Automated Frequency Coordination

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.

Table 1: Feature History for Automated Frequency Coordination

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

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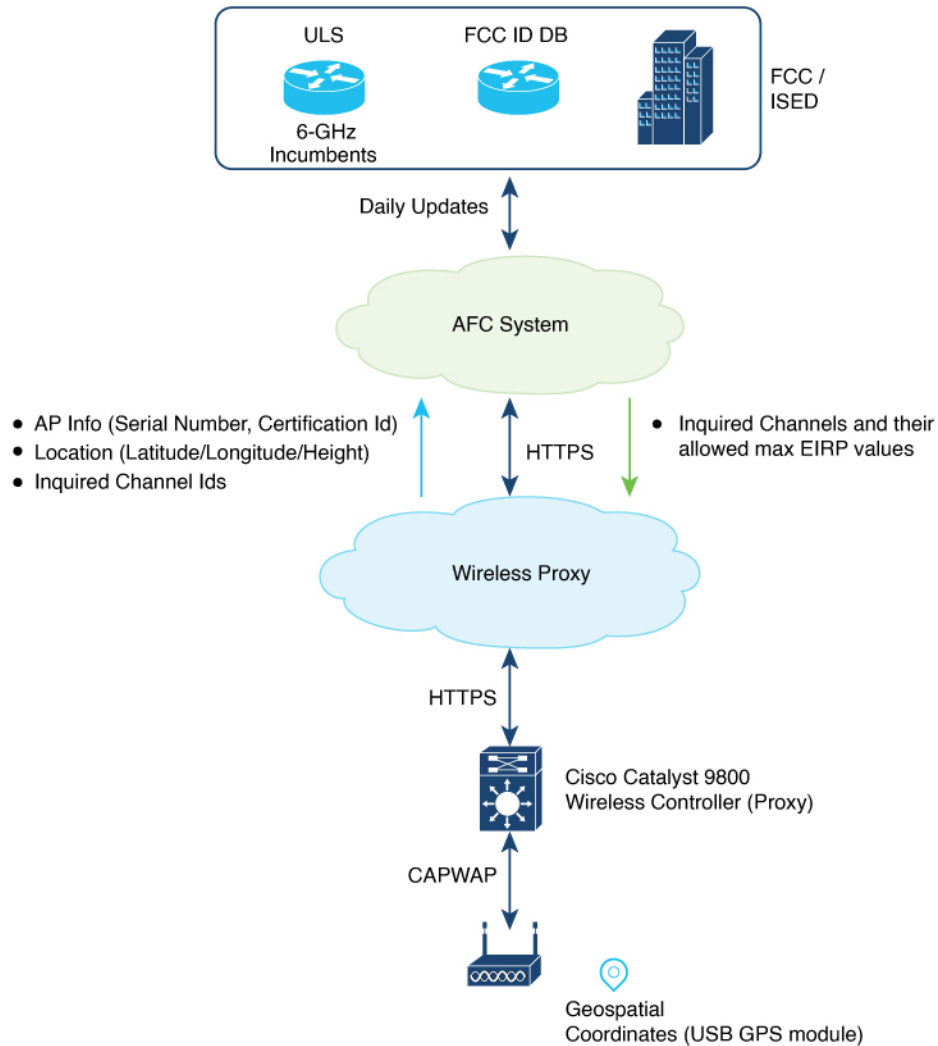
For the Cisco Catalyst APs, the AFC architecture includes the following components:

- 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 **Register**.
Step 5	Enter the product details such as **Host Name/IP**, **Product Name**, and **Description**.
Step 6	Click **Register**.

This generates an OTP.

The OTP token is a BASE64 encoded JSON payload. A sample OTP token is given below:

```
eyJiYXNlX3VybCI6ICJodHRwczovL21hZ2xldi5tYWdsZXJjbG91ZDMudGVzc2VyYWN0
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

Step 1	Choose **Configuration > Services > Cloud Services**.
Step 2	Click **DNA Services Configuration** tab.

The 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.

- **URL**: The base web address of the Cisco DNA Cloud instance that issued the token. This will be used to address the enrollment request.

- **API Endpoint Path**: 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.

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

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.

Note
- 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 **Configuration > 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 **Height Configuration** 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 **GNSS External Antenna Configuration** 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.

Note 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** **Example:** `Device> enable`	Enables privileged EXEC mode.
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	**ap name** *ap-name* **geolocation gnss antenna external cable-length** *length* **Example:** `Device# ap name cisco-ap1 geolocation gnss antenna external cable-length`	(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. **Note** This configuration step is required only if GNSS is using an external antenna.

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 : OK
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

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.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
 36
AP687D.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
 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

-------------------------------------------------------------------------------------------------

                             Last AFC Request Sent to AFC Service:
AP Name            Radio MAC      Request Id            AFC Request Status   Status
Timestamp
-------------------------------------------------------------------------------------------------
APCC9C.3EF1.1620   10f9.20fe.36a0 12195125900336565035 Response Received    08/07/2023
13:20:39
AP687D.B45C.17AC   687d.b45f.1af0 12195125900336565037 Response Received    08/07/2023
16:07:01
AP687D.B45C.321B   fc58.9a18.c840 12195125900336566836 Sent                 08/07/2023
17:36:11
AP687D.B45C.321F   fc58.9a18.c850 12195125900336566832 Timeout              08/07/2023
```

```
17:36:08
.
.
.
```

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

```
Device# show wireless afc response
```

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

```
! 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 Radio RF-Profile State Admin State	Radio MAC RF-Profile tx-power std	AFC AFC Country Status allowed	Power Mode Location Capability known	Current Height Power Mode known	AP Admin State	6GHz Admin
APCC9C.3EF1.1620 Yes	10f9.20fe.36a0 Yes	Inactive Yes	SP/LPi Yes	LPi Yes	Up	Down
AP687D.B45C.17AC Yes	687d.b45f.1af0 Yes	Active Yes	SP/LPi Yes	SP Yes	Up	Up
AP-ARCTIC 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 (degrees)	Radio MAC Area-of-uncert (sq. meters)	Location Height Type Type	Longitude Height (meters)	Latitude Uncertainty (degrees) (meters)	Major-axis (degrees)	Minor-axis (meters)	(meters)
AP687D.B45C.16A4	687d.b45f.0e90 1122	Lin Polygon AGL	-122.400140 150	37.794910 6			
			-122.399340	37.795020			
			-122.399180	37.794390			
			-122.400040	37.794270			
AP687D.B45C.17AC 5.340000	687d.b45f.1af0 254	Ellipse AGL	-73.977760 129	40.760168 3	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:

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

AP name               : AP687D.B45C.17AC
AP MAC Address        : 687d.b45f.1af0
Response Code         : SUCCESS
Request ID            : 2
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 :
        1       / 36.000000
        5       / 33.668693
        9       / 36.000000
        13      / 36.000000
        17      / 35.223532
        21      / 36.000000
        25      / 36.000000
        29      / 36.000000
        33      / 26.664962
        37      / 27.799478
        41      / 36.000000
        45      / 36.000000
        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
Transmit Power Threshold v1    : -70 dBm
Min Transmit Power             : -10 dBm
Max Transmit Power             : 30 dBm
Operational Rates
  802.11 6GHZ 6M Rate                  : Mandatory
  802.11 6GHZ 9M Rate                  : Supported
  802.11 6GHZ 12M Rate                 : Mandatory
  802.11 6GHZ 18M Rate                 : Supported
  802.11 6GHZ 24M Rate                 : Mandatory
  802.11 6GHZ 36M Rate                 : Supported
```

```
    802.11 6GHZ 48M Rate                : Supported
    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 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 height information available;
```