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Title	**Codebook based beamforming in AAS zone**
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Re:	Recirculation of P802.16 REVe/D6
Abstract	Codebook based beamforming scheme is proposed for AAS operation..
Purpose	Adoption of suggested changes into P802.16e/D7
Notice	
Release	
Patent Policy and Procedures	

Codebook based beamforming in AAS Zone

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Introduction

In the current text for AAS operation, there is no mechanism for supporting codebook based beam-forming, where MS reports index of predefined beamforming vector using CQICH channels. The codebook scheme can be very useful when uplink coverage is limited from MS's power amplifier. To enable codebook mechanism, the following specifications should be defined in AAS mode.

1) Orthogonal DL preamble for each transmit antenna
2) A predefined set of beamforming vector in $C^{N_{TX}}$, where N_{TX} denotes number of Tx. antenna
3) Mechanism for reporting beam index of each MS in addition to channel quality information

Proposed Solution

In the IEEE P802.16e/D6 documents, orthogonal preamble and codebook are already defined in MIMO precoding framework for 2, 3 and 4 Tx. antenna. Thus, to enable codebook based beamforming operation, we only have to add the required singling IE into the existing AAS Map IEs. Specifically, the following changes are to be made.

1) Describe the codebook based beamforming mechanism in AAS section with the definition of orthogonal DL preamble and code book for beamforming vector
2) Add an indicator bit in AAS_DL_IE() for antenna preamble presence
3) Add feedback type in CQICH allocation field of AAS_SDMA_DL_IE() for beam index reporting
4) Add feedback type in CQICH allocation field of Reduced AAS Private DL Map for beam index reporting
5) Add a codebook beamforming option in AAS subscriber basic capability (SBC) field with number of transmit antennas

Please notice that BS can control the codebook based beamforming operation of each MS with by CQICH allocation field and the capability of codebook scheme is optional for MS.

Suggested Text Changes

[Create "Codebook based beamforming in AAS zone" in Sec. 8.4.4.6.5]

8.4.4.6.5 Codebook based beamforming in AAS zone

To enable codebook based beamforming operation, BS may place an AAS Mid-amble at the first symbol in the first DL AAS zone. The definition of AAS Mid-amble is exactly same as MIMO Mid-amble defined in Sec. 8.4.8.5. The presence of AAS Mid-amble is indicated in AAS_DL_IE(). The BS can initiate the codebook based beamforming by assigning additional CQICH channel for SS to report predefined beam index. The set of beam forming vector is the same as the ones defined in Sec. 8.4.5.4.11. Only the codebook for single stream precoding in MIMO mode is used for codebook based beamforming in AAS zone. The number of Tx. antennas is known during the subscriber basic capability (SBC) negotiation process.

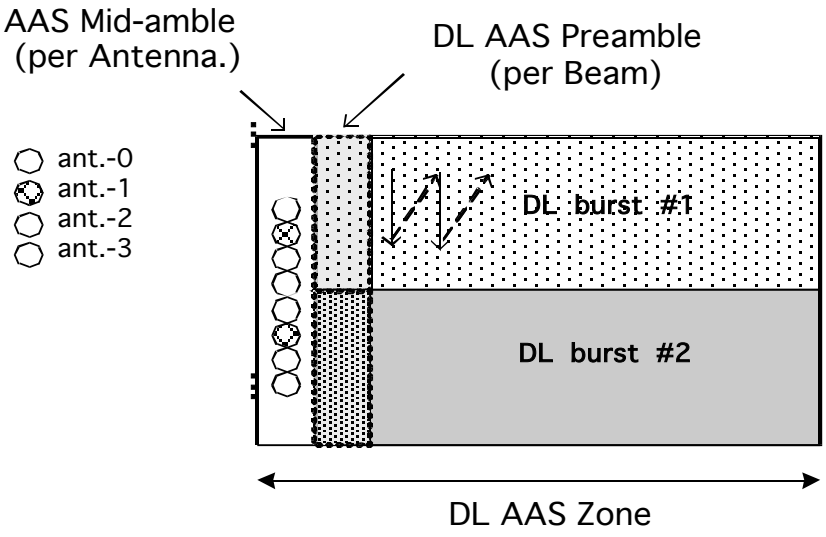

Fig. xxx. AAS Zone with AAS Mid-amble (4 Tx. antenna case)

8.4.4.6.5.1 Codebook selection

The SS should report codebook index optimized for entire band except AMC mode, where the SS reports the codebook index for best band only. The BS can know the best band by accumulating the differential channel quality information of the best five bands in AMC mode. The codebook selection algorithm is implementation specific.

8.4.4.6.5.2 CQICH operation

The BS can assign additional CQICH channel for SS to report predefined codebook index using the CQICH allocation field in AAS_SDMA_DL_IE() and Reduced AAS Private DL MAP. After receiving CQICH allocation for codebook index, the SS shall reports the channel quality information reflecting the beamforming gain.

[Add "AAS Mid-amble Presence Bit" into AAS_DL_IE in Sec. 8.4.5.3.3]

AAS_DL_IE in Sec. 8.4.5.3.3

Syntax	Size (bits)	Notes
AAS_DL_IE(){		
Extended DIUC	4	AAS = 0x02
Length	4	Length in bytes of following fields (0x03)
…	…	…
If (length = 0x04)		
Other permutation select	2	0b 00 = AMC 0b 01 = TUSC1 0b 10 = TUSC2 0b 11 = Reserved
Mid-amble Presence	2	0b 00 = No Mid-amble 0b 01 = Mid-amble without boosting 0b 10 = Mid-amble with 3 dB boosting (See MIMO Mid-amble defined in Sec. 8.4.8.5)
Reserved	~~6~~ 4	
}		

[Add feedback type in CQICH allocation field of AAS_SDMA_DL_IE() in Sec. 8.4.5.3.x]

(Note to Editor: AAS_SDMA_DL_IE() is adopted at session 35 but not incorporated in D6. The changes suggested here are based on existence of AAS_SDMA_DL_IE() in C802.16e-05/084r4)

AAS_SDMA_DL_IE in Sec. 8.4.5.3.x

Syntax	Size (bit)	Notes
AAS_H-ARQ_DL_IE(){		
Extended DIUC	4	AAS_H-ARQ_DL_IE = 0x ??
Length	4	Length in bytes of following fields
…		
If (CQICH Allocation Included) {		
Num. of CQICH	2	Number of CQICH channels to be allocated
for (j = 1: Num. of CQICH) {		
Feed back type	1	0b 0: channel quality information 0b 1: precoding index for beamforming (See codebook index defined in Sec 8.4.5.4.11)
Reserved	1	
Allocation Index	6 bits	Index to the channel in a frame the CQI report should be transmitted by the SS
}		
Period (p)	3 bits	A CQI feedback is transmitted on the CQI channels indexed by the (CQI Channel Index) by the SS in every 2^p frames.
Frame offset	3 bits	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)	4 bits	A CQI feedback is transmitted on the CQI channels indexed by the (CQI Channel Index) by the SS for $2^{(d-1)}$ frames. If d is 0b0000, the CQICH is de-allocated. If d is 0b1111, the MSS should report until the BS command for the MSS to stop
}		
…	…	…

[Add feedback type in CQICH allocation field of Reduced_AAS_Private_DL_MAP in Sec. 8.4.5.8.1]

(Note to Editor: CQICH allocation field is adopted at session 35 but not incorporated in D6. The changes suggested here are based on the implementation of Reduced_AAS_Private_DL_MAP in C802.16e-05/071r3)

Reduced_AAS_Private_DL_MAP

Syntax	**Size**	**Notes**
Reduced_AAS_Private_DL-MAP() {		
Compressed map indicator	2 bits	Set to binary 11 for compressed format
Reserved	1 bit	Shall be set to zero
UL-MAP appended	1 bit	
Compressed Map Type	2 bits	Shall be set to 0b11 for reduced private map
…	**…**	**…**
If (CQICH Configuration Included) {		
Num. of CQICH	2	Number of CQICH channels to be allocated
for (j = 1: Num. of CQICH) {		
Feed back type	1	0b 0: channel quality information 0b1: precoding index for beamforming (See codebook index defined in Sec 8.4.5.4.11)
Reserved	1	
Allocation Index	6 bits	Index to the channel in a frame the CQI report should be transmitted by the SS
}		
Period (p)	3 bits	A CQI feedback is transmitted on the CQI channels indexed by the (CQI Channel Index) by the SS in every 2^p frames.
Frame offset	3 bits	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)	4 bits	A CQI feedback is transmitted on the CQI channels indexed by the (CQI Channel Index) by the SS for $2^{(d-1)}$ frames. If d is 0b0000, the CQICH is de-allocated. If d is 0b1111, the MSS should report until the BS command for the MSS to stop
}		
…	…	…

[Add a capability bit for "OFDMA AAS Capabilities" in Sec. 11.8.3.7.x]

(Note to Editor: "OFDMA AAS Capabilities" is not in IEEE P802.16-REVd/D5 but in IEEE P802.16-2004/Cor1/D1)

Type	Length	Value	Scope
xxx	2	Bit #0: AAS Zone Bit #1: AAS Diversity Map Scan (AAS-DLFP) Bit #2: AAS-FBCK-RSP Support Bit #3: Downlink AAS Preamble Bit #4: Uplink AAS Preamble Bit #5: Codebook Beam-forming with 3 BS Ant. Bit #6: Codebook Beam-forming with 4 BS Ant. Bit #7-15: reserved	SBC-REQ (See 6.3.2.3.23) SBC-RSP (See 6.3.2.3.24)