IEEE P802.11
Wireless LANs

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| --- |
| TextDSC, CCAT and OBSS\_PD to Resolve SR Comments |
| `Date: 2017 - 07  |
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Abstract

17/0582 clearly demonstrated that the OSSS\_PD/TPC scheme is not acceptable and that as written simply will not work. When TPC is used, in almost every case the wanted SNIR is poor. A clear method for making the decision to transmit is essential and 17/0582 shows that DSC performs this function.

This document contains the proposed text for 11ax Draft for dynamic sensitivity control (DSC) which may also be used to set OBSS\_PD (as analysed in 17/0582.)

DSC may be used to set the CCA threshold, CCAT, which is used to decide whether to transmit over an inter-BSS packet. The STA may set the OBSS\_PD to the received signal level of the received inter-BSS packet (hence setting the TPC).

This text is proposed as resolution for the following CIDs:

* + 5494, 5495, 5503, 6762, 6768, 7129, 7230, 9947, 10031, 10033

**Resolution to CIDs 5494, 5495, 5503, 6762, 6768, 7129, 7230, 9947, 10031, 10033**

**REVISED, incorporate text in <this document>”**

**CID 166**

**Suggested changes for DSC to 802.11 Standard**

**BACKGROUND STUFF**

**Add to Section 3.4**

 “DSC dynamic sensitivity control”

**9.4.2.27 Extended Capabilities element**

Add to Table 9-134 Extended Capabilities field

|  |  |  |
| --- | --- | --- |
| Bit | Information | Notes |
| TBD | Dynamic Sensitivity Control (DSC) | STA sets DSC field to 1 when dot11DynamicSensitivityControlImplemented is true and sets it to 0 otherwise. |

**Add to 9.4.2**

**9.4.2.X DSC Parameter Set element**

The DSC Parameter Set element provides information for operation of dynamic sensitivity control and adaptive transmit power control that is used for spatial reuse.

The format of the DSC Parameter Set element is defined in Figure 9-xxx.

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Element ID 255 | Length | Element ID Extension | DSC Margin | DSC Upper Limit |

Octets 1 1 1 1 1

 **Figure 9-xxx – DSC Parameter Set element**

For an infrastructure BSS, the DSC Parameter Set element is used by an HE AP to establish the effective CCA threshold, to change policy when accepting new non-AP HE STAs, or to adapt to changing environmental or traffic loading conditions. Dynamic sensitivity control procedures are described in 27.9.3.1.

The DSC Margin field is one octet in length and indicates the value of the DSC Margin, in dBs, that shall be used by HE non-AP STAs associated to an HE AP that is advertising the DSC Parameter element.

The DSC Upper Limit field is one octet in length and indicates the value of the DSC Upper Limit in dBs below 0 dBm that shall be used by HE non-AP STAs associated to the HE AP that is advertising the DSC Parameter element. For example, a DSC Upper Limit field value of 42 indicates a DSC Upper Limit of -42 dBm.

Note: Following sentence may not be needed if a SR prohibited bit is used.

Setting the values of both the DSC Margin and the DSC Upper Limit fields to zero indicates that DSC operation is prohibited for HE non-AP STAs associated to that AP.

**Insert 27.9.3 to read as below**

**27.9.3 Adaptive CCA**

**25.9.3.1 Dynamic Sensitivity Control**

An HE STA indicates its support of Dynamic Sensitivity Control (DSC) procedures by setting dot11DynamicSensitivityControlImplemented to true and setting the Dynamic Sensitivity Control bit in the Extended Capabilities field to 1. An HE STA that is using DSC procedures is a DSC STA.

In an infrastructure network, a DSC AP may include the DSC Parameter element, as defined in 9.4.2.X, in beacons and probe responses. A DSC AP may advertise the values for DSC Margin and DSC Upper Limit in the DSC Parameter Set element. In this case, an associated DSC non-AP STA shall set its values of dot11DSCMargin and dot11DSCUpperLimit equal to the respective advertised values in the DSC Parameter element.

A DSP AP may set an effective CS/CCA threshold, CCAT, for itself so as to be compatible with the DSC Margin and DSC Upper Limit values advertised in its DSC Parameter element. Recommended procedures for DSC AP settings of DSC Margin, DSC Upper Limit and CCA threshold values are given in Annex (TBA).

A DSC non-AP STA that is associated to a DSC AP shall set its effective CS/CCA threshold, CCAT, as per equation 27-X:

 CCAT = MIN (DSC Upper Limit, RSSI beacon ) – DSC Margin 27-X

Where,

DSC Upper Limit is the value of dot11DSCUpper Limit,

DSC Margin is the value of dot11DSCMargin, and

RSSIbeacon is the received signal strength of the beacon transmitted by the DSC AP

NOTE: It is recommended that the value of RSSIbeacon is a value averaged over several beacons as described in Annex TBA.

The minimum value for CCAT is -82 dBm and the maximum value is -62 dBm for any 20 MHz channel. The value for CCAT is increased by 3 dB for 40 MHz channels, 6 dB for 80 MHz channels and 9 dB for 160 MHz channels.

*Note: If an SR Prohibited bit exists this next paragraph may be omitted or replaced*

A DSC AP may indicate that DSC procedures are prohibited by setting both the DSC Margin and DSC Upper Limit fields in the DSC Parameter element to 0. In this case a DSC non-AP STA associated to that AP shall not use DSC procedures.

If a DSC non-AP STA is associated to an AP that does not include the DSC Parameters element in its beacons, then the DSC STA may still use DSC procedures with a DSC Margin value set to a minimum of 25 dB, and the DSC Upper Limit set such that the maximum value for CCAT is -62 dBm for any 20 MHz channel.

The CCAT value is used by an HE STA to determine if it may transmit in the presence of an inter-BSS signal. If an inter-BSS transmission is received at an HE STA at a level equal to or below the CCAT value, then the HE STA may transmit.

**25.9.3.1.1 DSC Procedures for a non-AP STA**

In an infrastructure network, a DSC non-AP STA monitors the beacons transmitted by the AP to which it is associated and measures the received signal strength of the beacons. The received signal strength of beacon frames may be time averaged over recent history by a vendor-specific smoothing function. The value of dot11DSCMargin is then subtracted from the time averaged received signal strength of the beacons to provide an interim effective CS/CCA threshold value, using the formula shown in equation 27-X.

The CCAT value is based upon the time averaged received signal strength of the beacons, dot11DSCMargin and dot11DSCUpperLimit is valid for any 20 MHz channel. The CCAT value is increased by 3 dB for 40 MHz channels, 6 dB for 80 MHz channels and 9 dB for 160 MHz channels.

Annex TBA describes recommended practice for DSC procedures.

**27.9.3.1.2 DSC, SRG, NON SRG, OBSS\_PD**

DSC procedures may be used by an HE STA to set CCAT values to be used in combination with OBSS\_PD, NON SRG PD, and SRG PD levels.

The CCAT value is used by an HE STA to determine if it may transmit in the presence of an inter-BSS signal. If an inter-BSS transmission is received at the HE STA at a level equal to or below the CCAT value, then the HE STA may transmit using the OBSS\_PD, NON SRG PD, and SRG PD level equal to the received inter-BSS signal level.

**In C.3 MIB Detail**

**ADD to “dot11StationConfig TABLE”**

Dot11StationConfigEntry : : = SEQUENCE

 Dot11DynamicSensitivityControlImplemented TruthValue

**ADD to SA Query Procedure MIBs**

dot11DynamicSensitivityControlImplemented OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This attribute, when true, indicates that the STA implementation is capable

of supporting Dynamic Sensitivity Control."

DEFVAL { false }

::= { dot11StationConfigEntry TBA }

dot11DSCMargin OBJECT-TYPE

SYNTAX Unsigned32 (1..100)

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"This attribute indicates the value, in dBs, of the DSC Margin that a DSC STA adds to the received signal strength of Beacon frames received on the channel. The received signal strength of Beacon frames may be time averaged over recent history by a vendor-specific smoothing function.”

DEFVAL { 25 }

::= { dot11StationConfigEntry TBA }

dot11DSCUpperLimitLimit OBJECT-TYPE

SYNTAX Unsigned32 (1.. 100)

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"This attribute indicates the value, in dBs below 0dBm, of the DSC Upper Limit for a DSC STA. For example, a value of 42 indicates a DSC Upper Limit of -42dBm.”

DEFVAL { 40 }

::= { dot11StationConfigEntry TBA }

**ADD NEW ANNEX**

**ANNEX TBA**

(informative)

**Spatial Reuse Procedures**

**TBA.1 Dynamic Sensitivity Control**

When dot11DynamicReceiveSensitivityImplemented is true, the STA is a DSC STA. A DSC STA sets the DSC Supported bit to 1 in the Extended Capabilities field.

Dynamic Sensitivity Control (DSC) procedures may be used to control the effective carrier sense/clear channel assessment (CS/CCA) mechanism threshold, CCAT, in order to improve the spatial reuse performance of infrastructure networks. If an inter-BSS transmission is received at the HE STA at a level equal to or below the CCAT value, then the HE STA may transmit and may set the OBSS\_PD, NON SRG PD, and SRG PD level equal to the received inter-BSS signal level.

*Note: Following sentence may be deleted if an SR Prohibited bit is accepted.*

A DSC non-AP STA may use DSC procedures unless the DSC Margin and DSC Upper Limit fields in the DSC Parameter set element are both set to 0 by the AP to which the non-AP DSC STA is associated, in which case the STA sets dot11DynamicReceiveSensitivityImplemented to false.

**TBA.1.1 DSC Operation for DSC non-AP STA**

**TBA.1.1.1 Basic Operation**

There are two settings used in DSC: DSC Upper Limit and DSC Margin. In general the DSC non-AP STA measures the average signal strength of the received beacon and then subtracts the DSC Margin to arrive at the effective value for the CCA threshold, CCAT. For example, if the averaged signal strength of the beacon is -45 dBm and the DSC Margin is set to 25 dB, the effective CCA threshold is set to -45 -25 = -70 dBm. The DSC Upper Limit serves two functions; preventing DSC STAs close to the AP setting a high CCAT value that would represent a limited range with the result that other stations in the same network could be ‘hidden’, and setting an effective range or area coverage for the network. The DSC Upper Limit sets the maximum value to be used for the received signal strength of the beacon and this effectively sets the maximum CCAT value, DSC Upper Limit minus DSC Margin.

The DSC Margin value sets the target SNIR. For example, if it the target SNIR is 20 dB then the DSC Margin may be set to 20 dB. However, the CCAT value is based upon the received signal strength of the wanted beacon, and it is common that the AP transmission and antenna efficiency is higher than a non-AP STA. In this case, a non-AP STA may set the DSC Margin to a higher value to account for the difference. For example, if the AP is assumed to transmit at 20 dBm with a 0 dBi antenna(s) and the non-AP STA transmits at 15dBm, with a -2 dBi antenna(s), then a DSC Margin of -27 dB may be used for a target SNIR of 20 dB.

For example, if the DSC Upper Limit is -37 dBm and the DSC Margin is 25 dB, then the maximum value for the CCAT is -62 dBm, equivalent to about 15m indoor range at 5 GHz. Setting the DSC Upper Limit to -50 dBm with the DSC Margin at 25 dB, the DSC Threshold is decreased to -75 dBm and the effective indoor range increases to about 35m. Hence, by setting the DSC Upper Limit and DSC Margin it is possible to set an effective network coverage area such that all stations in the network will contend within that area.

If the AP to which the DSC non-AP STA is associated is transmitting the DSC Parameter element, the STA uses the values for Upper Limit and Margin that are included in the DSC Parameter element. In the case that the AP is not a DSC AP or does not transmit a DSC Parameter element, then the DSC non-AP STA may set values for the DSC Upper Limit and DSC Margin within the limitations given in 25.9.3.1.

As the beacon is transmitting in a 20 MHz channel, the CCAT value calculated using the DSC Margin and DSC Upper Limit is valid for a 20 MHz channel. The CCAT value would be 3 dB, 6 dB and 9 dB higher for channel bandwidths of 40 MHz, 80, MHz and 160 MHz respectively.

**TBA.1.2. DSC Non-AP STA Roaming**

DSC non-AP STAs may use the advertised DSC Upper Limit and DSC Margin values to estimate the effective network coverage area that the DSC AP is targeting. If the detected average signal strength of the received beacons is below DSC Upper Limit minus DSC Margin, then the DSC non-AP STA is aware that it is on the outer edge or beyond the effective network coverage area and should consider roaming procedures. It should be noted, however, that the DSC non-AP STA is still able to communicate with the DSC AP.

**TBA.1.3 Determining Beacon Signal Strength value**

It is recommended that the received signal strength of the beacon frames be averaged over time so as to account for the mobility of a DSC non-AP STA. The received signal strength may be calculated using a variety of averaging methods but a recommended method is to use a moving average such that the average signal strength value is more influenced by the latest reading than previous ones. It is further suggested that the time to update the average received signal strength value is in the order of one second so as to account for sudden variations due to obstructions or movement.

It is possible to miss a certain number of Beacons. The averaging and the update time for determining the received signal strength value may need to be adjusted to account for this.

**TBA.1.3.1 DSC operational algorithm**

A sample DSC operational algorithm is shown in Figure TBA – 1. In this example the following parameter settings might be used:

* BeaconCountLimit: the limit of consecutive missed beacons. When exceeded the averaged signal strength of the beacon, AverageRSSI, is decremented by a value of RSSI\_Decrement. An example default value is 3.
* UpdatePeriod: the period over which the received beacon signals are averaged. An example default value is 1 second.
* RSSI\_Decrement: the value, in dBs, that the existing averaged beacon signal strength, Average RSSI, is decreased by if the BeaconCountLimit is reached. An example default value is 6 dB.



**Figure TBA – 1 – Sample DSC Operational Algorithm**

**TBA.1.4 DSC Operation for DSC AP**

A DSC AP may transmit the DSC Parameter element in beacons and probe responses in order to set the values for DSC Margin and DSC Upper Limit in all associated DSC STAs within the limitations given in 25.9.3.1. A variety of methods could be used for the DSC AP to determine these values, either by pre-setting them based upon the location and environment of the network, or by a learning process. For example, if the DSC AP is located in an apartment or house then with advanced knowledge of the dimensions or ranges required, suitable values for DSC Upper Limit and DSC Margin could be derived and used. Similarly, in the cases of an enterprise or managed network, the values for the DSC Margin and DSC Upper Limit may be determined so as to set a desired network coverage area. Alternatively a DSC AP could discover the channel, overlapping situation and signal conditions by monitoring beacons and traffic from its own and overlapping networks. Based upon this monitoring, the DSC AP could then determine the DSC Upper Limit and DSC Margin values that would suit the environment and afford an improvement in network efficiency.

The DSC AP may set a CCAT value for itself that is compatible with its network area and the values for DSC Upper Limit and DSC Margin that it has set. In most practical situations an effective CCA threshold setting that is equal to the DSC Upper Limit minus the DSC Margin is suggested. An alternative is to set the CCAT to be a value equal to the target SNIR, e.g. 20 dB, less than the expected or actual received signal strength from a non-AP STA that is located at the edge of the network area.