Hotspot 2.0

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Introduction to Hotspot 2.0

The Hotspot 2.0 feature enables IEEE 802.11 devices to interwork with external networks. The interworking service aids network discovery and selection, enabling information transfer from external networks. It provides information to the stations about the networks before association.

Interworking not only helps users within the home, enterprise, and public access domains, but also assists manufacturers and operators to provide common components and services for IEEE 802.11 customers. These services are configured on a per-WLAN basis on the Cisco Wireless Controller (controller).

Hotspot 2.0, also known as HS2 and Wi-Fi Certified Passpoint, is based on the IEEE 802.11u and Wi-Fi Alliance Hotspot 2.0 standards. It seeks to provide better bandwidth and services-on-demand to end users. The Hotspot 2.0 feature allows mobile devices to join a Wi-Fi network automatically, including during roaming, when the devices enter the Hotspot 2.0 area.

The Hotspot 2.0 feature has four distinct parts:

- Hotspot 2.0 Beacon Advertisement: Allows a mobile device to discover Hotspot 2.0-compatible and 802.11u-compatible WLANs.
- Access Network Query Protocol (ANQP) Queries: Sends queries about the networks from IEEE 802.11 devices, such as network type (private or public); connectivity type (local network, internet connection, and so on), or the network providers supported by a given network.
- Online Sign-up: Allows a mobile device to obtain credentials to authenticate itself with the Hotspot 2.0 or WLAN.
- Authentication and Session Management: Provides authentication (802.1x) and management of the STA session (session expiration, extension, and so on).

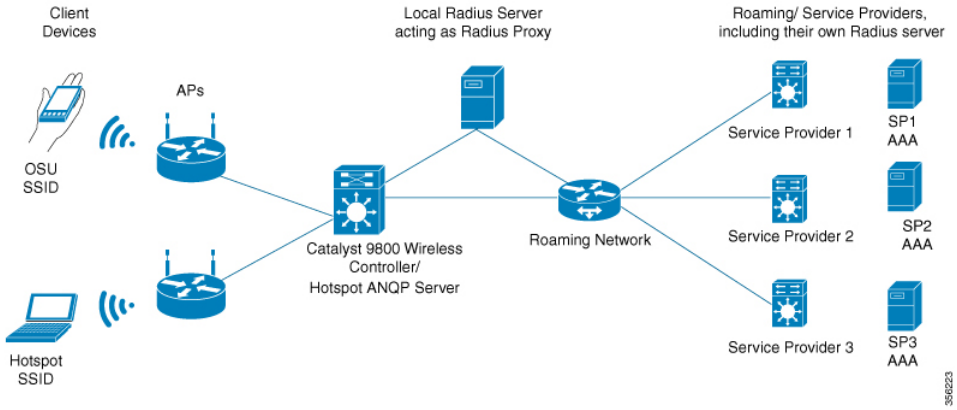
In order to mark a WLAN as Hotspot 2.0-compatible, the 802.11u-mandated information element and the Hotspot 2.0 information element is added to the basic service set (BSS) beacon advertised by the corresponding AP, and in WLAN probe responses.

Note The Hotspot 2.0 feature supports only local mode or FlexConnect mode (central switching and central authentication).

FlexConnect local switching is only supported when the Open Roaming configuration template is set up using the **wireless hotspot anqp-server** *server-name* **type open-roaming** command. If the configuration diverges from this template, FlexConnect local switching will not be supported.

The following figure shows a standard deployment of the Hotspot 2.0 network architecture:

Figure 1: Hotspot 2.0 Deployment Topology



Hotspot 2.0 Enhancements

From Cisco IOS XE Amsterdam 17.3.1, the Hotspot 2.0 feature has been enhanced with the following options:

- New ANQP elements:
  - Advice of charge: Provides information on the financial charges for using the SSID of the NAI realm
  - Operator icon metadata
  - Venue URL: Defines an optional URL for each of the configured venue names
- Introduction of Terms and Conditions: This requires a user to accept certain Terms and Conditions before being allowed internet access, after connecting to a Hotspot SSID.
- Integration of OSEN security and WPA2 security on the same SSID.

From Cisco IOS XE Amsterdam 17.3.1 onwards, two encryption methods are supported on a single SSID, namely WPA2 802.1x for Hotspot 2.0 and OSEN for online sign-up. Based on the type of encryption selected during client association, the client will be put on Hotspot 2.0 VLAN or online sign-up VLAN.

In WPA2 802.1x authentication, a client should match the credentials provisioned on a device. In online sign-up, a service provider WLAN is used by a client to perform online sign-up. For Hotspot 2.0 SSIDs, the RADIUS server enforces the terms and conditions before allowing internet connectivity to clients.

This release also supports OSEN-specific VLAN in a policy profile. If an OSEN VLAN is defined in a policy profile, OSEN clients are added to the VLAN. Otherwise, clients are added to the regular policy profile VLAN

or to the default VLAN. If OSEN is enabled with WPA2 on an SSID, it is mandatory to define an OSEN VLAN in the policy profile. Otherwise, clients cannot join the VLAN.

In FlexConnect mode, if an OSEN VLAN is defined in a policy profile, the same VLAN needs to be added to the flex profile. Failing to do so excludes the clients from the VLAN.

Note When Hotspot 2.0 is enabled in a WLAN, the Wi-Fi direct clients that support cross-connect feature should not be allowed to associate to the Hotspot 2.0 WLAN. To make sure this policy is enforced, ensure that the following configuration is in place:

```
wlan <wlan-name> <wlan-name> <ssid>
wifi-direct policy xconnect-not-allow
```

Restrictions

- Clients are excluded if an OSEN VLAN is not added to a flex profile.
- In FlexConnect mode, clients are excluded if an OSEN VLAN is not added in a flex profile.
- In FlexConnect deployments, the URL filter should reference an existing URL filter (configured using the **urlfilter list** *urlfilter-name* command). Otherwise, a client is added to the excluded list, after authentication.
- Only central authentication is supported.
- Fragmented ANQP replies are not synchronized to the standby controller in high-availability mode. Therefore, clients have to re-issue a query if there is a switchover.

Open Roaming

From Cisco IOS XE Amsterdam Release 17.2.1, the controller supports open roaming configuration, which enables mobile users to automatically and seamlessly roam across Wi-Fi and cellular networks.

The new configuration template of the open roaming ANQP server simplifies the task of setting up a Hotspot 2.0 ANQP server. When you configure open roaming, fixed ANQP parameters are automatically populated.

You can configure different identity types by defining roaming organizational identifiers. The organizational unique identifier (OUI) is a three-octet number that identifies the type of organizations available in a given roaming consortium. The OUI list determines the type of identities allowed to roam into the network. The default configuration allows all the identities on the access network. However, access networks can customize the Roaming Consortium Organization Identifier (RCOI) they advertise.

You can configure three types of policies for access networks:

- Allow all: Accepts users from any identity provider (IDP), with any privacy policy.
- Real ID: Accepts users from any IDP, but only with a privacy policy that shares real identity (anonymous not accepted).
- Custom: Accepts users of select identity types and privacy policies associated with the identity types; basically all the other RCOIs.

Users can select the following privacy modes:

- Anonymous
- Share real identity

The list of currently defined organizational identifiers and their aliases are given in the following table.

Table 1: Roaming Organizational Identifiers and Aliases

Description	Roaming Organizational Identifier	WBA Value	Display Name
All	004096	5A03BA0000	All
All with real ID	00500b	5A03BA1000	All with real-id only
All paid members	00500f	BAA2D00000	All paid
Device manufacturer all ID	00502a	5A03BA0A00	Device Manufacturer
Device manufacturer real ID only	0050a7	5A03BA1A00	Device Manufacturer real-id
Cloud or Social ID	005014	5A03BA0200	Cloud ID
Cloud or Social real ID	0050bd	5A03BA1200	Cloud ID real-id
Enterprise Employee ID	00503e	5A03BA0300	Enterprise ID
Enterprise Employee real ID	0050d1	5A03BA1300	Enterprise ID real ID
Enterprise Customer ID	005050	-	Enterprise Customer program ID
Enterprise Customer real ID	0050e2	-	Enterprise Customer program real ID
Loyalty Retail ID	005053	5A03BA0B00	Loyalty Retail
Loyalty Retail real ID	0050f0	5A03BA1B00	Loyalty Retail real ID
Loyalty Hospitality ID	005054	5A03BA0600	Loyalty Hospitality
Loyalty Hospitality real ID	00562b	5A03BA1600	Loyalty Hospitality real ID
SP free Bronze Qos	005073	5A03BA0100	SP free Bronze Qos
SP free Bronze Qos Real ID	0057D2	5A03BA1100	SP free Bronze Qos Real ID
SP paid Bronze QoS	-	BAA2D00100	SP paid Bronze QoS
SP paid Bronze QoS real ID	-	BAA2D01100	SP paid Bronze QoS real ID
SP paid Silver QoS	-	BAA2D02100	SP paid Silver QoS
SP paid Silver QoS real ID	-	BAA2D03100	SP paid Silver QoS real ID
SP paid Gold QoS	-	BAA2D04100	SP paid Gold QoS

Description	Roaming Organizational Identifier	WBA Value	Display Name
SP paid Gold QoS real ID	-	BAA2D05100	SP paid Gold QoS real ID
Government ID free	-	5A03BA0400	Government ID free
Automotive ID free	-	5A03BA0500	Automotive ID free
Automotive Paid	-	BAA2D00500	Automotive Paid
Education or Research ID free	-	5A03BA0800	Education or Research ID free
Cable ID free	-	5A03BA0900	Cable ID free

Configuring Hotspot 2.0

Configuring an Access Network Query Protocol Server

The Access Network Query Protocol Server (ANQP) is a query and response protocol that defines the services offered by an AP, usually at a Wi-Fi Hotspot 2.0.

Note When configuring roaming-oi in the ANQP server, ensure that you set the **beacon** keyword for at least one roaming-oi, as mandated by the 802.11u standard.

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**wireless hotspot anqp-server** *server-name* **Example:** `Device(config)# wireless hotspot anqp-server my_server`	Configures a Hotspot 2.0 ANQP server.
Step 3	**description** *description* **Example:** `Device(config-wireless-anqp-server)# description "My Hotspot 2.0"`	Adds a description for the ANQP server.
Step 4	**3gpp-info** *mobile-country-code mobile-network-code*	Configures a 802.11u Third Generation Partnership Project (3GPP) cellular network.

	Command or Action	Purpose
	Example: `Device(config-wireless-anqp-server)# 3gpp-info us mcc`	The *mobile-country-code* should be a 3-digit decimal number. The *mobile-network-code* should be a 2-digit or 3-digit decimal number.
Step 5	**anqp fragmentation-threshold** *threshold-value* **Example:** `Device(config-wireless-anqp-server)# anqp fragmentation-threshold 100`	Configures the ANQP reply fragmentation threshold, in bytes. The ANQP protocol can be customized by setting the fragmentation threshold, after which the ANQP reply is split into multiple messages. **Note** We recommend that you use the default values for the deployment.
Step 6	**anqp-domain-id** *domain-id* **Example:** `Device(config-wireless-anqp-server)# anqp-domain-id 100`	Configures the Hotspot 2.0 ANQP domain identifier.
Step 7	**authentication-type** {**dns-redirect** | **http-https-redirect** | **online-enrollment** | **terms-and-conditions**} **Example:** `Device(config-wireless-anqp-server)# authentication-type online-enrollment`	Configures the 802.11u network authentication type. Depending on the authentication type, a URL is needed for HTTP and HTTPS.
Step 8	**connection-capability** *ip-protocol port-number* {**closed** | **open** | **unknown**} **Example:** `Device(config-wireless-anqp-server)# connection-capability 12 40 open`	Configures the Hotspot 2.0 protocol and port capabilities. **Note** Hotspot 2.0 specifications require that you predefine some open ports and protocols. Ensure that you meet these requirements in order to comply with the Hotspot 2.0 specifications. See the **connection-capability** command in the Cisco Catalyst 9800 Series Wireless Controller Command Reference document for a list of open ports and protocols.
Step 9	**domain** *domain-name* **Example:** `Device(config-wireless-anqp-server)# domain my-domain`	Configures an 802.11u domain name. You can configure up to 32 domain names. The *domain-name* should not exceed 220 characters.
Step 10	**ipv4-address-type** *ipv4-address-type* **Example:**	Configures an 802.11u IPv4 address type in the Hotspot 2.0 network.

	Command or Action	Purpose
	`Device(config-wireless-anqp-server)# ipv4-address-type public`	
Step 11	**ipv6-address-type** *ipv6-address-type* **Example:** `Device(config-wireless-anqp-server)# ipv6-address-type available`	Configures an 802.11u IPv6 address type in the Hotspot 2.0 network.
Step 12	**nai-realm** *realm-name* **Example:** `Device(config-wireless-anqp-server)# nai cisco.com`	Configures an 802.11u NAI realm profile that identifies the realm that is accessible using the AP.
Step 13	**operating-class** *class-id* **Example:** `Device(config-wireless-anqp-server)# operating-class 25`	Configures a Hotspot 2.0-operating class identifier.
Step 14	**operator** *operator-name language-code* **Example:** `Device(config-wireless-anqp-server)# operator XYZ-operator eng`	Configures a Hotspot 2.0 operator-friendly name in a given language. Use only the first three letters of the language, in lower case, for the language code. For example, use *eng* for English. To see the full list of language codes, go to: http://www.loc.gov/standards/iso639-2/php/code_list.php. **Note** You can configure only one operator per language.
Step 15	**osu-ssid** *SSID* **Example:** `Device(config-wireless-anqp-server)# osu-ssid test`	Configures the SSID that wireless clients will use for OSU. The SSID length can be up to 32 characters.
Step 16	**roaming-oi** *OI-value* [**beacon**] **Example:** `Device(config-wireless-anqp-server)# roaming-oi 24 beacon`	Configures the 802.11u roaming organization identifier. If the **beacon** keyword is specified, the roaming OUI is advertised in the AP WLAN beacon or probe response. Otherwise, it will only be returned while performing the roaming OUI ANQP query. **Note** The hex string of a roaming OUI should contain only lowercase letters.
Step 17	**venue** *venue-name language-code*	Configures the 802.11u venue information.

	Command or Action	Purpose
	Example: `Device(config-wireless-anqp-server)# venue bank eng`	The *venue-name* should not exceed 220 characters and the *language-code* should only be 2 or 3 lowercase letters (a-z) in length.

Configuring ANQP Global Server Settings (GUI)

Procedure

Step 1 Choose **Configuration > Wireless > Hotspot/OpenRoaming**.

Step 2 Select an existing server from the list of servers.

Step 3 Click the **Server Settings** tab.

Step 4 Go to the **Global Server Settings** section.

Step 5 From the **IPv4 Type** drop-down list, choose an IPv4 type.

Step 6 From the **IPv6 Type** drop-down list, choose an IPv6 type.

Step 7 In the **OSU SSID** field, enter the SSID that wireless clients will use for Online Sign-Up (OSU).

Step 8 Click the **Show Advanced Configuration** link to view the advanced options.

- In the **Fragmentation Threshold (bytes)** field, enter the fragmentation threshold.

  Note Packets that are larger than the size you specify here will be fragmented.

- In the **GAS Request Timeout (ms)** field, enter the number of Generic Advertisement Services (GAS) request action frames sent that can be sent to the controller by an AP in a given interval.

Step 9 Click **Apply to Device**.

Configuring Open Roaming (CLI)

The new configuration template of the open roaming ANQP server simplifies the task of setting up a Hotspot 2.0 ANQP server. When you configure open roaming using this template, default ANQP parameters are automatically populated. The default values defined in the template always override any user-defined configuration values. For example, these are the default values enforced with the type open-roaming template:

- nai-realm open.openroaming.org
- eap-method eap-tls
- eap-method eap-ttls
- inner-auth-non-eap mschap-v2
- inner-auth-non-eap pap
- eap-method eap-aka

You can add more fields to the existing template, but ensure that they do not overlap with the existing default values. Also, if you change any of these default values, you will need to re-configure every time you enter in anqp type open-roaming config.

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**wireless hotspot anqp-server** *server-name* **type open-roaming** **Example:** `Device(config)# wireless hotspot anqp-server my-server type open-roaming`	Configures a Hotspot 2.0 ANQP server with open roaming.
Step 3	**open-roaming-oi** *alias* **Example:** `Device(config-wireless-anqp-server)# open-roaming-oi allow-all`	Sets the open roaming element alias.
Step 4	**domain** *domain-name* **Example:** `Device(config)# domain my-domain`	Configures a preferred domain name to ensure that clients roam into a preferred network. You can configure up to 32 domain names. The *domain-name* should not exceed 220 characters.

Configuring Open Roaming (GUI)

Procedure

Step 1 Choose **Configuration > Wireless > Hotspot/OpenRoaming**.

Step 2 Click **Add**.

The **Add New ANQP Server** window is displayed.

Step 3 In the **Name** field, enter a name for the server.

Step 4 In the **Description** field, enter a description for the server.

Step 5 Check the **OpenRoaming Server** check box to use the server as an open roaming server.

Note You can set the server as an open roaming server only at the time of server creation.

Step 6 Check the **Internet Access** check box to enable internet access for the server.

Step 7 From the **Network Type** drop-down list, choose the network type.

Step 8 Click **Apply to Device**.

Configuring NAI Realms (GUI)

Procedure

Step 1 Choose **Configuration > Wireless > Hotspot/OpenRoaming**.

Step 2 Select an existing server from the list of servers.

Step 3 Go to the **NAI Realms** section.

Step 4 Click **Add**.

The **Add NAI Realm** window is displayed.

Step 5 In the **NAI Realm Name** field, enter an 802.11u NAI realm of the OSU operator.

Step 6 In the **EAP Methods** section, use the toggle button to enable the required EAP methods.

After an EAP method is enabled, a pane is displayed to configure the details. Users are shown a configuration section where they can enable *credential*, *inner-auth-eap*, *inner-auth-non-eap*, *tunneled-eap-credential*. The user can select multiple options for each of the configuration.

- The **Credential** window has options such as certificate, hw-token, nfc, none, sim, softoken, username-password, and usim. Check the corresponding check box.
- The **inner-auth-eap** window has options such as eap-aka, eap-fast, eap-sim, eap-tls, eap-ttls, eap-leap, and eap-peap. Check the corresponding check box.
- The **inner-auth-eap** window has options such as eap-aka, eap-fast, eap-sim, eap-tls, eap-ttls, eap-leap, and eap-peap. Check the corresponding check box.
- The **tunneled-eap-credential** window has options such as anonymous, certificate, hw-token, nfc, sim, softoken, username-password, and usim. Check the corresponding check box.
- Click **Save**.

Step 7 Click **Apply to Device**.

Configuring Organizational Identifier Alias (GUI)

Procedure

Step 1 Choose **Configuration > Wireless > Hotspot/OpenRoaming**.

Step 2 Select an existing server from the list of servers.

Step 3 In the **Roaming OIs** area, enter an 802.11u roaming organization identifier in the **Roaming OI** field.

Step 4 Check the **Beacon State** check box to enable the beacon.

If the beacon is specified, the roaming OUI is advertised in the AP WLAN beacon or probe response. Otherwise, it will only be returned while performing the roaming OUI ANQP query.

Note Only three OUIs can be enabled in the beacon state.

Step 5 Click **Add** to add a roaming OI.

Step 6 In the **Available OpenRoaming OI** window, a list of organizational identifiers are displayed, along with the ones you have added. Select an organizational identifier and click the right arrow to add an **OpenRoaming OI**.

Step 7 In the **Domains** area, enter an 802.11u domain name in the **Domain Name** field.

Step 8 Click **Add** to use the domain name that you have entered as the preferred domain.

Step 9 Click **Apply to Device**.

Configuring WAN Metrics (GUI)

Procedure

Step 1 Choose **Configuration > Wireless > Hotspot/OpenRoaming**.

Step 2 Select an existing server from the list of servers.

Step 3 Click the **Server Settings** tab.

Step 4 Go to the **WAN Metrics** area.

Step 5 In the **Downlink Load** field, enter the WAN downlink load.

Step 6 In the **Downlink Speed (kbps)** field, enter the WAN downlink speed, in kbps.

Step 7 In the **Load Duration (100ms)** field, enter the load duration.

Step 8 In the **Upload Load** field, enter the WAN upload load.

Step 9 In the **Upload Speed (kbps)** field, enter the WAN upload speed, in kbps.

Step 10 From the **Link Status** drop-down list, choose the link status.

Step 11 Use the **Full Capacity Link** toggle button to enable the WAN link to operate at its maximum capacity.

Step 12 Click **Apply to Device**.

Configuring WAN Metrics

This procedure shows you how to configure the Wide Area Network (WAN) parameters such as uplink and downlink speed, link status, load, and so on.

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**wireless hotspot anqp-server** *server-name* **Example:**	Configures a Hotspot 2.0 ANQP server.

	Command or Action	Purpose
	`Device(config)# wireless hotspot anqp-server my_server`	
Step 3	**wan-metrics downlink-load** *load-value* **Example:** `Device(config-wireless-anqp-server)# wan-metrics downlink-load 100`	Configures the WAN downlink load.
Step 4	**wan-metrics downlink-speed** *speed* **Example:** `Device(config-wireless-anqp-server)# wan-metrics downlink-speed 1000`	Configures the WAN downlink speed, in kbps.
Step 5	**wan-metrics full-capacity-link** **Example:** `Device(config-wireless-anqp-server)# wan-metrics full-capacity-link`	Configures the WAN link to operate at its maximum capacity.
Step 6	**wan-metrics link-status** {**down** | **not-configured** | **test-state** | **up**} **Example:** `Device(config-wireless-anqp-server)# wan-metrics link-status down`	Sets the WAN link status.
Step 7	**wan-metrics load-measurement-duration** *duration* **Example:** `Device(config-wireless-anqp-server)# wan-metrics load-measurement-duration 100`	Configures the uplink or downlink load measurement duration.
Step 8	**wan-metrics uplink-load** *load-value* **Example:** `Device(config-wireless-anqp-server)# wan-metrics uplink-load 100`	Configures the WAN uplink load.
Step 9	**wan-metrics uplink-speed** *speed* **Example:** `Device(config-wireless-anqp-server)# wan-metrics uplink-speed 1000`	Configures the WAN uplink speed, in kbps.

Configuring Beacon Parameters (GUI)

Procedure

Step 1 Choose **Configuration > Wireless > Hotspot/OpenRoaming**.

Step 2 Select an existing server from the list of servers.

Step 3 Click **Server Settings** tab.

Step 4 Go to the **Beacon Parameters** section.

Step 5 In the **Hess id** field, enter the homogenous extended service set identifier.

Step 6 In the **Domain id** field, enter the domain's identifier.

Step 7 From the **Venue Type** drop-down list, select the venue.

Choosing a venue activates the subvenue type.

Step 8 From the **subvenue-type** drop-down list, select the sub-venue.

Step 9 Click **Apply to Device**.

Configuring Authentication and Venue (GUI)

Procedure

Step 1 Choose **Configuration > Wireless > Hotspot/OpenRoaming**.

Step 2 Select an existing server from the list of servers.

Step 3 Click the **Authentication/Venue** tab.

Step 4 Under the **Network Auth Types** section, check the **DNS Redirect**, **Online Enrolment**, **HTTP/HTTPS Redirect**, **Terms and Conditions** check boxes.

For **HTTP/HTTPS Redirect** and **Terms and Conditions**, the URL field is enabled after selecting them.

Step 5 Add the URL for the corresponding authentication type.

Step 6 Click **Apply**.

Step 7 Go to the **Venues** section and click **Add**.

The **Venue Details** pane is displayed.

Step 8 In the **Language Code** field, enter the language code.

Use the first two or three letters of the language, in lower case, for the language code. For example, use *eng* for English. To see the full list of language codes, go to: http://www.loc.gov/standards/iso639-2/php/code_list.php.

Step 9 In the **Venue URL** field, enter the URL of the venue.

Step 10 In the **Venue Name** field, enter the name of the venue.

Step 11 Click check mark icon to add the venue details.

Step 12 Go to the **Connection Capability** section and click **Add**.

The **Connection Capabilities** pane is displayed. See the **connection-capability** command in the Cisco Catalyst 9800 Series Wireless Controller Command Reference document for a list of open ports and protocols.

Step 13 In the **Port Number** field, enter the port number.

Step 14 From the **Connection Status** drop-down list, choose a connection status.

Step 15 In the **IP Protocol** field, enter the IP protocol number.

Hotspot 2.0 specifications require that you predefine some open ports and protocols. Ensure that you meet these requirements in order to comply with the Hotspot 2.0 specifications. See the **connection-capability** command in the Cisco Catalyst 9800 Series Wireless Controller Command Reference document for a list of open ports and protocols.

Step 16 Click the check mark icon to add the connection details.

Step 17 Click **Apply to Device**.

Configuring 3GPP/Operator (GUI)

Procedure

Step 1 Choose **Configuration > Wireless > Hotspot/OpenRoaming**.

Step 2 Select an existing server from the list of servers.

Step 3 Go to the **3GPP/Operator** tab.

Step 4 In the **Operating Class Indicator** field, enter the operating class identifier and click the + icon.

The operating class identifier is added and displayed in the pane below. Use the delete icon to delete them, if required.

Note Class IDs should be in the following ranges: 81-87, 94-96, 101-130, 180, and 192-254.

Step 5 Go to the **3GPP Cellular Networks** section and click **Add**.

The **3GPP Network Details** pane is displayed.

Step 6 In the **Mobile Country Code (MCC)** field, enter the mobile country code, which should be a 3-digit decimal number.

Step 7 In the **Mobile Network Code (MNC)** field, enter the mobile network code, which should be a 2 or 3-digit decimal number.

For the list of Mobile Country Codes (MCC) and Mobile Network Codes (MNC), see the following links: https://www.itu.int/pub/T-SP-E.212B-2018 or https://www.mcc-mnc.com.

Step 8 Click check mark icon to add the network details.

Step 9 Go to the **Hotspot 2.0 Operators** section and click **Add**.

The **Operator Details** pane is displayed.

Step 10 In the **Language Code** field, enter the language code.

Use only the first three letters of the language, in lower case, for the language code. For example, use *eng* for English. To see the full list of language codes, go to: http://www.loc.gov/standards/iso639-2/php/code_list.php.

Step 11 In the **Name** field, enter the name of the OSU operator.

Step 12 Click check mark icon to add the operator details.

Step 13 Click **Apply to Device**.

Configuring OSU Provider (GUI)

Procedure

Step 1 Choose **Configuration > Wireless > Hotspot/OpenRoaming**.

Step 2 Select an existing server from the list of servers.

Step 3 Go to the **OSU Provider** tab.

Step 4 Click **Add**.

The **General Config** pane is displayed.

Step 5 In the **Provider Name** field, enter the OSU provider name.

Step 6 In the **NAI Realm** field, enter the Network Access Identifier (NAI) realm of the OSU operator.

Step 7 From the **Primary Method** drop-down list, choose the primary supported OSU method of the OSU operator.

This activates the **Secondary Method** drop-down list. If you choose *None* as the primary supported OSU method, you will not get the secondary method.

Step 8 (Optional) From the **Secondary Method** drop-down list, choose the secondary supported OSU method of the OSU operator.

Step 9 In the **Server URI** field, enter the server Uniform Resource Identifier (URI) of the OSU operator.

Step 10 Click **Icon Config** tab.

Step 11 Click **Add**.

Step 12 From the **Icon Name** drop-down list, choose the icon name.

Step 13 Click **Save**.

Step 14 Click **Friendly Names** tab.

Step 15 Click **Add**.

Step 16 In the **Language** field, enter the language code.

Step 17 In the **Name** field, enter the name of the OSU operator.

Step 18 In the **Description** field, enter the description for the OSU operator.

Step 19 Click **Save**.

Step 20 Click the check mark icon to save.

Step 21 Click **Apply to Device**.

Configuring an Online Sign-Up Provider

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 2	**wireless hotspot icon bootflash:***system-file-name media-type language-code icon-width icon-height* **Example:** `Device(config)# wireless hotspot icon bootflash:logo1 image eng 100 200`	Configures an icon for Hotspot 2.0 and its parameters, such as media type, language code, icon width, and icon height.
Step 3	**wireless hotspot anqp-server** *server-name* **Example:** `Device(config)# wireless hotspot anqp-server my_server`	Configures a Hotspot 2.0 ANQP server.
Step 4	**osu-provider** *osu-provider-name* **Example:** `Device(config-wireless-anqp-server)# osu-provider my-osu`	Configures a Hotspot 2.0 OSU provider name.

Step 5	**name** *osu-operator-name lang-code description*
	Example:
	`Device(config-anqp-osu-provider)# name xyz-oper`
	`eng xyz-operator`
		Configures the name of the OSU operator in a given language.
		The *osu-operator-name* and *description* should not exceed 220 characters. The language code should be 2 or 3 lower-case letters (a-z).

Step 6	**server-uri** *server-uri* **Example:** `Device(config-anqp-osu-provider)# server-uri cisco.com`	Configures the server Uniform Resource Identifier (URI) of the OSU operator.
Step 7	**method** {**oma-dm** | **soap-xml-spp**} **Example:** `Device(config-anqp-osu-provider)# method oma-dm`	Configures the primary supported OSU method of the OSU operator.
Step 8	**nai-realm** *nai-realm* **Example:** `Device(config-anqp-osu-provider)# nai-realm cisco.com`	Configures the Network Access Identifier (NAI) realm of the OSU operator. The *nai-realm* should not exceed 220 characters.
Step 9	**icon** *file-name* **Example:** `Device(config-anqp-osu-provider)# icon xyz.jpeg`	Configures the icon for the OSU provider. The *file-name* should not exceed 100 characters.

Configuring Hotspot 2.0 WLAN

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**wlan** *wlan-name wlan-id ssid* **Example:** `Device(config)# wlan hs2 1 hs2`	Configures a WLAN and enters WLAN configuration mode.
Step 3	**security wpa wpa2 gtk-randomize** **Example:** `Device(config-wlan)# security wpa wpa2 gtk-randomize`	Configures random GTK for hole 196 mitigation. Hole 196 is the name of WPA2 vulnerability.
Step 4	**no shutdown** **Example:** `Device(config-wlan)# no shutdown`	Enables the WLAN.

Configuring an Online Subscription with Encryption WLAN

Online subscription with Encryption (OSEN) WLAN is used to onboard a Hotspot 2.0 network (to get the necessary credentials) in a secure manner.

Note You cannot apply a policy profile to the OSEN WLAN if a Hotspot 2.0 server is enabled on the WLAN.

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**wlan** *wlan-name wlan-id ssid* **Example:** `Device(config)# wlan hs2 1 hs2`	Configures a WLAN and enters WLAN configuration mode.
Step 3	**security wpa osen** **Example:**	Enables WPA OSEN security support.

	Command or Action	Purpose
	`Device(config-wlan)# security wpa osen`	**Note** OSEN and robust security network (RSN) are mutually exclusive. If RSN is enabled on a WLAN, OSEN cannot be enabled on the same WLAN.
Step 4	**no shutdown** **Example:** `Device(config-wlan)# no shutdown`	Enables the WLAN.

Attaching an ANQP Server to a Policy Profile

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**wireless profile policy** *policy-profile-name ssid* **Example:** `Device(config)# wireless profile policy policy-hotspot`	Configures a policy profile.
Step 3	**shutdown** **Example:** `Device(config-wireless-policy)# shutdown`	Disables the policy profile.
Step 4	**hotspot anqp-server** *server-name* **Example:** `Device(config-wireless-policy)# hotspot anqp-server my-server`	Attaches the Hotspot 2.0 ANQP server to the policy profile.
Step 5	**no shutdown** **Example:** `Device(config-wireless-policy)# no shutdown`	Enables the policy profile.

What to do next

Attach the policy profile to the WLAN to make the WLAN Hotspot 2.0 enabled.

Configuring Interworking for Hotspot 2.0

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**wireless hotspot anqp-server** *server-name* **Example:** `Device(config)# wireless hotspot anqp-server my_server`	Configures a Hotspot 2.0 ANQP server.
Step 3	**network-type allowed** *network-type* **internet-access** {**allowed** | **forbidden**} **Example:** `Device(config-wireless-anqp-server)# network-type guest-private internet-access allowed`	Configures a 802.11u network type.
Step 4	**hessid** *HESSID-value* **Example:** `Device(config-wireless-anqp-server)# hessid 12.13.14`	(Optional) Configures a homogenous extended service set.
Step 5	**group** *venue-group venue-type* **Example:** `Device(config-wireless-anqp-server)# group business bank`	Selects a group type and venue type from the list of available options.

Configuring the Generic Advertisement Service Rate Limit

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**ap profile** *profile-name* **Example:** `Device(config)# ap profile hs2-profile`	Configures an AP profile and enters AP profile configuration mode.

	Command or Action	Purpose
Step 3	**gas-ap-rate-limit** *request-number interval* **Example:** `Device(config-ap-profile)# gas-ap-rate-limit 20 120`	Configures the number of Generic Advertisement Services (GAS) request action frames sent to the controller by an AP in a given interval.
Step 4	**exit** **Example:** `Device(config-ap-profile)# exit`	Returns to global configuration mode.
Step 5	**wireless hotspot gas-rate-limit** *gas-requests-to-process* **Example:** `Device(config)# wireless hotspot gas-rate-limit 100`	Configures the number of GAS request action frames to be processed by the controller.

Configuring Global Settings

Procedure

Step 1 Choose **Configuration > Wireless > Hotspot/OpenRoaming > Global Settings**.

Step 2 In the **Gas Rate Limit (Requests per sec)** field, enter the number of GAS request action frames to be processed by the controller.

Step 3 Go to the **Icons Configuration** area.

Step 4 Click **Add**.

The **Add Global Icon** window is displayed.

Step 5 From the **System Path** drop-down list, choose the path.

Step 6 In the **Icon Name** field, enter the icon name.

Step 7 In the **Icon Type** field, enter the icon type.

Step 8 In the **Language Code** field, enter the language code.

Step 9 In the **Icon Height** field, enter the icon height.

Step 10 In the **Icon Width** field, enter the icon width.

Step 11 Click **Apply to Device**.

Configuring Advice of Charge

Use the following procedure to configure the advice of charge information for using the SSID of the Network Access Identifier (NAI) realm.

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**wireless hotspot anqp-server** *server-name* **Example:** `Device(config)# wireless hotspot anqp-server my_server`	Configures a Hotspot 2.0 ANQP server.
Step 3	**advice-charge** *type* **Example:** `Device(config-wireless-anqp-server)# advice-charge data`	Configures advice of charge for data usage. Advice of charge provides information on the financial charges for using the SSID of the NAI realm.
Step 4	**plan** *language currency* **info** *plan-info-file* **Example:** `Device(config-anqp-advice-charge)# plan eng eur info bootflash:plan_eng.xml`	Configures advice of charge information, which includes language, currency, and plan information. **Note** You can configure up to 32 plans.
Step 5	**nai-realm** *nai-realm* **Example:** `Device(config-anqp-advice-charge)# nai-realm cisco`	Configures NAI realm for this advice of charge. **Note** You can configure up to 32 realms.

Configuring Terms and Conditions

Before you begin

Define a URL filter list, as shown in the following example:

```
urlfilter list <url-filter-name>
    action permit
    filter-type post-authentication
    url <allow-url>
```

For information on configuring an URL list, see the *Defining URL Filter List* section.

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 2	**wireless hotspot anqp-server** *server-name* **Example:** `Device(config)# wireless hotspot anqp-server my_server`	Configures a Hotspot 2.0 ANQP server.
Step 3	**terms-conditions filename** *file-name* **Example:** `Device(config-wireless-anqp-server)# terms-conditions filename xyz-file`	Configures the terms and conditions filename for the clients.
Step 4	**terms-conditions timestamp** *date time* **Example:** `Device(config-wireless-anqp-server)# terms-conditions timestamp 2020-02-20 20:20:20`	Configures the terms and conditions timestamp.
Step 5	**terms-conditions urlfilter list** *url-filter-list* **Example:** `Device(config-wireless-anqp-server)# terms-conditions urlfilter list filter-yy`	Configures the terms and conditions URL filter list name.

Defining ACL and URL Filter in AP for FlexConnect

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	*sequence-number* **permit udp any eq bootpc any eq bootps** **Example:** `Device(config-ext-nacl)# 10 permit udp any eq bootpc any eq bootps`	Defines an extended UDP access list and sets the access conditions to match only the packets on a given port number of bootstrap protocol (BOOTP) clients from any source host to match only the packets on a given port number of the bootstrap protocol (BOOTP) server of a destination host.
Step 3	*sequence-number* **permit udp any eq bootps any eq bootpc** **Example:** `Device(config-ext-nacl)# 20 permit udp any eq bootps any eq bootpc`	Defines an extended UDP access list to forward packets and sets the access conditions to match only the packets on a given port number of bootstrap protocol (BOOTP) server from any source host to match only the packets of a given port number of the bootstrap protocol (BOOTP) clients of a destination host.

	Command or Action	Purpose
Step 4	*sequence-number* **permit udp any eq domain any eq domain** **Example:** `Device(config-ext-nacl)# 30 permit udp any eq domain any eq domain`	Defines an extended UDP access list to forward packets and sets the access conditions to match a destination host Domain Name Service (DNS) with only the packets from a given port number of the source DNS.
Step 5	*sequence-number* **permit ip any host** *dest-address* **Example:** `Device(config-ext-nacl)# 40 permit ip any host 10.10.10.8`	Defines an extended IP access list to forward packets from a source host to a single destination host.
Step 6	*sequence-number* **permit ip host** *dest-address* **any** **Example:** `Device(config-ext-nacl)# 50 permit ip host 10.10.10.8 any`	Defines an extended IP access list to forward packets from a single source host to a destination host.
Step 7	**exit** **Example:** `Device(config-ext-nacl)# exit`	Returns to global configuration mode.
Step 8	**wireless profile flex** *flex-profile-name* **Example:** `Device(config)# wireless profile flex test-flex-profile`	Configures a new FlexConnect policy and enters wireless flex profile configuration mode.
Step 9	**acl-policy** *acl-policy-name* **Example:** `Device(config-wireless-flex-profile)# acl-policy acl_name`	Configures an ACL policy.
Step 10	**urlfilter list** *url-filter-name* **Example:** `Device(config-wireless-flex-profile)# urlfilter list urllist_flex`	Applies the URL filter list to the FlexConnect profile.
Step 11	**vlan-name** *prod-vlanID* **Example:** `Device(config-wireless-flex-profile)# vlan-name test-vlan`	Configures a production VLAN. Ensure that **filter-type post-authentication** configuration is in place for the URL filter to work. For information on configuring URL filter list, see the *Defining URL Filter List* section of the chapter DNS-Based Access Control Lists.
Step 12	**vlan-id** *prod-vlanID* **Example:**	Creates a new production VLAN ID.

	Command or Action	Purpose
	`Device(config-wireless-flex-profile-vlan)# vlan-id 10`	
Step 13	**vlan-name** *OSU-vlanID* **Example:** `vlan-name test-vlan`	Configures an OSU VLAN.
Step 14	**vlan-id** *OSU-vlanID* **Example:** `vlan-id 20`	Creates an OSU VLAN ID.

Configuring an OSEN WLAN (Single SSID)

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**wlan** *wlan-name wlan-id ssid* **Example:** `Device(config)# wlan hs2 1 hs2`	Configures a WLAN and enters WLAN configuration mode.
Step 3	**no security ft over-the-ds** **Example:** `Device(config-wlan)# no security ft over-the-ds`	Disables fast transition over the data source on the WLAN.
Step 4	**no security ft adaptive** **Example:** `Device(config-wlan)# no security ft adaptive`	Disables adaptive 11r.
Step 5	**security wpa wpa2** **Example:** `Device(config-wlan)# security wpa wpa2`	Enables WPA2 security.
Step 6	**security wpa wpa2 ciphers aes** **Example:** `Device(config-wlan)# security wpa wpa2 ciphers aes`	Enables WPA2 ciphers for AES.
Step 7	**security wpa osen** **Example:**	Enables WPA OSEN security support.

	Command or Action	Purpose
	`Device(config-wlan)# security wpa osen`	
Step 8	**no shutdown** **Example:** `Device(config-wlan)# no shutdown`	Enables the WLAN.
Step 9	**exit** **Example:** `Device(config-wlan)# exit`	Returns to global configuration mode.
Step 10	**wireless profile policy** *policy-profile-name ssid* **Example:** `Device(config)# wireless profile policy policy-hotspot`	Configures a policy profile.
Step 11	**hotspot anqp-server** *server-name* **Example:** `Device(config-wireless-policy)# hotspot anqp-server my-server`	Attaches the Hotspot 2.0 ANQP server to the policy profile.
Step 12	**vlan** *vlan* **encryption osen** **Example:** `Device(config-wireless-policy)# vlan 10 encryption osen`	Configures the VLAN ID with OSEN encryption for single SSID.

Verifying Hotspot 2.0 Configuration

Use the following **show** commands to verify the quality of service (QoS) and AP GAS rate limit.

To view whether a QoS map ID is user configured or the default one, use the following command:

```
Device# show ap profile <profile name> detailed

QoS Map                        : user-configured
```

To view the QoS map values used and their source, use the following command:

```
Device# show ap profile <profile name> qos-map

QoS Map                        : default
DSCP ranges to User Priorities
 User Priority   DSCP low   DSCP high   Upstream UP to DSCP
---------------------------------------------------------
             0           0           7                     0
             2          16          23                    10
             3          24          31                    18
             4          32          39                    26
             5          40          47                    34
             6          48          55                    46
             7          56          63                    48

DSCP to UP mapping exceptions
```

```
 DSCP   User Priority
---------------------
    0               0
    2               1
    4               1
    6               1
   10               2
   12               2
   14               2
   18               3
   20               3
   22               3
```

To view the AP rate limiter configuration, use the following command:

```
Device# show ap name AP0462.73e8.f2c0 config general | i GAS

GAS rate limit Admin status                     : Enabled
Number of GAS request per interval              : 30
GAS rate limit interval (msec)                  : 100
```

Verifying Client Details

To verify the wireless-specific configuration of active clients based on their MAC address, use the following command:

```
Device# show wireless client mac 001e.f64c.1eff detail
.
.
.
Hotspot version : Hotspot 2.0 Release 2
Hotspot PPS MO ID :
Hotspot Terms and Conditions URL :
http://host1.ciscohotspot.com/terms.php?addr=b8:27:eb:5a:dc:39&ap=123
.
.
.
Policy Type : OSEN (within RSN)
Resultant Policies:
    VLAN Name        : VLAN0010
    VLAN             : 10
```