

Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Comment Resolutions for TX switched diversity]

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Re: [Comment Resolutions for TX switched diversity]

Abstract: [Comment Resolutions for TX switched diversity]

Purpose: [To be considered in TG3C baseline document.]

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Comment resolutions for TX switched diversity

High Level Summary

- This document provides the resolutions for the comments on **TX switched diversity (TSD)**
 - 7 received TSD comments are categorized as following
 1. 3 comments related to TSD protocol (#536, #583,#57)
 2. 3 comment related to receiving channel status (#560 ,#581,#582)
 3. 1 comments related to editorial modification in MLME (#23)
 - We suggest to
 1. combine the protocol of TSD and BF to complete TSD protocol
 2. modify receiving channel status as LQI (Link Quality Indication)
 3. modify MLME description

Comment resolution related to TSD protocol (1/4)

- Comment 536
 - Subclause: 8.16.1
 - Comment : What type of receiver architecture can be supported by the TX switch diversity. There is no mechanism or protocol described how feedback information can be transmitted.
 - SuggestedRemedy: Need clarification
- Comment 586
 - Subclause: 8.16.1
 - Comment: How does the transmit diversity procedure stabilize in the case that that both sides of the link may attempt to select transmitter/receiver antennas? If the PNC has selected one of K possible antennas for communication with a DEV and the DEV selects one of N possible antennas for communication with the PNC, then the PNC switches its selected antenna, the selected antenna at the DEV may no longer be the best choice.
 - SuggestedRemedy: What safeguards are in place to ensure that only one side of a link at a time is adjusting its selection?
- Comment 57
 - Subclause: 8.16.1
 - Comment: Missing standard usage of shall, may, should, etc.
 - SuggestedRemedy: This clause is written in an informal manner that is deviate of "standard" usage of shall, etc. Please re-write this clause in an appropriate manner.

Comment resolution related to TSD protocol (2/4)

- Suggested Resolution
 - TSD problem
 - Lacking “communication link set up protocol” between TX-DEV and RX-DEV
 - Solution of TSD problem
 - **Beam training** (Section 13.4) provides “communication link set up protocol”
 - After setting up communication link by Beam training, TSD protocol can be operated
 - Suggested solution
 - TSD protocol (8.16.1) is merged in BF (13.4) that TSD protocol is operated after Beam training
 - Capability IE for BF (7.4.7) includes TSD IE (7.4.23), then remove TSD IE.
 - TSD commands(7.5.11) is merged in Feedback IE (7.4.27) to reduce redundancy

Comment resolution related to TSD protocol (3/4)

- Following fields are added on Feedback IE (7.4.36) that is transmitted by the announce command
 1. **Mode (1bit)**
 - Mode shall be set to 0 for feedback mode of beamforming
 - Mode shall be set to 1 for TX switch mode of the originating DEV beam
 2. **Beam switch utility (1bit)**
 - Beam Switch Utility shall be set to 1 to request the originating DEV to switch the transmit beam
 - Beam Switch Utility shall be set to 0 to response the switching result of the originating DEV
 3. **Transmit beam index (4bits)**
 - Transmit Beam Index shall be set to the index of the transmit beam of the originating DEV

Bits: 2	4	4	4	4	4	1	1	8	8
Reserved	Transmit beam index	Second best sector SINR	Second best sector	Best sector SNIR	Best sector	Beam switch utility	Mode	Length	Element ID

Figure 48m—feedback information element format

Comment resolution related to TSD protocol (3/4)

- TSD description is added on BF protocol in 13.4
 - “During a data transmission from DEV1 to DEV2, when tracking is not able, DEV2 may request DEV1 to switch the transmitting beam according to LQI as defined in 12.x.x.x. To switch the transmitting beam of DEV1, DEV2 shall send the announce command frame to DEV1, which contains Feedback IE, as described in 7.4.27, where the mode field and the beam switch utility field shall be set to 1 and the transmit beam field indicates the next transmitting beam of DEV1.

According to the feedback information in the announce command frame from DEV2, DEV1 may switch the current transmitting beam to the next transmitting beam indicated in Feedback IE, as described in 7.4.27. DEV1 shall send the announce command containing Feedback IE of the switching result to DEV2, where the mode field shall be set to 1, the beam switch utility field shall be set to 0 and the transmit beam field indicates the switched beam of DEV1.”

Comment resolution related to receiving channel status (1/2)

- Comment 560
 - Subclause 6.3.19
 - Comment: What about other possible metrics?
 - SuggestedRemedy: For example, one could use a calculated capacity value, some sort of signal quality metric which is a function of LLRs, etc. Perhaps a more flexible or inclusive definition is required.

- Comment 581
 - Subclause: 8.16.1
 - Comment: Figure 147c indicates that the feedback is an "Antenna Switching Indicator". Why must the antenna selection be made at the receiving end? The receiver could feedback SNR, SINR, BER, etc. information and allow the decision to be made on the transmitting end.
 - SuggestedRemedy: Perhaps more implementation flexibility is required.

Comment resolution related to receiving channel status (2/2)

- Comment 582

- Subclause: 8.16.1
- Comment: The text states that received SNR is compared against a predetermined threshold. First of all, there is no truly normative ("SHALL") text. Second, why must SNR be used? In some cases, it may be impossible to get a good estimate of the true SNR. It may be easier to compare RSSI or perhaps better results could be obtained with a BER or capacity or SINR estimate.
- SuggestedRemedy: The comments about SNR should be clearly stated as informative and a more flexible definition with normative text provided.

- Suggested Resolution

- Accept comment. LQI (link quality indication) is used for receiving channel status
- The contents of LQI are left on implementers and are followed by the definition in BF

Comment resolution related to editorial modification in MLME (1/2)

- **Comment 23**
 - Subclause: 6.3.19
 - Comment: Much of the text in the Transmit Switched Diversity clause seems not appropriate for a section on MLME.
 - SuggestedRemedy: Parse this section into text suitable for the MLME section and text for either information elements and/or MAC commands.

Comment resolution related to editorial modification in MLME (1/2)

• Suggested Resolution

- Keep separately TSD MLME and BF MLME
- TxDiversityThresholdType and description in MLME are modified as following

Table 3z—MLME-TXDIV primitive parameters

Name	Type	Valid range	Description
TrgtID	Integer	Any valid DEVID, as defined in 7.2.3	Specifies the DEVID of the target DEV for exchanging transmit Switched Diversity information.
OrigID	Integer	Any valid DEVID, as defined in 7.2.3	The DEVID of the DEV that initiated the MLME request.
SupportedNumAntennas	Integer	0-15	The number of antennas supported by the DEV.
Timeout	Integer	0-65535	The time in milliseconds allowed for the primitive to complete.
TxDiversityThresholdType	Enumeration	SINR, RSSIR, FER_EXPONENT, BER_EXPONENT LQI as defined in 12.X.X.X	Specifies the type of threshold to use to trigger antenna switching.
TxDiversityThreshold	Integer	0-255	Specifies the value of the threshold based on the TxDiversityThresholdType.
AntennaSwitchingStatus	Enumeration	NOT_SWITCH, RESERVED, SWITCH, BEST_SWITCH	Indication of antenna switching status.
AntennaIndex	Integer	0-15	Specifies antenna index to be used.
ResultCode	Enumeration	SUCCESS, FAILURE	Indicates the result of the MLME request.
ReasonCode	Enumeration	NOT_SUPPORTED, OTHER	Indicates the reason for a ResultCode of FAILURE.

~~The TxDiversityThreshold is encoded based on the value of TxDiversityThresholdType parameter. The encodings are:~~

- ~~— SINR: 0 dB to 30 dB in 1 dB steps.~~
- ~~— RSSIR: 0 dB to 30 dB in 1 dB steps.~~
- ~~— FER_EXPONENT: The negative of the exponent, from 1 to 10 in 0.25 step size.~~
- ~~— BER_EXPONENT: The negative of the BER exponent from 1 to 10 in 0.25 step size.~~

~~For example, an SINR or RSSIR of 14 dB would be encoded as 14 whereas a BER or FER exponent of -3.25 representing 10^{-3.25} would be encoded as 9 (the negative of the exponent, minus one and multiplied by four).~~