IEEE P802.11  
Wireless LANs

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

This document contains the proposed text for 11ax Draft with respect to dynamic preamble detection (DPD) 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 PDP 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.**

**REV 8 Text changes to correspond to 16/0947r21 SRG and non-SRG**

**REV 9 Text changes to clarify DSC only used for PD**

**REV 10 typo correction**

**REV 11 DSC replaced with DPD**

**CID 166**

**Suggested changes for DPD to 802.11 Standard**

**BACKGROUND STUFF**

**Add to Section 3.4**

“DPD dynamic preamble detection”

**9.4.2.27 Extended Capabilities element**

Add to Table 9-134 Extended Capabilities field

|  |  |  |
| --- | --- | --- |
| Bit | Information | Notes |
| TBD | Dynamic Preamble Detection(DPD) | STA sets DPD field to 1 when dot11DynamicPreambleDetectionImplemented is true and sets it to 0 otherwise. |

**Add to 9.4.2**

**9.4.2.X DPD Parameter Set element**

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

The format of the DPD 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 | DPD Margin | DPD Upper Limit |

Octets 1 1 1 1 1

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

For an infrastructure BSS, the DPD 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 preamble detection procedures are described in 27.9.3.1.

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

The DPD Upper Limit field is one octet in length and indicates the value of the DPD 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 DPD/ATPC Parameter element. For example, a DPD Upper Limit field value of 42 indicates a DPD Upper Limit of -42 dBm.

Setting the values of both the DPD Margin and the DPD Upper Limit fields to zero indicates that DPD 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 DPD procedures, see 27.9.3.1.”

After Table 25-xyz as per 16/0947r21 insert the following:

“HE STAs may set a NON SRG OBSS\_PD level equal to the effective CCA level , CCA eff, derived using DPD procedures (see 27.9.3.1) for NON SRG PPDUs.”

After Table 25-yyz as per 16/0947r21 insert the following:

“HE STAs may set an SRG OBSS\_PD level equal to the effective CCA level , CCA eff, derived using DPD procedures (see 27.9.3.1) for SRG PPDUs.”

**Insert 27.9.3 to read as below**

**27.9.3 Adaptive CCA**

**25.9.3.1 Dynamic Preamble Detection**

An HE STA indicates its support of Dynamic Preamble Detection (DPD) procedures by setting dot11DynamicPreambleDetectionImplemented to true and setting the Dynamic Preamble Detection bit in the Extended Capabilities field to 1. An HE STA that is using DPD procedures is a DPD STA.

In an infrastructure network, a DPD AP may include the DPD Parameter element, as defined in 9.4.2.X, in beacons and probe responses. A DPD AP may advertise the values for DPD Margin and DPD Upper Limit in the DPD Parameter Set element. In this case, an associated DPD non-AP STA shall set its values of dot11DPDMargin and dot11DPDUpperLimit equal to the respective advertised values in the DPD Parameter element.

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

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

CCAeff = MIN (DPD Upper Limit, RSSI beacon ) – DPD Margin 27-X

Where,

DPD Upper Limit is the value of dot11DPDUpper Limit,

DPD Margin is the value of dot11DPDMargin, and

RSSIbeacon is the received signal strength of the beacon transmitted by the DPD 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 DPD AP may indicate that DPD procedures are prohibited by setting both the DPD Margin and DPD Upper Limit fields in the DPD Parameter element to 0. In this case a DPD non-AP STA associated to that AP shall not use DPD procedures.

If a DPD non-AP STA is associated to an AP that does not include the DPD Parameters element in its beacons, then the DPD STA may still use DPD procedures with the DPD Margin value set to a minimum of 20 dB, and the DPD Upper Limit set to a maximum of -42 dBm.

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

In an infrastructure network, a DPD 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 dot11DPDMargin 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, dot11DPDMargin and dot11DPDUpperLimit 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 DPD procedures.

**27.9.3.1.2 DPD, SRG, NON SRG, OBSS PD**

**DPD procedures shall only be used by an HE STA to set OBSS\_PD, NON SRG PD, and SRG PD levels, but an HE STA may set PD levels using non-DPD procedures**.

**In C.3 MIB Detail**

**ADD to “dot11StationConfig TABLE”**

Dot11StationConfigEntry : : = SEQUENCE

Dot11DynamicPreambleDetectionImplemented TruthValue

**ADD to SA Query Procedure MIBs**

dot11DynamicPreambleDetectionImplemented 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 Preamble Detection."

DEFVAL { false }

::= { dot11StationConfigEntry TBA }

dot11DPDMargin OBJECT-TYPE

SYNTAX Unsigned32 (1..100)

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"This attribute indicates the value, in dBs, of the DPD Margin that a DPD 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 }

dot11DPDUpperLimitLimit OBJECT-TYPE

SYNTAX Unsigned32 (1.. 100)

MAX-ACCESS read-write

STATUS current

DESCRIPTION

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

DEFVAL { 40 }

::= { dot11StationConfigEntry TBA }

**ADD NEW ANNEX**

**ANNEX TBA**

(informative)

**Spatial Reuse Procedures**

**TBA.1 Dynamic Sensitivity Control**

When dot11DynamicPreambleDetectionImplemented is true, the STA is a DPD STA. A DPD STA sets the DPD Supported bit to 1 in the Extended Capabilities field.

Dynamic Preamble Detection (DPD) procedures may be used to control the effective carrier sense/clear channel assessment (CS/CCA) mechanism threshold or the receive sensitivity of a DPD STA in order to improve the efficiency of an infrastructure network. A DPD non-AP STA may use DPD procedures unless the DPD Margin and DPD Upper Limit fields in the DPD Parameter set element are both set to 0 by the AP to which the non-AP DPD STA is associated, in which case the STA sets dot11DynamicPreambleDetectionImplemented to false.

**DPD procedures shall only be used by an HE STA to set OBSS\_PD, NON SRG PD, and SRG PD levels, but an HE STA may set PD levels using non-DPD procedures**.

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

**TBA.1.1.1 Basic Operation**

There are two settings used in DPD: DPD Upper Limit and DPD Margin. In general the non-AP DPD STA measures the average signal strength of the received beacon and then subtracts the DPD 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 DPD Margin is set to 20 dB, the effective CCA threshold is set to -45 -20 = -65 dBm. The DPD 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 DPD 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 DPD Upper Limit minus DPD Margin. For example, if the DPD Upper Limit is -42 dBm and the DPD 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 DPD Upper Limit to -55 dBm with the DPD Margin at 20 dB, the DPD Threshold is decreased to -75 dBm and the effective range increases to about 35m. Hence, by setting the DPD Upper Limit and DPD 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 DPD Parameter element, the STA uses the values for Upper Limit and Margin that are included in the DPD Parameter element. In the case that the AP is not a DPD AP or does not transmit a DPD Parameter element, then the DPD non-AP STA may set values for the DPD Upper Limit and DPD 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 DPD Margin and DPD 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 DPD operational algorithm**

A sample DPD 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 DPD. An example default value is -92 dBm.



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

**TBA.1.3 DPD Operation for DPD AP**

A DPD AP may transmit the DPD Parameter element in beacons and probe responses in order to set the values for DPD Margin and DPD Upper Limit in all associated DPD 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 DPD Upper Limit and DPD Margin could be derived and used. Similarly, in the cases of an enterprise or managed network, the values for the DPD Margin and DPD 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 DPD Upper Limit and DPD 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 DPD Upper Limit and DPD Margin that it has set. In most practical situations an effective CCA threshold setting that is equal to the DPD Upper Limit minus the DPD 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.