ENVELOPE

Evaluation and validation of connected mobility in real open systems beyond 5GS

Device Location - Geofencing API

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Table of contents

1 Introduction

The present document focuses on the Device Location (Geofencing) service. This document specifies the API with the data model and data format. We adopt the corresponding CAMARA Device Location (Geofencing) API specification.

The objective of the Device Location (Geofencing) API is to allow vertical applications to subscribe to geofenced event-based notifications related to the location of specified devices, i.e., when a device enters or leaves a certain geographical area.

2 API Overview

API name	Description	Modules Involved	Use Cases
Name of the API	Short summary of the API	List of 5GS or other modules interacting with this API	List of Use Cases using the API
Device Location (Geofencing)	Event-based notifications related to the location of specified devices, i.e., when a device enters or leaves a certain geographical area	NEF, AMF	Dt-UC3, Dt-UC4, Dt-UC5

3 Sequence Diagrams

3.1.1 Device Location (Geofencing)

The *DeviceLocation* (Geofencing) API allows vertical applications to subscribe to event-based notifications related to the location of specified devices, i.e., when a device enters or leaves a certain geographical area.

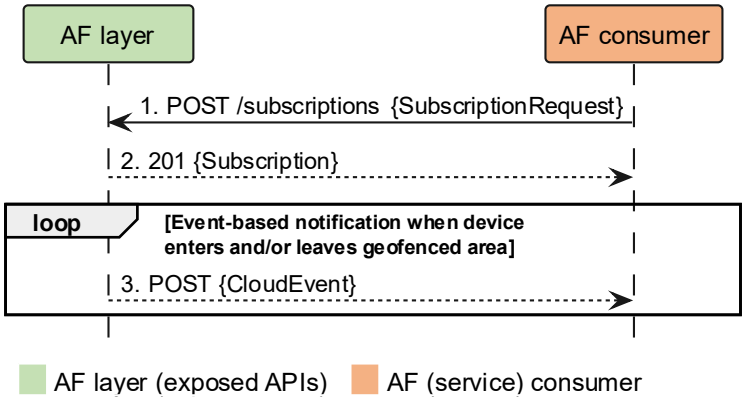

Figure 1 - Message flow for the *Device Location (Geofencing)* API

The message flow procedure for the Device Location (Geofencing) API is based on 3GPP[1][2] and CAMARA[3] specifications. This API has the following steps (as shown in Figure 1):

1. The AF consumer subscribes to event-based Device Location (geofencing) notifications for a specified UE by specifying the geofenced area and events to which the UE would like to subscribe (i.e., 'area-entered', 'area-left').
2. The AF layer confirms the subscription request.
3. Finally, the Device Location notification is sent to the AF consumer whenever the subscription conditions are met (i.e., a certain device entered/left an geographical area).

[1] 3GPP TS 29.522 V17.14.0 (2024-06), Technical Specification, 3rd Generation Partnership Project; 5G System; Network Exposure Function Northbound APIs; Stage 3; Release 17

[2] 3GPP TS 29.518 V17.14.0 (2024-06), Technical Specification, 3rd Generation Partnership Project; 5G System; Access and Mobility Management Services; Stage 3; Release 17

[3] https://camaraproject.org/device-location/

4 API definition

4.1 Resource structure

4.1.1 Resource URIs

The root of the resource URIs of this API shall be:

{apiRoot}/{apiName}/

where apiName is set to geofencing-subscriptions

The resource URI structure of this API is introduced in Figure 2.

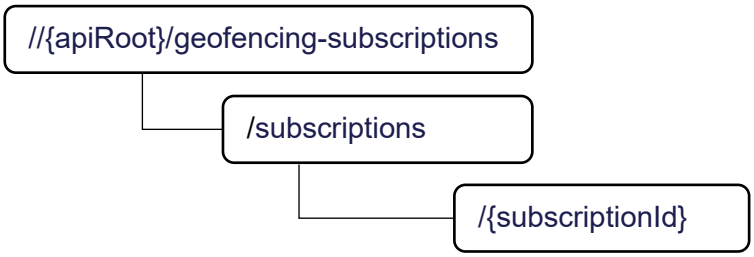

Figure 2 - Resource URI structure for the DeviceLocation (Geofencing) API

Table 1 introduces an overview of the resources and of the methods. This specification complies with the CAMARA Device Location (Geofencing) specification version 0.2.0.

Table 1. Resources and methods overview.

Resource name	Resource URI	HTTP method	Description
Device Location (Geofencing) subscription	geofencing-subscriptions/subscriptions	POST	Creates a new subscription
Device Location (Geofencing) subscription	geofencing-subscriptions/subscriptions	GET	Retrieve a list of geofencing subscription(s)
Individual Device Location (Geofencing) subscription	geofencing-subscriptions /subscriptions/{subscriptionId}	DELETE	Delete a subscription
Individual Device Location (Geofencing) subscription	geofencing-subscriptions /subscriptions/{subscriptionId}	GET	Retrieve a subscription

4.2 Data model

4.2.1 SubscriptionRequest data type

Table 2. SubscriptionRequest data type

Field	Data Type	Cardinality	Description
protocol	string	1	Only “HTTP” is allowed in the current implementation
sink	string	1	The HTTP address to which events shall be delivered to.
sinkCredential	structure (inlined)	0..1	Sink credential
→ credentialType	string	1	The type of the credential: only “ACCESSTOKEN” is supported
types	array of strings	1	Camara Event types eligible to be delivered by this subscription. Note: As of now, we enforce to have only one event type per subscription. Allowed values: "**org.camaraproject.geofencing-subscriptions.v0.area-entered**", or "**org.camaraproject.geofencing-subscriptions.v0.area-left**"
config	structure (inlined)	1	Implementation-specific configuration parameters needed by the subscription manager for acquiring events
→ subscriptionDetail	structure (inlined)	1	The detail of the requested event subscription
→→ area	structure (inlined)	1	Definition of the geofencing geographical area for which events are generated
→→→ areaType	string	1	Type of this area. Only “CIRCLE” is supported
→→→ radius	integer	1	Expected accuracy (radius) for the subscription event of device location, in meters from `center`. Allowed value range: [1, 200000]
→→→ center	structure (inlined)	1	Coordinates (latitude, longitude) defining the center point of the subscribed geofencing region
→→→→ latitude	Number (double)	1	Latitude component of the center point. Allowed value range: [-90, 90]
→→→→ longitude	Number (double)	1	Longitude component of the center point. Allowed value range: [-180, 180]
→→ device	structure (inlined)	1	The developer can choose to provide the below specified device identifiers: * ipv4Address (currently the only supported)

→→→ ipv4Address	structure (inlined)	1	In the current implementation, both public and private addresses should be set to the IPv4 address of the UE (device) as assigned by the B5G system
→→→→ publicAddress	string	1	A single IPv4 address with no subnet mask
→→→→ privateAddress	string	1	A single IPv4 address with no subnet mask
→→→→ publicPort	integer	1	TCP or UDP port number
→ subscriptionExpireTime	date-time	0..1	The subscription expiration time requested by the API consumer.
→ subscriptionMaxEvents	integer	0..1	Identifies the maximum number of event reports to be generated (>=1) requested by the API consumer - Once this number is reached, the subscription ends.
→ initialEvent	boolean	0..1	Set to true by API consumer if consumer wants to get an event as soon as the subscription is created and current situation reflects event request. Example: Consumer request area entered event. If consumer sets initialEvent to true and device is already in the geofence, an event is triggered

4.2.2 Subscription data type

Table 3. Subscription data type

Field	Data Type	Cardinality	Description
protocol	string	1	Only “HTTP” is allowed in the current implementation
sink	string	1	The HTTP address to which events shall be delivered to.
sinkCredential	Structure (inlined)	0..1	Sink credential
→ credentialType	string	1	The type of the credential: only “ACCESSTOKEN” is supported
types	Array of strings	1	Camara Event types eligible to be delivered by this subscription. Note: As of now, we enforce to have only one event type per subscription. Allowed values: **"org.camaraproject.geofencing-subscriptions.v0.area-entered"**, or **"org.camaraproject.geofencing-subscriptions.v0.area-left"**

config	Structure (inlined)	1	Implementation-specific configuration parameters needed by the subscription manager for acquiring events
→ subscriptionDetail	Structure (inlined)	1	The detail of the requested event subscription
→→ area	Structure (inlined)	1	Definition of the geofencing geographical area for which events are generated
→→→ areaType	string	1	Type of this area. Only “CIRCLE” is supported
→→→ radius	integer	1	Expected accuracy (radius) for the subscription event of device location, in meters from `center`. Allowed value range: [1, 200000]
→→→ center	Structure (inlined)	1	Coordinates (latitude, longitude) defining the center point of the subscribed geofencing region
→→→→ latitude	Number (double)	1	Latitude component of the center point. Allowed value range: [-90, 90]
→→→→ longitude	Number (double)	1	Longitude component of the center point. Allowed value range: [-180, 180]
→→ device	Structure (inlined)	1	The developer can choose to provide the below specified device identifiers: * ipv4Address (currently the only supported)
→→→ ipv4Address	Structure (inlined)	1	In the current implementation, both public and private addresses should be set to the IPv4 address of the UE (device) as assigned by the B5G system
→→→→ publicAddress	string	1	A single IPv4 address with no subnet mask
→→→→ privateAddress	string	1	A single IPv4 address with no subnet mask
→→→→ publicPort	integer	1	TCP or UDP port number
→ subscriptionExpireTime	date-time	0..1	The subscription expiration time requested by the API consumer.
→ subscriptionMaxEvents	integer	0..1	Identifies the maximum number of event reports to be generated (>=1) requested by the API consumer - Once this number is reached, the subscription ends.
→ initialEvent	boolean	0..1	Set to true by API consumer if consumer wants to get an event as soon as the subscription is created and current situation reflects event request. Example: Consumer request area entered event. If consumer sets initialEvent to true and device is

			already in the geofence, an event is triggered
id	string	1	The unique identifier of the subscription
startsAt	date-time	1	Date and time when the event subscription will begin/began
expiresAt	date-time	0..1	Date and time when the event subscription will expire
status	string	0..1	Current status of the subscription: ACTIVATION_REQUESTED: Subscription creation (POST) is triggered but subscription creation process is not finished yet. ACTIVE: Subscription creation process is completed. Subscription is fully operative. DEACTIVE: Subscription is temporarily inactive, but its workflow logic is not deleted. EXPIRED: Subscription is ended (no longer active). This status applies when subscription is ended due to SUBSCRIPTION_EXPIRED or ACCESS_TOKEN_EXPIRED event. DELETED: Subscription is ended as deleted (no longer active). This status applies when subscription information is kept (i.e. subscription workflow is no longer active but its meta-information is kept).

4.2.3 SubscriptionAsync data type

Table 4. SubscriptionAsync data type

Field	Data Type	Cardinality	Description
id	string	1	The unique identifier of the subscription

4.2.4 CloudEvent data type

Table 5. CloudEvent data type.

Field	Data Type	Cardinality	Description
id	string	1	The unique identifier of this event

source	string	1	Identifies the context in which an event happened – defined as a non-empty URI-reference, for example: URI with a DNS authority: https://github.com/cloudevents Universally-unique URN with a UUID: urn:uuid:6e8bc430-9c3a-11d9-9669-0800200c9a66 Application-specific identifier:/cloudevents/spec/pull/123
type	string	1	Camara Event type corresponding to this subscription Possible values: "**org.camaraproject.geofencing-subscriptions.v0.area-entered**", or "**org.camaraproject.geofencing-subscriptions.v0.area-left**"
specversion	string	1	Version of the specification to which this event conforms (must be 1.0 if it conforms to cloudevents 1.0.2 version)
datacontenttype	string	0..1	Media-type that describes the event payload encoding, must be "application/json" for CAMARA APIs
time	date-time	1	Timestamp of when the occurrence happened. Must adhere to RFC 3339.
data	structure (inlined)	1	Event details payload described in each CAMARA API and referenced by its type
→ subscriptionId	string	1	The unique identifier of the subscription
→ device	Structure (inlined)	1	The developer can choose to provide the below specified device identifiers: * ipv4Address (currently the only supported)
→→ ipv4Address	Structure (inlined)	1	In the current implementation, both public and private addresses should be set to the IPv4 address of the UE (device) as assigned by the B5G system
→→→ publicAddress	string	1	A single IPv4 address with no subnet mask
→→→ privateAddress	string	1	A single IPv4 address with no subnet mask

→→→ publicPort	integer	1	TCP or UDP port number
→ area	Structure (inlined)	1	Definition of the geofencing geographical area for which events are generated
→→ areaType	string	1	Type of this area. Only “CIRCLE” is supported
→→ radius	integer	1	Expected accuracy (radius) for the subscription event of device location, in meters from `center`. Allowed value range: [1, 200000]
→→ center	Structure (inlined)	1	Coordinates (latitude, longitude) defining the center point of the subscribed geofencing region
→→→ latitude	Number (double)	1	Latitude component of the center point. Allowed value range: [-90, 90]
→→→ longitude	Number (double)	1	Longitude component of the center point. Allowed value range: [-180, 180]

4.2.5 ErrorInfo data type

Table 6. ErrorInfo data type.

Field	Data Type	Cardinality	Description
status	integer	1	HTTP status code returned along with this error response
code	string	1	Code given to this error
message	string	1	Detailed error description

4.3 API operations

4.3.1 Resource: Device Location (Geofencing) subscriptions

The resource URI is: {apiRoot}/geofencing-subscriptions/subscriptions

The content of the methods requests and response is JSON and it is indicated by setting the content type "application/json".

4.3.1.1 Resource methods

4.3.1.1.1 POST

Create a subscription for a device to receive notifications when a device enters or exits a specified geographical area.

Parameters: no parameters

Table 7. Data structures supported by the POST request on this resource

Request body	Data type	Cardinality	Notes
	SubscriptionRequest	1	

Table 8. Data structures supported by the POST response on this resource

Response body	Data type	Cardinality	Response Codes	Notes
	Subscription	1	201	Subscription created
	SubscriptionAsync	0..1	202	Request accepted to be processed. It applies for async creation process
	ErrorInfo	0..1	400	Problem with the client request
	ErrorInfo	0..1	401	Authentication problem with the client request
	ErrorInfo	0..1	403	Client does not have sufficient permission
	ErrorInfo	0..1	409	Conflict
	ErrorInfo	0..1	415	Unsupported Media Type
	ErrorInfo	0..1	422	Unprocessable Entity
	ErrorInfo	0..1	429	Too many requests
	ErrorInfo	0..1	500	Internal server error
	ErrorInfo	0..1	503	Service unavailable

4.3.1.1.1.1 Callback

Important: this endpoint is to be implemented by the API consumer. The Device Location (Geofencing) server will call this endpoint (given during subscription creation by the ‘sink field) whenever a new subscription event is available.

Parameters: no parameters

Table 9. Data structures supported by the callback of this resource

Request body	Data type	Cardinality	Notes
	CloudEvent	1	

4.3.1.1.2 GET

Retrieve a list of geofencing event subscription(s).

Parameters: no parameters

Table 10. Data structures supported by the GET request on this resource

Request body	Data type	Cardinality	Notes
			No request body

Table 11. Data structures supported by the GET response on this resource

Response body	Data type	Cardinality	Response Codes	Notes
	Array of Subscription(s)	1	200	Subscription created
	ErrorInfo	0..1	400	Problem with the client request
	ErrorInfo	0..1	401	Authentication problem with the client request
	ErrorInfo	0..1	403	Client does not have sufficient permission
	ErrorInfo	0..1	422	Unprocessable Entity
	ErrorInfo	0..1	500	Internal server error
	ErrorInfo	0..1	503	Service unavailable

4.3.2 Resource: Individual Device Location (Geofencing) subscription

The resource URI is: {apiRoot}/geofencing-subscriptions/subscriptions/{subscriptionId}

4.3.2.1 Resource methods

4.3.2.1.1 DELETE

Delete a Device Location (Geofencing) subscription. Parameters support by this method are listed in Table 12.

Table 12. URI parameters supported by the DELETE method on this resource

Name	Data type	Cardinality	Notes
subscriptionId	string	1	Subscription identifier that was obtained from the create event subscription operation

Table 13. Data structures supported by the DELETE response on this resource

	Data type	Cardinality	Response Codes	Notes
Response body	SubscriptionAsync	1	200	Successful Response
	SubscriptionAsync	1	202	Request accepted to be processed. It applies for async deletion process.
	string	1	204	Subscription deleted
	ErrorInfo	0..1	400	Problem with the client request
	ErrorInfo	0..1	401	Authentication problem with the client request
	ErrorInfo	0..1	403	Client does not have sufficient permission
	ErrorInfo	0..1	404	Resource Not Found
	ErrorInfo	0..1	422	Validation Error
	ErrorInfo	0..1	500	Server error
	ErrorInfo	0..1	503	Service unavailable. Typically the server is down.

4.3.2.1.2 GET

Retrieve a Device Location (Geofencing) subscription. Parameters support by this method are listed in Table 14.

Table 14. URI parameters supported by the GET method on this resource

Name	Data type	Cardinality	Notes
subscriptionId	string	1	Subscription identifier that was obtained from the create event subscription operation

Table 15. Data structures supported by the GET response on this resource

	Data type	Cardinality	Response Codes	Notes
Response body	Subscription	1	200	Successful Response
	ErrorInfo	0..1	400	Problem with the client request
	ErrorInfo	0..1	401	Authentication problem with the client request
	ErrorInfo	0..1	403	Client does not have sufficient permission
	ErrorInfo	0..1	404	Resource Not Found
	ErrorInfo	0..1	422	Validation Error
	ErrorInfo	0..1	500	Server error
	ErrorInfo	0..1	503	Service unavailable. Typically the server is down.