IEEE P802.11
Wireless LANs

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| TextDSC and OBSS\_PD |
| `Date: 2017 - 02  |
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Abstract

This document contains the proposed text for 11ax Draft with respect to dynamic sensitivity control (DSC) and also its use to establish the OBSS\_PD value

**CIDS on D0.5 addressed by this resolution include:**

**69, 187, 188, 208, 209, 225, 257, 463, 464, 651, 703, 704, 953, 994, 1016, 2332, 2336, 2912, 2724, 2742**

**CIDs on D1.0 related to this resolution include:**

**5203, 5204, 5205, 5483, 5494, 5495, 5503, 5691, 6761, 6762, 6768, 7122, 7123, 7129, 7230, 7405, 8725, 9540, 9947, 10031, 10033**

**Revisions:**

**REV 0,1,2 August 2016**

**REV** 3 **revised to reflect changes accepted in 16/1223r6**

**REV 4 revised to reflect Draft 1.0.**

**REV 5 ATPC removed and Max Upper Limit set to -42 dBm so as to match -62dBm maximum CCAeff and OBSS\_PD**

**REV 6 Annex text edited to describe setting DSC Upper Limit for network area coverage**

**REV 7 Condition added that CCAeff can only be used as OBSS\_PD for inter\_BSS PPDUs, i.e. not independently.**

**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 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/ATPC Parameter element. For example, a DSC Upper Limit field value of 42 indicates a DSC Upper Limit of -42 dBm.

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.

#### 27.9.2.2 Adjustment of OBSS\_PD and transmit power

At P191 L4, after “A STA can select an OBSS\_PD level during its operation under SR mode. This level can be dynamically adjusted or can be static.”

Insert “The OBSS PD level may be set equal to the effective CCA level, CCAeff, derived using DSC procedures, see 27.9.3.1.”

**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 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, CCAeff, as per equation 27-X:

 CCAeff = 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 effective CCAeff is -82 dBm for any 20 MHz channel. The value for CCAeff is increased by 3 dB for 40 MHz channels, 6 dB for 80 MHz channels and 9 dB for 160 MHz channels.

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 the DSC Margin value set to a minimum of 20 dB, and the DSC Upper Limit set to a maximum of -42 dBm.

**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 effective CS/CCA threshold based upon the time averaged received signal strength of the beacons, dot11DSCMargin and dot11DSCUpperLimit is valid for any 20 MHz channel. The effective CS/CCA threshold 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, and inter-BSS OBSS PD**

The effective CS/CCA threshold, CCAeff, as derived using the DSC procedures, may only be used to apply to inter-BSS frames and not to intra-BSS frames, see 27.9.2, in this case the OBSS\_PD level is set equal to the CCAeff.

**In C.3 MIB Detail**

**ADD to “dot11StationConfig TABLE”**

Dot11StationConfigEntry : : = SEQUENCE

 Dot11DynamicSensitivityControlImplemented TruthValue

 Dot11 AdaptiveTransmitPowerControlImplemented 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 { 20 }

::= { 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 or the receive sensitivity of a DSC STA in order to improve the efficiency of an infrastructure network. 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 non-AP DSC STA**

**TBA.1.1.1 Basic Operation**

There are two settings used in DSC: DSC Upper Limit and DSC Margin. In general the non-AP DSC 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. For example, if the averaged signal strength of the beacon is -45 dBm and the DSC Margin is set to 20 dB, the effective CCA threshold is set to -45 -20 = -65 dBm. The DSC Upper Limit serves two functions; preventing STAs close to the AP setting a high CCA threshold representing a limited range with the result that other stations in the same network could be ‘hidden’, and setting an effective range or area for the network. The DSC Upper Limit sets the maximum value for the received signal strength of the beacon and this effectively sets the maximum CCA threshold at a value given by DSC Upper Limit minus DSC Margin. For example, if the DSC Upper Limit is -42 dBm and the DSC Margin is 20 dB, then the maximum value for the CCA threshold is -62 dBm, equivalent to about 15m range at 5 GHz. Setting the DSC Upper Limit to -55 dBm with the DSC Margin at 20 dB, the DSC Threshold is decreased to -75 dBm and the effective 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 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 effective CCA threshold calculated using the DSC Margin and DSC Upper Limit is also valid for a 20 MHz channel. The effective CCA threshold 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 Determining Beacon Signal Strength value**

It is recommended that the received signal strength of the beacon frames be averaged over time. The received signal strength may be calculated using a variety of averaging methods but a recommended method is to use a moving average so 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 relatively common to miss a certain number of Beacons especially if the STA is in Power Save mode where the STA may deliberately sleep through a 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.1.2.1 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.
* Min\_RX\_Sensitivity: the minimum value for receiver sensitivity threshold, set to a value that corresponds to RX sensitivity for the STA if it was not using DSC. An example default value is -92 dBm.



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

**TBA.1.3 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 STA within the limitations given in 25.9.3.1. A variety of methods could be used for the 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 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 an 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 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 AP may set a CCA Threshold for itself that is compatible with its network 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 effective CCA threshold to be 10 dB less than the expected or actual received signal strength from a non-AP STA that is located at the edge of the network.

**TBA.2 DSC and OBSS\_PD**

An HE STA adjusts the transmit power according to the OBSS\_PD level as used in OBSS\_PD based spatial reuse operation. The effective CS/CCA threshold, CCAeff, as derived using DSC, can only be used to dynamically set the OBSS\_PD level for inter-BSS frames as described in 27.9.2.