IEEE P802.11
Wireless LANs

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| CID 1693 LOS Determination 11-18-0459-01-00ay |
| Date: 2018-07-08 |
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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 happened

**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 measurements are performed on non-line of sight paths the resulting location estimates is 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 procedure 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 be 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 measurements for reflection absorption for multiple materials. It is observed that many materials have very good reflection properties with almost no absorption. The same contribution shows the impact of the polarization on the reflected waveform. It was showed that different polarization has substantial different absorption 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 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,***

***TGay Editor, In 9.4.2.130 Replace in Figure 9-512 the reserved bit 73 with EDMG Dual Polarization TRN Channel Measurement Present bit***”

 :



***TGay Editor: Add the following after P79L9 (before* 9.4.2.132 Extended Schedule element)**

EDMG Dual Polarization TRN Channel Measurement Present equal to 1 indicates that the EDMG Channel Measurement Feedback element contains the Dual Polarization TRN Measurement field. When EDMG Dual Polarization TRN Channel Measurement Present equal to 0 the EDMG Channel Measurement Feedback element does not contain the Dual Polarization TRN Measurement field.

***TGay Editor: Add the following text before P82L2 (D1.2)***

***Modify the text in P1225L39 (paragraph before table-256 (Channel Measurement)***

The format of channel measurement is specified in Table 9-256~~.~~ For the case where the Dual Polarization TRN field were set to 1 in the packet over which the measurements were performed the channel measurement is specified in Table 9-xxx, which is appended to the channel measurements as specified in Table 9-256. For the case where the Dual Polarization field was set to 1 and First Path set to 1, only measurements corresponding to the Tap# 1 (shortest delay) from Table 9-xxx are added to the channel measurements specified in Table 9-256.The Relative I/Q Component Tap #N Polarization #1or #2 represent the measured signal strength for the I or Q component for the tap #N and polarization #1 or #2.

 Table 9-xxx Dual Polarization TRN enabled

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

***TGay Editor: Add a field (Dual Polarization TRN) 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

If the Dual Polarization TRN field is set to one, it indicates a request for a BRP transmitter to send TRN subfields with different polarizations for the same AWV. If set to zero otherwise (see 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 subfields in the TRN field appended to this packet has different polarizations per same AWV. When set to 0 indicates the TRN field appended to this packet are without polarization change per each AWV | Y | Y |

***TGay Editor: Add the following subfield to Table 51-EDMG-MCS field definition when the Number of SS field is 0 PPDU***

|  |  |  |  |
| --- | --- | --- | --- |
| Dual Polarization TRN Training | 1 | 6 | When set to 1, and field Number of SS equals 0 (one spatial stream), indicates that the TRN subfields appended to this packet have different polarization for the same sector (AWV) – used as described in 30.9.2.2.5When 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 AWVThis 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 subfields appended to this packet have different polarizations for the same sector (AWV) – used as described in 30.9.2.2.5.When set to 0 indicates that TRN subfields appended to this packet are without polarization change per each AWV  |

***TGay Editor: Add the following subfield to Figure 32 Beamforming Capability field format***

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | B9 | B11 | B12  | B13 | B14B16 | B17 B23 |
|  | … | 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 | 3 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |

***TGay Editor: Add the following text at the end of 9.4.2.250.2 (P86L34)***

The Dual Polarization Supported field indicates the support for 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 the difference in dB in the radiated power for the consecutive 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 after the end 10.38.9.6***

**10.38.9.7 Dual Polarization TRN beamforming exchange.**

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 Supported field is set to 1 in the Beamform Capability field
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 L-RX subfield in the EDMG BRP request may be set to a value greater than 0.

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-xxx. The initiator changes polarization on a TRN subfields basis 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 to 1, the responder shall perform 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. If the initiator set the L-RX subfield in the EDMG BRP Request element to a value greater than 0, the responder shall append a TRN field to the frame. In the TRN field the responder changes polarization every N TRN subfields as described in 30.9.2.2.5 where N is the value of the EDMG\_TRN\_N field in the TX-VECTOR. If the initiator and responder have performed first path beamforming training (10.39.9.6) before the initiator initiated this exchange, the responder shall use the first path AWV for transmitting the response PPDU and the TRN field.

***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-RX, BRP-TX or BRP-TX/RX PPDU, the transmitter changes polarization at the end of each group of N/2 TRN subfields, in the last M subfields in each TRN unit, where N and M are the values of the EDMG TRN-Unit N and EDMG TRN-Unit N fields in the EDMG-Header-A of the PPDU. The polarization change shall be done while keeping the same AWV.

The receiver shall also switch polarization at the end of each *k* TRN subfields within the last M subfields in each TRN unit, where *k* is N/2 and M and N are respectively, the values of the EDMG TRN-Unit M and EDMG TRN-Unit N fields in the EDMG-Header-A of the received PPDU as defined in Table 42.