Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Per Stream Power Control in CQICH Enhanced Allocation IE**
Date Submitted	**2005-03-09**
Source(s)	Xiangyang (Jeff) Zhuang Timothy A. Thomas Frederick W. Vook Kevin L. Baum Mark C. Cudak Motorola Labs 1301 E. Algonquin Road Schaumburg, IL 60196 Email: Jeff.Zhuang@motorola.com
Re:	IEEE P802.16-REVe/D6
Abstract	Defines the missing details on per stream power control feedback in CQICH enhanced allocation IE
Purpose	Adoption of proposed changes into P802.16e
Notice	
Release	
Patent Policy and Procedures	

Per Stream Power Control in CQICH Enhanced Allocation IE

Xiangyang (Jeff) Zhuang, Timothy A. Thomas, Frederick W. Vook, Kevin L. Baum, Mark C. Cudak
Motorola Labs, Schaumburg, IL, USA

1 Introduction

In section 8.4.5.4.15 of IEEE 80216e/D6, a few new types of feedback information are specified in CQICH_Enhanced_Alloc_IE() so that the SS can transmit feedback information of that specified type on the assigned CQICH. However, there is no detail on how the payload bits should be if the feedback type is "101", i.e., when per stream power control feedback is required by the base.

This contribution provides the missing specifications on how per-stream power weighting feedback is performed. Power weighting on different streams can be very effective in dealing with the different spatial channel quality in MIMO communications. When the power weighting of streams are ordered and summed up to one, the quantization of the power weightings can be done with very fine granularity and also very efficiently (three bits for up to two streams, six bits for up to three streams, and nine bits for up to four streams).

2 Feedback Types and Per Stream Power Control Feedback

In table 302a of section 8.4.5.4.15 of IEEE 80216e/D6, a three bit feedback type field is defined for each CQICH. For example, "000" indicates that the CQICH should carry the information about Fast DL measurement/Default Feedback with antenna grouping, i.e., both the DL SNR measurement and MIMO mode can be fed back where some codewords for MIMO mode feedback are interpreted differently in case of antenna grouping ("000"), antenna selection ("001"), or reduced precoding matrix code book ("010"), as detailed in section 8.4.5.4.10.7. Feedback type "011" indicates that the MSS shall report the quantized MIMO precoding coefficient according to the mapping defined in section 8.4.5.4.10.6. Feedback type "100" indicates that the MSS shall report the index to the precoding matrix defined in 8.4.5.4.11. However, **bits "101" is define twice**: once for "channel matrix information" and once for "per stream power control". The "channel matrix information" might mean the same as quantized MIMO coefficients by bits "011". If so, it can be deleted. Otherwise, a new bit word out of the reserved ones must be used for "per stream power control". **The encoding of the payload bits for "per stream power control" is not defined anywhere.**

Per stream power weighting can be very effective in dealing with the different spatial channel quality in MIMO communications. One way to inform the base about the different quality of spatial channels is to use multiple CQICH to convey the post-processing SNR of each stream. Then the BS has to choose a different coding/modulation to take advantage of that information. Sometime, there is no coding/modulation combination that can match the SNR of the stream, in which case adjusting the power of each stream can be found useful. Still, per stream SNR feedback and coding/modulation selection means additional control overhead for both uplink and downlink. In addition, if the receiver uses some non-linear MIMO demodulation methods such as ML or successive cancellation, there is no effective SNR for each stream to be computed. One alternative to reduce the overhead is to use the same code and modulation for all streams, but with different power weighting so that the mean squared error at the particular receiver (e.g., one uses successive cancellation) is equalized on each stream. Reference [1] gives a description of how the power weighting may be calculated. There are other cases that power weighting can be found useful too, such as described before. In addition, the power weighting can be combined with beamforming codebook weights.

For the quantization of power weightings for all streams, a more efficient quantization method is described here after recognizing the fact that the range of each stream can be refined after the power weightings of previous streams are quantized. The method sequentially quantizes the power weightings of the data streams in a numerical range that depends on the power weighting of the previously quantized stream powers. Also noted here that the streams are indexed in the order of decreasing power weighting and all power weightings sum up to one. So the number of bits assigned to quantize each stream can be smaller due to the decreasing range. Due to the fact that only a minimum dynamic range is quantized, the quantization granularity is very fine. In most of the cases a granularity of less than 0.01 in power difference is achieved with extreme cases being about 0.08.

The quantization scheme is given as (note that the quantization step includes both the lower and upper range values and the remaining B-2 levels are uniformly positioned between the lower and upper limits):

1. Determine the maximum number of data streams that the BS and MSS support based on the number of antennas at MSS and BS (e.g., up to N_s data streams)
2. Determine the power weighting P_1 of the strongest data stream between $1/N_s$ and 1. Quantize the squared root of P_1 (i.e., α_1=sqrt(P_1)) with B_1 bits (B_1=3 if N_s=2, B_1=4 if N_s=3 or 4).
3. For the m-th stream where m=2 to N_s-1, determine the power weighting of the m-th data stream that should be in the range of $\frac{1}{N_s+1-m}(1-\sum_{n=1}^{m-1}\alpha_n^2) \le \alpha_m^2 \le \min(\alpha_{m-1}^2, 1-\sum_{n=1}^{m-1}\alpha_n^2)$. Quantize α_m with B_m bits (B_2=2 if N_s=3, B_2=3 and B_3=2 if N_s=4).
4. The power weighting of the last stream is $1-\sum_{n=1}^{N_s-1}\alpha_n^2$, which does not need to be fed back.

Thus the total amount of feedback (in number of bits) needed for the power weight is $\sum_{m=1}^{N_s-1} B_m$. A three-bit CQICH is allocated if the feedback for up to N_s=2 streams is requested by the BS. A six-bit CQICH is allocated (or two three-bit CQICH) if the feedback for up to N_s=3 streams is requested by the BS. A six-bit and a three-bit CQICH (or 3 three-bit CQICH) are allocated if the feedback for up to N_s=4 streams is requested by the BS. Note that if the MSS preferred a stream number smaller than N_s, the remaining streams will be allocated with zero power.

3 Specific Text Changes

[NOTE: In the following, we propose that the working group adopt one of two functionally equivalent remedies that enable the per-stream power control scheme described above: The first version (Section 3.1) specifies the per-stream power control strategy with both equations and tables to show the specific encoding values. The second version (Section 3.2) omits the tables and contains only the equations.]

3.1 Remedy 1 – Version with Formulas and Tables

[Insert the following after Section 8.4.5.4.10.10:]

8.4.5.4.10.11 Per Stream Power Control

When the feedback type field in CQICH Enhanced Allocation IE is "101" = Per stream power control, the BS require the power weighting of each spatial streams that can be supported by the MSS if the BS considers sending more than one stream to this MSS. If required by the BS, the MSS shall report the square root of the power weighting factors of the spatial streams (i.e., to report α_i with i=1..N_s (number of streams) where $\sum_i \alpha_i^2=1$). The first stream shall correspond to the largest weighting and the second stream to the second largest weighting, and so on. The power weighting of the last stream can be derived as the remaining power and thus needs not to be reported.

The feedback allocation and power weighting quantization procedure is as follows:

If the BS wants the MSS to feed back the power weightings for up to Ns=2 streams, one 3-bit CQI channel is allocated. A numerical range of [$\sqrt{1/2}$,1] is first uniformly divided into 2^3=8 levels (i.e., with the interval between levels being (1-$\sqrt{1/2}$)/7) and the MSS quantizes the squared root of the power weighting of the first stream to the nearest level according to table XXX. All "1" means the first stream uses all transmit power (i.e., a single stream is preferred by the MSS, rather than two streams).

Table XXX. Encoding of the payload bits for per-stream power control (up to 2 stream case)

α_1 bits	000	001	010	011	100	101	110	111
α_1	0.7071	0.7489	0.7908	0.8326	0.8745	0.9163	0.9582	1.0000

If the BS wants the MSS to feed back power weighting for up to Ns=3 streams, one 6-bit CQI (or two 3-bit CQI channels) is allocated. The first power weighting is quantized using 4 bits and the second using 2 bits. A numerical range of [$\sqrt{1/3}$,1] is first uniformly divided into 2^4=16 levels (i.e., with the interval between levels being (1-$\sqrt{1/3}$)/15) and the MSS quantizes the squared root of the power weighting of the first stream to the nearest level (denoted as α_1). Then, 2 bits are used to quantize the range of [$\frac{1}{2}(1-\alpha_1^2)$, min($\alpha_1^2, 1-\alpha_1^2$)]. The exact quantization is given in table YYY-1 and YYY-2.

Table YYY-1. Encoding of the payload bits for per-stream power control (up to 3 stream case)

α_1 bits	0000	0001	0010	0011	0100	0101	0110	0111
α_1	0.5774	0.6055	0.6337	0.6619	0.6901	0.7182	0.7464	0.7746

α_1 bits	1000	1001	1010	1011	1100	1101	1110	1111
α_1	0.8028	0.8309	0.8591	0.8873	0.9155	0.9436	0.9718	1.0000

Table YYY-2. Encoding of the payload bits for per-stream power control (up to 3 stream case)

α_1 bits	0000	0001	0010	0011	0100	0101	0110	0111
α_2: "00"	0.5774	0.5627	0.5470	0.5301	0.5118	0.4920	0.4706	0.4472
"01"	0.5774	0.5770	0.5759	0.5740	0.5712	0.5599	0.5355	0.5090
"10"	0.5774	0.5913	0.6048	0.6179	0.6306	0.6279	0.6005	0.5707
"11"	0.5774	0.6055	0.6337	0.6619	0.6901	0.6958	0.6655	0.6325
α_1 bits	1000	1001	1010	1011	1100	1101	1110	1111
α_2: "00"	0.4216	0.3934	0.3619	0.3261	0.2845	0.2340	0.1667	0
"01"	0.4799	0.4477	0.4118	0.3711	0.3238	0.2663	0.1897	0
"10"	0.5381	0.5020	0.4618	0.4162	0.3631	0.2986	0.2127	0
"11"	0.5963	0.5564	0.5118	0.4612	0.4024	0.3310	0.2357	0

If the BS wants the MSS to feed back power weighting for up to Ns=4 streams, one 6-bit CQI and one 3-bit CQI (or three 3-bit CQI channels) are allocated. The first power weighting is quantized using 4 bits, the second using 3 bits, and the third using 2 bits. A numerical range of [$\sqrt{1/4}$,1] is first uniformly divided into 2^4=16 levels (i.e., with the interval between levels being (1-$\sqrt{1/4}$)/15) and the MSS quantizes the squared root of the power weighting of the first stream to the nearest level (denoted as α_1). Then, 3 bits are used to quantize the range of [$\frac{1}{3}(1-\alpha_1^2)$, min($\alpha_1^2$,$1-\alpha_1^2$)] for the second stream squared-root power weighting (denotes as α_2). Finally, 2 bits are used to quantize the range of [$\frac{1}{2}(1-\alpha_1^2-\alpha_2^2)$, min($\alpha_2^2$,$1-\alpha_1^2-\alpha_2^2$)] for the third stream squared-root power weighting. The exact quantization is given in table ZZZ-1, ZZZ-2, and ZZZ-3.

Table ZZZ-1. Encoding of the payload bits for per-stream power control (up to 4 streams case)

α_1 bits	0000	0001	0010	0011	0100	0101	0110	0111
α_1	0.5000	0.5333	0.5667	0.6000	0.6333	0.6667	0.7000	0.7333
α_1 bits	1000	1001	1010	1011	1100	1101	1110	1111
α_1	0.7667	0.8000	0.8333	0.8667	0.9000	0.9333	0.9667	1.0000

Table ZZZ-2. Encoding of the payload bits for per-stream power control (up to 4 streams case)

α_1 bits	0000	0001	0010	0011	0100	0101	0110	0111
α_2: "000"	0.5000	0.4884	0.4757	0.4619	0.4468	0.4303	0.4123	0.3925
"001"	0.5000	0.4948	0.4887	0.4816	0.4734	0.4641	0.4534	0.4336

"010"	0.5000	0.5012	0.5017	0.5013	0.5001	0.4979	0.4945	0.4746
"011"	0.5000	0.5076	0.5147	0.5211	0.5267	0.5316	0.5356	0.5157
"100"	0.5000	0.5141	0.5277	0.5408	0.5534	0.5654	0.5767	0.5567
"101"	0.5000	0.5205	0.5407	0.5605	0.5800	0.5991	0.6178	0.5978
"110"	0.5000	0.5269	0.5537	0.5803	0.6067	0.6329	0.6589	0.6388
"111"	0.5000	0.5333	0.5667	0.6000	0.6333	0.6667	0.7000	0.6799
α_1 bits	1000	1001	1010	1011	1100	1101	1110	1111
$\alpha_{2:}$ "000"	0.3707	0.3464	0.3191	0.2880	0.2517	0.2073	0.1478	0
"001"	0.4095	0.3826	0.3525	0.3182	0.2780	0.2290	0.1633	0
"010"	0.4482	0.4189	0.3859	0.3483	0.3043	0.2506	0.1787	0
"011"	0.4870	0.4551	0.4193	0.3784	0.3306	0.2723	0.1942	0
"100"	0.5257	0.4913	0.4526	0.4085	0.3569	0.2940	0.2097	0
"101"	0.5645	0.5275	0.4860	0.4386	0.3833	0.3157	0.2251	0
"110"	0.6033	0.5638	0.5194	0.4688	0.4096	0.3373	0.2406	0
"111"	0.6420	0.6000	0.5528	0.4989	0.4359	0.3590	0.2560	0

Table ZZZ-3. Encoding of the payload bits for per-stream power control (up to 4 streams case)

$\alpha_1\alpha_2$bits	0000000	0000001	0000010	0000011	0000100	0000101	0000110	0000111
$\alpha_{3:}$"00"	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
"01"	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
"10"	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
"11"	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
$\alpha_1\alpha_2$bits	0001000	0001001	0001010	0001011	0001100	0001101	0001110	0001111
$\alpha_{3:}$"00"	0.4884	0.4851	0.4818	0.4785	0.4750	0.4715	0.4679	0.4643
"01"	0.4884	0.4884	0.4883	0.4882	0.4880	0.4878	0.4876	0.4873
"10"	0.4884	0.4916	0.4948	0.4979	0.5011	0.5042	0.5073	0.5103

"11"	0.4884	0.4948	0.5012	0.5076	0.5141	0.5205	0.5269	0.5333
$\alpha_1\alpha_2$bits	0010000	0010001	0010010	0010011	0010100	0010101	0010110	0010111
α_3: "00"	0.4757	0.4691	0.4622	0.4550	0.4475	0.4396	0.4315	0.4230
"01"	0.4757	0.4756	0.4753	0.4749	0.4742	0.4733	0.4722	0.4709
"10"	0.4757	0.4822	0.4885	0.4948	0.5009	0.5070	0.5129	0.5188
"11"	0.4757	0.4887	0.5017	0.5147	0.5277	0.5407	0.5537	0.5667
$\alpha_1\alpha_2$bits	0011000	0011001	0011010	0011011	0011100	0011101	0011110	0011111
α_3: "00"	0.4619	0.4517	0.4408	0.4292	0.4169	0.4036	0.3894	0.3742
"01"	0.4619	0.4617	0.4610	0.4598	0.4582	0.4559	0.4432	0.4258
"10"	0.4619	0.4716	0.4812	0.4905	0.4995	0.5082	0.4969	0.4775
"11"	0.4619	0.4816	0.5013	0.5211	0.5408	0.5605	0.5507	0.5292
$\alpha_1\alpha_2$bits	0100000	0100001	0100010	0100011	0100100	0100101	0100110	0100111
α_3: "00"	0.4468	0.4329	0.4176	0.4009	0.3825	0.3622	0.3397	0.3145
"01"	0.4468	0.4464	0.4451	0.4428	0.4353	0.4123	0.3866	0.3579
"10"	0.4468	0.4599	0.4726	0.4848	0.4882	0.4623	0.4335	0.4013
"11"	0.4468	0.4734	0.5001	0.5267	0.5410	0.5123	0.4804	0.4447
$\alpha_1\alpha_2$bits	0101000	0101001	0101010	0101011	0101100	0101101	0101110	0101111
α_3: "00"	0.4303	0.4124	0.3922	0.3694	0.3434	0.3135	0.2784	0.2357
"01"	0.4303	0.4296	0.4274	0.4204	0.3909	0.3568	0.3168	0.2682
"10"	0.4303	0.4469	0.4626	0.4714	0.4383	0.4001	0.3552	0.3008
"11"	0.4303	0.4641	0.4979	0.5224	0.4857	0.4434	0.3937	0.3333
$\alpha_1\alpha_2$bits	0110000	0110001	0110010	0110011	0110100	0110101	0110110	0110111
α_3: "00"	0.4123	0.3901	0.3643	0.3340	0.2978	0.2533	0.1947	0.1000
"01"	0.4123	0.4112	0.4077	0.3801	0.3390	0.2883	0.2216	0.1138
"10"	0.4123	0.4323	0.4511	0.4262	0.3801	0.3232	0.2485	0.1276
"11"	0.4123	0.4534	0.4945	0.4724	0.4212	0.3582	0.2754	0.1414

$\alpha_1\alpha_2$bits	0111000	0111001	0111010	0111011	0111100	0111101	0111110	0111111
$\alpha_{3:}$"00"	0.3925	0.3703	0.3442	0.3133	0.2759	0.2290	0.1645	0
"01"	0.3925	0.3914	0.3877	0.3566	0.3140	0.2606	0.1872	0
"10"	0.3925	0.4125	0.4312	0.3998	0.3521	0.2923	0.2099	0
"11"	0.3925	0.4336	0.4746	0.4431	0.3902	0.3239	0.2327	0
$\alpha_1\alpha_2$bits	1000000	1000001	1000010	1000011	1000100	1000101	1000110	1000111
$\alpha_{3:}$"00"	0.3707	0.3497	0.3251	0.2959	0.2606	0.2163	0.1554	0
"01"	0.3707	0.3696	0.3661	0.3367	0.2966	0.2461	0.1768	0
"10"	0.3707	0.3895	0.4072	0.3776	0.3325	0.2760	0.1983	0
"11"	0.3707	0.4095	0.4482	0.4184	0.3685	0.3059	0.2197	0
$\alpha_1\alpha_2$bits	1001000	1001001	1001010	1001011	1001100	1001101	1001110	1001111
$\alpha_{3:}$"00"	0.3464	0.3268	0.3038	0.2765	0.2435	0.2021	0.1452	0
"01"	0.3464	0.3454	0.3421	0.3147	0.2771	0.2300	0.1652	0
"10"	0.3464	0.3640	0.3805	0.3528	0.3108	0.2579	0.1853	0
"11"	0.3464	0.3826	0.4189	0.3910	0.3444	0.2858	0.2053	0
$\alpha_1\alpha_2$bits	1010000	1010001	1010010	1010011	1010100	1010101	1010110	1010111
$\alpha_{3:}$"00"	0.3191	0.3011	0.2799	0.2547	0.2244	0.1862	0.1338	0
"01"	0.3191	0.3182	0.3152	0.2899	0.2553	0.2119	0.1522	0
"10"	0.3191	0.3354	0.3505	0.3251	0.2863	0.2376	0.1707	0
"11"	0.3191	0.3525	0.3859	0.3602	0.3173	0.2633	0.1892	0
$\alpha_1\alpha_2$bits	1011000	1011001	1011010	1011011	1011100	1011101	1011110	1011111
$\alpha_{3:}$"00"	0.2880	0.2717	0.2526	0.2299	0.2025	0.1680	0.1207	0
"01"	0.2880	0.2872	0.2845	0.2616	0.2304	0.1913	0.1374	0
"10"	0.2880	0.3027	0.3164	0.2934	0.2584	0.2145	0.1541	0
"11"	0.2880	0.3182	0.3483	0.3251	0.2864	0.2377	0.1707	0

$\alpha_1\alpha_2$bits	1100000	1100001	1100010	1100011	1100100	1100101	1100110	1100111
α_3: "00"	0.2517	0.2374	0.2207	0.2009	0.1769	0.1468	0.1055	0
"01"	0.2517	0.2509	0.2486	0.2286	0.2013	0.1671	0.1200	0
"10"	0.2517	0.2645	0.2764	0.2563	0.2258	0.1874	0.1346	0
"11"	0.2517	0.2780	0.3043	0.2841	0.2502	0.2076	0.1492	0
$\alpha_1\alpha_2$bits	1101000	1101001	1101010	1101011	1101100	1101101	1101110	1101111
α_3: "00"	0.2073	0.1955	0.1818	0.1654	0.1457	0.1209	0.0869	0
"01"	0.2073	0.2067	0.2047	0.1883	0.1658	0.1376	0.0989	0
"10"	0.2073	0.2178	0.2277	0.2111	0.1859	0.1543	0.1109	0
"11"	0.2073	0.2290	0.2506	0.2340	0.2061	0.1710	0.1229	0
$\alpha_1\alpha_2$bits	1110000	1110001	1110010	1110011	1110100	1110101	1110110	1110111
α_3: "00"	0.1478	0.1395	0.1296	0.1180	0.1039	0.0862	0.0620	0
"01"	0.1478	0.1474	0.1460	0.1343	0.1183	0.0982	0.0705	0
"10"	0.1478	0.1553	0.1624	0.1506	0.1326	0.1101	0.0791	0
"11"	0.1478	0.1633	0.1787	0.1669	0.1470	0.1220	0.0876	0
$\alpha_1\alpha_2$bits	1111000	1111001	1111010	1111011	1111100	1111101	1111110	1111111
α_3: "00"	0	0	0	0	0	0	0	0
"01"	0	0	0	0	0	0	0	0
"10"	0	0	0	0	0	0	0	0
"11"	0	0	0	0	0	0	0	0

[Add a new section 11.7.8.11]

11.7.8.11 Advanced Receiver Capability

This field indicates whether the MSS is advanced receiver capable

Type	Length	Value	Scope

21	1	Bit 0: Successive Interference Receiver Capability Bit 1-7: Reserved	REG-REQ REG-RSP

-------------------------- End of Text Changes for Remedy 1 ---

3.2 Remedy 2 – Version with formulas only (no tables)

[Insert the following after Section 8.4.5.4.10.10:]

8.4.5.4.10.11 Per Stream Power Control

When the feedback type field in CQICH Enhanced Allocation IE is "101" = Per stream power control, the BS require the power weighting of each spatial streams that can be supported by the MSS if the BS considers sending more than one stream to this MSS. If required by the BS, the MSS shall report the square root of the power weighting factors of the spatial streams (i.e., to report α_i with i=1..N_s (number of streams) where $\sum_i \alpha_i^2=1$). The first stream shall correspond to the largest weighting and the second stream to the second largest weighting, and so on. The power weighting of the last stream can be derived as the remaining power and thus needs not to be reported.

The feedback allocation and power weighting quantization procedure is as follows:

If the BS wants the MSS to feed back the power weightings for up to Ns=2 streams, one 3-bit CQI channel is allocated. A numerical range of [$\sqrt{1/2}$,1] is first uniformly divided into 2^3=8 levels (i.e., with the interval between levels being (1-$\sqrt{1/2}$)/7) and the MSS quantizes the squared root of the power weighting of the first stream to the nearest level. The value of "1" means the first stream uses all transmit power (i.e., a single stream is preferred by the MSS, rather than two streams).

If the BS wants the MSS to feed back power weighting for up to Ns=3 streams, one 6-bit CQI (or two 3-bit CQI channels) is allocated. The first power weighting is quantized using 4 bits and the second using 2 bits. A numerical range of [$\sqrt{1/3}$,1] is first uniformly divided into 2^4=16 levels (i.e., with the interval between levels being (1-$\sqrt{1/3}$)/15) and the MSS quantizes the squared root of the power weighting of the first stream to the nearest level (denoted as α_1). Then, 2 bits are used to quantize the range of [$\frac{1}{2}(1-\alpha_1^2)$, min($\alpha_1^2$,$1-\alpha_1^2$)].

If the BS wants the MSS to feed back power weighting for up to Ns=4 streams, one 6-bit CQI and one 3-bit CQI (or three 3-bit CQI channels) are allocated. The first power weighting is quantized using 4 bits, the second using 3 bits, and the third using 2 bits. A numerical range of [$\sqrt{1/4}$,1] is first uniformly divided into 2^4=16 levels (i.e., with the interval between levels being (1-$\sqrt{1/4}$)/15) and the MSS quantizes the squared root of the power weighting of the first stream to the nearest level (denoted as α_1). Then, 3 bits are used to quantize the range of [$\frac{1}{3}(1-\alpha_1^2)$, min($\alpha_1^2$,$1-\alpha_1^2$)] for the second stream squared-root power weighting (denotes as α_2). Finally, 2 bits are used to quantize the range of [$\frac{1}{2}(1-\alpha_1^2-\alpha_2^2)$, min($\alpha_2^2$,$1-\alpha_1^2-\alpha_2^2$)] for the third stream squared-root power weighting.

[**Add a new section 11.7.8.11**]

11.7.8.11 Advanced Receiver Capability

This field indicates whether the MSS is advanced receiver capable

Type	Length	Value	Scope
21	1	Bit 0: Successive Interference Receiver Capability Bit 1-7: Reserved	REG-REQ REG-RSP

-------------------------- End of Text Changes for Remedy 2 ---

References

[1] T. A. Thomas and F. W. Vook, “A Method for Improving the Performance of Successive Cancellation in Mobile Spread MIMO OFDM,” *Proc. IEEE VTC-2002/Fall*, Vancouver, Canada, September 2002.