IEEE P802.11
Wireless LANs

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| CID 1693 LOS Determination 11-18-0459-00-00ay |
| Date: 2018-05-10 |
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Abstract

This document proposes text for CID 1693 regarding the BF LOS determination.

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**CID 1693**: Clause: 10.38.9.6 - First received path itself is not a reliable estimator of LOS/NLOS propagation.

**Proposed Resolution:** Add other means to improve the precision for LOS/NLOS determination - for instance the polarization change to estimate if a reflection of the first path happemned

**Resolution: Revised.**

**Discussion**:

For location applications, it is desired that range (time of flight) and direction (angle of arrival and angle of departure) measurement are performed on a line of sight (LOS) path, rather than on non line of sight paths. When location meausrements are performed on non line of sight paths the resulting location estimates are wrong. Sometimes the LOS path is blocked and attenuated, so the beamforming training protocol chooses an NLOS path for communications. To solve this problem, in 11-17-1436-01-00ay was proposed to enable a mode of BF training in which training looks for the First Path rather than the strongest path. The predure to support First Path consisted of:

1. Add a field to the EDMG BRP request element indicating that the procedure is a First Path training procedure.
2. Add a bit to the EDMG-A header indicating that the TRN field is for First Path training – this is needed because the processing may done at the PHY level.
3. Add text to support this procedure.
4. Add a capability bit for this feature.

In the contribution 11-18/0401-00-00ay the authors present measuremnts for reflection absorbtion for multiple materials. It is observed that many materials have very good reflection properties with almost no absorbtion. The same contribution show the impact of the polarization on the reflected waveform. It was showed that different polarization have substantial different absorbtion for the same material.

The reflection measurements suggest that the First Path, which corresponds to the first received copy of transmitted signal is a necessary indication of the LOS path. However, the first received copy of transmitted signal is not a definitive indication for LOS. Moreover, the measurements showed that if the polarization is changed a reflected wave suffers changes in the strength, which suggest that by changing the transmit polarization the receiver could infer if received wave suffered a reflection.

Based on the above arguments, we add to the First Path procedure new elements to allow the to determine if the first path received propagates NLOS More precisely, the same TRN sequence is sent multiple times by the transmitter with the same beamforming and different polarizations. Then the first received paths are compared at the receiver: if the first path’s received power difference is above a threshold, it indicates that the first path corresponds to NLOS path.

Instruct the TGay editor to make the following changes:

***TGay Editor: Add to the 9.4.2.136***

The format of each channel measurement is specified in Table 9-241, in Table 9-xxx for when the First Path and the Dual Polarization TRN are enabled and respectively in Table 9-YYY when Dual Polarization is enabled and First Path is not enabled.

Table 9-XXX Channel Measurement for First Path and Dual Polarization TRN enabled

|  |  |  |
| --- | --- | --- |
| Field | Size | Meaning |
| Relative I Component Tap #1 Polarization #1  | 8 bits | The in-phase component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative Q Component Tap #1 Polarization #1 | 8 bits | The in-quadrature component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative I Component Tap #1 Polarization #2 | 8 bits | The in-phase component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative Q Component Tap #1 Polarization #2 | 8 bits | The in-quadrature component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |

Table 9-YYY Dual Polarization TRN enabled

|  |  |  |
| --- | --- | --- |
| Field | Size | Meaning |
| Relative I Component Tap #1 Polarization #1  | 8 bits | The in-phase component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative Q Component Tap #1 Polarization #1 | 8 bits | The in-quadrature component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative I Component Tap #1 Polarization #2 | 8 bits | The in-phase component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative Q Component Tap #1 Polarization #2 | 8 bits | The in-quadrature component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative I Component Tap #2 Polarization #1  | 8 bits | The in-phase component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative Q Component Tap #2 Polarization #1 | 8 bits | The in-quadrature component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative I Component Tap #2 Polarization #2 | 8 bits | The in-phase component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative Q Component Tap #2 Polarization #2 | 8 bits | The in-quadrature component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| …. |  |  |
| Relative I Component Tap #Ntaps Polarization #1  | 8 bits | The in-phase component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative Q Component Tap #Ntaps Polarization #1 | 8 bits | The in-quadrature component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative I Component Tap #Ntaps Polarization #2 | 8 bits | The in-phase component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |
| Relative Q Component Tap #Ntaps Polarization #2 | 8 bits | The in-quadrature component of impulse response for Tap #1 (shortest delay), and polarization # 1 in Dual Polarization TRN |

***TGay Editor: Add a field to the EDMG BRP request element (9.4.2.255):***

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 B7 | B8 B15 | B16 B23 | B24 B31 | B32 B39 | B40 B50 | B51 B52 | B53 B56 | B57 B58 |
|  | Element ID | Length | Element ID Extension | L-RX | L-TX-RX | TX Sector ID | EDMG TRN-Unit P | EDMG TRN-Unit M | EDMG TRN-Unit N |
| Bits: | 8 | 8 | 8 | 8 | 8 | 11 | 2 | 4 | 2 |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | B85 | B86 |  B87 |
|  | **…** | First Path Training | Digital BF Request | Dual Polarization TRN |
| Bits: |  |  |  |  |  | 1 | 1 | 1 |

Figure 54—EDMG BRP Request element format

The Dual Polarization TRN field if set to one indicates a request for BRP transmitter to send the repetitions of TRN sequences with different polarizations for the same AWV (beamform). If set to zero indicates that the TRN shall be sent without polarization change per each AWV. The indication triggers the procedure of LOS vs NLOS classification as presented in 10.38.9.7

***TGay Editor Add the following field to the table TXVECTOR and RXVECTOR parameters***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| DUAL POLARIZATION\_TRNS | FORMAT is EDMG | When set to 1, indicates that the TRN field appended to this packet shall have different polarizations per same AWV (beamform). When set to 0 idicates the TRN field appended to this packet are without polarization change per each AWV (beamform) | Y | Y |

***TGay Editor: Change the following field to Table 36-*** ***EDMG-Header-A field structure and definition for a SU PPDU***

|  |  |  |  |
| --- | --- | --- | --- |
| Dual Polarization TRN Training | 1 | 48 | When set to 1, and field Number of SS equals 0 indicates that the TRN field sequences appended to this packet have different polarization for the same sector (AWV) – used as described in 10.38.9.7When set to 0 and field Number of SS equals 0 indicates that TRN field sequences appended to this packet are without polarization change per each AWV (beamform)This field is reserved if the Number of SS field is greater than 0. |

***TGay Editor: Add the following field to table 35-*** ***EDMG-Header-A2 subfield definition***

|  |  |  |  |
| --- | --- | --- | --- |
| Dual Polarization TRN Training | 1 | 6 | When set to 1 indicates that the TRN field sequences appended to this packet have different polarization for the same sector (AWV) – used as described in 10.38.9.7.When set to 0 indicates that TRN field sequences appended to this packet are without polarization change per each AWV (beamform) |

***TGay Editor: Add the following subfield to Figure29 Beamforming Capability field format***

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | B9 | B11 | B12  | B13 | B14B17 | B18B23 |
|  | … | First PathTraining Supported | Hybrid Beamforming and MU-MIMO Supported  | Hybrid Beamforming and SU-MIMO Supported  | Dual Polarization TRN Supported | Dual Polarization Power Difference | Reserved |
| Bits: |  |  |  |  |  | 1 | 1 | 5 | 1 |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |

The Dual Polarization Supported field indicate the support of the Dual Polarization TRN training procedure – used as described in 10.38.9.7.

|  |  |
| --- | --- |
| Dual Polarization TRN Supported | TRN Power difference  |

 Bits 1 3

 Figure xx – Dual Polarization TRN Capability Field format

Dual Polarization TRN Supported indicates that the repetition of the same TRN with different polarizations is supported. If set to 1 indicates the support of the feature, if 0 indicates that this feature is not supported.

TRN Power difference indicates in dB the diffence in the radiated power for the consequitive TRNs with different polarization. The radiated power difference between the first TRN subfield and the second TRN subfield values are presented in the table XX

Table XX

|  |  |
| --- | --- |
| ***TRN Power difference bits*** | ***TRN power difference between the first TRN polarization and the second TRN polarization(dB)*** |
| ***000*** | ***0***  |
| ***001*** | ***1*** |
| ***010*** | ***2*** |
| ***011*** | ***3 or larger*** |
| ***101*** | ***-1*** |
| ***110*** | ***-2*** |
| ***111*** | ***-3*** |
| ***100*** | ***-4 or smaller*** |

***TGay Editor: Add the following text at the end of 9.4.2.250.2 (P28L17)***

A STA sets the Dual Polarization TRN beamforming training supported subfield to 1 to indicate it supports successive TRNs with different polarization that can be used for the NLOS detection procedure defined in 10.38.9.7

***TGay Editor: Insert the following text as 30.9.2.2.6***

 TGay Editor Add the following text after the end 10.38.9.6

**10.38.9.7 Dual Polarization TRN beamforming exchagne.**

Dual Polarization TRN beamforming may be used to assist detection of LOS vs NLOS propagation.

An EDMG STA may initiate a Dual Polarization TRN exchange if the responding EDMG STA has the indicated the following capabilities:

1. The Dual Polarization TRN field is set to 1
2. Indicated that it is capable of sending channel measurement feedback by setting the Chan-FBCK-CAP subfield to 1 in a BRP Request field sent by the responding EDMG STA.

An EDMG STA initiates a Dual Polarization TRN exchange by sending a PPDU with the following TXVECTOR parameters setting:

1. DUAL POLARIZATION\_TRNS to 1,
2. EDMG\_PACKET\_TYPE to either EDMG-TRN-T-PACKET or EDMG-TRN-R/T-PACKET.
3. EDMG\_TRN\_LEN to a value greater than 0.
4. EDMG-TRN-N set to either 1 or 3

The Dual Polarization TRN subfield in the EDMG BRP request element shall be set to 1.

The responder responds to this EDMG BRP-TX or BRP-TX/RX PPDU by sending a BRP frame with DMG channel measurement feedback and EDMG channel measurement feedback elements with the Dual Polarization TRN field in the EDGM BRP request element with channel measurement element having the format in table 9-YYY. The initiator change polarization every EDMG-TRN-N/2 TRN subfields as described in 30.9.2.2.5.

If in addition to the TXVECTOR parameters above the initiator set the FIRST\_PATH\_TRAINING to 1 and the First Path Training field of the EDMG BRP request element, the responder will perform the measurement on the first arrival path, and respond with a BRP frame with DMG channel measurement feedback and EDMG channel measurement feedback with the Dual Polarization TRN field and First Path Training field in the EMDG BRP request element set to 1 with the channel measurement element having the format in table 9-xxx.

The initiator may use the tap fields of the channel measurement feedback, measurement on different polarizations, to estimate whether the measured path was on LOS or NLOS propagation.

TGay Editor: Add the following text at the end of 30.9.2.2.5

When the Dual Polarization TRN training field is set to 1 and the EDMG TRN-Unit N field in the EDMG-Header-A is set to an even value in a BRP-TX or BRP-TX/RX PPDU, the transmitter change polarization at the end of each group of EDMG TRN-Unit N/2 TRN subfields, in the last EDMG TRN-Unit M subfields in each TRN unit. The polarization change shall be done while keeping the same AWV.