### **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 change Clause 9.4.2.318 as follows:***

* Sensing Measurement Report element

The Sensing Measurement Report element contains a single sensing measurement report. The format of the Sensing Measurement Report element is defined in 9-1002aw (Sensing Measurement Report element format). The Sensing Measurement Report element is included in the Sensing Measurement Report frame, as described in 9.6.7.51 (Sensing Measurement Report frame format), and in the Protected Sensing Measurement Report frame, as described in 9.6.36.2 (Protected Sensing Measurement Report frame).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | Sensing Measurement Report Type | Sensing Measurement Report Control | Sensing Measurement Report |
| Octets: | 1 | 1 | 1 |  1 | TBD | variable |
| * Sensing Measurement Report element format
 |

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1 (General).

The Sensing Measurement Report Type field is set to a number that identifies the type of sensing measurement report. The Sensing Measurement Report Type values that have been allocated are shown in Table 9-401s (Sensing Measurement Report Type field definition).

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| --- |
| * Sensing Measurement Report Type field definition
 |
| Name | Sensing Measurement Type |
| 0 | CSI |
| 1-255 | Reserved |

The Sensing Measurement Report Control field contains information necessary to interpret the Sensing Measurement Report field, and the Sensing Measurement Report field is used to report sensing measurements obtained by a sensing receiver.

If the Sensing Measurement Report Type field is 0, the Sensing Measurement Report Control field is defined in 9.4.2.318.2, and the Sensing Measurement Report field is defined in 9.4.2.318.3. The processes of encoding and decoding CSI sent within a Sensing Measurement Report field is described in 9.4.2.318.1.

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

9.4.2.318.1 CSI encoding and decoding for Sensing Measurement Report field

9.4.2.318.1a General

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 denoted as and decoded version of the CSI is denoted as

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 number of subcarriers, is specified in Table C (Number of Subcarriers as a function of Channel Width and ). 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 value of may be used in the selection of the to avoid an overflow. 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 is 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 if the Sensing Measurement Report Type field is 0**

The Sensing Measurement Report Control field provides the information needed to process the Sensing Measurement Report field if the Sensing Measurement Report Type field is equal to 0. The Sensing Measurement Report Control field signals the Channel Width, the number of transmit antennas (), the number of receive antennas (), the number of bits () used for each encoded CSI value, and an indicator () of the subcarrier grouping.

The fields of the Sensing Measurement Report Control field if the Sensing Measurement Report Type field is 0 are specified in Table A.

**Table A: Sensing Measurement Report Control field if the Sensing Measurement Report Type field is 0**

|  |  |  |  |
| --- | --- | --- | --- |
| **Field** | **Size (bits)** | **Definition** | **Meaning** |
| BW | 4 | Bandwidth | (Encoding of BW subfield is TBD) |
|  | 3 | Indicates the number of transmit antennas | Set to the number of transmit antennas minus 1 |
|  | 3 | Indicates the number of receive antennas | Set to the number of receive antennas minus 1 |
|  | 1 | Indicates the number of bits for each CSI value | Set to 0 for an 8-bit word size;Set to 1 for a 10-bit word size. |
|  | 1 | Indicates the subcarrier grouping setting | Set to 0 to indicate a subcarrier grouping of if there are less than or equal to four transmit antennas.Set to 0 to indicate a subcarrier grouping ofif there are five or more transmit antennas and the bandwidth is 80 MHz or less.Set to 0 to indicate a subcarrier grouping if there are five or more transmit antennas and the bandwidth is 160 MHz.Set to 1 to indicate a subcarrier grouping of .NOTE: Ng =16 is optionally supported |
| Reserved | 4 |  | Reserved |

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

**9.4.2.318.3 Sensing Measurement Report field if the Sensing Measurement Report Type field is 0**

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

The fields of the Sensing Measurement Report field if the Sensing Measurement Report Type field is 0, are specified in Table B.

Since the scaling and quantization is performed for 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.

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 padding subfield. If there are an even number of scaling factors then a 0-bit padding subfield is included. If there are an odd number of scaling factors then a 4-bit padding 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 is repeated for each subcarrier. The number of subcarriers () depends 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 .

Note: The size of the Sensing Measurement Report field if the Sensing Measurement Report Type field is 0, in octets, is given by Equation E,

 (E)

Note: The size of the Sensing Measurement Report field if the Sensing Measurement Report Type field is 0, increases with the number of transmit antennas, the number of receive antennas, the bandwidth, the smaller group size, and the larger number of bits. The smallest Sensing Measurement Report field if the Sensing Measurement Report Type field is 0 is 42 octets, and the largest Sensing Measurement Report field if the Sensing Measurement Report Type field is 0 is 40416 octets.

**Table B: Sensing Measurement Report field if the Sensing Measurement Report Type field is 0**

|  |  |  |
| --- | --- | --- |
| **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  |
| Padding | 0 or 4 | The Padding 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  |

**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 |
| 16 | 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.