

## **Automated Frequency Coordination**

- Feature History for Automated Frequency Coordination, on page 1
- Information About Automated Frequency Coordination, on page 2
- Onboarding the Cloud Controller, on page 4
- Configuring DNA Services (GUI), on page 5
- Configuring Power Mode per RF Profile (CLI), on page 6
- Configuring Power Mode per RF Profile (GUI), on page 7
- Configuring AP Parameters (GUI), on page 7
- Configuring AP Parameters, on page 8
- Verifying AFC Details, on page 8

### **Feature History for Automated Frequency Coordination**

This table provides release and related information for the feature explained in this module.

This feature is also available in all the releases subsequent to the one in which they are introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE 17.12.3	Automated Frequency Coordination	Automated Frequency Coordination (AFC) is an advanced system for coordinating the allocation and utilization of spectrum for access points (APs) that operate within the 6-GHz band.
		This feature is supported on the following APs:
		Cisco Catalyst Wireless 9136I Access Point
		Cisco Catalyst Wireless 9163E Access Point
		Cisco Catalyst Wireless 9166D Access Point
		Cisco Catalyst Wireless 9166I Access Point
		Cisco Catalyst Wireless 9162I Access Point
		Cisco Catalyst Wireless 9164I Access Point

Table 1: Feature History for Automated Frequency Coordination

### Information About Automated Frequency Coordination

Automated Frequency Coordination (AFC) is an advanced system for coordinating the allocation and utilization of spectrum for access points (APs) that operate within the 6-GHz band. The AFC system utilizes the Universal Licensing System (ULS) as a regulatory database, which is updated daily by the FCC, the regulatory body. This database encompasses a wide range of frequency bands used by various radio frequency services within a specific region. This extensive database ensures seamless and efficient management of spectrum resources, enabling optimal utilization of spectrum and minimizing the chances of interference among different radio frequency services.

The FCC's decision to open the 6-GHz band for unlicensed Wi-Fi usage brings about significant advantages, including accelerated connectivity and expanded capacity. By unlocking the potential of the 6-GHz band, you can experience unprecedented performance and seamless connectivity, effortlessly engage in data-intensive activities and enjoy immersive online experiences.

Several other technologies, including fixed satellite services (FSS) used in the broadcast and cable industries, are already active in the 6-GHz band. To ensure that the new unlicensed Wi-Fi entrants do not interfere with current services, FCC has implemented the AFC system for Wi-Fi operation within this band. Indoor APs operate at reduced power levels and are less likely to interfere with current 6-GHz users. The outdoor or standard power APs have a higher probability of causing interference with the existing 6-GHz users. These APs are permitted to operate only within the frequency ranges allocated to each country. For example, in the US, APs are authorized to function in the 5.925-6.425 GHz and 6.525-7.125 GHz bands.

Under the AFC system, a new wireless device is required to verify its compatibility with the existing services. This is done by accessing a registered database of the local AFC system provided by an AFC service provider before starting data transmission. This compatibility check ensures that the device's operation does not cause any interference with the current services. To facilitate the compatibility check, the AFC provider maintains an extensive database containing information about the existing 6-GHz operators, including geolocation details, frequencies in use, power levels, antenna coverage, and other relevant data. For areas where an AFC service is available, outdoor or standard power 6-GHz Wi-Fi deployments are only authorized if they comply with the AFC guidelines.

Individual standard power APs are exempt from interfacing directly with the AFC system, if the necessary registration data is communicated by a proxy device such as the wireless controller. Still, APs are responsible for providing their precise location information. In return, they receive a designated set of available frequencies suitable for that specific location.

#### Figure 1: AFC Architecture



For the Cisco Catalyst APs, the AFC architecture includes the following components:

- Cisco Catalyst APs supporting 6-GHz
- Cisco Catalyst 9800 Series Wireless Controller acting as AFC proxy
- · A cloud-based wireless proxy tunneling the communication between the AFC proxy and the AFC system
- AFC System

### 6-GHz AFC Workflow'

The information flow is briefly explained here:

1. A standard power AP joins the system. Before enabling standard power, the AP must get the available frequencies and the power in each frequency range from the AFC system.

- 2. The AFC proxy sends the AP information to the AFC system.
- **3.** The AFC system computes the available frequencies and maximum allowable power based on the information provided by the regulatory body (FCC for United States).
- 4. The response is sent back to controller, which may assign a standard power channel to the AP based on the allowed channel list returned by the AFC system.

#### Prerequisites

• Ensure that there is cloud connectivity from the controller to the cloud, with a DNS entry in place. AFC operates through either the management port or data ports.

The AFC request is sent only when the controller is onboarded with cloud. This is automatic for hardware platforms like 9800-80, 9800-40 and 9800-L. For cloud controller, you have to manually enter a one-time password (OTP). See *Onboarding the Cloud Controller*.

- Before sending an AFC request, check whether the AFC service can be requested by using the **show** wireless afc ap command. If command output shows *yes* or *up* status for all the parameters of an AP, then request is sent out.
- Standard APs must register with the AFC system by providing the following parameters:
  - Geographic coordinates (latitude and longitude)
  - Antenna height above ground level and tolerance as uncertainty height
  - FCC identification number
  - Manufacturer's unique serial number

#### Restrictions

AFC is not supported on Embedded Wireless Controller (EWC)

#### Supported APs

- Cisco Catalyst Wireless 9136I Access Point
- Cisco Catalyst Wireless 9163E Access Point
- Cisco Catalyst Wireless 9166D Access Point
- Cisco Catalyst Wireless 9166I Access Point
- Cisco Catalyst Wireless 9162I Access Point
- Cisco Catalyst Wireless 9164I Access Point

### **Onboarding the Cloud Controller**

Onboarding the cloud controller requires the generation of a one-time password (OTP). Controller must register with cloud framework to access any cloud service. The cloud service provides identity management services to the controller and securely authenticates the device.

### Procedure

Step 1	Go to Cisco DNA portal.
Step 2	Click Application/Products.
Step 3	Select Region using the drop-down and click Register.
Step 4	Click <b>Register</b> .
Step 5	Enter the product details such as Host Name/IP, Product Name, and Description.
Step 6	Click <b>Register</b> .
	This generates an OTP.
	The OTP token is a BASE64 encoded JSON payload. A sample OTP token is given below:
	eyJiYXNlX3VybCl6lCJodHRwczovL21hZ2xldi5tYWdsZXZjbG91ZDMudGVzc2VyYWN0 aW50ZXJuYWwuY29tIiwib3RwIjogImNjNDY3ZDA5NzE1ZjQ3ZWI4NzhhN2UyOTA2YjllNzE0MTYzY mQzZjA1MWExNDUxZjg2ODViMjVhZDhmNWNkMTQifQo=
Step 7	Copy the OTP.
Step 8	Go to the controller console.
Step 9	Run cloud otp token import command.
Step 10	Paste the OTP copied in Step 7 to the console.
	This completes the onboarding procedure. Wait for a few minutes to complete the process.

# **Configuring DNA Services (GUI)**

### Procedure

Choo Click	se Configuration > Services > Cloud Services. DNA Services Configuration tab.
The I	DNA Services Configuration section displays the following details:
Note	We recommend that you retain default values for URL, API endpoint path and certificate bundle path.
• 1 t	URL: The base web address of the Cisco DNA Cloud instance that issued the token. This will be used to address the enrollment request.
• / 1	<b>API Endpoint Path</b> : An API path that allows client applications like AFC to register for notifications for any Cloud state change.
• (	Certificate Bundle Path: The path for certificate-based authentication. In addition to OTP-based authentication, you can use certificate-based authentication.
• ] 1	<b>HTTP Proxy (Hostname/IP)</b> : The HTTP proxy that serves incoming HTTPs requests from clients and processes received HTTPs responses.

Step 3 In the DNA OTP Configuration section and under Generate OTP, select the link provided to navigate to the Cisco DNA website to generate an OTP.
 Step 4 Enter the generated OTP in the OTP Token field and

```
Step 5 Click Submit OTP.
```

### **Configuring Power Mode per RF Profile (CLI)**

You can allow or disallow standard power mode in configuration per RF profile. However, the operating mode for each RF profile is determined based on the configuration, the capabilities of the AP, and the response from the AFC system regarding channel and transmit power values. If there is no connection with the AFC system or if the received Tx power values are extremely low, the AP might automatically switch from standard-power mode to low-power mode as a fallback.

If the standard power granted by the AFC server is greater than the low power, the radio is switched to standard power mode in the case of mixed-mode APs. If the granted standard power is equal to or greater than the low power, the radio is switched to standard power mode.



Note

We recommend using standard power indoors for unparalleled speed and coverage. While the client and vendor ecosystem is evolving, the current Cisco standard power technology continues to provide advantages for existing standard power and dual-mode clients. Low-power clients will default to 2.4/5GHz until they are fully upgraded to standard power by the client vendors.

#### Procedure

	Command or Action	Purpose				
Step 1	configure terminal	Enters global configuration mode.				
	Example:					
	Device# configure terminal					
Step 2	ap dot11 6ghz rf-profile rf-profile-name	Configures the RF profile and enters RF profile				
	Example:	configuration mode.				
	<pre>Device(config)# ap dot11 6ghz rf-profile     prof-afc</pre>					
Step 3	tx-power standard	Configures standard-power mode for 6-GHz				
	Example:	band for APs that are capable of low power (LP) and standard power (SP) APs that support only				
	Device(config-rf-profile)# tx-power standard	SP mode are not affected by this setting (SP mode is always enabled).				
Step 4	end	Returns to privileged EXEC mode.				
	Example:					
	Device(config-rf-profile)# end					

### **Configuring Power Mode per RF Profile (GUI)**

### Procedure

- **Step 1** Go to **Configuration > Tags & Profiles > RF/Radio**.
- Step 2 Click **RF** tab.

To add a new RF profile, see *Configuring an RF Profile (GUI)*. To modify an existing RF profile, select the required RF profile.

Step 3 Enable Standard-Power Service to allow dual-power (low power or standard power) mode APs to operate as standard power APs in the 6-GHz spectrum.

The AP can access the external AFC service through cloud. Based on geographical coordinates and spectrum-inquiry requests from APs, the AFC provides responses on the available frequencies and the maximum permissible power in each frequency range.

- This setting is available for the 6-GHz band radio and standard-power supported APs only.
  - DNA services need to be configured to connect to AFC. You can configure DNA services in Configuration > Services > Cloud Services > DNA Services page.
- Step 4 Click Apply to Device.

### **Configuring AP Parameters (GUI)**

AFC requires the longitude, latitude, and height of the AP to determine the geolocation of the AP. Longitude and latitude of the AP will be automatically calculated based on one of the following methods:

- From an internal or external GPS attached to the AP.
- From an another AP with GPS (also known as anchor AP) and the distance between the two APs.

**Note** Only a few APs on a floor require the GPS unit. The remaining APs can derive their location from the AP with the GPS unit.

You can use bulk AP provisioning to configure multiple AP parameters for multiple APs simultaneously. GUI path is **Configure > Wireless > Bulk AP Provisioning**.

### Procedure

Step 1	Go to <b>Configuration</b> >	Wireless >	Access Points.
--------	------------------------------	------------	----------------

**Step 2** In the **All Access Points** section, select a supported AP.

Step 3	In the Geolocation tab, enter the following details:
	a) In the <b>Height Configuration</b> section, enter the above ground level height in meters. The range is from -100 to 1000. Enter the tolerance as uncertainty height in meters. The range is from 1 to 100.
	b) In the <b>GNSS External Antenna Configuration</b> section, enter the cable length in meters. The range is from 1 to 100, with a default of 10. We recommend that you keep the default value of 10 meters with the Cisco provided external antenna.
	<b>Note</b> This option is available on selected models that support an external antenna.
Step 4	Click Apply to Device.

### **Configuring AP Parameters**

To configure the height and gnss antena details of the AP, use the following procdure:

### Procedure

	Command or Action	Purpose
Step 1	enable	Enables privileged EXEC mode.
	<b>Example:</b> Device> enable	
Step 2	ap name ap-name geolocation height height uncertainty uncertainty Example: Device# ap name cisco-ap1 geolocation height 100 uncertainty 10	Configures the AP Above Ground Level (AGL) height in meters. The value range for height is -100 to 1000 meters. The valid range for height uncertainty is 1 to 100 meters.
Step 3	<pre>ap name ap-name geolocation gnss antenna external cable-length length Example: Device# ap name cisco-ap1 geolocation gnss antenna external cable-length</pre>	<ul> <li>(Optional) Configure AP GNSS antenna external cable length, in meters. The value range for cable length is 1 to 100, with a default value of 10.</li> <li>Note This configuration step is required only if GNSS is using an external antenna.</li> </ul>

### **Verifying AFC Details**

To see AFC statistics information, use the following command:

```
Device# show wireless afc statistics
Total number of 6GHz APs : 4
Number of APs requiring AFC service : 4
Messages sent to AFC : 229
Successful messages received from AFC : 229
Errored AFC messages : 0
AFC messages pending : 0
```

```
Last InquiredChannel message sent:
requestId : 12195125900336565222
AP MAC : 10f9.20fd.54e0
Sent timestamp : 08/09/2023 15:14:20
Last InquiredChannel message received:
requestId : 12195125900336565222
AP MAC : 10f9.20fd.54e0
Received timestamp : 08/09/2023 15:14:21
Minimum response time (ms) : 337
Maximum response time (ms) : 40842
Average response time (ms) : 1315
Health check query : Idle
Health check status : 0K
Health check timestamp : 08/09/2023 14:58:50
Number of times health check went down : 0
```

Health check event history Timestamp #Times Event State RC Context

\_\_\_\_ \_\_\_\_\_

08/09/2023 14:58:50.348063 53 Response received OK 0 08/09/2023 14:58:48.271529 58 Scheduled 0 Timer: 3600s 08/09/2023 14:58:48.271507 53 Sent 0 08/07/2023 09:33:55.990412 6 Not sent No token 0

#### To see information of AFC channels, use the following command:

Device# show wireless afc channels 20mhz

802.11	6ghz	:	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Channel	. IDs	:	1	1	2	2	2	3	3	4	4	4	5	5	6	6	6	7	7	8	8	8	9	9	0	0	0
(20MHz	width	) :	1	5	9	3	7	1	5	9	3	7	1	5	9	3	7	1	5	9	3	7	1	5	9	3	7
AP687D. 36	B45C.	08F0	:	36	33	36	36	35	36	36	36	26	27	36	36	36	36	36	36	33	33	36	36	36	36	36	36
AP687D. 36	B45C.	1824	:	36	33	36	36	35	36	36	36	24	26	27	36	36	36	36	36	33	33	36	36	36	36	36	36

! Due to space constraints, the channel IDs (for 2-digit and 3-digit channel IDs) ! are given vertically in the output. The output is also truncated to fit the page width.

\_\_\_\_\_

#### To see status of the request sent to AFC, use the following command:

Device# show wireless afc request

AP Name Timestamp	La: Radio MAC	st AFC Request Sent to Request Id	D AFC Service: AFC Request Status	Status
APCC9C.3EF1.1620	10f9.20fe.36a0	12195125900336565035	Response Received	08/07/2023
AP687D.B45C.17AC 16:07:01	687d.b45f.1af0	12195125900336565037	Response Received	08/07/2023
AP687D.B45C.321B 17:36:11	fc58.9a18.c840	12195125900336566836	Sent	08/07/2023
AP687D.B45C.321F 17:36:08	fc58.9a18.c850	12195125900336566832	Timeout	08/07/2023
•				

-----

•

To see AFC response to requests, use the following command:

Device# show wireless afc response

AP Name Response Code	Radio MAC	Request Id	Expire Time	Last Rcvd Time
AP687D.B45C.16A4 SUCCESS	687d.b45f.0e90	1	11/14/2021 21:56:29	11/14/2021 17:56:29
AP687D.B45C.17AC SUCCESS	687d.b45f.1af0	2	11/14/2021 21:56:30	11/14/2021 17:56:29
AP687D.B45C.2276 INVALID VALUE	687d.b45f.3190	3	11/14/2021 21:56:30	11/14/2021 17:56:29

! See the Response Code column.

To check whether AFC service request can be sent, use the following command:

Device# show wireless afc ap

AP Name	PF-Drofilo	Radio MAC	AFC	Power Mode	Current	AP	6GHz
Ctata	Admin Ctate	Kr-rioiile	Status	Capability	Power Mode	Admin State	Admin
APCC9C.	3EF1.1620	10f9.20fe.36a0	Inactive	SP/LPi	LPi	Up	Down
AP687D.1	Yes B45C.17AC Yes	Yes 687d.b45f.laf0 Yes	Yes Active Yes	Yes SP/LPi Yes	Yes SP Yes	Up	Up
AP-ARCT:	IC Yes	fc58.9a18.c890 Yes	Inactive Yes	SP/LPi Yes	LPi No	Up	Up

#### To see AFC geolocation information to be used in an AFC Request, use the following command:

Device# show wireless afc geolocation

AP Name Orientation	F Area-o	Radio MAC f-uncert	L Height	ocation Height Type	Longitude Uncertainty (degrees)	Latitude (degrees)	Major-axis (meters)	Minor-axis (meters)
(degrees)	(sq.	meters)	Туре	e (meter	s) (meters)			
AP687D.B45C.1	L6A4	687d.b45f	.0e90	Lin Polyg	on -122.4001	40 37.794910		
	1122		AGL	150	6			
						-122.399	340 37.79502	20
						-122.399	180 37.7943	90
						-122.400	040 37.7942	70
AP687D.B45C.1 5.340000	17AC 254	687d.b45f	.1af0 AGL	Ellipse 129	-73.97776 3	40.760168	9	9

! The afc geolocation information given in the output refers to coordinates to be used for future AFC requests.

! They do not represent the coordinates used by past AFC requests; for such info see AFC responses in 'show wireless afc response' command.

To see geolocation information of a Cisco AP, use the following command:

Device# show ap name AP687D.B45C.17AC afc geolocation

Location type	:	Ellipse
Center ellipse – longitude	:	-73.977769
Center ellipse – latitude	:	40.760168
Ellipse major-axis (meters)	:	8
Ellipse minor-axis (meters)	:	8
Ellipse orientation	:	2.5
Height (meters)	:	129
Uncertainty (meters)	:	3

To see the response from AFC for a service request from an AP, use the following command:

: Mandatory

: Supported

: Supported

Device# show ap name AP687D.B45C.17AC afc response

```
: AP687D.B45C.17AC
AP name
AP MAC Address : 687d.b45f.laf0
Response Code : SUCCESS
Permest ID : 2
                     : 2
Request ID
Expire Time
Expire Time : 11/14/2021 21:56:30
Last Rcvd Time : 11/14/2021 17:56:29
Global Operating Class : 131
    Channel Cfi / Max Eirp :
              / 36.000000
       1
        5
              / 33.668693
        9
              / 36.00000
              / 36.000000
        13
               / 35.223532
        17
               / 36.000000
        21
        25
               / 36.000000
               / 36.000000
        29
              / 26.664962
        33
              / 27.799478
        37
              / 36.000000
        41
               / 36.000000
        45
        49
              / 36.000000
        53
              / 36.000000
.
To see the details of an RF profile, use the following command:
Device# show ap rf-profile name default-rf-profile-6ghz detail
Description
                                  : default rfprofile for 6GHz radio
RF Profile Name
                                  : default-rf-profile-6ghz
Band
                                 : 6 GHz
                                 : -70 dBm
Transmit Power Threshold v1
Min Transmit Power
                                  : -10 dBm
                                  : 30 dBm
Max Transmit Power
Operational Rates
  802.11 6GHZ 6M Rate
                                     : Mandatory
  802.11 6GHZ 9M Rate
                                     : Supported
                                     : Mandatory
  802.11 6GHZ 12M Rate
  802.11 6GHZ 18M Rate
                                      : Supported
```

802.11 6GHZ 24M Rate 802.11 6GHZ 36M Rate

802.11 6GHZ 48M Rate

802.11 6GHZ 54M Rate	: Supported
Max Clients	: 200
Trap Threshold	
Clients	: 12 clients
Interference	: 10%
Noise	: -70 dBm
Utilization	: 80%
Multicast Data Rate	: auto
Rx SOP Threshold	: auto
Load Balancing	
Window	: 5 clients
Denial	: 3 count
Coverage Data	
Data	: -80 dBm
Voice	: -80 dBm
Minimum Client Level	: 3 clients
Exception Level	: 25%
RSSI Settings	
RSSI Low Check	: Disabled
RSSI Threshold	: -127 dbm
DCA Channel List	:
Unused Channel List	:
PSC Channel List	:
DCA Bandwidth	: best
DBS Min Channel Width	: 20 MHz
DBS Max Channel Width	: MAX ALLOWED
DCA Foreign AP Contribution	: Enabled
State	: Up
Client utilization threshold	: 5%
Client Reset count	: 1
Client Network Preference	: default
802.11ax	
OBSS PD	: Disabled
Non-SRG OBSS PD Maximum	: -62 dBm
SRG OBSS PD	: Disabled
SRG OBSS PD Minimum	: -82 dBm
SRG OBSS PD Maximum	: -62 dBm
Broadcast Probe Response	: Disabled
FILS Discovery	: Disabled
Multi-BSSID Profile Name	: default-multi-bssid-profile
NDP mode	: Auto
Guard Interval	: 800ns
PSC Enforcement	: Disabled
Standard-Power mode	: Allowed

### To see AFC power-mode of a Cisco AP, use the following command:

Device# show ap name AP687D.B45C.17AC dot11 6ghz power-mode

Standard-power mode

: Allowed

### To see the 802.11 parameter configuration of a Cisco AP, use the following command:

Device# show ap name AP687D.B45C.1908 config dot11 6ghz

AP 6GHZ Power Mode	:	Low	Power	Indoor
Low Power Indoor Capable	:	Yes		
Standard Power Capable	:	Yes		

To see detailed information about AFC events for a Cisco AP, use the following command:

Device# show ap name AP687D.B45C.1908 afc detail

AFC event history

Timestamp	Event	AFC Status	Context
08/07/2023 16:07:01.244077	AFC_EVT_REQ_RESP_RECEIVED	Active	ReqId
12195125900336565037 Response	e code: 0; SUCCESS		
08/07/2023 16:06:55.491957	AFC_EVT_REQ_SENT	Inactive	ReqId
12195125900336565037 Sent to	AFC System		
08/07/2023 16:06:51.823938	AFC_EVT_REQ_QUEUED	Inactive	AFC request queued:
immediate scheduling			
08/07/2023 15:28:54.608117	AFC_EVT_REQ_INACTIVE	Inactive	No location
information available; No he	ight information available;		