	Interpretation according to table 296e, 296f or 296g, depending on if antenna grouping, antenna selection or a reduced precoding matrix code book is used.
0b110111	Closed loop precoding with 1 stream.
0b111000	Closed loop precoding with 2 streams.
0b111001	Closed loop precoding with 3 streams.
0b111010	Closed loop precoding with 4 streams.
0b111011 - 0b111111	Reserved

Clarification of streams concept:
The number of streams is the number of outputs from the space-time code.

Table 296e —Interpretation of code words 0b101110-0b110110 in Table 296d in the case of using antenna grouping

Value	Description
0b101110	Antenna Group A1 for rate 1 For 3-antenna BS, See 8.4.8.3.4 For 4-antenna BS, See 8.4.8.3.5
0b101111	Antenna Group A2 for rate 1
0b110000	Antenna Group A3 for rate 1
0b110001	Antenna Group B1 for rate 2 For 3-antenna BS, See 8.4.8.3.4 For 4-antenna BS, See 8.4.8.3.5
0b110010	Antenna Group B2 for rate 2
0b110011	Antenna Group B3 for rate 2
0b110100	Antenna Group B4 for rate 2 (only for 4-antenna BS)
0b110101	Antenna Group B5 for rate 2 (only for 4-antenna BS)
0b110110	Antenna Group B6 for rate 2 (only for 4-antenna BS)

Table 296f —Interpretation of code words 0b101110-0b110110 in Table 296d in the case of using antenna selection

Value	Description
0b101110	Antenna selection option 0
0b101111	Antenna selection option 1
0b110000	Antenna selection option 2

0b110001	Antenna selection option 3
0b110010	Antenna selection option 4
0b110011	Antenna selection option 5
0b110100	Antenna selection option 6
0b110101	Antenna selection option 7
0b110110	Reserved

Table 296g —Interpretation of code words 0b101110-0b110110 in Table 296d in the case of using reduced precoding matrix code book

Value	Description
0b101110	Reduced Precoding matrix code book entry 0
0b101111	Reduced Precoding matrix code book entry 1
0b110000	Reduced Precoding matrix code book entry 2
0b110001	Reduced Precoding matrix code book entry 3
0b110010	Reduced Precoding matrix code book entry 4
0b110011	Reduced Precoding matrix code book entry 5
0b110100	Reduced Precoding matrix code book entry 6
0b110101	Reduced Precoding matrix code book entry 7
0b110110	Reserved

[End of "Replace Section 8.4.5.4.10.7 with the following"]

[Remove the entire Section 8.4.5.4.10.8]

~~8.4.5.4.10.8 MIMO related Type Independent Feedback for enhanced FAST_FEEDBACK channel~~

~~For 6 bit payload case, MIMO related feedback shall be encoded as is shown in Table 294d .~~

~~Table 297 —Encoding of payload bits for MIMO feedback with 6 bit payload~~

~~Value~~	~~Description~~
~~0b101000~~	~~STC and PUSC/FUSC permutation~~
~~0b101001~~	~~STC and adjacent-subcarrier permutation~~
~~0b101010~~	~~SM and PUSC/FUSC permutation~~
~~0b101011~~	~~SM and adjacent-subcarrier permutation~~
~~0b101100~~	~~Closed-loop SM and PUSC/FUSC permutation~~
~~0b101101~~	~~Closed-loop SM and adjacent-subcarrier permutation~~
~~0b101110~~	~~Hybrid and PUSC/FUSC permutation~~
~~0b101111~~	~~Hybrid and adjacent-subcarrier permutation~~

0b110000	Beamforming and adjacent-subcarrier permutation
0b110001	Antenna Group A For 3-antenna BS, 00 = Antenna group 0,1 & 0,2 For 4-antenna BS, 00 = Antenna group 0,1 & 2,3
0b110010	Antenna Group BFor 3-antenna BS, 00 = Antenna group 0,1 & 1,2 For 4-antenna BS, 00 = Antenna group 0,2 & 1,3
0b110011	Antenna Group CFor 3-antenna BS, 00 = Antenna group 0,2 & 1,2 For 4-antenna BS, 00 = Antenna group 0,3 & 1,2
0b110 1 0 0 - 0b111111	Reserved

[Modify the following section as indicated]

[Added at the end (i.e., line 49) in section 8.4.5.4.10.12 on page 270 of [1] as follows]

8.4.5.4.10.12 MIMO feedback for transmit beamforming

Codebooks are defined for the feedback of MIMO transmit beamforming, whose codeword may be employed as the beamforming matrix in MIMO precoding in 8.4.8.3.6. The vector codebooks for 2x1, 3x1, and 4x1 with 3 bit feedback index are listed in **Table 1**Table 1Table 1, **Table 2**Table 2Table 2, and **Table 3**Table 3Table 3. The notation $V(N_t, S, L)$ denotes the vector codebook, which consists of 2^L complex, unit vectors of a dimension N_t .and S denotes the number of streams. The integer L is the number of bits required for the index that can indicate any vector in the codebook.

Table 1 $V(2,1,3)$

Vector index	1	2	3	4	5	6	7	8
v_1	1	0.7940	0.7940	0.7941	0.7941	0.3289	0.5112	0.3289
v_2	0	-0.5801 + j0.1818	0.0576 + j0.6051	-0.2978 - j0.5298	0.6038 + j0.0689	0.6614 + j0.6740	0.4754 - j0.7160	-0.8779 - j0.3481

Table 232 $V(3,1,3)$

Vector index	1	2	3	4	5	6	7	8
v_1	1	0.500	0.500	0.500	0.500	0.4954	0.500	0.500
v_2	0	-0.7201 - j0.3126	-0.0659 + j0.1371	-0.0063 + j0.6527	0.7171 + j0.3202	0.4819 - j0.4517	0.0686 - j0.1386	-0.0054 - j0.6540
v_3	0	0.2483 - j0.2684	-0.6283 - j0.5763	0.4621 - j0.3321	-0.2533 + j0.2626	0.2963 - j0.4801	0.6200 + j0.5845	-0.4566 + j0.3374

Table 353 $V(4,1,3)$

Vector index	1	2	3	4	5	6	7	8
v_1	1	0.3780	0.3780	0.3780	0.3780	0.3780	0.3780	0.3780
v_2	0	-0.2698 - j0.5668	-0.7103 + j0.1326	0.2830 – j0.0940	-0.0841 + j0.6478	0.5247 + j0.3532	0.2058 - j0.1369	0.0618 – j0.3332
v_3	0	0.5957 + j0.1578	-0.2350 – j0.1467	0.0702 – j0.8261	0.0184 + j0.0490	0.4115 + j0.1825	-0.5211 + j0.0833	-0.3456 + j0.5029

v_4	0	0.1587 - j0.2411	0.1371 + j0.4893	-0.2801 + j0.0491	-0.3272 - j0.5662	0.2639 + j0.4299	0.6136 - j0.3755	-0.5704 + j0.2113

*[**Note to the editor** the following text will be replaced by the tabulated 3 bits code books for V(2,2,3), V(3,2,3),V(3,3,3), V(4,2,3), V(4,3,3), V(4,4,3), and 6 bits code books for V(2,1,6),V(2,2,6), V(3,1,6), V(3,2,6),V(3,3,6), V(4,1,6), V(4,2,6), V(4,3,6), V(4,4,6)]*

-----------------start text repleace ------------------

An operation, $\mathrm{H}(\mathbf{v})$, is defined. It generates a unitary N by N matrix $\mathrm{H}(\mathbf{v})$ using a N vector $\mathbf{v}$ as

$$\mathrm{H}(\mathbf{v}) = \begin{cases} \mathbf{I}, & \mathbf{v} = \mathbf{e}_1 \\ \mathbf{I} - p\mathbf{w}\mathbf{w}^H, & \text{otherwise} \end{cases}, \qquad (1)$$

where $\mathbf{w} = \mathbf{v} - \mathbf{e}_1$ and $\mathbf{e}_1 = [1 \quad 0 \quad \cdots \quad 0]^T$; $p = \frac{2}{\|\mathbf{w}^H\mathbf{w}\|}$; $\mathbf{I}$ is the N by N identity matrix; ^{H} denotes the conjugate transpose operation. Vector codebooks $V(3,6)$ and $V(4,6)$ are generated as follows. All the vector codewords $\mathbf{v}_i$, $i = 2,\cdots,2^L$, are derived from the first codeword $\mathbf{v}_1$ as

$$\tilde{\mathbf{v}}_i = \mathrm{H}(\mathbf{s})Q^i(\mathbf{u})\mathrm{H}^H(\mathbf{s})\mathbf{v}_1, \text{ for } i = 2,\cdots,2^L \qquad (2)$$

$$\mathbf{v}_i = \tilde{\mathbf{v}}_i e^{-j\phi_i}, \text{ for } i = 2,\cdots,2^L \qquad (2)$$

where $Q^i(\mathbf{u}) = \mathrm{diag}\left(e^{j\frac{2\pi}{L}u_1 i}, \cdots, e^{j\frac{2\pi}{L}u_{N_t} i}\right)$ is a diagonal matrix; $\mathbf{u} = [u_1 \quad \cdots \quad u_{N_t}]$ is an integer vector; ϕ_i is the phase of the first entry of $\tilde{\mathbf{v}}_i$. The parameters for the generation of $V(3,6)$ and $V(4,6)$ are listed in **Table 4**~~Table 4Table 4~~.

Table 4~~74~~ Generating parameters for $V(3,6)$ and $V(4,6)$

N_t	L	$\mathbf{u}$ in $Q^i(\mathbf{u})$	$\mathbf{s}$ in $\mathrm{H}(\mathbf{s})$
3	6	$[1 \quad 26 \quad 57]$	$[1.2518 - j0.6409,\ -0.4570 - j0.4974,\ 0.1177 + j0.2360]^T$
4	6	$[1 \quad 45 \quad 22 \quad 49]$	$[1.3954 - j0.0738,\ 0.0206 + j0.4326,\ -0.1658 - j0.5445,\ 0.5487 - j0.1599]^T$

The matrix codebooks for multiple stream transmission are constructed from the vector codebooks using three operations. The first operation is $\mathrm{H}(\mathbf{v})$. The second denoted as $\mathrm{HC}(\mathbf{v}_N, \mathbf{A}_{(N-1)\times M})$ generates a N by $M+1$ unitary matrix from a unit N vector and a unitary $N-1$ by M matrix as

$$\mathrm{HC}(\mathbf{v}_N, \mathbf{A}_{(N-1)\times M}) = \mathrm{H}(\mathbf{v}_N)\begin{bmatrix} 1 & 0 & \cdots & 0 \\ 0 & & & \\ \vdots & & \mathbf{A}_{(N-1)\times M} & \\ 0 & & & \end{bmatrix}, \qquad (3)$$

where $N-1 \geq M$; the $N-1$ by M matrix unitary matrix has property $\mathbf{A}^H\mathbf{A} = \mathbf{I}$. The third operation denoted as $\mathrm{HE}(\mathbf{v}_N, M)$ generates a N by M matrix from a unit N vector, $\mathbf{v}_N$, by taking the last M columns of $\mathrm{H}(\mathbf{v}_N)$ as

$$\mathrm{HE}(\mathbf{v}_N, M) = \mathrm{H}(\mathbf{v}_N)_{:,N-M+1:N}. \quad (4)$$

The three operations jointly generate matrix codebooks as listed in Table 5~~Table 5Table 5~~.

Table 5 Generating operations for N_t by N_s codebooks with 3, 6, and 9 bit indexes.

N_t, L \ N_s	2	3	4
2 antennas, 3 bit	$\mathrm{H}(V(2,3))$		
3 antennas, 3 bit	$\mathrm{HE}(V(3,3),2)$	$\mathrm{H}(V(3,3))$	
4 antennas, 3 bit	$\mathrm{HE}(V(4,3),2)$	$\mathrm{HE}(V(4,3),3)$	$\mathrm{H}(V(4,3))$
3 antennas, 6 bit	$\mathrm{HC}(V(3,3),V(2,3))$	$\mathrm{HC}(V(3,3),\mathrm{H}(V(2,3)))$	
4 antennas, 6 bit	$\mathrm{HC}(V(4,3),V(3,3))$	$\mathrm{HE}(V(4,6),3)$	$\mathrm{H}(V(4,6))$

The set notation $V(N_t, L)$ in the input arguments of the operations (i.e. H, HC, and HE) denotes that each vector in the codebook $V(N_t, L)$ is sequentially taken as an input to the operations. The output of the operation with one or more codebooks as input arguments is a codebook. For example, in $\mathrm{HC}(V(3,6),\mathrm{H}(V(2,3)))$, HC has two codebooks as input. The first is $V(3,6)$ with 64 vectors and the second is $\mathrm{H}(V(2,3))$ with 8 2 by 2 matrixes, which are computed from $V(2,3)$. The feedback index is constructed by sequentially concatenating all the indexes of the input argument vector codebooks in binary format. For example, the feedback index of $\mathrm{HC}(V(3,6),\mathrm{H}(V(2,3)))$ is constructed as $i_2 j_2$, where i_2 and j_2 are the indexes of the vectors in codebooks $V(3,6)$ and $V(2,3)$ in binary format respectively; $_2$ denotes binary format for the indexes.

-----------------*End text replace* ------------------

[Modify the following section as indicated]

8.4.5.4.15 CQICH Enhanced Allocation IE Format

CQICH_Enhanced_Alloc_IE(), is introduced to dynamically allocate or de-allocate a CQICH to a SS. This IE shall only be used with enhanced FAST FEEDBACK channel in 8.4.5.4.10.4. Once allocated, the SS transmit feedback information of the specified type on the assigned CQICH with the determined period, until the SS receives a CQICH_Enhanced_Alloc_IE() to de-allocate the assigned CQICH.

Table 298a. CQICH Enhanced allocation IE format

Syntax	**Size (bits)**	**Notes**
CQICH_Enhanced_Alloc_IE() {		
Extended U~~D~~IUC	4	0x09
Length	4	Length in bytes of following fields
CQICH_ID	variable	Index to uniquely identify the CQICH resource assigned to the MSS
Period (=p)	~~2~~3	A CQI feedback is transmitted on the CQICH every 2^p frames
Frame offset	3	The MSS starts reporting at the frame of which the number has the same 3 LSB as the specified frame offset. If the current frame is specified, the MSS should start reporting in 8 frames
Duration (=d)	3	A CQI feedback is transmitted on the CQI channels indexed by the

		CQICH_ID for 10 x 2^d frames. If d==0, the CQICH is de-allocated. If d == 111, the MSS should report until the BS command for the MSS to stop.
~~NT actual BS antennas~~	~~3~~	~~001 = Reserved~~ ~~010 = 2 actual antennas~~ ~~011 = 3 actual antennas~~ ~~100 = 4 actual antennas~~ ~~101 = 5 actual antennas~~ ~~110 = 6 actual antennas~~ ~~111 = 7 actual antennas~~ ~~000 = 8 actual antennas~~
~~Feedback_type~~	~~3~~	~~000 = Fast DL measurement/Default Feedback~~ ~~001 = Precoding weight matrix information~~ ~~010 = Channel matrix H~~ ~~011 = MIMO mode and permutation zone~~ ~~100 = Open loop precoding~~ ~~101- 111 = Reserved~~
CQICH_Num	4	Number of CQICHs assigned to this CQICH_ID is (CQICH_Num +1)
for (i=0;i<CQICH_Num+1;i++) {		
Feedback_type	3	000 = Fast DL measurement/Default Feedback with antenna grouping 001 = Fast DL measurement/Default Feedback with antenna selection 010 = Fast DL measurement/Default Feedback with reduced code book 011 = Quantized precoding weight feedback 100 = Index to precoding matrix in code book 101 = Channel Matrix Information 101 = Per stream power control 110 ~ 111 = Reserved
Allocation index	6	Index to the fast feedback channel region marked by UIUC=0
CQICH Type	2	00 = 6 bit CQI, 01 = DIUC-CQI, 10 = 3 bit CQI (even), 11 = 3 bit CQI(odd)
}		
~~if ((Feedback_type != 011) & (! 6-bit CQICH)) {~~ ~~MIMO_permutation_feedback cycle }~~	~~2~~	~~This field exists only for 4-bit and 5-bit CQI payload.~~ ~~00 = No MIMO and permutation mode feedback~~ ~~01 = the MIMO and permutation mode indication shall be transmitted on the CQICH indexed by the CQICH_ID every 4 frames. The first indication is sent on the 8th CQICH frame.~~ ~~10 = the MIMO mode and permutation mode indication shall be transmitted on the CQICH indexed by the CQICH_ID every 8 frames. The first indication is sent on the 8th CQICH frame.~~ ~~11 = the MIMO mode and permutation mode indication shall be transmitted on the CQICH indexed by the CQICH_ID every 16 frames. The first indication is sent on the 16th CQICH frame.~~
~~if ((Feedback_type != 011) & (! 6-bit CQICH)) {~~ ~~MIMO_permutation_feedback cycle }~~	~~2~~	~~This field exists only for 4-bit and 5-bit CQI payload.~~ ~~00 = No MIMO and permutation mode feedback~~ ~~01 = the MIMO and permutation mode indication shall be transmitted on the CQICH indexed by the CQICH_ID every 4~~

~~cycle }~~		~~frames. The first indication is sent on the 8th CQICH frame.~~ ~~10 = the MIMO mode and permutation mode indication shall be transmitted on the CQICH indexed by the CQICH_ID every 8 frames. The first indication is sent on the 8th CQICH frame.~~ ~~11 = the MIMO mode and permutation mode indication shall be transmitted on the CQICH indexed by the CQICH_ID every 16 frames. The first indication is sent on the 16th CQICH frame.~~
Band_AMC_Precoding_Mode	1	0 = One common precoder for all bands. 1 = Distinct precoders for the bands with the highest S/N values, up to the number of short term precoders fed back as specified by Nr_Precoders_feedback

If (Band_AMC_Precoding_Mode =1) {
 	
Nr_Precoders_feedback (=N)
 	
}
	3	Nr of precoders feedback = N.

Padding	variable	The padding bits are used to ensure the IE size is integer number of bytes.
}		

Feedback Type
For feedback types 000-010 it instructs the SS to transmit the feedback of the specified type using the 5 LSBs on its assigned CQICH as in Table 296d. In this case the MSB is set to 0. In addition, for feedback types 000-010, the SS may transmit, on its assigned CQICH, the feedback information specified in 8.4.5.4.10.7. ~~For 4-bit or 5-bit CQI payload, the type dependent feedback in 16 or 32 levels shall be feedback, respectively. For 6-bit CQI payload, however, the MSB of 6-bit payload from a SS is the indicator of the usage for the remaining 5 bits. When the MSB is set to '0' with 6-bit payload, the following 5-bit payload shall be used for the type dependent feedback, and '1' indicates the following 5-bit payload shall be used for type independent feedback in Table 294d.~~

4. MIMO Precoding

[Add section 6.3.2.3.59]

6.3.2.3.59 MIMO precoding setup/tear-down

The BS can setup longterm precoding with feedback from a particular SS by sending the MAC-manage message PRC-LT-CTRL to the SS. The BS can also use the same MAC-management message to tear-down the longterm precoding with feedback.
The precoding feedback delay of the base station, in number of frames, should be signaled from the BS to the SS in the PRC-LT-CTRL MAC-management message.

Table 108a – Setup/Tear-down of long term MIMO precoding (PRC-LT-CTRL) message format

Syntax	Size	Notes
PRC-LT-CTRLformat(){		
Management message type = 64	8 bits	
Setup/Tear-down long term precoding with feedback	1 bit	1=Turn on 0=Turn off
BS precoding application delay	2 bits	k, delay in number of frames beyond the minimal delay of 1 frame for when

		precoding information fed back from the SS to the BS can or will be applied.
}		

[End of adding text]

[Modify Section 6.3.2.3 MAC Management messages]

[Add row to Table 14a, MAC Management messages according to the Table below:]

[Row to be added to Table 14a—MAC Management messages]

Type	Message description	Connection
64	Setup/Tear-down of long term MIMO precoding	Basic

[End of Modification to Section 6.3.2.3 MAC Management messages]

[Modify the following table at the end of section 6.3.2.1.4.1]

Table 7b. Feedback Type and feedback content.

Feedback Type	Feedback contents	Description
0b0000	Set as described in table 296d.	MIMO mode and permutation. Feedback
0b0001	DL average CQI (5bits)	5 bits CQI feedback
0b0010	Number of index, L (2 bits) + L occurrences of Antenna index (2 bits) + MIMO coefficients (5 bits, 8.4.5.4.10.6)	MIMO coefficients feedback
0b0011	Preferred-DIUC (4 bits)	Preferred DL channel DIUC feedback
0b0100	UL-TX-Power (7 bits) (see table 7a)	UL transmission power
0b0101	Preferred DIUC(4 bits) + UL-TX-Power(7 bits) + UL-headroom (6 bits) (see Table 7a)	PHY channel feedback
0b0110	Number of bands, N (2 bits) + N occurrences of 'band index (6 bits) + CQI (5 bits)'	CQIs of multiple AMC bands
0b0111	Number of feedback types, O (2 bits) + O occurrences of 'feedback type (4bits) + feedback content (variable)'	Multiple types of feedback
0b01000	Feedback of index to long term precoding matrix in code book (6 bits), rank of precoding code book (2 bits) and FEC and QAM feedback (6 bits) according to Table Z.	Long term precoding feedback
0b01001	Life span of short term precoding feedback (4 bits) according to Table Z2.	The recommended number of frames the short term precoding feedback can be used for.
0b1010	AS/AG Index/Precoding matrix (5bits)	0000~0100 for AG in Table 296e 01001~1001 for AS in Table 296f 10010~11010 for Precoding Matrix in Table 296g 11011~1111 : reserved
0b1011	MIMO channel feedback (see Table 7c)	MIMO mode channel condition feedback
0b1001-0b1111	Reserved for future use	

[End of "Modify the following table at the end of section 6.3.2.1.4.1"]

[Insert the following section:]

6.3.2.1.4.3 MIMO Channel Feedback header

The MIMO Channel Feedback header is used for MSS to provide DL MIMO channel quality feedback to the BS. The MIMO Channel Feedback header can be used to provide a single or composite channel feedback. The MIMO Channel Feedback header with or without basic CID field is illustrated in Figure 20d and Figure 20e respectively.

<table>
<tr><td>HT=1 (1)</td><td>EC=1 (1)</td><td>N/M=0 (1)</td><td>CII=1(1)</td><td>Feedback Type =1000 (4)</td><td colspan="2">PREFERRED-DIUC (4)</td><td>PBWI (4)</td></tr>
<tr><td colspan="5">SLPB (7)</td><td>BPLI (1)</td><td colspan="2">Basic CID MSB (8)</td></tr>
</table>

Basic CID LSB (8)	HCS (8)

Figure 20d—MIMO Channel Feedback header with CID field

HT=1 (1)	EC=1 (1)	N/M=0 (1)	CII=0(1)	Feedback Type =1000 (4)	PREFERRED-DIUC (4)	PBWI (4)
SLPB (7)				BPLI (2)	CTI (3)	AI (4)
MI (2)		CT (1)	CQI (5)		HCS (8)	

Figure 20e—MIMO Channel Feedback header without CID field

The MIMO Channel Feedback header shall have the following properties:

a) The length of the header shall always be 6 bytes.
b) The TYPE field shall be “1000”
c) PREERRED-DIUC indicates the preferred DIUC suggested by the MSS
d) PBWI provides the size of the preferred bandwidth which can be used for DIUC transmission
e) SLPB points to the starting preferred bandwidth location. Combining with PBWI field, BS knows the exact size and location of the preferred bandwidth in the channel
f) BPRI can be used to rank up to 4 preferred burst profiles within the DL channel
g) CTI provides coherent time information
h) AI can support up to 4 antennas
i) MI suggests the preferred STC/MIMO Matrix for the MSS
j) CT/CQI can support two types of CQI report

The fields of MIMO Channel Feedback header are defined in Table 7c.

Table 7c—Description of MIMO Channel Feedback header fields

Name	**Length (bits)**	**Description**
HT	1	Header Type = 1
EC	1	Always set to 1
N/M	1	Always set to zero
CII	1	The CII field (Full CID Inclusion Indication) shall be set to 1 for the header with full CID field and set to 0 for the header with truncated CID field.
Feedback Type	4	Type = 1011
PREFERRED-DIUC	4	Index of the DIUC preferred by the MSS
PBWI	4	Preferred Bandwidth Index indicates the ratio of the preferred bandwidth over used channel bandwidth: 0000: 1 0001: 3/4 0010: 2/3 0011: 1/2 0100: 1/3 0101: 1/4 0110: 1/5 0111: 1/6 1000: 1/8 1001: 1/10 1010: 1/12 1011: 1/16 1100: 1/24 1101: 1/32 1110: 1/48 1111: 1/64 Where Ratio = $BW_{preferred}/BW_{used}$ $BW_{preferred}$: Preferred bandwidth for DIUC transmission BW_{used}: Actual used channel bandwidth (excluding guard bands)

SLPB	7	Starting Location of Preferred Bandwidth: 0-127 The effective bandwidth (used bandwidth) is divided into 1/128 interval, from 0 to 127 representing from lower to higher band. SLPB indicates the starting location of preferred bandwidth for the DIUC burst profile
BPRI	1/2	Burst Profile Ranking Indicator (without basic CID): ~~(Or, Channel Condition Ranking Indicator)~~ BPRI indicates the ranking for DL channel condition of the preferred bandwidth as reported in the current header where 0 is the most preferred bandwidth) 00: 1st preferred burst profile 10: 2nd preferred burst profile 01: 3rd preferred burst profile 11: 4th preferred burst profile Burst Profile Ranking Indicator (including basic CID): 0: 1st preferred burst profile 1: 2nd preferred burst profile
CTI	3	Coherent Time Index: CTI indicates the proximate duration of the valid MIMO channel conditions 000: Infinite 001: 1 frame 010: 2 frames 011: 3 frames 100: 4 frames 101: 8 frames 110: 14 frames 111: 24 frames
AI	4	This report can be a composite channel condition report, each bit represents for each antenna; "1" is applicable, "0" is not applicable Antenna Index: Bit 0 (MSB)- Antenna 0 Bit 1 – Antenna 1 Bit 2 – Antenna 2 Bit 3 (LSB) – Antenna 3
MI	2	Matrix Indicator: 00: No STC 01: Matrix A 10: Matrix B 11: Matrix C
CT	1	CQI Type: The type of CQI feedback in the CQI field 0: DL average CQI feedback 1: CQI feedback for the preferred bandwidth indicated in the current header
CQI	5	CQI feedback
CID	16	MSS basic CID
HCS	8	Header Check Sequence (same usage as HCS entry in Table 5).

[Modify the following section as indicated]

8.4.8.3.6 MIMO Precoding

The space time coding output can be weighted by a matrix before mapping onto transmit antennas:

where x is a vector with the output from the space-time coding (per-subcarrier), is the number of ~~antennas~~ streams at the output of the space-time coding scheme. The matrix W is an weighting matrix where the quantity is the number of actual transmit antennas. The vector contains the signals after weighting for the different actual antennas. The labeling of the elements in the weighting matrix is performed in accordance with the example of given below for the case of 4 actual antennas and 2 space-time coding output ~~antennas~~ streams:

$$W = \begin{bmatrix} w_{11} & w_{12} \\ w_{21} & w_{22} \\ w_{31} & w_{32} \\ w_{41} & w_{42} \end{bmatrix}$$

Short term closed loop precoding:

When Mt=1, then single stream precoding or beamforming shall be applied with the vector W of dimension $N_t \times 1$. The transmission scheme before the precoder is the regular single antenna transmission. When Mt=2, 3 or 4, then the two, three or four STC output streams shall be transmitted with ~~the 2, 3 or 4 Tx pure spatial multiplexing transmission scheme with~~ a precoding matrix of dimension , or .

When using CQICH feedback type 100 (Index to precoding matrix in code book) in Table 298a, the number of bits in the precoding matrix index in the code book is determined by the number of bits in the CQICH Type (also in Table 298a).

Long term closed loop precoding

The rank of the precoding matrix is indicated in the long term precoding feedback from the SS. The number of columns in the precoding matrix equals its rank. The STC scheme used, Matrix A, B or C, is selected from the set of STC schemes associated with the number of transmit antennas equaling the rank of the long term precoding matrix used. For example, if the rank of the long term precoding matrix is 2 and the spatial rate used is 1 then the Matrix A scheme for 2 Tx antennas is used.

When the long term closed loop precoding is turned on, the life span of short term precoding information, the rank of the long term precoding code book used and the index to the precoding matrix in the specified long term precoding code book is fed back with MAC-header feedback messages 0b0000 and 0b0001. If a short term precoding matrix is available, the BS shall use this short term matrix. If not, the BS shall use the fed back long term precoding matrix, if available.

The long term closed loop precoding uses the 6 bit code book as specified in Section 8.4.5.4.10.12.

Feeding back multiple precoder for band AMC operation

For band AMC the BS has the choice to request a common precoding matrix for all bands or can request a programmable number, N (see Table 298a), of precoding matrices to be fed back for the N best bands selected in an ordered fashion. In the latter case, the precoding matrices are associated with the bands with the highest S/N values. As a secondary selection criteria, in case the ordering according to highest S/N is not unique, the bands with the lowest band index are chosen first. The index for each precoder is mapped to a CQICH channel of the corresponding size. The precoders for the different bands, in the order described above, is signaled in the corresponding CQICH channels.

Table Z – Feedback for long term precoding in MAC feedback header message

MAC-header feedback type bit indication	Feedback element	Number of bits	Description
0b01000	Feedback of index to long term precoding matrix in code book	6	Index to long term precoding matrix element in code book
0b01000	Rank of precoding code book	2	k, Rank of precoding code book = k+1
0b01000	FEC and QAM feedback	6	FEC and QAM specification

Table Z2 – Feedback for life span of short term precoding in MAC feedback header message 0b01001

Bit field (N)	**Life span in number of frames**
0000-1111	0.125*2^(N+1)

Precoding state feedforward and precoding application delay

If the precoding state is not fed forward in the DL burst allocation IE, then the BS shall apply precoding according to the precoding feedback from the SS (antenna grouping, antenna selection or code book based) with a predetermined number of frames delay.

[End of modification of the following section as indicated]

5. MIMO Precoding Operation for H-ARQ MAP

Some clarification is made on burst mapping for H-ARQ when multiple MIMO layers are transmitted on the same physical resource. The multiple layer transmission is enabled when spatial multiplexing (SM) schemes are employed with multiple modulation and coding blocks implemented for each spatial layer. We call it horizontal encoding (HE) and this mode enables adaptive rate control for each spatial layer. The other class of spatial multiplexing schemes is called vertical encoding (VE) and it features a common modulation and coding block. Transmit diversity (TD) can be also regarded as single layer technique. Figure 1~~Figure 1~~~~Figure 2~~ shows an example of 2x2 VE MIMO system, whereas Figure 2~~Figure 2~~~~Figure 3~~ illustrates that of 2x2 HE MIMO system. In both figures, L equals the number of layers, Mt the number of STC output streams, Nt the number of BS transmit antennas, and W denotes the precoding matrix. Their relations according to the current standard are tabularized in Table 5~~Table 5~~~~Table 5~~.

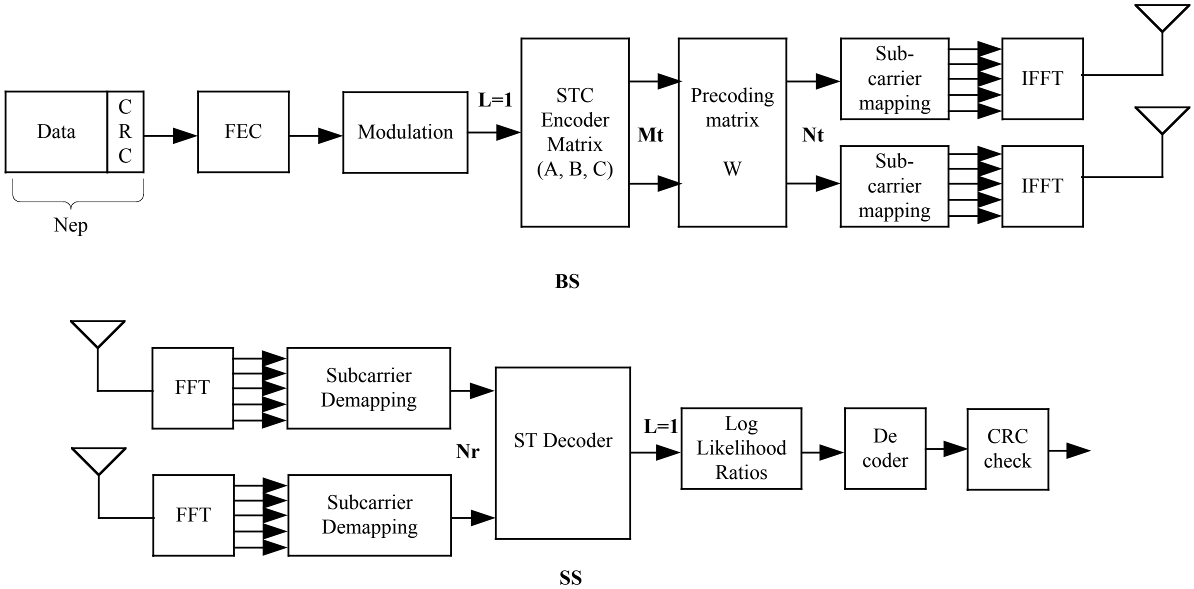


Figure 1~~112~~ H-ARQ Enabled Vertically Encoded 2x2 MIMO System

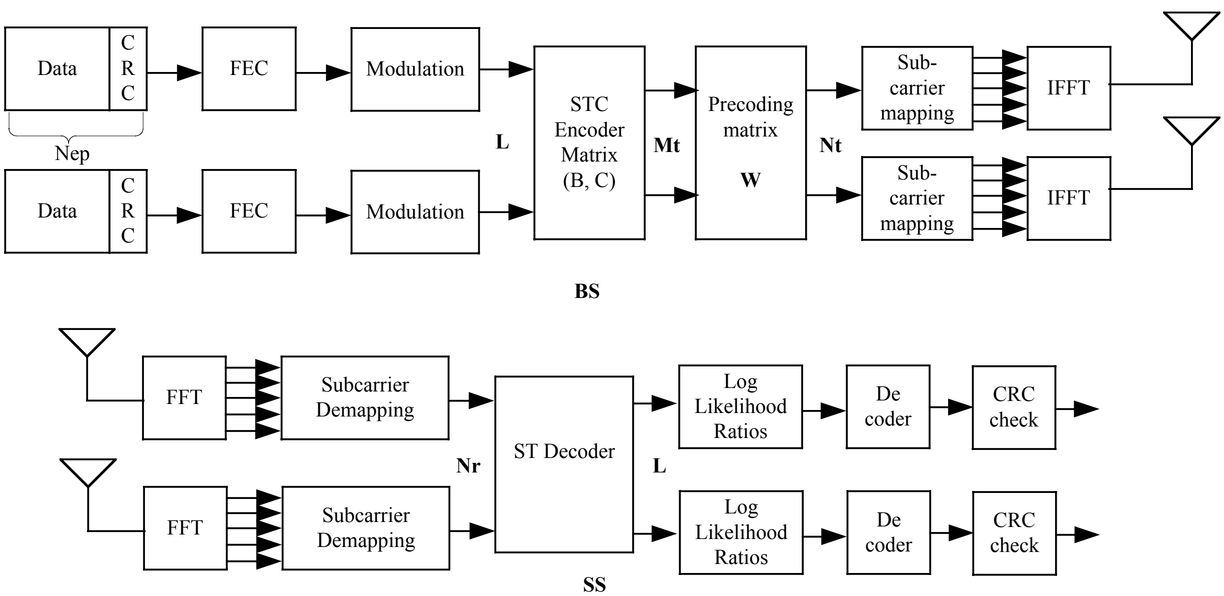


Figure 2~~323~~ H-ARQ Enabled Horizontally Encoded 2x2 MIMO System

Layer = 1 (TD or VE only)				L = 2 (HE only)			L = 3 (HE only)		L = 4 (HE only)
Mt=1	2	3	4	Mt=2	3	4	Mt=3	4	Mt=4
AAS	A (TD)	A (TD)[1]	A (TD)[1]						
		B (VE)[1]	B (VE)[1]		B (HE)[1]	B (HE)[1]			
	C (VE)	C (VE)	C (VE)	C (HE)			C (HE)		C (HE)

Table 5~~95~~ Clarification on Layer, Mt and Matrix

In both Figure 1 and Figure 2, when there is no precoding matrix at Tx, Mt becomes the number of transmit antennas. In Table 1, the existing open-loop matrices (A, B, or C) are noted and the superscript [1] indicates the applicability of the antenna grouping technique.

[Replace the following table in Section 6.3.2.3.43.6.7 as follows]

6.3.2.3.43.6.7 MIMO Compact DL MAP IE format

Table 99a—MIMO Compact DL-MAP IE format

Syntax	Size (bits)	Notes
MIMO_Compact_DL-MAP_IE() {		
Compact DL-MAP Type	3	Type = 7
DL-MAP Sub-type	5	MIMO = 0x01
Length	4	Length of the IE in Bytes
Mode Change	1 bit	Indicates change of MIMO mode 0 = No change from previous allocation 1 = Change of MIMO mode
Antenna Grouping/Selection	1 bit	Application of antenna grouping/selection to the burst 0 = Not applied 1 = AG/AS applied
Codebook based Precoding	1 bit	Application of codebook based precoding to the burst 0 = Not applied 1 = Codebook based precoding applied
N_layer	2	Number of multiple coding/modulation layers 00 – 1 layer 01 – 2 layers 10 – 3 layers 11 – 4 layers
if(Mode Change == 1){		
Matrix	2 bits	Indicates transmission matrix (See 8.4.8) 00 = Matrix A (Transmit Diversity) 01 = Matrix B (Hybrid Scheme) 10 = Matrix C (Spatial Multiplexing) 11 = Reserved
Mt	2 bits	Indicates number of STC output streams 00 = 1 stream 01 = 2 streams 10 = 3 streams 11 = 4 streams
if (Antenna Grouping/Selection == 1) {		
Antenna Grouping/Selection Index }	4 bits	Indicates the index of antenna grouping/selection See 8.4.8.3.4 and 8.4.8.3.5
if (Codebook based precoding == 1) {		
Codebook based precoding Index }	6 bits	Indicates the index of precoding matrix W in the codebook See 8.4.8.3.6
}		

for (j=1;j<N_layer+1; j++) {		This loop specifies the Nep/DIUC for layers 2 and above when required for STC. The same Nsch and RCID applied for each layer

if (H-ARQ Mode =CTC Incremental Redundancy) {
Nep }
elseif (H-ARQ Mode = Generic Chase) {
DIUC
}
	4 bits	H-ARQ Mode is specified in the H-ARQ Compact_DL-MAP IE format for Switch H-ARQ Mode.

if (CQICH indicator == 1) {		CQICH indicator comes from the preceding Compact DL-MAP IE
Allocation Index[1]}	6	Index to CQICH assigned to this layer.
}		
if (CQICH indicator == 1) {	2	The number of additional CQICHs allocated to this SS. (0 – 3)
CQICH_Num	2	The number of additional CQICHs allocated to this SS. (0 – 3)
for (i=0; i<CQICH_Num; i++) {		
Feedback_type	3	Type of contents on the additional CQICH
Allocation index	6	
CQICH Usage	2	Indicates the usage of this CQICH 00 = 6 bit CQI (default) 01 = DIUC-CQI 10 = 3 bit CQI (even) 11 = 3 bit CQI(odd)
}		
}		
Padding	variable	Padding to byte; shall be set to 0
}		

Matrix Indicator
This field indicates MIMO matrix for the burst.
~~For 2-antenna BS, 00 = Matrix A; 01 = Matrix B; 10-11 = Reserved.~~
~~For 3-antenna BS, 00 = Matrix A; 01 = Matrix B; 10 = Matrix C; 11 = Reserved.~~
~~For 4-antenna BS, 00 = Matrix A; 01 = Matrix B; 10 = Matrix C; 11 = Reserved.~~

```
if (Num_layer=1) {
  if (Mt = 1) {
    SISO or AAS mode}
  elseif (Mt = 2) {
    00 = A (TD); 01 = C (VE); 10 – 11 = Reserved}
  elseif (Mt = 3) {
    00 = A (TD); 01 = B (VE); 10 = C (VE); 11 = Reserved}
  elseif (Mt = 4) {
    00 = A (TD); 01 = B (VE); 10 = C (VE); 11 = Reserved}
}
elseif (Num_layer = 2) {
  if (Mt = 2) {
    00 = C (HE); 01 – 11 = Reserved}
  elseif (Mt = 3) {
    00 = B (HE); 01 – 11 = Reserved}
  elseif (Mt = 4) {
    00 = B (HE); 01 – 11 = Reserved}
}
elseif (Num_layer = 3) {
  if (Mt = 3) {
    00 = C (HE); 01 – 11 = Reserved}
```

}
elseif (Num_layer = 4) {
if (Mt = 4) {
00 = C (HE); 01 – 11 = Reserved}
}
TD means transmit diversity;
VE means vertical encoding (see 8.4.8.3)
HE means horizontal encoding (see 8.4.8.3)

CQI Feedback Type
For 4-bit or 5-bit CQI payload, the type dependent feedback in 16 or 32 levels shall be feedback, respectively. For 6-bit CQI payload, however, the MSB of 6-bit payload from a SS is the indicator of the usage for the remaining 5 bits. When the MSB is set to '0' with 6-bit payload, the following 5-bit payload shall be used for the type dependent feedback, and '1' indicates the following 5-bit payload shall be used for type independent feedback in Table 294d.

Allocation Index
It indicates its position from the start of the CQICH region.

Antenna Grouping/Selection Index
This field indicates antenna grouping/selection index for the current burst. For the actual description of the following matrices, see 8.4.8.3.4 and 8.4.8.3.5.
if (Num_layer=1) {
if (Mt = 3) {
0000 = A1; 0001 = A2; 0010 = A3;
0011 = B1 (VE); 0100 = B2 (VE); 0101 = B3 (VE);
0110-1111 = Reserved}
elseif (Mt = 4) {
0000 = A1; 0001 = A2; 0010 = A3;
0011 = B1 (VE); 0100 = B2 (VE); 0101 = B3 (VE); 0110 = B4 (VE); 0111 = B5 (VE); 1000 = B6 (VE);
1001-1111 = Reserved}
}
elseif (Num_layer = 2) {
if (Mt = 3) {
0000 = B1 (HE); 0001 = B2 (HE); 0010 = B3 (HE);
0011-1111 = Reserved}
elseif (Mt = 4) {
0000 = B1 (HE); 0001 = B2 (HE); 0010 = B3 (HE); 0011 = B4 (HE); 0100 = B5 (HE); 0101 = B6 (HE);
0110-1111 = Reserved}}

Allocation Index[1]
Indicates position from the start of the CQICH region.
The Feedback type of this CQICH shall be one of the three default types (type 000, 001, 010) according to the following rule:
Feedback type = 000 if ((Antenna Grouping/Selection == 1) & (matrix == A or B))
Feedback type = 001 if ((Antenna Grouping/Selection == 1) & (matrix == C))
Feedback type = 010 if ((Codebook based precoding == 1))
Feedback Type
Indicates the type of feedback content on the allocated CQICH from SS. Its mapping shall be
000 = Fast DL measurement/Default Feedback with antenna grouping
001 = Fast DL measurement/Default Feedback with antenna selection
010 = Fast DL measurement/Default Feedback with reduced code book
011 = Quantized precoding weight feedback
100 = Index to precoding matrix in code book
101 = Channel Matrix Information
101 = Per stream power control
110 ~ 111 = Reserved000 = Fast DL measurement/Default Feedback with antenna grouping
001 = Fast DL measurement/Default Feedback with antenna selection
010 = Fast DL measurement/Default Feedback with reduced code book

~~011 = Quantized precoding weight feedback~~
~~100 = Index to precoding matrix in code book~~
~~101 = Index to MCS table~~
~~110-111 = Reserved~~
When the feedback type is either 000, 001, or 010, the SS shall transmit either the regular S/N measurement using the formula in 8.4.5.4.10.5 in its lower 32 codewords in 8.4.5.4.10.4, or the MIMO mode feedback of the specified type in its upper 32 codewords according to Table 296d in 8.4.5.4.10.7.

For each layer, a codeword shall be constructed according to 8.4.9.2.3.5 with the Nep and Nsch combination and mapped onto the corresponding layer. Multiple codewords from multiple layers shall be interpreted as one H-ARQ channel whose parameters are given in the preceding Compact DL-MAP IE.
At the receiver, an ACK shall be transmitted only when there is no CRC error detected on every layer. Otherwise, a NACK shall be transmitted.

6. CL MIMO Enhanced IE

[Insert Section 8.4.5.3.19 Close-loop MIMO DL Enhanced IE format]

8.4.5.3.19 Close-loop MIMO DL enhanced IE format

This IE is used by BS to assign resource to close loop MIMO enabled MSSs.

Syntax	Size	Notes
CL_MIMO_DL_Enhanced_IE () {		
Extended DIUC	4 bits	0x??
Length	4 bits	Length in bytes
Num_Region	4 bits	
for (i = 0; i< Num_Region; i++) {		
OFDMA Symbol offset	10 bits	
Subchannel offset	5 bits	
Boosting	3 bits	
No. OFDMA Symbols	9 bits	
No. subchannels	5 bits	
Matrix_indicator	1 bits	Indicates transmission matrix (See 8.4.8) 00 = Matrix A (Transmission deversity) 01 = Matrix B (Hybrid Scheme) 10 = Matrix C (Spatial Multiplexing) 11 = Codebook
If (Matrix indicator == 01)		
Antenna Grouping Index	3 bits	Indicating the index of the antenna grouping index
Elseif (Matrix indicator == 10)		
Antenna Selection Index	3 bits	Indicating the index of the selected antenna
Elseif (Matrix == 11)		
Codebook Precoding Index	6 bits	Indicate the index of the precoding matrix in the codebook
Num_stream	2 bits	
for (j = 0; j< Num_stream; j++) {		
if (INC_CID == 1) {		
CQICH_ID	*variable*	Index to uniquely identify the CQICH resource assigned to the MSS The size of this field is dependent on system parameter defined in DCD.
}		
stream_index	2 bits	
DIUC	4 bits	0-11 burst profiles
}		
}		

[Add the following text below the table]

Num_Region

This field indicates the number of the regions defined by OFDMA_Symbol_offset, Subchannel_offset, Boosting, No._OFDMA_Symbols and No._subchannels in this IE.

Matrix_indicator

The values of these two bits indicate the STC matrix (see 8.4.8).

Antenna Grouping Index

This field is used to indicatethe index of the antenna grouping index

Antenna Selection Index

This field is used to indicate the index of the selected antenna

Codebook Precoding Index

This field is used to indicate the index of the precoding matrix in the codebook

Num_stream

The value of these 2 bits plus one indicate the number of MIMO transmission streams.

Stream_index

This field specifies the stream index.

6. Direct Channel Coefficient Feedback

Direct channel coefficient feedback provides an enhancement to the uplink sounding that is already in the standard. With the direct channel coefficient feedback, FDD operation is enabled for the uplink sounding. This section provides the signaling framework for the direct channel coefficient feedback.

---------------------- Beginning of Text Changes -------------------------------------

[In Section 8.4.6.2.7, modify Table 311 as follows:]

Table 311: UL_Sounding_Command_IE()

Syntax	Size	Notes
UL_Sounding_Command_IE(){		
Extended UIUC	4 bits	0x09
Length	4 bits	Variable
Sounding_Type	1 bit	0 = Type A 1 = Type B
Send Sounding Report Flag	1 bit	
Include additional feedback	2 bits	00 = No additional feedback 01 = include channel coefficients (See Section 8.4.6.2.7.3) 10 = include received pilot coefficients 11 = include feedback message
If (Sounding_Type == 0) {		
Num_Sounding_symbols	3 bits	Total number of sounding symbols being allocated, from 1 (“000”) to 2^3=8 (“111”)
Separability Type	1 bit	0: occupy all subcarriers in the assigned bands; 1: occupy decimated subcarriers
if (Separability type==0) {		(using cyclic shift separability)
Max Cyclic Shift Index P	~~2~~3 bits	000: P=4; 0~~0~~01: P=8; 0~~0~~10: P=16, 0~~0~~11: P=32 100: P=9; 101: P=18; 110-111: reserved,
} Else {		(using decimation separability)
Decimation Value D	3 bits	Sound every D^{th} subcarrier within the sounding allocation. Decimation value D is 2 to the power of (~~2~~ 1 plus this value), hence 2,4,8,… up to maximum of 128 ~~64~~., and 111 means decimation of 5

Decimation offset randomization	1 bit	0= no randomization of decimation offset 1= decimation offset pseudo-randomly determined
}		
For (i=0;i<Num_Sounding_symbols;i++){		
Sounding symbol index	3 bits	Symbol index within the Sounding Zone, from 1 (bits "000") to 2^3=8 (bits "111")
Number of CIDs	~~4~~ 6 bits	Number of CIDs sharing this sounding allocation
For (j = 0; j<Num. of CIDs; j++) {		
Shorted basic CID	12 bits	12 LS bits of the MSS basic CID value
Starting Frequency Band	7 bits	Out of 96 bands at most (FFT size dependent)
Number of frequency bands	7 bits	Contiguous bands used for sounding
Power Assignment Method	2 bits	0b00 = equal power; 0b01 = reserved; 0b10 = Interference dependent. Per subcarrier power limit; 0b11 = Interference dependent. Total power limit
Power boost	1 bit	0 = no power boost 1= power boost
Multi-Antenna Flag	1 bit	0=MSS sounds first antenna only 1=MSS sounds all antennas
if (Separability type==0) {		
Cyclic time shift index m	5 bits	Cyclically shifts the time domain symbol by multiples (from 0 to P –1) of N/P where N=FFT size, and P=Max Cyclic Shift Index.
} Else {		
Decimation Offset d	6 bits	Relative starting offset position for the first sounding occupied subcarrier in the sounding allocation
If (Include additional feedback==01) {		
Use same symbol for additional feedback	1 bit	0 = the additional feedback is sent in the symbol(s) following the allocated sounding symbol 1 = the additional feedback is sent in the same symbol as the allocated sounding symbol
}		
}		
Periodicity	~~2~~ 3 bits	~~00=single command, not periodic, or terminate periodicity~~ ~~01=repeat sounding once per frame until terminated~~ ~~10= repeat instructions once per 2 frames~~ ~~11= repeat instructions once per 4 frames~~ 000 = single command, not periodic, or terminate periodicity. Otherwise, repeat sounding once per r frames, where r = 2^(n-1), where n is the decimal equivalent of the periodicity field
}		
}		
} else {		
Permutation	2 bits	0b00 = PUSC perm. 0b01 = FUSC perm. 0b10 = Optional FUSC perm. 0b11 = Adjacent subcarrier perm.

IDcell	6 bits	
Num_Sounding_symbols	3 bits	
for (i=0;i<Num_Sounding_symbols;i++){		
Number of CIDs	7 bits	
For (j=0; j<Number of CIDs; j++) {		
Shortend basic CID	12 bits	12 LS bits of the MSS basic CID value
Subchannel offset	7 bits	The lowest index subchannel used for carrying the burst, starting from subchannel 0
Number of subchannels	3 bits	The number subchannels with subsequent indexes, used to carry the burst.
Periodicity	~~2~~ 3 bits	~~00=single command, not periodic, or terminate periodicity~~ ~~01=repeat sounding once per frame until terminated~~ ~~10= repeat instructions once per 2 frames~~ ~~11= repeat instructions once per 4 frames~~ 000 = single command, not periodic, or terminate periodicity. Otherwise, repeat sounding once per r frames, where r = 2^(n-1), where n is the decimal equivalent of the periodicity field
Power Assignment Method	2 bits	0b00 = equal power; 0b01 = reserved; 0b10 = Interference dependent. Per subcarrier power limit; 0b11 = Interference dependent. Total power limit
Power boost	1 bit	0 = no power boost 1= power boost
}		
}		
}		
Padding	Variable	Pad IE to octet boundary. Bits shall be set to 0
}		

If the field "Include Channel Coefficients" is enabled, then the UL Sounding Command IE() enables the MSS to perform the direct transmission of DL channel coefficients to the BS along with the UL sounding waveform. For the description of the direct channel coefficient encoding method, see Section 8.4.6.2.7.3.

References:

[1] 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

[2] IEEE P802.16e/D5a 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