Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Enhancing MIMO features for OFDMA PHY layer**
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Re:	Contribution on comments to IEEE 802.16d
Abstract	Contribution elaborating of the MIMO enhancements for 802.16d OFDMA
Purpose	Adopt into IEEE 802.16 REVd/D5 document
Notice	
Release	
Patent Policy and Procedures	

Consolidation and elaboration of the MIMO features for 802.16d OFDMA

1 Introduction

This contribution describes the MIMO enhancements to IEEE802.16REVd/D4 OFDMA PHY. The following PHY features are proposed:

- DL MIMO Preamble
- DL MIMO scattered pilot for FUSC, PUSC
- UL MIMO tile, MIMO bin and scattered pilot
- MIMO antenna configurations and transmission format
- MIMO H-ARQ
- MIMO DL fast signaling support

To support MIMO-OFDMA, the MAC enhancements are also proposed, which include:

- MIMO_DL_Config_IE
- DL burst assignment to support adaptive MIMO transmission
- UL burst assignment to support adaptive MIMO transmission
- Dynamic CQICH allocation and the use of CQICH_ID for DL burst allocation

In addition, several basic OFDMA PHY features are described to enhance the performance for the interference limited multi-cell environment.

- DL FUSC and PUSC scattered pilot planning
- Differential Modulation for range extension

2 Specific text changes

2.1 DL MIMO Preamble Construction and backward compatible with non-MIMO SS

[Add the following text into section 8.4.8.4]

---------Start text proposal-------

For each segment as defined in previous sections, two or four antennas are used to transmit the MIMO ~~transmit diversity~~ signals. Therefore from the definition in section 8.4.6.1.1, the following applies:

Each segment uses 2 types of preamble carrier-sets (one for each antenna or pair of antennas) out of the 6 sets in the following manner:

For two transmit MIMO:

Segment 0 - carrier set 0 used by antenna 0, ~~preamble~~ carrier set 3 used by antenna 1
Segment 1 - carrier set 1 used by antenna 0, ~~preamble~~ carrier set 4 used by antenna 1
Segment 2 - carrier set 2 used by antenna 0, ~~preamble~~ carrier set 5 used by antenna 1

For four transmit MIMO:

Segment 0 - carrier set 0 used by antenna 0 and 2, carrier set 3 used by antenna 1 and 3
Segment 1 - carrier set 1 used by antenna 0 and 2, carrier set 4 used by antenna 1 and 3
Segment 2 - carrier set 2 used by antenna 0 and 2, carrier set 5 used by antenna 1 and 3

The same PN series as defined in that 8.4.6.1.1 ~~section~~ is also used in the MIMO ~~transmit diversity~~ mode.

---------End text proposal-------

2.2 DL MIMO scattered pilot for FUSC and PUSC

[Add the following text into section 8.4.8.5]

---------Start text proposal-------

The same symbol structure defined in sections 8.4.6.1.1 and 8.4.6.1.2 shall apply for the MIMO ~~transmit diversity~~ mode. The pilots allocated to each antenna and their details are specified in Table 276. which specifies the pilot sets and actual pilot index used for different MIMO transmissions and only first pair of pilots is shown.

Table 276 DL pilot allocation for MIMO mode

	OFDMA symbol index		Antenna-0	Antenna-1	Antenna-2	Antenna-3
FUSC	k		$PN_{\pi(i)}(2i)$	$-PN_{\pi(i)}(2i+1)^*$	$PN_{\pi(i)+6}(2i)$	$-PN_{\pi(i)+6}(2i+1)^*$
	k+1		$PN_{\pi(i)}(2i+1)$	$PN_{\pi(i)}(2i)^*$	$PN_{\pi(i)+6}(2i+1)$	$PN_{\pi(i)+6}(2i)^*$
PUSC	4-transmit	k	$PN_{\pi(i)+!}(2i)$	$-PN_{\pi(i)+1}(2i+1)^*$	$PN_{\pi(i)+2}(2i)$	$-PN_{\pi(i)+2}(2i+1)^*$
			$PN_{\pi(i)+11}(2i+2)$	$-PN_{\pi(i)+11}(2i+3)^*$	$PN_{\pi(i)+12}(2i+2)$	$-PN_{\pi(i)+12}(2i+3)^*$
		k+1	$PN_{\pi(i)}(2i+1)$	$PN_{\pi(i)}(2i)^*$	$PN_{\pi(i)+2}(2i+1)$	$PN_{\pi(i)+2}(2i)^*$
			$PN_{\pi(i)+11}(2i+3)$	$PN_{\pi(i)+11}(2i+2)^*$	$PN_{\pi(i)+12}(2i+3)$	$PN_{\pi(i)+12}(2i+2)^*$
	2-transmit	k	$PN_{\pi(i)}(2i)$	$-PN_{\pi(i)}(2i+1)^*$		
			$PN_{\pi(i)+6}(2i+2)$	$-PN_{\pi(i)+6}(2i+3)^*$		
			$PN_{\pi(i)+13}(2i+4)$	$-PN_{\pi(i)+13}(2i+5)^*$		
		k+1	$PN_{\pi(i)}(2i+1)$	$PN_{\pi(i)}(2i)^*$		
			$PN_{\pi(i)+6}(2i+3)$	$PN_{\pi(i)+6}(2i+2)^*$		
			$PN_{\pi(i)+13}(2i+5)$	$PN_{\pi(i)+13}(2i+4)^*$		

Where $PN_j(i)$ denotes the j^{th} subcarrier with i^{th} pilot PN sequence and π( ) is the permutation rules defined in Table 271 for FUSC VaribleSet pilot and in Table272 for PUSC respectively.

~~(using Segment X ranging from 0..2). InFDD mode no discontinuity of the pilot set rotation is allowed pilot sets and actual pilot index used for different transmissions (using Segment X ranging from 0..2). In FDD mode no discontinuity of the pilot set rotation is allowed.~~

~~**Table 276—Transmit diversity pilot allocation**~~

~~**Transmission Variable pilots set used Shift indices of variable pilots set by Constant pilot set used**~~

Subchannels allocated to regular users shall be transmitted by Antenna 0 only, while Subchannels that are allocated to ~~transmit diversity~~ MIMO use shall be transmitted from ~~both~~ allocated antennas. ~~Preamble carriers shall be divided between the two antennas by allocating the first carrier (from the pilots carriers allocated for the specified segment) and then every second carrier up to the end of the pilots to antenna 0, and all the remaining carriers to antenna 1.~~

---------End text proposal-------

[Add the following text into section 8.4.8.2.1]

---------Start text proposal-------

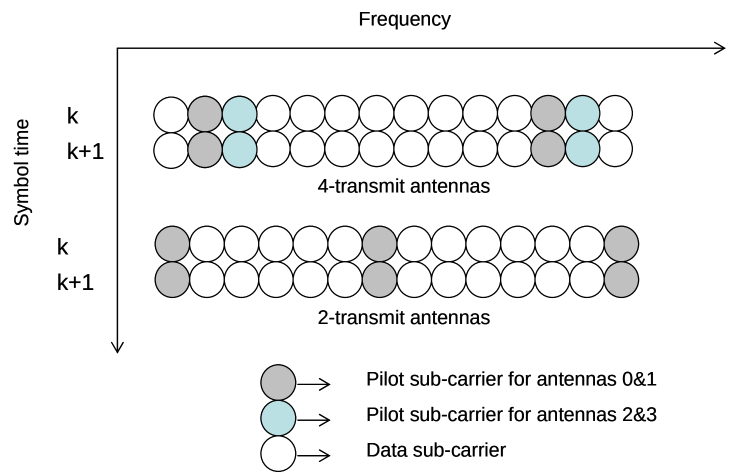

Figure 234 MIMO pilot for DL cluster

---------End text proposal-------

2.3 UL MIMO tile, MIMO UL bin and scattered pilot

[Add the following text into section 8.4.8.6]

---------Start text proposal-------

8.4.8.6 Uplink MIMO

~~Not changed compared to the regular mode of operation.~~
A two transmit MIMO burst in the uplink is defined as MIMO tile and uplink bin, 2-transmit diversity data or 2-transmit spatial multiplexing data can be mapped onto each subcarrier, each MIMO tile is composed of 3-continuous subcarriers and 8-continuous time symbols it's configuration is illustrated in Figure xxx-1. One subchannel is constructed from 8 uplink MIMO tiles, within each burst, there are 160 data subcarriers and 32 fixed-location pilot subcarrier. Each MIMO bin is composed of 6-continuous subcarriers and 8-continuous time symbols it's configuration is illustrated in Figure xxx-2.

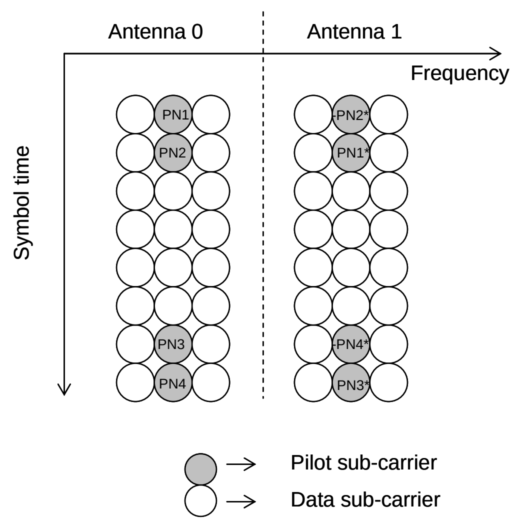

Figure xxx-1 UL MIMO tile

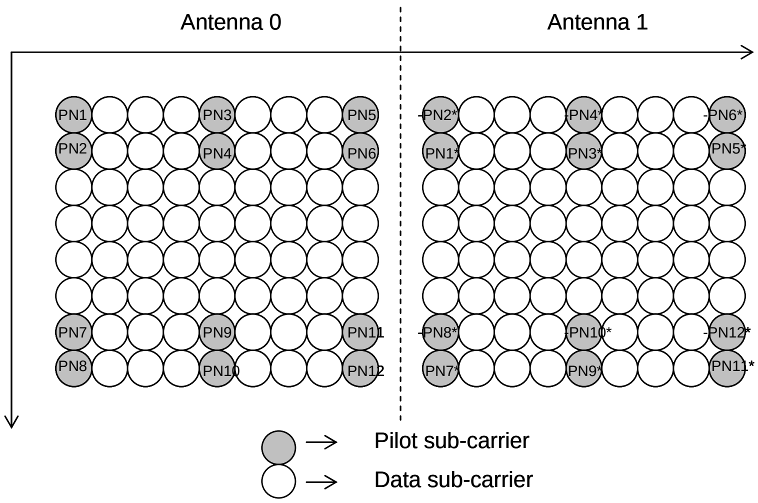

Figure xxx-2 UL MIMO bin

Two single transmit antenna SS's can perform collaborative spatial multiplexing onto the same subcarrier. In this case, the one SS should use the uplink tile with pattern-A, and the other SS should use the uplink tile with pattern-B. Figure xxx-3 depicts the uplink tile and Figure xxx-4 depicts the uplink bin.

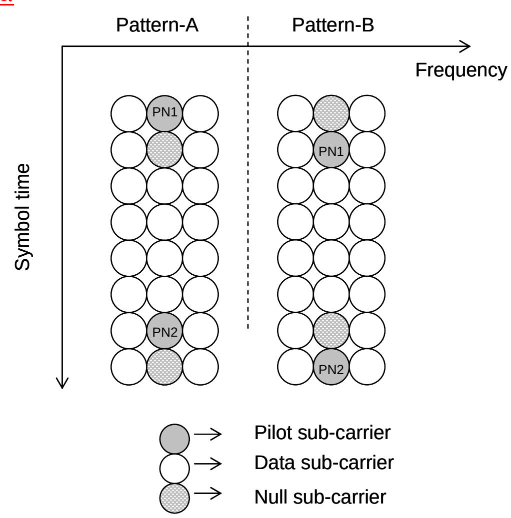

Figure xxx-3. uplink tile for collaborative spatial multiplexing

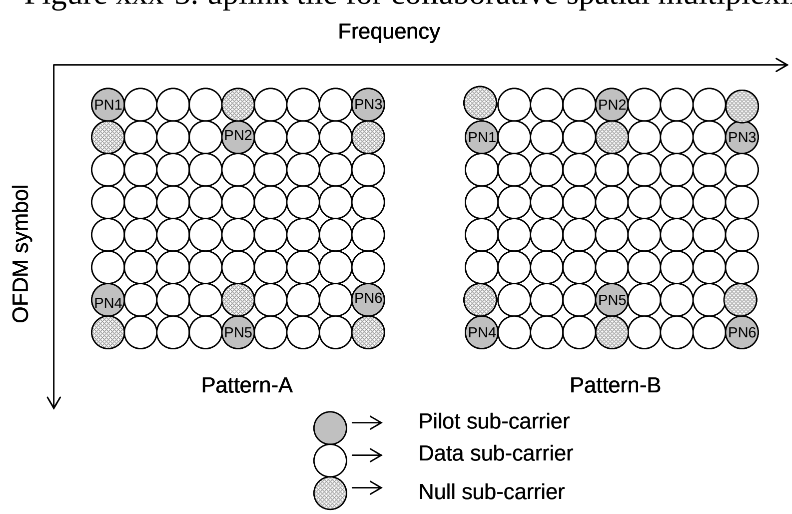

Figure xxx-4 uplink bin for collaborative spatial multiplexing

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---------End text proposal-------
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2.4 *MIMO antenna configurations and transmission format*

[Add the following text into section 8.4.8.8]

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---------Start text proposal-------
```

~~8.4.8.8 Transmission through 4 antennas (possible enhancement)~~

~~The Transmit diversity schemes could be further enhanced by using 4 antennas at the transmission site. Two antennas are now being used in order to transmit each symbol (the first antenna transmits the signal as defined in 8.4.8.2 and 8.4.8.3, and the second transmits the same signal with a complex vector rotation), this transmission shall create additional multipaths received by the user, these multipaths aim are to reduce the effect of the Rayleigh channel variation. This method gives the space diversity associated with the STC/FHDC with an additional multipath creation caused by another antenna; this scheme is presented in Figure 237:~~

~~**Figure 237—Illustration of Transmit diversity using 4 antennas**~~

~~This method does not change the channel estimation process of the user, therefore this scheme could be implemented without any changes made to the Transmit diversity user.~~

8.4.8.8 MIMO antenna configurations and transmission format

Assuming that the N_T is the number of transmit antenna at BS and N_R is the number of receive antennas at terminal SS. The MIMO configuration is denoted as N_TxN_R. For the MIMO down link transmission, the space time coding is employed, a 4x4 *quasi-orthogonal space time transmits diversity* (QOSTTD) code is used as the mother code for space time coding, the QOSTTD can be punctured *in-time* and *in-space* to optimize for different receive antenna configurations. Assuming the MIMO transmission and reception can be expressed by $Y=HS$, where Y^{1xM} is the output of MIMO channel and H^{MxNT} is the MIMO channel and S denotes the space time coding matrix., with the row index indicate the antenna number and column index indicate the symbol time. In all the MIMO transmission configurations the different transmit antenna , the antenna

8.4.8.8.1 4x1 configuration: (space time coding rate = 1)

$$S_{4x1}=\begin{bmatrix} s_1 & -s_2^* & -s_3^* & s_4 & s_5 & -s_7^* & -s_8^* & s_6 & s_9 & -s_{12}^* & -s_{10}^* & s_{11} \\ s_2 & s_1^* & -s_4^* & -s_3 & s_6 & s_8^* & s_7^* & s_5 & s_{10} & -s_{11}^* & s_9^* & -s_{12} \\ s_3 & -s_4^* & s_1^* & -s_2 & s_7 & s_5^* & -s_6^* & -s_8 & s_{11} & s_{10}^* & s_{12}^* & s_9 \\ s_4 & s_3^* & s_2^* & s_1 & s_8 & -s_6^* & s_5^* & -s_7 & s_{12} & s_9^* & -s_{11}^* & -s_{10} \end{bmatrix}$$

8.4.8.8.2 4x2 configuration: (space time coding rate = 2)

By in-time puncturing the columns 3&4, 7&8 and 11&12 of S_{4x1}

$$S_{4x2}=\begin{bmatrix} s_1 & -s_2^* & s_5 & -s_7^* & s_9 & -s_{12}^* \\ s_2 & s_1^* & s_6 & s_8^* & s_{10} & -s_{11}^* \\ s_3 & -s_4^* & s_7 & s_5^* & s_{11} & s_{10}^* \\ s_4 & s_3^* & s_8 & -s_6^* & s_{12} & s_9^* \end{bmatrix}$$

8.4.8.8.3 4x4 configuration (space time coding rate = 4)

By in-time puncturing the columns 1, 3 and 5 of S_{4x2}.

$$S_{4x4}=\begin{bmatrix} s_1 & s_5 & s_9 \\ s_2 & s_6 & s_{10} \\ s_3 & s_7 & s_{11} \\ s_4 & s_8 & s_{12} \end{bmatrix}$$

8.4.8.8.4 2x1 configuration: (space time coding rate = 1)

By in-space puncturing antenna 3&4 and in-time puncturing columns 3&4 and 5&6 of S_{4x2}

$$S_{2x1}=\begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \end{bmatrix}$$

8.4.8.8.5 2x2, 2x4 configurations: (space time coding rate = 2),

By in-time puncturing the even columns of S_{2x1}:

$$S_{2x2,2x4}=\begin{bmatrix} s_1 \\ s_2 \end{bmatrix}$$

The MIMO transmission formats S_{4x1}, S_{4x2} and S_{2x1} generate space time transmit diversity (STTD), and the formats S_{4x4} and $S_{2x2,2x4}$ generate the vertical spatial multiplexing (SM)

---------End text proposal-------

2.5 MIMO H-ARQ

[Add new section 8.4.8.9]

---------Start text proposal-------

8.4.8.9 MIMO sub-packet generation for H-ARQ

In the MIMO transmission, for both downlink and uplink, the HARQ re-transmission sub-packet can be generated by using the Space time code incremental redundancy version. The transmission rule for space time coded incremental redundancy codes set is listed in Table aaa-2 and Table aaa-3.

Table aaa-2 H-ARQ Incremental Space time coding redundancy (2-transmit antenna case)

	initial transmission	odd re-transmission	even re-transmission
Space time code incremental redundancy	$S_{2xN_R}^{(0)}=\begin{bmatrix} s_1 & s_3 \\ s_2 & s_4 \end{bmatrix}$	$S_{2xN_R}^{(odd)}=\begin{bmatrix} -s_2^* & -s_4^* \\ s_1^* & s_3^* \end{bmatrix}$	$S_{2xN_R}^{(even)}=\begin{bmatrix} s_1 & s_3 \\ s_2 & s_4 \end{bmatrix}$

Table aaa-3 H-ARQ Incremental Space time coding redundancy (4-transmit antenna case)

	initial transmission	odd re-transmission	even re-transmission
Space time code incremental redundancy	$S_{4xN_R}^{(0)}=\begin{bmatrix} s_1 & s_5 \\ s_2 & s_6 \\ s_3 & s_7 \\ s_4 & s_8 \end{bmatrix}$	$S_{4xN_R}^{(odd)}=\begin{bmatrix} -s_2^* & -s_6^* \\ s_1^* & s_5^* \\ -s_4^* & -s_8^* \\ s_3^* & s_7^* \end{bmatrix}$	$S_{4xN_R}^{(even)}=\begin{bmatrix} s_1 & s_5 \\ s_2 & s_6 \\ s_3 & s_7 \\ s_4 & s_8 \end{bmatrix}$

The SS shall process the initial transmission, 1st re-transmission and 2nd re-transmission etc in the form of space time decoding. The re-transmission of FEC code word shall use the Chase combing re-transmission version, in this case, the sub-packet index is always set to zero in section 8.4.9.2.3.6.

---------End text proposal-------

2.6 Fast DL signaling channel support

[Add new section 8.4.4.8]

---------Start text proposal-------

8.4.4.8 MIMO fast signaling zone

The AAS diversity MAP zone is used for the MIMO mode to transmit MIMO specific compressed DL_MAP such as MIMO DL Enhanced IE format. The construction of this zone is as follows: the message with QPSK rate ½ with 4 repetitions is denoted as $s_{m,n}$ where *m* denotes subcarrier number *n* denotes the OFDM symbol number. MIMO_DL_Config_IE message is then differentially space time encoded in the OFDM symbol direction as: $Z_n = \frac{1}{\sqrt{2}} Z_{n-1} X_n$ where, $X_i = \begin{bmatrix} s_{m,n} & s_{m,n+1} \\ -s_{m,n}^{*} & s_{m,n+1}^{*} \end{bmatrix}$ for $m = N_{offset}, N_{offset}+1, \ldots$, where the 1st row of Z_n is mapped onto 1st transmit antenna and 2nd row of Z_n is mapped onto 2nd transmit antenna and the N_{offset} is the sub-carrier offset.

---------End text proposal-------

2.7 MIMO_DL_Config_IE

[Change the following text in table 244]

---------Start text proposal-------

Table 224-OFDMA downlink Frame Prefix format

Syntax	Size	Notes
DL_Frame_Prefix_Format() {	6 bits	
First channel	6 bits	
Last channel	6 bits	
Midambles Used	1 bit	0 - No midambles on downlink 1 - Optional midambles used in downlink
Ranging_Change_Indication	1 bit	
Repetition_Coding_Indication	2 bits	00 - No repetition coding on DL-MAP 01 - Repetition coding of 2 used on DL-MAP 10 - Repetition coding of 4 used on DL-MAP 11 - *reserved*; shall be set to zero.
AAS/MIMO Indication	1 bit	0 – AAS 1 - MIMO
DL-Map_Length	7 bits	
}		

---------End text proposal-------

2.8 DL Burst Assignment to Support Adaptive MIMO Transmission

[Add a new section 8.4.5.3.8]

8.4.5.3.8 MIMO DL Basic IE format

In the DL-MAP, a MIMO-enabled BS may transmit DIUC=15 with the MIMO_DL_Basic_IE() to indicate the MIMO mode of the subsequent downlink allocation to a specific MIMO-enabled SS' CID. The MIMO mode indicated in the MIMO_DL_Basic_IE() shall only apply to the subsequent downlink allocation until the end of frame.

Table x - MIMO DL Basic IE

Syntax	**Size**	**Notes**
MIMO_DL_Basic_IE () {		
Extended DIUC	4 bits	0x05
Length	8 bits	Length in bytes
Num_Assign	8 bits	
For (i = 0; i< Num_Assign; i++) {		
CID	16 bits	SS basic CID
OFDMA Symbol offset	10 bits	
Subchannel offset	5 bits	
Boosting	3 bits	
No. OFDMA Symbols	9 bits	
No. subchannels	5 bits	
STC_Mode	2 bits	0: STTD; 1: SM mode 1; 2: SM mode 2
If ((STC == 0) || (STC ==1) {		
DIUC }	4 bits	0-11 burst profiles
else {		
Num_layer	2 bits	
for (i = 0; i <Num_layer; i++) {		
Layer_index	2 bits	
DIUC}	4 bits	
}}}		

2.9 UL Burst Assignment to Support Adaptive MIMO Transmission

[Add a new section 8.4.5.4.10]

8.4.5.4.10 MIMO UL Basic IE format

In the UL-MAP, a MIMO-enabled BS may transmit UIUC=15 with the MIMO_UL_Basic_IE() to indicate the MIMO mode of the subsequent uplink allocation to a specific MIMO-enabled SS' CID. The MIMO mode indicated in the MIMO_UL_Basic_IE() shall only apply to the subsequent uplink allocation until the end of frame.

Table x - MIMO UL Basic IE

Syntax	Size	Notes
MIMO_UL_Basic_IE () {		
Extended UIUC	4 bits	0x02
Length	4 bits	Length in bytes
Num_Assign		

For (i = 0; i < Num_assign; i++) {		
CID	16 bits	SS basic CID
UIUC	4 bits	
MIMO_Control	1 bit	For dual transmission capable SS 0: STTD; 1: SM For Collaborative SM capable SS 0: pilot pattern A; 1: pilot pattern B
Duration	48 bits	In OFDMA slots (see 8.4.3.1)

3 Additional OFDMA PHY Enhancements

3.1 DL FUSC scattered pilot planning

[Add the following text into section 8.4.6.1.2.1.1]

---------Start text proposal-------

8.4.6.1.2.1.1 Downlink subchannels subcarrier allocation

Each subchannel is composed of 48 subcarriers. The subchannel indices are formulated using a RS series, and is allocated out of the data subcarriers domain. The data subcarriers domain includes 48*32=1536 subcarriers, which are the remaining subcarriers after removing from the subcarrier's domain (0-2047) all possible pilots and zero subcarriers (including the DC subcarrier). The allocated vlaues of the variableSet pilot defined in Table 271 shall add an offset (ID_{Cell})mod12, and since the down link transmission is OFDMA symbol pairs based therefore the allocated of the variableSet pilot shall be based on the OFDMA symbol pair. After allocating the data subcarriers domain, the procedure of partitioning those subcarriers into subchannels shall be as specified in section 8.4.6.1.3.

---------End text proposal-------

3.2 Differential Modulation for range extension

[Add the following text into section 8.4.9.2]

---------Start text proposal-------

Additional differential modulations for MIMO, SISO and SIMO are listed in table zzz-1

Table zzz-1 differential space time code for 1, 2 and 4 transmit antennas

Antenna Configuration	Modulation Rule	X_i
1-transmit antenna	$Z_i = \frac{1}{\sqrt{2}} Z_{i-1} X_i$	Table xxx-2
2-transmit antenna	$Z_i = \frac{1}{\sqrt{2}} Z_{i-1} X_i$	$X_i = \begin{bmatrix} x_1 & x_2 \\ -x_2^* & x_1^* \end{bmatrix}$
4-transmit antenna	$Z_i = \frac{1}{\sqrt{2}} Z_{i-1} X_i$	$X_i = \begin{bmatrix} x_1 & x_2 & \frac{x_3}{\sqrt{2}} & \frac{x_3}{\sqrt{2}} \\ -x_2^* & x_1^* & \frac{x_3}{\sqrt{2}} & -\frac{x_3}{\sqrt{2}} \\ \frac{x_3^*}{\sqrt{2}} & \frac{x_3^*}{\sqrt{2}} & \frac{-x_1 - x_1^* + x_2 - x_2^*}{2} & \frac{x_1 - x_1^* - x_2 - x_2^*}{2} \\ \frac{x_3^*}{\sqrt{2}} & -\frac{x_3^*}{\sqrt{2}} & \frac{x_1 - x_1^* + x_2 + x_2^*}{2} & \frac{-x_1 - x_1^* - x_2 + x_2^*}{2} \end{bmatrix}$

For single antenna transmission the input bit and symbol mapping is shown in Table zzz-2

Table zzz-2 π/4-DQPSK modulation

Codeword b_0b_1	Modulation symbol, X_i
00	1
01	j
11	-1
10	-j

---------End text proposal-------

3.3 Dynamic CQICH Allocation and the Use of CQICH_ID for DL Burst Allocation

The number of available CQICHs on the uplink is dependent on the amount of uplink sub-carriers and OFDM symbols allocated for the CQICHs. The fast CQI feedback represents non-negligible overhead on the uplink and therefore the CQICH resource should be dynamically allocated and de-allocated to different SSs. The dynamic allocation and de-allocation to different SSs should be done without incurring too much downlink signaling overhead. We therefore propose to allow the option of allocating/de-allocating the CQICH on a multiple-burst basis rather than on a per-burst basis. We propose to broadcast the region allocated to CQICHs on the **Uplink Channel Descriptor (UCD)**. As broadcast in the UCD, there is a CQICH_ID associated with each CQICH. Each CQICH is dynamically allocated or de-allocated to a SS through a new UL-MAP information element called **CQICH_Alloc_IE()**. Once allocated, the SS transmit channel quality information on the assigned CQICH on every subsequent frames, until the SS receives a CQICH_Alloc_IE() to de-allocate to assigned CQICH.

When a SS is assigned a CQICH, there is a one-to-one mapping between the SS and the CQICH_ID assigned. Therefore, we can replace the 16-bit basic CID by the smaller size CQICH_ID when allocating DL burst to the SS. This reduces the DL signaling overhead. To achieve this, we introduce a new information element on the DL-MAP, i.e. **MIMO_DL_Enhanced_IE()**.

[Modify Table 18 in section 6.4.2.4.3]

Table 18 – UCD Message Format

Syntax	Size	Notes
UCD_Message_Format() {		
Management Message Type = 0	8 bits	
Uplink channel ID	8 bits	
Configuration Change Count	8 bits	
Minislot size	8 bits	
Ranging Backoff Start	8 bits	
Ranging Backoff End	8 bits	
Request Backoff Start	8 bits	
Request Backoff End	8 bits	
TLV Encoded information for the overall channel	*variable*	TLV specific
Begin PHY Specific Section {		See applicable PHY section.
for (*i* = 1; *i* <= *n*; *i*++) {		For each uplink burst profile 1 to *n*.
Uplink_Burst_Profile	*variable*	PHY specific
}		
CQICH_Profile_Included	1 bit	0: no CQICH Profile included 1: CQICH Profile included

If (CQICH_Profile_Included) {		
CQICH_Profile	0 or *variable*	See section 8.4.5.7
}		
}		
}		

[Add a section 8.4.5.4.10 to allow the option of dynamic allocation/de-allocation of the CQICH on a multiple-burst basis]

8.4.5.4.10 CQICH Allocation IE Format

CQICH channels as defined in the UCD are dynamically allocated and de-allocated to different SSs using the CQICH_Alloc_IE(). The allocation to a SS takes effect on the subsequent UL frames until a de-allocation message is received on the CQICH_Alloc_IE(). To allocate or de-allocated CQICH, the BS shall transmit UIUC=15 with the CQICH_Alloc_IE().

Table x – CQICH Alloc IE

Syntax	Size	Notes
CQICH_Alloc_IE () {		
Extended UIUC	4 bits	0x03
Length	8 bits	Length in bytes of following fields
Num_alloc	5 or 7 bits	System parameter (depend on the number of CQICHs supported by the system)
For (i = 0; i <Num_alloc; i++) {		
CID	16 bits	SS basic CID
CQICH_ID }}	5 or 7 bits	Number of bits is defined in the CQICH_Profile (see section 8.4.5.7)

A CQICH_ID of all zeros indicates de-allocation of a previously assigned CQICH from the SS. When a SS receives the CQICH_ID of all zeros, the SS shall stop transmitting on the currently assigned CQICH on the subsequent UL frame and frames thereafter.

[Add a new section 8.4.5.3.9 to use CQICH_ID for DL burst assignment]

8.4.5.3.9 MIMO DL Enhanced IE format

In the DL-MAP, a MIMO-enabled BS may transmit DIUC=15 with the MIMO_DL_Enhanced_IE() to indicate the MIMO mode of the subsequent downlink allocation to a specific MIMO-enabled SS identified by the CQICH_ID previously assigned to the SS. The MIMO mode indicated in the MIMO_DL_Enhanced_IE() shall only apply to the subsequent downlink allocation until the end of frame.

Table x - MIMO DL Enhanced IE

Syntax	**Size**	**Notes**
MIMO_DL_Enhanced_IE () {		
Extended DIUC	4 bits	0x06
Length	8 bits	Length in bytes
Num_Assign	8 bits	

For (i = 0; i< Num_Assign; i++) {		
CQICH_ID	5 or 7 bits	CQICH_ID to which a SS is assigned
OFDMA Symbol offset	10 bits	
Subchannel offset	5 bits	
Boosting	3 bits	
No. OFDMA Symbols	9 bits	
No. subchannels	5 bits	
STC_Mode	2 bits	0: STTD; 1: SM mode 1; 2: SM mode 2
If ((STC == 0) || (STC == 1))		
{ DIUC }	4 bits	0-11 burst profiles
else {		
Num_layer	2 bits	
for (i = 0; i <Num_layer; i++) {		
Layer_index	2 bits	
DIUC}	4 bits	
}}}		

[Add a new section 8.4.5.7 for CQICH_Profile broadcast in UCD]

8.4.5.7 CQICH Profile

The Table x describes the CQICH Profile in the UCD message.

Table x – CQICH_Profile

Syntax	Size	Notes
Length of CQICH_ID field	1 bit	0: 5-bit CQICH_ID 1: 7-bit CQICH_ID
Num_CQICH	5 bits or 7 bits	
for (i = 0; i< Num_CQICH; i++) {		
CQICH_ID	5 bits or 7 bits	
Duration	48 bits	
Reporting rate	2 bits	00: Full rate CQI reporting 01: Half rate CQI reporting 10: quarter rate CQI reporting 11: 1/8 rate CQI reporting
Offset	3 bits	In OFDMA slots (see 8.4.3.1)
}		