IEEE P802.11  
Wireless LANs

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| 802.11 TGac WG Letter Ballot LB187  Proposed resolutions to comments 4206 and 5384 | | | | |
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Abstract

Text changes for comment 4206 and 5384

* General

SU-MIMO and MU-MIMO beamforming are techniques used by a STA (the beamformer) to steer signals using knowledge of the channel to improve PPDU reception at another STA (the beamformee). With SU-MIMO beamforming, all spatial streams in the transmitted signal are intended for reception at a single STA. With MU-MIMO beamforming, the space-time streams are divided between one or more STAs.

For SU-MIMO beamforming, the steering matrix *Qk* is determined by the beamforming feedback matrix *Vk* that is sent back to beamformer by beamformee using the compressed beamforming feedback matrix(#4723) format as in 20.3.12.3.6 (Compressed beamforming feedback matrix). The feedback report format is described in 8.4.1.48 (VHT Compressed Beamforming Report field).

For MU-MIMO beamforming, the receive signal vector in subcarrier *k* at beamformee *u*, , is shown in Equation (22-98), where denotes the transmit signal vector in subcarrier *k* for all beamformees, with being the transmit signal for beamformee *u*.

***y***

*k*

*u*



*y*

*k*

0



*y*

*k*

1





*y*

*k*

*N-1*

*R*

*X*

*u*













*T*

=

***x***

*k*

***x***

*k*

0



*T*

***x***

*k*

1



*T*



***x***

*k*

*N-1*

*users*



*T*











*T*

=

*N*

*users*

***x***

*k*

*u*



*x*

*k*

0



*x*

*k*

1





*x*

*k*

*N-1*

*S*

*T*

*S*

*u*















*T*

=



***y***

*k*

*u*



***H***

*k*

*u*



*Q*

*k*

0



*Q*

*k*

1





*Q*

*k*

*N-1*

*users*















***x***

*k*

***n***

+



=

where

***H****k,u* is the channel matrix from the beamformer to beamformee *u* in subcarrier *k* with dimensions

*N*

*R*

*X*

*u*

*N*

*T*

*X*



is the number of receive antennas at beamformee *u*

*N*

*R*

*X*

*u*

is the number of space-time streams transmitted to beamformee *u*

*N*

*S*

*T*

*S*

*u*



is a steering matrix for beamformee *u* in subcarrier *k*

*Q*

*k*

*u*



with dimensions

*N*

*T*

*X*

*N*

*S*

*T*

*S*

*u*



*Nusers* is the number of MU PPDU recipients (see 22.3.7 (Mathematical description of signals

))

***n*** is a vector of additive noise

and may include interference

The MU-MIMO steering matrix can be determined by the beamformer using the beamforming feedback matrices for subcarrier *k* from beamformee *u*, *Vk,u,* and SNR information for subcarrier *k* from beamformee *u*, *SNRk,u*, where . The steering matrix that is computed (or updated) using new beamforming feedback matrices and new SNR information from some or all of participating beamformees might replace the existing steering matrix for the next MU-MIMO data transmission. When there is feedback information from more than *Nusers* STAs available at the beamformer, the beamformer may choose a beamformee group of *Nusers* STAs for an MU(#4668) transmission for which the steering matrix can be designed to reduce interference between the signals intended for different beamformees. The beamformee group for the MU(#4668) transmission is signaled using the Group ID field in VHT-SIG-A (see 22.3.8.2.3 (VHT-SIG-A definition

*Q*

*k*

*Q*

*k*

0



*Q*

*k*

1





*Q*

*k*

*N-1*

*users*













=

*u*

0

1



*N-1*

*users*







=

) and 22.3.11.4 (Group ID

)).

* Beamforming Feedback Matrix *V*

Upon receipt of a VHT(#5197) NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 22-11 (Cyclic shift values for the VHT modulated fields of a PPDU(#5157)) from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, *Vk,u*, found by the beamformee *u* for subcarrier *k* shall be compressed in the form of angles using the method described in 20.3.12.3.6 (Compressed beamforming feedback matrix). The angles, *k* and *k*, are quantized according to Table 8-53e (Quantization of angles). The number of bits for quantization is chosen by beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or MU-MIMO beamforming. The compressed beamforming feedback using 20.3.12.3.6 (Compressed beamforming feedback matrix) is the only Clause 22 beamforming feedback format defined.

The beamformee shall generate the beamforming feedback matrices with the number of rows (*Nr*) equal to the *NSTS*(#) of the NDP.

After receiving the angle information, *k* and *k*, the beamformer reconstructs *Vk,u* using Equation (20-79). For SU-MIMO beamforming, the beamformer uses this *Vk,*0 matrix to determine the steering matrix *Qk*. For MU-MIMO beamforming, the beamformer may calculate a steering matrix using *Vk,u* and () in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix *Qk* is implementation specific.

*Q*

*k*

*Q*

*k*

0



*Q*

*k*

1





*Q*

*k*

*N-1*

*users*













=

*S*

*N*

*R*

*k*

*u*



0

*u*

*N-1*

*users*





The beamformee decides the tone grouping value to be used in the beamforming feedback matrix *V*. The beamformer shall support all tone grouping values and shall support all codebook information based on MU Beamformer Capability.