Radio Channels and Transmit Frequencies

This configuration note provides the information on determining the radio type and configuring the radio channel frequency and spacing. It also describes Dynamic Frequency Selection and lists Wireless Device Channels and Frequencies for most regulatory domains.

By default, the channel selected by Cisco wireless devices is the one that is least congested. At startup and by default, wireless devices passively scan for and select the least-congested channel. The channel settings on wireless devices correspond to the frequencies available in your regulatory domain.

In the European Telecommunications Standards Institute (ETSI) domain, the regulatory agencies do not allow the channel to be set on 5.0 GHz (802.11a/h) radios by the users. However, channel groups can be *blocked* on wireless devices running ETSI images. When a wireless device boots from an ETSI image, it automatically selects the least congested channel where radar is not detected by using Dynamic Frequency Selection (DFS). Blocking a channel group forces the wireless device to skip a block of channels.

Note The ability to block a channel group is not available on the Cisco 3200 Series WMICs.

Additional Information

For general information on channel selection and transmit power, see the “FCC Regulations Update For 2004” white paper at:

http://www.cisco.com/en/US/products/hw/wireless/ps4555/products_white_paper0900aecd801c4a88.shtml

Additional information on DFS and TPC can be found in the Cisco “Dynamic Frequency Selection and IEEE 802.11h Transmit Power Control” document available at:

http://www.cisco.com/en/US/products/ps6441/products_feature_guide09186a008060f7c2.html

For additional information on the 4.9 GHz (public safety) band, see the “Cisco Support for 4.9 GHz Public Safety Broadband Spectrum in the US” white paper at:

http://www.cisco.com/en/US/products/hw/routers/ps272/prod_brochure0900aecd802d816e.html

Corporate Headquarters:
Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

Setting a Channel

To set the channel, the following steps are described in detail in this section:

- Determine the Radio Type to verify that the radio manual setting of the channel and to verify that the wireless device is not operating in a regulatory domain that requires DFS.
- Configure the Radio Channel Number or Frequency to eliminate overlapping channels on models that allow user-set channel selection or block a radio frequency group where radar is known to operate.
- Configure the Radio Channel Spacing to eliminate overlapping channels on models that allow user-set channel selection.

Note If the wireless device is using a 5.0 GHz (802.11a/h) radio and running an ETSI IOS image, the channel cannot be modified.

Determine the Radio Type

Determine the radio type to establish the frequency range of the radio. Use the **show controllers dot11Radio** command to show the radio type, frequency, and current channel for the wireless device. For example:

```
wd>enable
wd>password                                    ! If prompted
wd#show controllers dot11Radio interfacenumber
interface Dot11Radio0
!
Radio AIR-AP1242GA, Base Address 0014.1b58.08f   ! AIR-AP1242GA radio type shown
Version 5.80.12
Serial number: GAM09200992
Number of supported simultaneous BSSID on Dot1
Carrier Set: Americas (US)                     ! Domain
DFS Required: No                               ! DFS requirement
!
Current Frequency: 2412 MHz Channel 1          ! Frequency
```

Configure the Radio Channel Number or Frequency

To set the radio channel, use the following command, beginning in privileged EXEC mode:

channel {*channel_number* | *frequency* | **least_congested**}

To automatically search for the least congested channel on startup and use this channel for the wireless device radio, use the **least-congested** parameter.

When specifying a frequency, enter the center frequency for the radio channel. The valid center frequencies and channel numbers depend on the channels allowed in the regulatory domain.

If the radio is operating in an area where it is known that radar is in use, blocking a specific frequency group can save processing time.

Note This command is not available on the Cisco 3200 Series WMICs.

To prevent a wireless device from selecting a group of frequencies, use the **dfs band** command, beginning in privileged EXEC mode.

dfs band *frequency-group* **block**!

The *frequency-group* value can be **1**, **2**, **3**, or **4**:

- **1** specifies frequencies 5.150 to 5.250 GHz
- **2** specifies frequencies 5.250 to 5.350 GHz
- **3** specifies frequencies 5.470 to 5.725 GHz
- **4** specifies frequencies 5.725 to 5.825 GHz

Configure the Radio Channel Spacing

To set the radio channel spacing, use the following command:

spacing {**5** | **10** | **20**} **channel**

To let the DFS mechanism determine which channel to use, see the "Configuring a Preferred Channel" section.

Note The Cisco 3205 WMIC supports only 20 MHz spacing.

Dynamic Frequency Selection

Transmission Power Control (TPC) is used to automatically adjust the transmission power level on 5.0-GHz radios, also to avoid interfering with radar. 5.0 GHz (802.11a/h) radios in wireless devices running Cisco IOS version 12.4(6)T and later shipped to Europe and Japan are required to use Dynamic Frequency Selection (DFS) to detect and avoid interfering with radar signals to comply with those regulatory domains.

DFS is the process of detecting radar signals that must be protected against interference from 5.0 GHz (802.11a/h) radios, and upon detection switching the operating frequency of the 5.0 GHz (802.11a/h) radio to one that is not interfering with the radar systems. Transmission Power Control (TPC) is used to adapt the transmission power of a radio based on regulatory requirements and range information.

The wireless device automatically sets the frequency on a DFS-enabled 5.0 GHz (802.11a/h) radio operating in a regulatory domain where DFS is required for compliance with the rules of that regulatory agency. A specific channel cannot be configured for DFS-enabled radios; the **channel** command is disabled.

Note On the some wireless devices you can configure a specific channel for DFS-enabled radios. See Configuring a Preferred Channel, page 5.

If the wireless device is set to use DFS and it is deployed in a regulatory domain that does not allow or does not require the use of DFS, disable DFS by using the **no dfs band block** command in interface configuration mode.

DFS Actions

DFS-enabled radios monitor the operating frequency for radar signals. If radar signals are detected on the channel, the wireless device takes these steps:

- Blocks new transmissions on the channel.
- Flushes the power-save client queues.[1]
- Broadcasts an 802.11h channel-switch announcement.
- Disassociates remaining client devices.
- Randomly selects a different channel:
  - If the wireless device does not select a DFS-required channel, it enables beacons and accepts client associations.
  - If the wireless device selects a DFS-required channel, it scans the new channel for radar signals for 60 seconds. If there are no radar signals on the new channel, the wireless device enables beacons and accepts client associations. If a radar signal is detected, the wireless device selects a different channel.

If a prefered channel is configurable and available, it is selected first.

Radar Detection By Clients

Note This command is available on the Cisco 3205 WMIC only.

By default, radar detection is disabled in the workgroup bridge and non-root bridge modes (client modes). However, you can use the **radar-detection-enabled** command in the workgroup bridge or non-root bridge mode to enable radar detection in the client mode.

After a wireless device in client mode associates with a root device, it checks whether radar detection is enabled and whether the current uplink channel is a DFS channel. If radar detection is enabled and the current uplink channel is a DFS channel, the wireless device in client mode enables radar detection for this channel.

When the wireless device detects a radar signal, it immediately notifies the root device, brings down its interface, and restarts mixed uplink scanning, as described in Mixed Uplink Scanning Mode, page 4.

When the root device receives radar detection notification from a client, it check the association status:

- If the client is associated and authenticated, the root device immediately responds to the client's radar detection notification by marking the channel specified by the client as a radar channel and switches to a new channel following the channel availability check.

  In addition, the root device sends an SNMP trap to the network administrator.
- If the client is not authenticated or associated to the root device, the root device silently drops the client's notification.

1. Not supported on the Cisco 3200 Series WMIC

Mixed Uplink Scanning Mode

Note This feature is available on the Cisco 3205 WMIC only.

The wireless device supports a mixed scanning mode in the client mode for wireless clients to comply with DFS rules, which require clients to perform in the way of “listen before you talk.”

The wireless client always starts with passive scanning. During a passive scan, the client marks the channels on which it detects beacons from any root device. If the client cannot find a matched root device after a full round of passive scanning, the client switches to the active scanning mode, but broadcasts probe request only on the channels marked by the previous passive scanning.

If the wireless device in client mode still cannot find a matched root device after a full round active scanning, it resets the channel marks and goes back to passive scanning. This process repeats until the wireless device in client mode finds a matched root device.

After the wireless device successfully associates to a root device, the scanning mode switches to active mode to avoid beacon processing.

Note If a wireless device needs to perform uplink scanning again, it returns to the passive mode.

Configuring a Preferred Channel

Note This command is available on the Cisco 3205 WMIC only.

By default, a wireless device in the root mode randomly selects its operating channel to meet the uniform channel distribution requirement for standalone deployments. However, the random selection of the operating channel can result in adjacent and co-channel interference in deployments with multiple overlapping access points.

To minimize this type of interference, specify the channel of operation (prefer channel) of each access point. The user is then responsible for ensuring that the selected channels are uniformly distributed across the network.

To configure a prefered channel, use the following command:

spacing {**5** | **10** | **20**} **channel** *prefered_channel* [**return-time** <1-48>]

This command lets you specify a *prefered* channel for the wireless device to use as its operating channel. The command marks the specified channel with the highest priority to be chosen, but not the only channel that can be used.

After the prefered channel is configured, the wireless device resets its radio and selects the configured prefered channel to go through the channel availability check (60 seconds of scanning for radar signals) prior to enabling transmission on the channel.

However, if a radar signal is detected on the prefered channel, a new operating channel is randomly selected, which again can result in interchannel interference.

To resolve this issue, you can use the **return-time** option to specify a timeout period. This forces the wireless device to periodically try to return to the configured prefer channel after the timeout period expires, provided no radar is operating on the channel. If radar is operating on the prefer channel, the

wireless device tries again after another timeout period expires. The wireless device keeps trying until it finds no radar on the prefer channel, at which point the wireless device switches back to the prefer channel.

The **return–time** parameter pecifies in 30-minute time units how long to wait before trying to return to the prefer channel after radar has been detected on the operating prefer channel. The minimum value is 1 time unit (30 minutes). The maximum value is 48 time units (1,440 minutes or 24 hours). The default value is 1 (30 minutes).

The wireless device sends an SNMP management trap whenever a channel is switched due either to radar detection or a return to the prefer channel.

Dynamic Frequency Selection Channels

When a Dynamic Frequency Selection (DFS)–enabled radio is operating on one of the following channels, the wireless device uses DFS to monitor the operating frequency and switch to another frequency or reduce power as necessary:

- 52 (5260 MHz)
- 56 (5280 MHz)
- 60 (5300 MHz)
- 64 (5320 MHz)
- 100 (5500 MHz)
- 104 (5520 MHz)
- 108 (5540 MHz)
- 112 (5560 MHz)
- 116 (5580 MHz)
- 120 (5600 MHz)
- 124 (5620 MHz)
- 128 (5640 MHz)
- 132 (5660 MHz)
- 136 (5680 MHz)
- 140 (5700 MHz)

The maximum legal transmit power is greater for some 5 GHz channels than for others. When the wireless device randomly selects a 5 GHz channel on which power is restricted, the wireless device automatically reduces transmit power to comply with power limits for that channel in that regulatory domain.

Wireless Device Channels and Frequencies

This section lists the channels and frequencies for most regulatory domains.

2.4 GHz (802.11b/g) Channels and Frequencies

802.11b and 802.11g radios operate on 11 channels from 2412 MHz to 2462 MHz. Although the center frequency of the channels are 5 MHz apart, each channel is 22 MHz wide and overlaps the adjacent channels. For best performance, use channels that are not adjacent (such as channel 1, channel 6, and channel 11) for wireless devices that are physically close enough to each other that their signals overlap.

The channel identifiers, channel center frequencies, and regulatory domains of each IEEE 802.11b and 802.11g channel are shown in Table 1.

Table 1 Channels for IEEE 802.11b and 802.11g

Channel Identifier	Center Frequency (MHz)	Regulatory Domains							
		Americas (–A)		EMEA (–E)		Israel (–I)		Japan (–J)	
		CCK[1]	OFDM[2]	CCK	OFDM	CCK	OFDM	CCK	OFDM
1	2412	X	X	X	X	–	–	X	X
2	2417	X	X	X	X	–	–	X	X
3	2422	X	X	X	X	–	–	X	X
4	2427	X	X	X	X	–	–	X	X
5	2432	X	X	X	X	X	X	X	X
6	2437	X	X	X	X	X	X	X	X
7	2442	X	X	X	X	X	X	X	X
8	2447	X	X	X	X	X	X	X	X
9	2452	X	X	X	X	–	–	X	X
10	2457	X	X	X	X	–	–	X	X
11	2462	X	X	X	X	–	–	X	X
12	2467	–	–	X	X	–	–	X	X
13	2472	–	–	X	X	–	–	X	X
14	2484	–	–	–	–	–	–	X	–

1. Complementary Code Keying
2. Orthogonal Frequency Division Modulation

Note Mexico is included in the Americas (–A) regulatory domain; however, channels 1 through 8 are for indoor use only while channels 9 through 11 can be used both indoors and outdoors. Users are responsible for ensuring that the channel set configuration is in compliance with the regulatory standards of Mexico.

4.9 GHz (public safety) Channels and Frequencies

This band is available only in the U.S. The radio operates on 5 MHz wide, 10 MHz wide, or 20 MHz wide channels between 4940 MHz and 4990 MHz for the licensed public safety community.

The channel identifiers, channel center frequencies, and channel width for the 4.90GHz band are shown in Table 2.

Table 2 Channels, Center Frequencies, and Channel Widths

Channel	Center Frequency (MHz)	Channel Width (MHz)
1	4942.5	5
2	4947.5	5
3	4952.5	5
4	4957.5	5
5	4962.5	5
6	4967.5	5
7	4972.5	5
8	4977.5	5
9	4982.5	5
10	4987.5	5
11	4945	10
12	4950	10
13	4955	10
14	4960	10
15	4965	10
16	4970	10
17	4975	10
18	4980	10
19	4985	10
20	4950	20
21	4955	20
22	4960	20
23	4965	20
24	4970	20
25	4975	20
26	4980	20

5.0 GHz (802.11a/h) Channels and Frequencies

The channel identifiers, channel center frequencies, and regulatory domains of each IEEE 5.0 GHz (802.11a/h) channel are shown in Table 3.

Table 3 5 GHz Radio Channels

Channel Identifier	Center Frequency (MHz)	Regulatory Domains					
		North America	ETSI	Japan[1]	China[1]	Singapore[1]	Taiwan[1]
34	5170			X			
36	5180	X	X	X		X	
40	5200	X	X	X		X	
44	5220	X	X	X		X	
48	5240	X	X	X		X	
52	5260	X	X	X			X
56	5280	X	X	X			X
60	5300	X	X	X			X
64	5320	X	X	X			X
100	5500	–	X	–			
104	5520	–	X	–			
108	5540	–	X	–			
112	5560	–	X	–			
116	5580	–	X	–			
120	5600	–	X	–			
124	5620	–	X	–			
128	5640	–	X	–			
132	5660	–	X	–			
136	5680	–	X	–			
140	5700	–	X	–			
149	5745	X	–	–	X		
153	5765	X	–	–	X		
157	5785	X	–	–	X		
161	5805	X	–	–	X		

1. The Cisco 3200 Series WMIC has not been tested for this domain.

Note All channel sets are restricted to indoor usage except the Americas (–A), which allows for indoor and outdoor use on channels 52 through 64 in the United States.

5.0-GHz Support

The 5.0 GHz (802.11a/h) radio supports the ETSI regulatory domains listed in Table 4.

Table 4 802.11a Channelization

OFDM ETSI Channels[1]
5.250 to 5.350 GHz:
5260 MHz (52)
5280 MHz (56)
5300 MHz (60)
5320 MHz (64)
5.470 to 5.725 GHz:
5500 MHz (100)
5520 MHz (104)
5540 MHz (108)
5560 MHz (112)
5580 MHz (116)
5600 MHz (120)
5620 MHz (124)
5640 MHz (128)
5660 MHz (132)
5680 MHz (136)
5700 MHz (140)

1. Channels 52 through 140 are ETSI outdoor.