BSS Coloring

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Information About BSS Coloring

The 802.11 Wi-Fi standard minimizes the chance of multiple devices interfering with one another by transmitting at the same time. This carrier-sense multiple access with collision avoidance (CSMA/CA) technology is based on static thresholds that allow Wi-Fi devices to avoid interfering with each other on air. However, with an increase in density and the number of Wi-Fi devices, these static thresholds often lead to CSMA/CA causing devices to defer transmissions unnecessarily.

For example, if two devices that are associated with different BSS, can hear every transmission from each other at relatively low signal strengths, each device should defer its transmission when it receives a transmission from the other. But if both the devices were to transmit at the same time, it is likely that neither would cause enough interference at the other BSS' receiver to cause reception failure for either transmission.

Devices today must demodulate packets to look at the MAC header in order to determine whether or not a received packet belongs to their own BSS. This process of demodulation consumes power, which can be saved if devices can quickly identify the BSS by looking at the PHY header alone, and subsequently drop packets that are from a different BSS. Prior to Wi-Fi 6, there was no provision for devices to do this.

The new 802.11ax (Wi-Fi 6) standard addresses both of the issues discussed above, through the new BSS Coloring and Spatial Reuse mechanism. BSS Coloring is a new provision that allows devices operating in the same frequency space to quickly distinguish between packets from their own BSS and packets from an Overlapping BSS (OBSS), by simply looking at the BSS color value contained in the HE PHY header. In some scenarios, Spatial Reuse allows devices, to transmit at the same time as the OBSS packets they receive, instead of deferring transmissions because of legacy interference thresholds. Since every Wi-Fi 6 device understands the BSS color, it can be leveraged to increase power savings by dropping packets earlier, and to identify spatial reuse opportunities.

BSS Coloring

BSS Coloring is a method used to differentiate between the BSS of access points and their clients on the same RF channel. Wi-Fi 6 enables each AP radio to assign a value (from 1 to 63), known as BSS color, to be included in the PHY header of all HE transmissions from devices in its BSS. With devices of each BSS transmitting a locally-unique color, a device can quickly and easily distinguish transmissions coming from its BSS from those of a neighboring BSS.

The following platforms support this feature:

- Cisco Catalyst 9800 Series Wireless Controllers
- Cisco Catalyst 9115 Access Points
- Cisco Catalyst 9117 Access Point
- Cisco Catalyst 9120AX Series Access Points
- Cisco Catalyst 9124AX Series Access Points
- Cisco Catalyst 9130AX Access Points

OBSS-PD and Spatial Reuse

Overlapping BSS Packet Detect (OBSS-PD) is a more aggressive Wi-Fi packet detect threshold for inter-BSS packets, which can be higher than the typical/legacy -82 dBm. Inter-BSS packets are easily identified by comparing the BSS color in the HE PHY header of the packets received with the BSS color of the device.

In OBSS-PD based Spatial Reuse, to improve throughput and network efficiency by increasing transmitting opportunities, a Wi-Fi 6 or 802.11ax device can transmit over an inter-BSS packet with an RSSI that is below the OBSS-PD threshold instead of deferring.

Note Cisco Catalyst 9120AX Series Access Points do not support OBSS-PD.

Configuring BSS Color on AP (GUI)

Procedure

Step 1 Choose **Configuration** > **Wireless** > **Access Points**.

Step 2 Click the **5 GHz Radios** section or the **2.4 GHz Radios** section.
The list of the AP radios in the band is displayed.

Step 3 Click the required AP name.
The **Edit Radios** window is displayed.

Step 4 From the **Edit Radios** window, select the **Configure** tab.
The general information, Antenna Parameters, RF Channel Assignment, Tx Power Level Assignment, and BSS Color are displayed.

Step 5 In the **BSS Color** area and from the **BSS Color Configuration** drop-down list, choose **Custom** configuration

- **Custom**: To manually select the BSS color configuration for the AP radio.
  a. Click the **BSS Color Status** field to disable or enable the feature.
  b. In the **Current BSS Color** field, specify a corresponding BSS color for the AP radio. The valid range is between 1 and 63.

Step 6 Click **Update & Apply to Device**.

Configuring BSS Color in the Privileged EXEC Mode

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.

Step 2	**ap name** *ap-name* **dot11** { **24ghz** | **5ghz** | **dual-band** [**slot** *slot-id*] } **dot11ax bss-color** *<1-63>*
	Example:
	`Device#ap name apn dot11 24ghz slot 0 dot11ax bss-color 12`
	Example:
	`Device#ap name apn no dot11 24ghz slot 0 dot11ax bss-color`
		Sets the BSS color on the 2.4-GHz, 5-GHz, or dual-band radio, for a specific access point on the following slots:
		• 5 GHz: Slot 1 and 2
		• 2.4 GHz: Slot 0
		• Dual-band: Slot 0
		Use the `no` form of this command to disable BSS color.

Configuring BSS Color Globally (GUI)

Procedure

Step 1 Choose **Configuration** > **Radio Configurations** > **Parameters**.

Step 2 In the **11ax Parameters** section, enable BSS color globally for the 5 GHz and 2.4 GHz radios by checking the **BSS Color** check box.

Configuring BSS Color in the Configuration Mode

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**[no] ap dot11** {**24ghz** | **5ghz** } **dot11ax bss-color** **Example:** `Device(config)#[no] ap dot11 24ghz dot11ax bss-color`	Enables the 802.11ax BSS color on all 2.4-GHz or 5-GHz radios. Use the `no` form of this command to disable BSS color.

Configuring Overlapping BSS Packet Detect (GUI)

Procedure

Step 1 Choose **Configuration** > **Radio Configurations** > **Parameters**.

The parameters page is displayed where you can configure global parameters for 5 GHz Band and 2.4 GHz Band radios.

Step 2 In the **11ax Parameters** section, check the **OBSS PD** check box to enable the overlapping BSS packet detect (OBSS PD) feature.

Step 3 In the **Non-SRG OBSS PD Max Threshold** field, enter the threshold in decibel-milliwatts. Value range is between -82 dBm and -62 dBm.

Configuring OBSS-PD Spatial Reuse Globally (CLI)

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**[no] ap dot11** {**24ghz** | **5ghz** } **dot11ax spatial-reuse obss-pd** **Example:** `Device(config)#[no] ap dot11 24ghz dot11ax spatial-reuse obss-pd`	Configures 802.11ax OBSS PD based spatial reuse on all 2.4-GHz or 5-GHz radios. Use the `no` form of this command to disable this feature.
Step 3	**ap dot11** {**24ghz** | **5ghz** } **dot11ax spatial-reuse obss-pd non-srg-max** *-82 - -62* **Example:** `Device(config)#[no] ap dot11 24ghz dot11ax spatial-reuse obss-pd non-srg-max -62`	Configure 802.11ax non-SRG OBSS PD max on all 2.4-GHz or 5-GHz radios. The default value is -62.

Configuring OBSS PD in an RF Profile (GUI)

Procedure

Step 1 Choose **Configuration** > **Tags & Profiles** > **RF**.

Step 2 On the **RF Profile** page, click **Add** to configure the following:

- General
- 802.11
- RRM
- Advanced

Step 3 In the **Advanced** tab, under the **11ax Parameters** section, complete the following:

a) Use the toggle button to enable or disable the **OBSS PD** field.

b) In the **Non-SRG OBSS PD Max Threshold (dBm)**, enter the threshold value. The default value is -62 dBm. Values range between -82 dBm and -62 dBm.

Step 4 Click **Save & Apply to Device**.

Configuring OBSS-PD Spatial Reuse in the RF Profile Mode (CLI)

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**ap dot11** { **24ghz | 5ghz** } **rf-profile** *rf-profile-name* **Example:** `Device(config)# ap dot11 24ghz rf-profile rfprof24_1`	Configures an RF profile and enters RF profile configuration mode.
Step 3	**[no] dot11ax spatial-reuse obss-pd** **Example:** `Device(config-rf-profile)#[no] dot11ax spatial-reuse obss-pd`	Configures 802.11ax OBSS PD based spatial reuse in the RF profile configuration mode. Use the `no` form of this command to disable this feature.
Step 4	**dot11ax spatial-reuse obss-pd non-srg-max** *-82 - -62* **Example:** `Device(config-rf-profile)# dot11ax spatial-reuse obss-pd non-srg-max -62`	Configure 802.11ax non-SRG OBSS PD max on all 2.4-GHz or 5-GHz radios. The default value is -62.

Verifying BSS Color and OBSS-PD

To verify if the global per-band BSS color and OBSS-PD are enabled, use the following **show** command:

```
Device# show ap dot11 24ghz network
802.11b Network                          : Enabled
11gSupport                               : Enabled
11nSupport                               : Enabled
.
.
.
802.11ax                                 : Enabled
  DynamicFrag                            : Enabled
  MultiBssid                             : Enabled
  Target Wakeup Time                     : Enabled
  Target Wakeup Time Broadcast           : Enabled
  BSS Color                              : Enabled
  OBSS PD                                : Enabled
  Non-SRG OBSS PD Max                    : -62 dBm
802.11ax MCS Settings:
  MCS  7, Spatial Streams = 1            : Supported
.
.
.
```

To view the RF profile OBSS-PD configuration, use the following **show** command:

```
Device# show ap rf-profile name rf-profile-name detail
Description                        : pre configured rfprofile for 5gh radio
RF Profile Name                    : rf-profile-name
Band                               : 5 GHz
Transmit Power Threshold v1        : -65 dBm
Min Transmit Power                 : 7 dBm
Max Transmit Power                 : 30 dBm
.
.
.
802.11ax
  OBSS PD                          : Enabled
  Non-SRG OBSS PD Max              : -62 dBm
NDP mode                           : Auto
```

To view the BSS color configuration of all the AP radios on a band in the summary list, along with Channel, TX Power and so on, use the following **show** command:

```
Device# show ap dot11 24ghz summary extended
AP Name                          Mac Address     Slot    Admin State    Oper State    Width
  Txpwr           Channel                         BSS Color
-----------------------------------------------------------------------------------------------


Ed2-JFW-AP1                       84b2.61ba.4730  1       Enabled        Up            40
    1/6 (17 dBm)    (136,132)*
11AX-9120-AP1                     d4ad.bda2.3fc0  1       Enabled        Up            20
    1/8 (23 dBm)    (36)                             30
Ed2-JFW-AP2                       f8c2.8885.59f0  1       Enabled        Up            20
    1/5 (15 dBm)    (40)
```

To view the BSS color configuration and the capability of an AP radio, use the following **show** commands:

```
Device# show ap name AP7069.5A74.816C config dot11 24ghz
Cisco AP Identifier                              : 502f.a876.1e60
Cisco AP Name                                    : AP7069.5A74.816C
Attributes for Slot 0
  Radio Type                                     : 802.11b
  Radio Mode                                     : REAP
  Radio Role                                     : Auto
  Radio SubType                                  : Main
  Administrative State                           : Enabled
  Operation State                                : Up
  .
  .
  .
Phy OFDM Parameters
    Configuration                                : Automatic
    Current Channel                              : 6
    Channel Width                                : 20 MHz
    TI Threshold                                 : 1157693440
    Antenna Type                                 : External
    External Antenna Gain (in .5 dBi units)      : 8
    .
    .
    .
  !BSS color details are displayed below:
  802.11ax Parameters
    HE Capable                                   : Yes
    BSS Color Capable                            : Yes
    BSS Color Configuration                      : Customized
    Current BSS Color                            : 34

Device# show ap name AP70XX.5XX4.8XXX config slot 0
Cisco AP Identifier                              : 502f.a876.1e60
```

```
Cisco AP Name                                   : AP70XX.5XX4.8XXX
Country Code                                    : US
AP Country Code                                 : US  - United States
AP Regulatory Domain                            : -A
MAC Address                                     : 7069.5a74.816c
IP Address Configuration                        : DHCP
IP Address                                      : Disabled
.
.
.
Attributes for Slot 0
  Radio Type                                    : 802.11n - 2.4 GHz
  Radio Role                                    : Auto
  Radio Mode                                    : REAP
  Radio SubType                                 : Main
  Administrative State                          : Enabled
.
.
.
  Phy OFDM Parameters
    Configuration                               : Automatic
    Current Channel                             : 6
    Channel Assigned By                         : DCA
    Extension Channel                           : NONE
    Channel Width                               : 20
    Allowed Channel List                        : 1,2,3,4,5,6,7,8,9,10,11
    TI Threshold                                : 1157693440
    DCA Channel List                            :
    Antenna Type                                : EXTERNAL_ANTENNA
    External Antenna Gain (in .5 dBi units)     : 8
Diversity                                       : DIVERSITY_ENABLED
    802.11n Antennas
      A                                         : ENABLED
      B                                         : ENABLED
      C                                         : ENABLED
      D                                         : ENABLED
  .
  .
  .
  !BSS color details are displayed below:
  802.11ax Parameters
    HE Capable                                  : Yes
    BSS Color Capable                           : Yes
    BSS Color Configuration                     : Customized
    Current BSS Color                           : 34
.
.
.
```