### **IEEE P802.11Wireless LANs**

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| PDT Formatting of CSI  |
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**Introduction**

This document provides proposed draft text for IEEE 802.11bf D0.2.

The following Motions apply to this PDT:

(Motion 96, 22/0533r3) In the formatting of the Sensing Measurement report all the in-phase and quadrature components of each of the tones of the CSI from a given measurement instance for a given TX/RX antenna pair, shall be scaled with the same value.

(Motion 97, 22/0533r3) If a STA supports the Sensing Measurement report, then the conditionally mandatory and optional supported values of Ng in the Sensing Measurement report shall depend on the number of transmit antennas and the NDP bandwidth according to the following table:

 • Note, this is relative to a 4x LTF



The indices for the Ng = 8 for a 160 MHz NDP are specified in the following table:



Note: the maximum number of transmit antennas is 8.

(Motion 98, 22/0533r3) The Sensing Measurement report shall support word size values for the in-phase and quadrature components of the scaled CSI of both Nb = 8 and Nb = 10 bits.

***TGbf editor: Please insert a new subclause in Clause 9.4.2.318:***

9.4.2.318.1 CSI Formatting for Sensing Measurement Report field

9.4.2.318.1a General

The Sensing Measurement Report value includes the CSI subfield. Subclause 9.4.2.318.1b describes the encoding of the measured CSI which involves scaling and quantizing the measured CSI, for inclusion in the Sensing Measurement Report field. Subclause 9.4.2.318.1c describes the decoding of the scaled and quantized CSI, received in the Sensing Measurement Report field.

The measured CSI for the t-th transmit antenna, the r-th receive antenna, and the k-th subcarrier is the complex value indicated by . The real part of the CSI is indicated by while the imaginary part of the CSI is indicated by . The real and imaginary parts of the CSI are represented as 2s complement binary integers.

The encoded version of the CSI is indicated by and decoded version of the CSI is indicated by

9.4.2.318.1b CSI Encoding Procedure

The number of transmit antennas is indicated by and the number of receive antennas is indicated by .

1. For a given tuple of transmit and receive antennas, , the maximum of the absolute value of the real and imaginary parts of the CSI for all subcarriers is calculated using Equation (A).

 (A)

The set of subcarriers, is specified in the Sensing Measurement Report Control field. This calculation is performed for each tuple of receive and transmit antennas, , with and .

1. For a given tuple of transmit and receive antennas, , the positive scaling factor is selected to avoid overflow when scaling and quantizing the measured CSI using Equations (B) and (C). The sensing receiver selects the exact value of the scaling factor.

This calculation is performed for each tuple of receive and transmit antennas, , with and .

1. Each real and imaginary part of the CSI is scaled and quantized to bits using Equations (B) and (C). The value of is signaled in the Sensing Measurement report, and may have a value of 8 or 10 bits.

 (B)

 (C)

9.4.2.318.1c CSI Decoding Procedure

The received encoded CSI shall be decoded as follows,

1. The received real and imaginary parts of the scaled and quantized CSI, and , are decoded as a pair of 2s complement numbers and are combined to form the complex CSI, .
2. Each CSI value is rescaled according to Equation (D),

 (D)

***TGbf editor: Please insert a new subclause in Clause 9.4.2.318:***

 **9.4.2.318.2 Sensing Measurement Report Control field for CSI reporting**

The Sensing Measurement Report Control field, if the Sensing Measurement Report Type field is equal to CSI, see Table 9-401s – Sensing Measurement Report Type field definition, signals the Channel Width, the number of transmit antennas (), the number of receive antennas (), the number of bits () used for each CSI value, the subcarrier grouping (). The Sensing Measurement Report Control field subfield 1, provides the information needed to process the Sensing Measurement Report field if the Sensing Measurement Report Type field is equal to CSI.

The fields of the CSI Control subfield are specified in Table A.

**Table A: CSI Control subfield**

|  |  |  |
| --- | --- | --- |
| **Field** | **Size (bits)** | **Meaning** |
| BW | 4 | Bandwidth(Encoding of BW subfield is TBD) |
|  | 4 | Number of Transmit AntennasThe value of is set equal to the number of transmit antennas minus 1 |
|  | 4 | Number of Receive AntennasThe value of is set equal to the number of receive antennas minus 1 |
|  | 1 | Number of Bits for each CSI value is set to 0 for an 8-bit word size and set to 1 for a 10-bit word size |
|  | 1 | Subcarrier GroupingIf there are less than or equal to four transmit antennas is set to 0 to indicate a subcarrier grouping of four.If there are five or more transmit antennas and the bandwidth is 80 MHz or less, then is set to 0 to indicate a subcarrier grouping of four.If there are five or more transmit antennas and the bandwidth is 160 MHz, then is set to 0 to indicate a subcarrier grouping of eight.is set to 1 to indicate a subcarrier grouping of sixteen. |
| Reserved | 2 | Reserved |

***TGbf editor: Please insert a new subclause in Clause 9.4.2.318:***

**9.4.2.318.3 Sensing Measurement Report Field**

The scaled and quantized CSI values are contained in the Sensing Measurement Report field.

The fields of the CSI Measurements subfield are specified in Table B.

Since the scaling and quantization is performed by each TX/RX antenna pair, the scaled and quantized CSI values are ordered by TX/RX pair. The CSI Sensing Measurement subfield begins with the set of scaling factors.

For each TX/RX-antenna pair there is a 12-bit positive scaling factor. After the set of scaling factors there is either a 0-bit or 4-bit reserved subfield. If there are an even number of scaling factors then a 0-bit reserved subfield is included. If there are an odd number of scaling factors then a 4-bit reserved subfield is included.

For each TX/RX-antenna pair the in-phase (real) component of the CSI is entered first and followed by the quadrature (imaginary) component of the CSI. This begins with the lowest frequency subcarrier, and this is repeated for each subcarrier. The number of subcarriers () is dependent on the bandwidth and the value of . The number of subcarriers is provided in Table C.

The subcarrier indices for and are provided in Table 9-91e—Subcarrier indices for compressed beamforming feedback matrix. The subcarrier indices for a channel width of 160 MHz and are provided in Table D – Subcarrier indices for Sensing CSI field, for Channel Width of 160 MHz and .

**Table B: CSI Measurements subfield**

|  |  |  |
| --- | --- | --- |
| **Field** | **Size (bits)** | **Meaning** |
| Scaling Factor () | 12 | Scaling Factor for Transmit Antenna 1 and Receive Antenna 1 |
| Scaling Factor () | 12 | Scaling Factor for Transmit Antenna 1 and Receive Antenna 2 |
|  |  |  |
| Scaling Factor () | 12 | Scaling Factor for Transmit Antenna 1 and Receive Antenna  |
| Scaling Factor () | 12 | Scaling Factor for Transmit Antenna 2 and Receive Antenna 1 |
| Scaling Factor () | 12 | Scaling Factor for Transmit Antenna 2 and Receive Antenna 2 |
|  |  |  |
| Scaling Factor () | 12 | Scaling Factor for Transmit Antenna 2 and Receive Antenna  |
| Scaling Factor () | 12 | Scaling Factor for Transmit Antenna and Receive Antenna 1 |
| Scaling Factor () | 12 | Scaling Factor for Transmit Antenna and Receive Antenna 2 |
|  |  |  |
| Scaling Factor () | 12 | Scaling Factor for Transmit Antenna and Receive Antenna  |
| Reserved | 0 or 4 | Reserved subfield so that the next subfield is aligned on an octet boundary. |
| CSI () |  | CSI for Transmit Antenna 1 and Receive Antenna 1 |
| CSI () |  | CSI for Transmit Antenna 1 and Receive Antenna 2 |
|  |  |  |
| CSI () |  | CSI for Transmit Antenna 1 and Receive Antenna  |
| CSI () |  | CSI for Transmit Antenna 2 and Receive Antenna 1 |
| CSI () |  | CSI for Transmit Antenna 2 and Receive Antenna 2 |
|  |  |  |
| CSI () |  | CSI for Transmit Antenna 2 and Receive Antenna  |
|  |  |  |
| CSI () |  | CSI for Transmit Antenna and Receive Antenna 1 |
| CSI () |  | CSI for Transmit Antenna and Receive Antenna 2 |
|  |  |  |
| CSI () |  | CSI for Transmit Antenna and Receive Antenna  |
| Reserved | 0 or 4 | For case , , and BW is either 40 or 80 MHz, then there are 4 reserved bits, otherwise there are 0 reserved bits |

**Table C: Number of Subcarriers as a function of Channel Width and**

|  |  |  |
| --- | --- | --- |
| **Channel Width** |  | **Number of Subcarriers ()** |
| 20 MHz | 4 | 64 |
| 16 | 20 |
| 40 MHz | 4 | 122 |
| 16 | 32 |
| 80 MHz | 4 | 250 |
| 8 | 64 |
| 160 MHz | 8 | 252 |
| 16 | 128 |

**Table D: Subcarrier indices for Sensing CSI field, for Channel Width of 160 MHz and**

|  |  |  |
| --- | --- | --- |
| **Channel Width** |  | **Subcarrier Indices** |
| 160 MHz | 8 | -1012, -1004, … -20, -12, 12, 20, … 1004, 1012 |

***TGbf editor: Please insert a new subclause in 11.21.18.2:***

A WLAN sensing STA that supports the Sensing Measurement report shall support values of 8 and 10.

A WLAN sensing STA with four or less transmit antennas, which supports the Sensing Measurement report, shall support an value of 4 and may optionally support an value of 16.

A WLAN sensing STA with five or more transmit antennas, and a bandwidth of 80 MHz, which supports the Sensing Measurement report shall support an value of 4 and may optionally support an value of 16.

A WLAN sensing STA with five or more transmit antennas, and a bandwidth of 160 MHz, which supports the Sensing Measurement report shall support an value of 8 and may optionally support an value of 16.