



Cisco Spaces Connect for IoT Services Programmability Guide, Release 1.0.0

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Preface

This preface describes the conventions of this document and information on how to obtain other documentation. It also provides information on what's new in Cisco product documentation.

- [Document Conventions](#) , on page vii
- [Related Documentation](#), on page vii
- [Communications, Services, and Additional Information](#), on page viii

Document Conventions

This document uses the following conventions:

Convention	Description
^ or Ctrl	Both the ^ symbol and Ctrl represent the Control (Ctrl) key on a keyboard. For example, the key combination ^D or Ctrl-D means that you hold down the Control key while you press the D key. (Keys are indicated in capital letters but are not case sensitive.)
bold font	Commands and keywords and user-entered text appear in bold font .
<i>Italic font</i>	Document titles, new or emphasized terms, and arguments for which you supply values are in <i>italic font</i> .
[x]	Elements in square brackets are optional.

Reader Alert Conventions

This document may use the following conventions for reader alerts:



Note Means *reader take note*. Notes contain helpful suggestions or references to material not covered in the manual.

Related Documentation

- *Cisco Spaces Connect for IoT Services Configuration Guide, Release 1.0.0*

- *Cisco Spaces Connect for IoT Services Online Help* (Refer **Initial Configuration Workflow of IoT Orchestrator** section)

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CHAPTER 1

Overview

- [Overview of Cisco Spaces Connect for IoT Services, on page 1](#)
- [Introduction to Cisco Spaces Connect APIs, on page 1](#)
- [IoT Orchestrator in Cisco Catalyst 9800 Wireless Controller, on page 3](#)
- [Solution Overview, on page 3](#)
- [About Onboarding BLE Devices, on page 6](#)
- [About Control Operations on BLE Devices, on page 6](#)
- [About Data Telemetry from BLE Devices, on page 7](#)
- [About Security Model, on page 7](#)

Overview of Cisco Spaces Connect for IoT Services

Enterprise customers need easy ways to onboard, authorize, and control IoT devices onto a single unified infrastructure. The Cisco Spaces Connect addresses this by providing a set of interfaces to:

- Onboard devices into the infrastructure.
- Control and receive events from the devices.

To accomplish this, the Cisco Spaces Connect leverages the following interfaces between the network and applications:

1. **Onboarding Interface:** This interface is used to onboard a device to a network.
2. **Control Interface:** This interface is used for bi-directional communication with a non-IP device.
3. **Telemetry Interface:** This interface is used for streaming telemetry from a non-IP device.

Introduction to Cisco Spaces Connect APIs

The IoT Orchestrator is a Cisco IOx container that is an integral part of the Cisco Spaces Connect solution. You can deploy the IoT Orchestrator on the Cisco Catalyst 9800 Wireless Controllers.

The IoT Orchestrator exposes APIs that allow applications to:

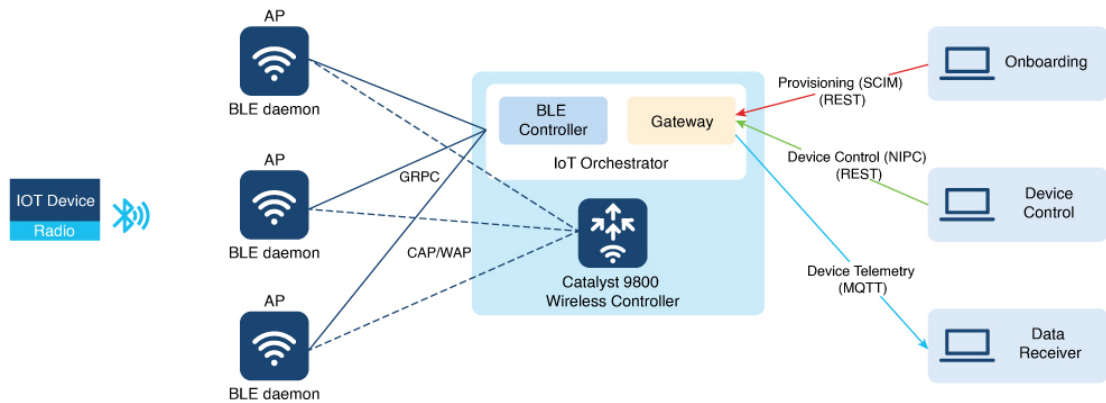
- Introduce devices to enterprise networks
- Control devices

- Receive telemetry from those devices



Note Device control and data reception are not required for IP-based end points because the devices can communicate directly using their IP address.

Figure 1: Cisco Spaces Connect APIs



The IoT Orchestrator exposes the following APIs:

- **Provisioning Interface:**

- Leverages the IETF System for Cross-Domain Identity Management (SCIM) API, specifically the SCIM for devices model.

For information on the Device Schema Extensions to the SCIM model, see <https://datatracker.ietf.org/doc/draft-ietf-scim-device-model/>.



Note The SCIM has a hierarchical schema with a core device schema and extensions.

The SCIM allows an application to:

- Send a SCIM object to a SCIM server (gateway) to create, update, and delete devices in networks.

For information on the System for Cross-domain Identity Management (SCIM) API, see [RFC7643](#) and [RFC7644](#).

- **Control Interface:**

- Allows an application to connect to a non-IP device.
- Enables data exchange with the device.
- Register topics for streaming telemetry. The IETF draft for this protocol is called the Non-IP Control (NIPC).

- **Telemetry Interface:**

- A streaming data interface with publisher sub-topics of different types, such as:
 - Device broadcasts
 - Device streaming data, or
 - Device connection state.

API Security

The API security in the IoT Orchestrator is configured using either:

- API Key
- Certificate-Based Authentication

IoT Orchestrator in Cisco Catalyst 9800 Wireless Controller

The Cisco Catalyst 9800 Wireless Controller and APs support interfaces as mentioned in the [Introduction to Cisco Spaces Connect APIs](#) for BLE devices.

The IoT Orchestrator has two internal components:

- Gateway
- BLE Controller

These components are collocated in a single containerized application.

The IoT Orchestrator works in conjunction with a BLE daemon in the Cisco Catalyst APs. The controller unlearns the AP infrastructure to the application and ensures that the device is connected to the most appropriate AP. This means that the application can communicate with a single Gateway and does not have to manage the network topology.

Gateway

The gateway supports the following functionalities:

- **Onboarding (using SCIM) Interfaces:** The gateway acts as the SCIM server.
- **Control (using NIPC) Interfaces:** The gateway provides NIPC interfaces as RESTful interfaces (Gateway is the server).
- **Telemetry (using MQTT) Interfaces:** The gateway functions as MQTT (Gateway is the MQTT broker).

Solution Overview

To communicate with or receive data from a BLE device, an application needs to first onboard the device by creating a SCIM object and send it to the SCIM server (the gateway). The SCIM object uses the device schema and has a BLE extension. If the SCIM call is successful, the gateway generates a unique Device ID and returns the complete SCIM object as registered with the Device ID.

Subsequently, the application uses the Device ID and leverages the control interfaces to communicate with the device or execute a specific NIPC operation.

The NIPC API covers the following types of APIs:

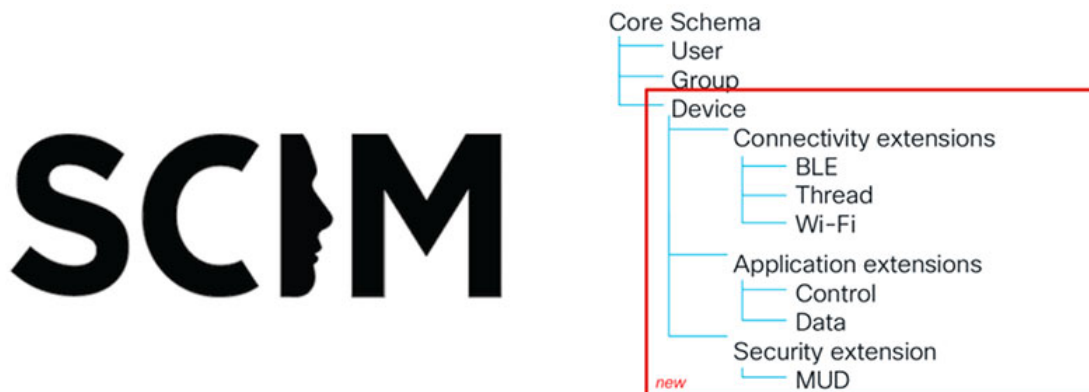
- **Connectivity:** Connect or disconnect, and pair BLE operations.
- **Data:** Read or write, start notifications or indications, discover.
- **Registrations:** Register data application, register topic (either advertisement or connection state).
- **Bulk:** API that allows for bulk operations (multiple operations in one API call).

About System for Cross-Domain Identity Management (SCIM)

The System for Cross-Domain Identity Management (SCIM) is an open standard designed to manage user identity information.

SCIM provides a defined schema to represent users and groups, and a RESTful API to run create, read, update, delete (CRUD) operations on the user and group resources.

Figure 2: SCIM



For more information, see [SCIM](#).

About Non-IP Control (NIPC)

The use cases in building management, healthcare, workplaces, manufacturing, logistics, and hospitality have introduced low-power devices into these environments. These devices typically do not support IP-based interface. Hence, there is a need for gateway functions to allow these devices to communicate with the applications that manage them.

The control interface addresses the device and group objects as ID. Therefore, it is essential to declare a device to the gateway before addressing a NIPC operation in a device. You can address the NIPC operation in a device using SCIM.



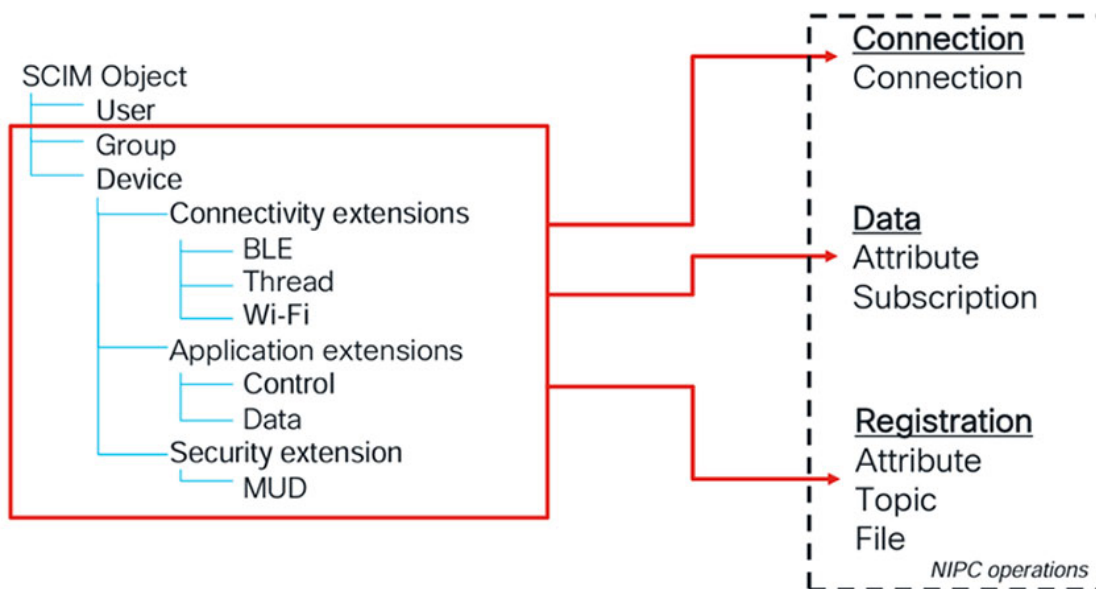
Note The NIPC operation can be performed using a device or group ID.

The gateway leverages information from the SCIM object to execute a specific NIPC operation. For instance, the keying information in SCIM object may be required to connect to a device.

Advantages of using NIPC

- Enables bi-directional communication with non-IP devices.
- Allows an application to register publisher or subscriber topics to support the data streaming interface.

Figure 3: Non-IP Control (NIPC)



For more information, see [NIPC](#).

About Message Queuing Telemetry Transport (MQTT)

The Message Queuing Telemetry Transport (MQTT) is a messaging protocol used to establish communication between multiple devices. This protocol relies on the publish-subscribe model widely used for communication in IoT framework.



Note The MQTT broker is Mosquitto, and the version is 2.0.11. The MQTT message format version is v3.1.

Publish-Subscribe Model

This model separates the client that sends messages (publisher) from the client that receives messages (subscriber). Publisher and subscribers do not need to establish a direct connection and MQTT broker is responsible to route and distribute all messages.

For example, consider the temperature sensor. It connects to the MQTT server as a client and publishes the temperature data to a topic (Temperature), and the server receives the message and forwards it to the client subscribed to the Temperature topic.

Topic

The MQTT protocol route messages based on topic. For information on the MQTT topics, see [MQTT Topics and Wildcards: A Beginner's Guide](#).

About Onboarding BLE Devices

The Internet of Things present a management challenge in many dimensions. One of them being the ability to onboard and manage large number of devices. There are many models to bootstrap trust between devices and network deployments.

The System for Cross Identity Management (SCIM) defines a protocol and a schema to provision users. However, the SCIM is extended to provision devices. The protocol and core schema are designed to allow such extensions.

Why SCIM for devices

The SCIM considers only the information necessary to bootstrap trust so that the device can establish connectivity.

What's Next

For information about the API definition, see [Onboarding BLE Devices using SCIM](#).

About Control Operations on BLE Devices

There is a need for non-IP devices to support processes in manufacturing, healthcare, retail, home, and office. Similarly, wireless access points are deployed nearly everywhere, many of which have radios that can transmit and receive different frame types (such as BLE). To integrate both these use cases to leverage a single wireless infrastructure and avoid the need of parallel infrastructure, you need a non-IP device gateway function.

The non-IP device gateway provides the following functions:

- Authenticate and authorize application clients to communicate with devices.
- APIs that allow an application to set up a connection with a device.
- APIs that allow an application to exchange data with a device.
- APIs that allow a device to create registrations in the network.

All these APIs along with the onboarding API (SCIM for devices) allows application to perform a complete set of operations in non-IP devices.

The following are the supported API tags:

Table 1: Supported API Tags

API Tags	Description
connectivity	APIs that allow applications to manage device connections.

API Tags	Description
data	APIs that allow applications to exchange data with non-IP devices.
registrations	APIs that allow applications to make registrations in the network for devices.
bulk	Compound API that allows applications to combine requests into a single call.

What's Next

For information about the API definition, see **Control Operations on BLE Devices**.

About Data Telemetry from BLE Devices

The NIPC is extensible in two ways:

- **Protocol Extensions:** This allows for extensions to the schema to integrate new non-IP communication protocols.
- **Interface Extensions:** This allows for defining extensions, such as publish/subscribe interface or data streaming interface.

Publish or Subscribe Interface

The publish or subscribe interface or data streaming interface is an MQTT publishing interface. Pub or sub topics can be created and managed by means of the **/register/topic** NIPC element.

What's Next

For information about the API definition, see **Data Telemetry from BLE Devices**.

About Security Model

All RESTful and MQTT interfaces in the Gateway are TLS secured. You will need to configure a server certificate in the Gateway.

Client authentication can be done either using an API key or a certificate. For more information, see the **Uploading Certificate and Key to Open HTTP Server and Listen for APIs** section in the *Cisco Spaces Connect for IoT Services Configuration Guide, Release 1.0.0*.



CHAPTER 2

Onboarding BLE Devices using SCIM

- [SCIM API Definition, on page 9](#)
- [SCIM HTTP Methods, on page 9](#)
- [SCIM API Resource and Versions, on page 10](#)
- [SCIM Schema, on page 10](#)
- [API Example, on page 12](#)

SCIM API Definition

API for Onboarding Device	Description
POST /scim/v2/Devices	This is the API used for onboarding a BLE device using SCIM.
GET /scim/v2/Devices/{id}?onboardApp={onboardAppID}	
DELETE /scim/v2/Devices/{id}?onboardApp={onboardAppID}	

SCIM HTTP Methods

The SCIM protocol specifies end points and HTTP methods to manage resources.

The following are the supported HTTP methods:

HTTP Method	SCIM Usage
GET	Retrieve a resource.
POST	Create a new resource.
DELETE	Deletes a resource.

SCIM API Resource and Versions

The resource and endpoint supported in the SCIM APIs are **Device** and **/Devices** respectively.

The URL path covers the base URL and version identifier as a segment. The SCIM APIs support **v2** as the version identifier.

/scim/v2/Devices are the SCIM API resource and version supported for HTTP POST, GET, or DELETE.

SCIM Schema

SCIM Core Device Schema

The SCIM core device schema supports the following attributes:

Attributes	Description	Sample
schemas	<p>The schemas section of the SCIM APIs cover the list of schemas part of the API requests.</p> <p>The following are the supported schemas:</p> <ul style="list-style-type: none"> • Core device schema • BLE device extension schema • Endpoint application extension schema 	<pre>"schemas": ["urn:ietf:params:scim:schemas:core:2.0:Device", "urn:ietf:params:scim:schemas:extension:ble:2.0:Device", "urn:ietf:params:scim:schemas:extension:application:2.0:Device"]</pre>
deviceDisplayName	<p>The attribute is of “string” type and provides a human-readable name for a device.</p>	<pre>"deviceDisplayName": "BLE Heart Monitor",</pre>
adminState	<p>The attribute is of “Boolean” type and is a mutable attribute.</p> <p>If adminState is set to TRUE, connect, disconnect, and subscribe commands that control app sends to the controller for the devices will be processed by the application.</p> <p>If adminState is set to FALSE, any command coming from the control app for the device will be rejected by the application.</p>	<pre>"adminState": true,</pre>

BLE Device Extension Schema

The SCIM device extension schema supports the following attributes:

Attributes	Description	Sample
DeviceMacAddress	<ul style="list-style-type: none"> Is a string value that represents a public MAC address assigned by the manufacturer. It is a unique 48-bit value. It is required, case-sensitive, mutable, and returned as default. The following is the regex pattern: $^{[0-9A-Fa-f]{2}}(:[0-9A-Fa-f]{2}){5}\$ 	<pre>"deviceMacAddress": "CA:2B:5C:EC:95:46",</pre>
isRandom	<ul style="list-style-type: none"> Is a Boolean flag. If set to FALSE, the device uses a public MAC address. If set to TRUE, the device uses a static random MAC address. This attribute is not required, mutable, and returned by default. The default value is FALSE. 	<pre>"isRandom": false,</pre>
versionSupport	<ul style="list-style-type: none"> Provides all the BLE versions supported by the device in the form of an array. For example, [4.1, 4.2, 5.0, 5.1, 5.2, 5.3]. This attribute is required, mutable, and returned as default. 	<pre>"versionSupport": ["5.3"],</pre>
pairingMethods	<ul style="list-style-type: none"> Is an array of pairing methods associated with the BLE device. May require sub-attributes, such as key or password for the device pairing process. This attribute is required, case-sensitive, mutable, and returned by default. 	<pre>"pairingMethods": ["urn:ietf:params:scim:extens:pairing:full:2.0:Device", "urn:ietf:params:scim:extens:pairing:full:2.0:Device"], "urn:ietf:params:scim:extens:pairing:full:2.0:Device": null, "urn:ietf:params:scim:extens:pairing:full:2.0:Device": { "key": null }</pre>

Attributes	Description	Sample
mobility	<ul style="list-style-type: none"> • Is a Boolean flag. • When set to FALSE, this feature disables seamless movement between APs, requiring manual intervention for the IoT Orchestrator to handle connections and disconnections. • When set to TRUE, this feature allows devices to move between APs seamlessly, with the IoT Orchestrator automatically handling connections and disconnections without manual intervention. • This attribute is not required, mutable, and returned by default. • The default value is FALSE. 	"mobility": true,

API Example

The following example lists the SCIM object for onboarding the BLE device:

```
{
  "schemas": [
    "urn:ietf:params:scim:schemas:core:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:ble:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:endpointapps:2.0:Device"
  ],
  "deviceDisplayName": "BLE Heart Monitor",
  "adminState": true,
  "urn:ietf:params:scim:schemas:extension:ble:2.0:Device": {
    "versionSupport": [
      "5.3"
    ],
    "deviceMacAddress": "CA:2B:5C:EC:95:46",
    "isRandom": false,
    "mobility": false,
    "pairingMethods": [
      "urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device",
      "urn:ietf:params:scim:schemas:extension:pairingJustWorks:2.0:Device"
    ],
    "urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device": null,
    "urn:ietf:params:scim:schemas:extension:pairingJustWorks:2.0:Device": {
      "key": null
    }
  }
},
```

```
"urn:ietf:params:scim:schemas:extension:endpointAppsExt:2.0:Device": {  
  "onboardingUrl": "onboardApplication",  
  "deviceControlUrl": [  
    "controlApplication"  
  ],  
  "dataReceiverUrl": []  
}
```




CHAPTER 3

Control Operations on BLE Devices

- [Non-IP Control \(NIPC\) Open API Definition, on page 15](#)
- [Other Supported API Types, on page 15](#)
- [Connecting to a BLE Device, on page 16](#)
- [Reading from a BLE Device, on page 19](#)
- [Writing to a BLE Device, on page 20](#)
- [Discovering Services from a BLE Device, on page 21](#)
- [Disconnecting from a BLE Device, on page 24](#)

Non-IP Control (NIPC) Open API Definition

API	Description
POST /control/connectivity/connect	This API is used to connect a BLE device to the network.
POST /control/data/read	This API is used to read a value from an attribute in the BLE device.
POST /control/data/write	This API is used to write a value to an attribute in the BLE device.
POST /control/data/discover	This API is used to discover services in a BLE device.
POST /control/connectivity/disconnect	This API is used to disconnect a connected BLE device from the network.

Other Supported API Types

API	Path	Summary
Register Data App	/registration/registerDataApp	Register a data application.
Unregister Data App	/registration/unregisterDataApp	Unregister a data application.

API	Path	Summary
Register Topic	/registration/registerTopic	Register a publish or subscribe topic.
Unregister Topic	/registration/unregisterTopic	Unregister a publish or subscribe topic.
Subscribe Topic	/data/subscribe	Subscribe to the streaming data from an attribute in the device.
Unsubscribe Topic	/data/unsubscribe	Unsubscribe to the streaming data from an attribute in the device.

Connecting to a BLE Device

Connect Request - API Definition

Fields	Description
location 'https://10.195.78.33:8081/control/connectivity/connect'	Connect a BLE device to the network.
header 'x-api-key: 2215dec3718288ad9028d39864f87d4c'	API key
header 'Content-Type: application/json'	Content type is JSON.
data	
technology	BLE
id	Device ID
serviceID	Service ID of the BLE device.
"controlApp": "controlApplication"	Control application address

Connect Response - API Definition

Fields	Description
status	Status message
id	Device ID
requestID	Request ID
serviceID	Service ID
handle	Handle number

Fields	Description
characteristicID	Characteristic ID
descriptorID	Descriptor ID
flags	Flags

API Example – Connect Request and Connect Response

Connect Request:

```
curl -k --location 'https://10.195.78.33:8081/control/connectivity/connect' \
--header 'x-api-key: 2215dec3718288ad9028d39864f87d4c' \
--header 'Content-Type: application/json' \
--data '
{
  "technology": "ble",
  "id": "f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "ble": {
    "services": [
      {
        "serviceID": "1800"
      },
      {
        "serviceID": "2022"
      },
      {
        "serviceID": "1822"
      },
      {
        "serviceID": "180F"
      }
    ],
    "controlApp": "controlApplication"
  }
}
```

Connect Response:

```
{
  "status": "SUCCESS",
  "id": "f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "requestID": "75310f89-79c6-4e7b-93cb-f58a8f18fc57",
  "services": [
    {
      "serviceID": "1800",
      "characteristics": [
        {
          "characteristicID": "3443",
          "descriptors": [
            {
              "descriptorID": "9059"
            }
          ],
          "flags": [
            "read",

```

```

    "write",
    "notify"
  ]
}
],
},
{
  "serviceID": "2022",
  "handle": 1,
  "characteristics": [
    {
      "characteristicID": "8065",
      "descriptors": [
        {
          "descriptorID": "9620"
        }
      ],
      "flags": [
        "read",
        "write",
        "notify"
      ]
    }
  ],
},
{
  "serviceID": "1822",
  "handle": 2,
  "characteristics": [
    {
      "characteristicID": "8912",
      "descriptors": [
        {
          "descriptorID": "1554"
        }
      ],
      "flags": [
        "read",
        "write",
        "notify"
      ]
    }
  ],
},
{
  "serviceID": "180F",
  "handle": 3,
  "characteristics": [
    {
      "characteristicID": "2810",
      "descriptors": [
        {
          "descriptorID": "1517"
        }
      ],
      "flags": [
        "read",
        "write",
        "notify"
      ]
    }
  ],
}
}

```

```

]
}

```

Reading from a BLE Device

Read Request - API Definition

Fields	Description
location 'https://10.195.78.33:8081/control/data/read'	Read a value from an attribute in the BLE device.
header 'x-api-key: 2215dec3718288ad9028d39864f87d4c'	API key
header 'Content-Type: application/json'	Content type is JSON.
technology	BLE
id	Device ID
serviceID	Service ID of the BLE device.
characteristicID	Characteristic ID of the BLE device.
"controlApp": "controlApplication"	Control application address.

Read Response - API Definition

Fields	Description
status	Status message
id	Device ID
requestID	Request ID
value	Value

API Example – Read Request and Read Response

Read Request:

```

curl -k --location 'https://10.195.78.33:8081/control/data/read' \
--header 'x-api-key: 2215dec3718288ad9028d39864f87d4c' \
--header 'Content-Type: application/json' \
--data '
{
"technology": "ble",
"id": "decf0dc6-9e9d-4d39-8c8b-00c541699b6a",

```

```

"ble": {
  "serviceID": "1800",
  "characteristicID": "2A00"
},
"controlApp": "controlApplication"
}

```

Read Response:

```

{
  "status": "SUCCESS",
  "id": " decf0dc6-9e9d-4d39-8c8b-00c541699b6a",
  "requestID": "8ba846aa-6133-4392-b911-9850a90791f2",
  "value": "2342432"
}

```

Writing to a BLE Device

Write Request - API Definition

Fields	Description
location 'https://10.195.78.33:8081/control/data/write'	Write a value to an attribute in the BLE device.
header 'x-api-key: 2215dec3718288ad9028d39864f87d4c'	API key
header 'Content-Type: application/json'	Content type is JSON.
technology	BLE
id	Device ID
value	Value
serviceID	Service ID of the BLE device.
characteristicID	Characteristic ID of the BLE device.
"controlApp": "controlApplication"	Control application address.

Write Response – API Definition

Fields	Description
status	Status message
id	Device ID
requestID	Request ID

Fields	Description
value	Value

Discovering Services from a BLE Device

Service Discovery Request - API Definition

Fields	Description
location 'https://10.195.78.33:8081/control/data/discover'	Discover services in a BLE device.
header 'x-api-key: 2215dec3718288ad9028d39864f87d4c'	API key
header 'Content-Type: application/json'	Content type is JSON.
technology	BLE
id	Device ID
serviceID	Service ID of the BLE device.
"controlApp": "controlApplication"	Control application address

Service Discovery Response - API Definition

Fields	Description
status	Status message
id	Device ID
requestID	Request ID
serviceID	Service ID
handle	Handle
characteristicID	Characteristic ID
descriptorID	Descriptor ID
Flags	Flags: read, write, notify

API Example - Service Discovery Request and Service Discovery Response

Service Discovery Request:

```
curl -k --location 'https://10.195.78.33:8081/control/data/discover' \
--header 'x-api-key: 2215dec3718288ad9028d39864f87d4c' \
--header 'Content-Type: application/json' \
--data '
{
  "technology": "ble",
  "id": "f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "ble": {
    "services": [
      {
        "serviceID": "1800"
      },
      {
        "serviceID": "2022"
      },
      {
        "serviceID": "1822"
      },
      {
        "serviceID": "180F"
      }
    ],
    "controlApp": "controlApplication"
  }
}
```

Service Discovery Response:

```
{
  "status": "SUCCESS",
  "id": "f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "requestID": "d4a225b1-fc62-478e-ad54-928c8973351d",
  "services": [
    {
      "serviceID": "1800",
      "characteristics": [
        {
          "characteristicID": "1797",
          "descriptors": [
            {
              "descriptorID": "7062"
            }
          ],
          "flags": [
            "read",
            "write",
            "notify"
          ]
        }
      ],
      "handle": 1,
      "characteristics": [

```

```
{
  "characteristicID": "4654",
  "descriptors": [
    {
      "descriptorID": "8815"
    }
  ],
  "flags": [
    "read",
    "write",
    "notify"
  ]
},
{
  "serviceID": "1822",
  "handle": 2,
  "characteristics": [
    {
      "characteristicID": "7126",
      "descriptors": [
        {
          "descriptorID": "4823"
        }
      ],
      "flags": [
        "read",
        "write",
        "notify"
      ]
    }
  ]
},
{
  "serviceID": "180F",
  "handle": 3,
  "characteristics": [
    {
      "characteristicID": "4675",
      "descriptors": [
        {
          "descriptorID": "9631"
        }
      ],
      "flags": [
        "read",
        "write",
        "notify"
      ]
    }
  ]
}
]
```

Disconnecting from a BLE Device

Disconnect Request - API Definition

Fields	Description
location 'https://10.195.78.33:8081/control/connectivity/disconnect'	Disconnect a connected BLE device from the network.
header 'x-api-key: 2215dec3718288ad9028d39864f87d4c'	API key
header 'Content-Type: application/json'	Content type is JSON.
data	
technology	BLE
id	Device ID
"controlApp": "controlApplication"	Control application address

Disconnect Response - API Definition

Fields	Description
status	Status message
id	Device ID
requestID	Request ID

API Example – Disconnect from a BLE Device

Disconnect Request:

```
curl -k --location 'https://10.195.78.33:8081/control/connectivity/disconnect' \
\
--header 'x-api-key: 2215dec3718288ad9028d39864f87d4c' \
--header 'Content-Type: application/json' \
--data '
{
  "technology": "ble",
  "id" : "decf0dc6-9e9d-4d39-8c8b-00c541699b6a",
  "controlApp" : "controlApplication"
}
'
```


Disconnect Response:

```
{  
  "status": "SUCCESS",  
  "id": "decf0dc6-9e9d-4d39-8c8b-00c541699b6a",  
  "requestID": "cb838a8d-775b-4e71-874d-1aa22e61f9af"  
}
```




CHAPTER 4

Data Telemetry from BLE Devices

- [Registering Topics, on page 27](#)
- [Subscribing to Advertisements and Notifications, on page 28](#)

Registering Topics

Register Topics - API Definition

API	Description
<code>/control/registration/registerTopic</code>	<p>This API registers the topic with the gateway to subscribe to GATT notifications from device using ID, service UUID, and characteristic UUID.</p> <p>The subscriptions can be placed to various GATT attributes:</p> <ul style="list-style-type: none">• Blood Oxygen level• Heart rate• Walking rate

API Example - Register Topics

Register Topics Request:

```
{
  "technology": "ble",
  "ids": [
    "df553860-975c-4d7f-8c1f-b2996f34e26f",
  ],
  "controlApp": "controlApplication",
  "topic": "enterprise/hospital/pulse_oximeter",
  "dataFormat": "default",
  "ble": {
    "type": "gatt",
  }
}
```

```
"serviceID": "1800",
"characteristicID": "2A5E"
}
}
```

Register Topics Response:

```
{
  "status": "SUCCESS",
  "topic": "enterprise/hospital/pulse_oximeter",
  "reason": "Gatt topics successfully registered!"
}
```

Telemetry Data Format

For information, see https://github.com/iot-onboarding/non-ip-iot-control/blob/nipc-asdf-01/proto/data_app.proto.

Telemetry Message Format

The telemetry messages are in **protobuf** format. All the telemetry messages are encapsulated in the **DataSubscription** message.

Subscribing to Advertisements and Notifications

Subscribing to Advertisements and Notifications - API Definition

API	Description
/control/data/subscribe	Use this API to enable GATT notifications or indications in the BLE device using the device ID, GATT service UUID, and characteristic UUID.

API Example – Subscribing to Advertisements and Notifications

Request:

```
{
  "technology": "ble",
  "id": "df553860-975c-4d7f-8c1f-b2996f34e26f",
  "ble": {
    "serviceID": "1800",
    "characteristicID": "2A5E"
  },
  "controlApp": "controlApplication"
}
```

Response:

```
{
  "status": "SUCCESS",
  "id": "df553860-975c-4d7f-8c1f-b2996f34e26f",
  "requestID": "12345678-5678-1234-5578-abcdef1234"
}
```

MQTT Subscription Messages

Once the notification is enabled using the subscribe API, the data receiver application starts to receive the GATT notification. To receive the notification, you will need to execute the following command in your terminal session:

```
mosquitto_sub -h localhost -p 41883 -t
enterprise/hospital/pulse_oximeter -u
https://dataApplication --pw
c4e80e0483af0a4394dfb6e3ec5e820b
```

Telemetry Message Format for Onboarded Advertisements and Notifications

The following is the code snippet of Telemetry message format:

```
syntax = "proto3";

import "google/protobuf/timestamp.proto";

option java_package = "org.ietf.nipc.proto";
option java_multiple_files = true;

package nipc;

message DataSubscription {
  optional string device_id = 1;
  bytes data = 2;
  google.protobuf.Timestamp timestamp = 3;
  optional string ap_mac_address = 4;

  reserved 5 to 10;

  oneof subscription {
    BLESubscription ble_subscription = 11;
    BLEAdvertisement ble_advertisement = 12;
    RawPayload raw_payload = 14;
    BLEConnectionStatus ble_connection_status = 15;
  }

  message BLESubscription {
    optional string service_uuid = 1;
    optional string characteristic_uuid = 2;
  }

  message BLEAdvertisement {
    string mac_address = 1;
    optional int32 rssi = 2;
  }

  message BLEConnectionStatus {
    string mac_address = 1;
  }
}
```

```
        bool connected = 2;  
        optional int32 reason = 3;  
    }  
  
    message RawPayload {  
        optional string context_id = 1;  
    }  
}
```



CHAPTER 5

Use Case 1 - Asset Tracking

- [Use Case 1: Asset Tracking, on page 31](#)
- [Onboarding a Device, on page 32](#)
- [Registering the Data Receiver Application, on page 33](#)
- [Registering a Topic, on page 34](#)
- [Onboarded Advertisements Subscription, on page 35](#)

Use Case 1: Asset Tracking

If you have an asset to be tracked using a BLE tag, you need to:

- Onboard the BLE device.
- Register topics for receiving the onboarded device advertisements over MQTT.

Consider a large factory with many moving carts, each equipped with a BLE tag.

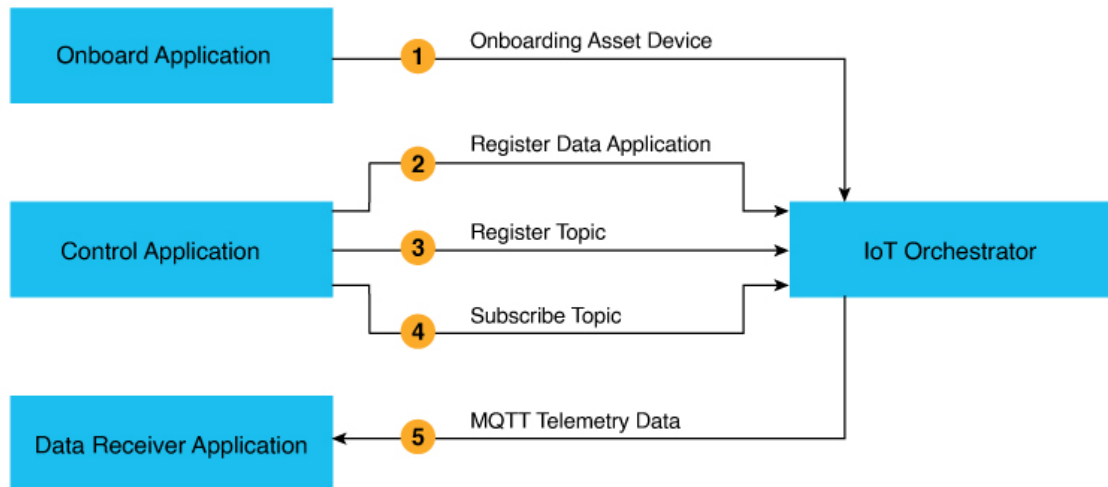
To track the location of a cart, you need to:

- Onboard the BLE device.
- Register topics for receiving the onboarded device advertisements over MQTT.

In this use case, the device to be tracked has the following details:

- Display Name: `Asset Tag`
- MAC Address Type: `Public`
- MAC Address: `EF:00:00:00:00:00`

For information on the BLE device tracking, refer to the following workflow:



The following workflow covers the sequence of operations:

1. [Onboarding a Device.](#)
2. [Registering the Data Receiver Application.](#)
3. [Registering a Topic.](#)
4. [Onboarded Advertisements Subscription.](#)

Onboarding a Device

Request Format:

```

curl -k --location 'https://10.195.78.33:8081/scim/v2/Devices' \
--header 'x-api-key: 5a9095d0457f24518bba93c50d69efe5' \
--header 'Content-Type: application/json' \
--data '
{
  "schemas": [
    "urn:ietf:params:scim:schemas:core:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:ble:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:endpointapps:2.0:Device"
  ],
  "deviceDisplayName": "BLE Heart Monitor",
  "adminState": true,
  "urn:ietf:params:scim:schemas:extension:ble:2.0:Device": {
    "versionSupport": [
      "5.3"
    ],
    "deviceMacAddress": "CA:2B:5C:EC:95:46",
    "isRandom": false,
    "mobility": false,
    "pairingMethods": [
      "urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device",
      "urn:ietf:params:scim:schemas:extension:pairingJustWorks:2.0:Device"
    ],
  },
}

```



```

    "urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device": null,
    "urn:ietf:params:scim:schemas:extension:pairingJustWorks:2.0:Device": {
      "key": null
    }
  },
  "urn:ietf:params:scim:schemas:extension:endpointAppsExt:2.0:Device": {
    "onboardingUrl": "onboardApplication",
    "deviceControlUrl": [
      "controlApplication"
    ],
    "dataReceiverUrl": []
  }
}

```

Response Format:

```

{
  "schemas": [
    "urn:ietf:params:scim:schemas:core:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:ble:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:endpointapps:2.0:Device"
  ],
  "id": "8ba69997-9062-4fc4-9d4e-6956c019c44b",
  "deviceDisplayName": "Asset Tag",
  "adminState": true,
  "urn:ietf:params:scim:schemas:extension:ble:2.0:Device": {
    "versionSupport": [
      "5.3"
    ],
  },
  "deviceMacAddress": "EF:00:00:00:00:00",
  "isRandom": false,
  "pairingMethods": [
    "urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device"
  ],
  "mobility": false,
  "urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device": null
},
  "urn:ietf:params:scim:schemas:extension:endpointAppsExt:2.0:Device": {
    "onboardingUrl": "onboardApplication",
    "deviceControlUrl": [
      "controlApplication"
    ],
    "dataReceiverUrl": []
  }
}

```

Registering the Data Receiver Application

You need to register a data receiver application with the app ID "dataApplication" to subscribe to the topic "enterprise/hospital/advertisements".

Request Format:

```

curl -k --location
'https://10.195.78.33:8081/control/registration/registerDataApp' \
--header 'Content-Type: application/json' \
--header 'x-api-key: 6aab774c4d474e387ffab9638c3f917f' \

```

```
--data '
{
  "controlApp": "controlApplication",
  "topic": "enterprise/hospital/advertisements",
  "dataApps": [
    {
      "dataAppID": "dataApplication"
    }
  ]
}'
```

Response Format:

```
{
  "status": "SUCCESS",
  "reason": "Data apps are registered",
  "topic": "enterprise/hospital/advertisements",
  "isOnboarded": true
}
```

Registering a Topic

You will need to register the topic "enterprise/hospital/advertisements" with the gateway to be able to subscribe to advertisements from the device with ID "8ba69997-9062-4fc4-9d4e-6956c019c44b".

Request Format:

```
curl -k --location
'https://10.195.78.33:8081/control/registration/registerTopic' \
--header 'x-api-key: 2215dec3718288ad9028d39864f87d4c' \
--header 'Content-Type: application/json' \
--data '
{
  "technology": "ble",
  "topic": "enterprise/hospital/advertisements",
  "ids": [
    "8ba69997-9062-4fc4-9d4e-6956c019c44b"
  ],
  "controlApp": "controlApplication",
  "ble": {
    "type": "advertisements"
  }
}'
```

Response Format:

```
{
  "status": "SUCCESS",
  "topic": "enterprise/hospital/advertisements"
}
```

Onboarded Advertisements Subscription

```
mosquitto_sub -h localhost -p 41883 -t enterprise/hospital/advertisements -u  
https://dataApplication --pw c4e80e0483af0a4394dfb6e3ec5e820b
```

```
$97cfed0b-6729-49a6-9285-92913a4b1e4a dnaspaces.io/iot"  
FF:00:00:00:00:01  
$97cfed0b-6729-49a6-9285-92913a4b1e4a dnaspaces.io/iot"  
FF:00:00:00:00:01  
$97cfed0b-6729-49a6-9285-92913a4b1e4a dnaspaces.io/iot"  
FF:00:00:00:00:01  
$97cfed0b-6729-49a6-9285-92913a4b1e4a dnaspaces.io/iot"  
FF:00:00:00:00:01  
$97cfed0b-6729-49a6-9285-92913a4b1e4a dnaspaces.io/iot"  
FF:00:00:00:00:01
```




CHAPTER 6

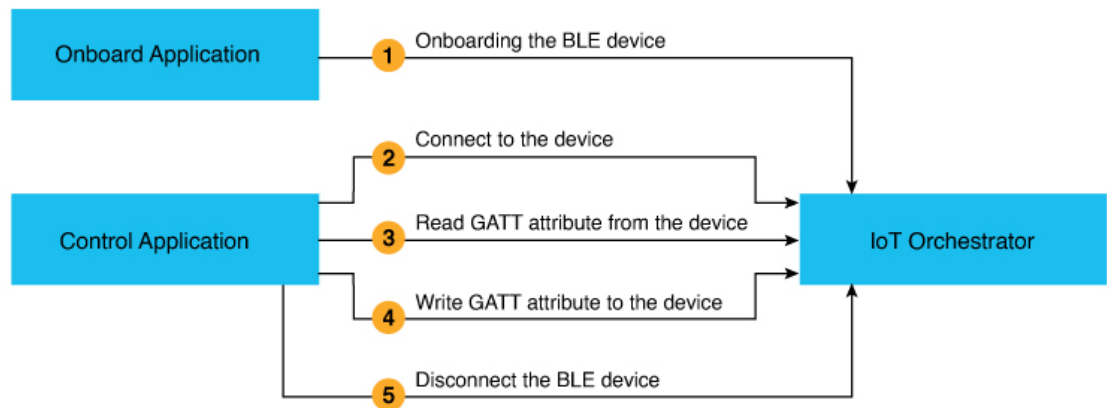
Use Case 2 - Remote Patient Health Monitoring

- [Use Case 2 - Remote Patient Health Monitoring \(requiring BLE connection, reading, and writing\)](#), on page 37
- [Onboarding a Device](#), on page 38
- [Connecting to a Device](#), on page 40
- [Writing a Characteristic to the Device](#), on page 43
- [Reading a Characteristic to the Device](#), on page 43
- [Disconnecting the Device](#), on page 44

Use Case 2 - Remote Patient Health Monitoring (requiring BLE connection, reading, and writing)

In this use case, you can:

1. Onboard a device.
2. Connect to the device.
3. Perform service discovery.
4. Write a characteristic.
5. Read the characteristic.
6. Disconnect from the device.



The following workflow covers the sequence of operations:

1. [Onboarding a Device.](#)
2. [Connecting to a Device.](#)
3. [Writing a Characteristic to the Device.](#)
4. [Reading a Characteristic to the Device.](#)
5. [Disconnecting the Device.](#)

Onboarding a Device

API Definition

API	Description
POST /scim/v2/Devices	This is the API for onboarding a device.

Request Format for Onboarding the Device without Pairing

```

curl -k --location 'https://10.195.78.33:8081/scim/v2/Devices' \
--header 'x-api-key: 5a9095d0457f24518bba93c50d69efe5' \
--header 'Content-Type: application/json' \
--data '
{
  "schemas": [
    "urn:ietf:params:scim:schemas:core:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:ble:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:endpointapps:2.0:Device"
  ],
  "deviceDisplayName": "BLE Heart Monitor",
  "adminState": true,
  "urn:ietf:params:scim:schemas:extension:ble:2.0:Device": {
    "versionSupport": [
      "5.3"
    ],
  },
  "deviceMacAddress": "EF:00:00:00:00:00",
}
  
```

```

"isRandom": false,
"mobility": false,
"pairingMethods": [
  "urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device"
],
"urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device": null
},
"urn:ietf:params:scim:schemas:extension:endpointAppsExt:2.0:Device": {
  "onboardingUrl": "onboardApplication",
  "deviceControlUrl": [
    "controlApplication"
  ],
  "dataReceiverUrl": []
}
}
'

```

Response Format for Onboarding the Device without Pairing

```

{
  "schemas": [
    "urn:ietf:params:scim:schemas:core:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:ble:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:endpointapps:2.0:Device"
  ],
  "id": "f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "deviceDisplayName": "BLE Heart Monitor",
  "adminState": true,
  "urn:ietf:params:scim:schemas:extension:ble:2.0:Device": {
    "versionSupport": [
      "5.3"
    ],
    "deviceMacAddress": "CA:2B:5C:EC:95:46",
    "isRandom": false,
    "pairingMethods": [
      "urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device"
    ],
    "mobility": false,
    "urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device": null
  },
  "urn:ietf:params:scim:schemas:extension:endpointAppsExt:2.0:Device": {
    "onboardingUrl": "onboardApplication",
    "deviceControlUrl": [
      "controlApplication"
    ],
    "dataReceiverUrl": []
  }
}

```

Request Format for Onboarding the Device with Pairing

```

{
  "schemas": [
    "urn:ietf:params:scim:schemas:core:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:ble:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:endpointapps:2.0:Device"
  ],
  "deviceDisplayName": "BLE Heart Monitor",
  "adminState": true,
  "urn:ietf:params:scim:schemas:extension:ble:2.0:Device": {
    "versionSupport": [

```

```

"5.3"
],
"deviceMacAddress": "CA:2B:5C:EC:95:46",
"isRandom": false,
"mobility": true,
"pairingMethods": [
"urn:ietf:params:scim:schemas:extension:pairingJustWorks:2.0:Device"
],
"urn:ietf:params:scim:schemas:extension:pairingJustWorks:2.0:Device": {
"key": null
}
},
"urn:ietf:params:scim:schemas:extension:endpointAppsExt:2.0:Device": {
"onboardingUrl": "onboardApplication",
"deviceControlUrl": [
"controlApplication"
],
"dataReceiverUrl": []
}
}

```

Response Format for Onboarding the Device with Pairing

```

{
"schemas": [
"urn:ietf:params:scim:schemas:core:2.0:Device",
"urn:ietf:params:scim:schemas:extension:ble:2.0:Device",
"urn:ietf:params:scim:schemas:extension:endpointapps:2.0:Device"
],
"id": "f837c89a-e1dd-4b90-a446-06016c0d2b75",
"deviceDisplayName": "BLE Heart Monitor",
"adminState": true,
"urn:ietf:params:scim:schemas:extension:ble:2.0:Device": {
"versionSupport": [
"5.3"
],
"deviceMacAddress": "CA:2B:5C:EC:95:46",
"isRandom": false,
"pairingMethods": [
"urn:ietf:params:scim:schemas:extension:pairingJustWorks:2.0:Device"
],
"mobility": true,
"urn:ietf:params:scim:schemas:extension:pairingJustWorks:2.0:Device": {
"key": null
}
},
"urn:ietf:params:scim:schemas:extension:endpointAppsExt:2.0:Device": {
"onboardingUrl": "onboardApplication",
"deviceControlUrl": [
"controlApplication"
],
"dataReceiverUrl": []
}
}

```

Connecting to a Device

To connect to a BLE device and discover its services, perform the following:

1. Use the Device ID:

The device ID is "f837c89a-e1dd-4b90-a446-06016c0d2b75".

2. Connect the BLE device from the AP:

Use the device ID to establish a connection with the BLE device from the AP.

3. Discover Services:

Discover the services with the following service UUIDs:

- 1800
- 2002
- 1822
- 180F

API Definition

API	Description
/control/connectivity/connect	This API is used to connect to a device.

Request Format

```
{
  "technology": "ble",
  "id": "f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "ble": {
    "services": [
      {
        "serviceID": "1800"
      },
      {
        "serviceID": "2022"
      },
      {
        "serviceID": "1822"
      },
      {
        "serviceID": "180F"
      }
    ]
  },
  "controlApp": "controlApplication"
}
```

Response Format

```
{
  "status": "SUCCESS",
  "id": "f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "requestID": "75310f89-79c6-4e7b-93cb-f58a8f18fc57",
  "services": [
    {
      "serviceID": "1800",
      "characteristics": [
```

```

{
  "characteristicID": "3443",
  "descriptors": [
    {
      "descriptorID": "9059"
    }
  ],
  "flags": [
    "read",
    "write",
    "notify"
  ]
}
},
{
  "serviceID": "2022",
  "handle": 1,
  "characteristics": [
    {
      "characteristicID": "8065",
      "descriptors": [
        {
          "descriptorID": "9620"
        }
      ],
      "flags": [
        "read",
        "write",
        "notify"
      ]
    }
  ],
},
{
  "serviceID": "1822",
  "handle": 2,
  "characteristics": [
    {
      "characteristicID": "8912",
      "descriptors": [
        {
          "descriptorID": "1554"
        }
      ],
      "flags": [
        "read",
        "write",
        "notify"
      ]
    }
  ],
},
{
  "serviceID": "180F",
  "handle": 3,
  "characteristics": [
    {
      "characteristicID": "2810",
      "descriptors": [
        {
          "descriptorID": "1517"
        }
      ]
    }
  ],
}

```

```

"flags": [
  "read",
  "write",
  "notify"
]
}
]
}
]
}

```

Writing a Characteristic to the Device

API Definition

API	Description
/control/data/write	This API is used to write a characteristic to the device.

Request Format

```

{
  "technology": "ble",
  "id": " f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "value": "0001",
  "ble": {
    "serviceID": "1800",
    "characteristicID": "2A00"
  },
  "controlApp": "controlApplication"
}

```

Response Format

```

{
  "status": "SUCCESS",
  "id": " f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "requestID": "191bc8f1-927f-4fb0-b0b5-7944ea5b34f0",
  "value": "0001"
}

```

Reading a Characteristic to the Device

API Definition

API	Description
/control/data/read	This API is used to read a characteristic to the device.

Request Format

```
{
  "technology": "ble",
  "id": " f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "ble": {
    "serviceID": "1800",
    "characteristicID": "2A00"
  },
  "controlApp": "controlApplication"
}
```

Response Format

```
{
  "status": "SUCCESS",
  "id": " f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "requestID": "8ba846aa-6133-4392-b911-9850a90791f2",
  "value": "2342432"
}
```

Disconnecting the Device

API Definition

API	Description
/control/connectivity/disconnect	This API is used to disconnect the device.

Request Format

```
{
  "technology": "ble",
  "id": " f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "controlApp": "controlApplication"
}
```

Response Format

```
{
  "status": "SUCCESS",
  "id": " f837c89a-e1dd-4b90-a446-06016c0d2b75",
  "requestID": "cb838a8d-775b-4e71-874d-1aa22e61f9af"
}
```



CHAPTER 7

Use Case 3 - BLE Notification-based Use Cases

- [Use Case 3 - BLE Notification-Based Use Cases, on page 45](#)
- [Onboarding the BLE Device, on page 46](#)
- [Registering a Topic, on page 49](#)
- [Connecting to a BLE Device from an AP, on page 49](#)
- [Starting Notifications, on page 51](#)
- [MQTT Subscription Messages, on page 52](#)

Use Case 3 - BLE Notification-Based Use Cases

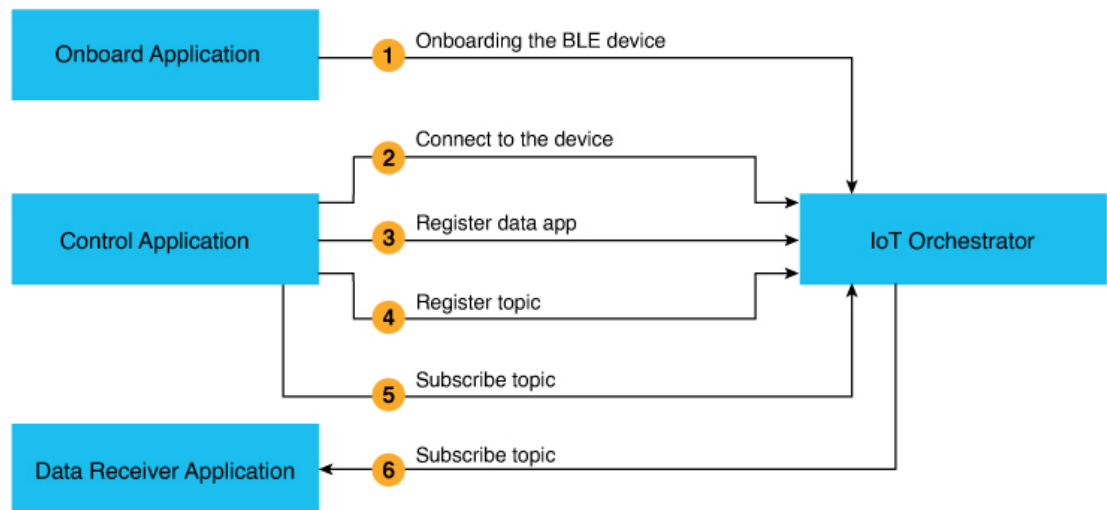
A BLE device can have multiple services and each service can have multiple characteristics. For BLE notification, you can register the topic and subscribe for a specific service or characteristic ID for which the notification needs to be received. In this case, the best example is to subscribe for BLE GATT notification.

In this use case, you will be able to onboard a device, register a topic, connect to a device, and subscribe for notification.

Here, the sample use case is that of a Pulse Oximeter. A Pulse Oximeter is a medical device that non-invasively measures the oxygen saturation level (SpO2) of a person's blood and pulse rate. The Pulse Oximeter is a small portable device commonly used in hospitals, clinics, and home to monitor patients with respiratory or cardiovascular conditions.

The following are the GATT attributes associated with the Pulse Oximeter:

1. Oxygen level
2. Heart rate



The following workflow covers the sequence of operations:

1. [Onboarding the BLE Device.](#)
2. [Registering a Topic.](#)
3. [Connecting to a BLE Device from an AP.](#)
4. [Starting Notifications.](#)
5. [MQTT Subscription Messages.](#)

Onboarding the BLE Device

API Definition

API	Description
POST /scim/v2/Devices	This API is used to onboard the BLE device.

Request Format for Onboarding the Device without Pairing

```

curl -k --location 'https://10.195.78.33:8081/scim/v2/Devices' \
--header 'x-api-key: 5a9095d0457f24518bba93c50d69efe5' \
--header 'Content-Type: application/json' \
--data '
{
  "schemas": [
    "urn:ietf:params:scim:schemas:core:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:ble:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:endpointapps:2.0:Device"
  ],
  "deviceDisplayName": "BLE Heart Monitor",
  "adminState": true,
  "urn:ietf:params:scim:schemas:extension:ble:2.0:Device": {

```

```

"versionSupport": [
  "5.3"
],
"deviceMacAddress": "EF:00:00:00:00:00",
"isRandom": false,
"mobility": false,
"pairingMethods": [
  "urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device"
],
"urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device": null
},
"urn:ietf:params:scim:schemas:extension:endpointAppsExt:2.0:Device": {
  "onboardingUrl": "onboardApplication",
  "deviceControlUrl": [
    "controlApplication"
  ],
  "dataReceiverUrl": []
}
}
,

```

Response Format for Onboarding the Device without Pairing

```

{
  "schemas": [
    "urn:ietf:params:scim:schemas:core:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:ble:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:endpointapps:2.0:Device"
  ],
  "id": " df553860-975c-4d7f-8c1f-b2996f34e26f",
  "deviceDisplayName": "BLE Heart Monitor",
  "adminState": true,
  "urn:ietf:params:scim:schemas:extension:ble:2.0:Device": {
    "versionSupport": [
      "5.3"
    ],
    "deviceMacAddress": "CA:2B:5C:EC:95:46",
    "isRandom": false,
    "pairingMethods": [
      "urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device"
    ],
    "mobility": false,
    "urn:ietf:params:scim:schemas:extension:pairingNull:2.0:Device": null
  },
  "urn:ietf:params:scim:schemas:extension:endpointAppsExt:2.0:Device": {
    "onboardingUrl": "onboardApplication",
    "deviceControlUrl": [
      "controlApplication"
    ],
    "dataReceiverUrl": []
  }
}

```

Request Format for Onboarding the Device with Pairing

```

{
  "schemas": [
    "urn:ietf:params:scim:schemas:core:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:ble:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:endpointapps:2.0:Device"
  ],

```

```

"deviceDisplayName": "BLE Heart Monitor",
"adminState": true,
"urn:ietf:params:scim:schemas:extension:ble:2.0:Device": {
  "versionSupport": [
    "5.3"
  ],
  "deviceMacAddress": "CA:2B:5C:EC:95:46",
  "isRandom": false,
  "mobility": true,
  "pairingMethods": [
    "urn:ietf:params:scim:schemas:extension:pairingJustWorks:2.0:Device"
  ],
  "urn:ietf:params:scim:schemas:extension:pairingJustWorks:2.0:Device": {
    "key": null
  }
},
"urn:ietf:params:scim:schemas:extension:endpointAppsExt:2.0:Device": {
  "onboardingUrl": "onboardApplication",
  "deviceControlUrl": [
    "controlApplication"
  ],
  "dataReceiverUrl": []
}
}

```

Response Format for Onboarding the Device with Pairing

```

{
  "schemas": [
    "urn:ietf:params:scim:schemas:core:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:ble:2.0:Device",
    "urn:ietf:params:scim:schemas:extension:endpointapps:2.0:Device"
  ],
  "id": "df553860-975c-4d7f-8c1f-b2996f34e26f",
  "deviceDisplayName": "BLE Heart Monitor",
  "adminState": true,
  "urn:ietf:params:scim:schemas:extension:ble:2.0:Device": {
    "versionSupport": [
      "5.3"
    ],
    "deviceMacAddress": "CA:2B:5C:EC:95:46",
    "isRandom": false,
    "pairingMethods": [
      "urn:ietf:params:scim:schemas:extension:pairingJustWorks:2.0:Device"
    ],
    "mobility": true,
    "urn:ietf:params:scim:schemas:extension:pairingJustWorks:2.0:Device": {
      "key": null
    }
  },
  "urn:ietf:params:scim:schemas:extension:endpointAppsExt:2.0:Device": {
    "onboardingUrl": "onboardApplication",
    "deviceControlUrl": [
      "controlApplication"
    ],
    "dataReceiverUrl": []
  }
}

```


Registering a Topic

You can register the topic "enterprise/hospital/pulse_oximeter" with the gateway to subscribe to GATT notifications from the device ID "df553860-975c-4d7f-8c1f-b2996f34e26f", service UUID "1800", and characteristic UUID "2A5E".

API Definition

API	Description
/control/registration/registerTopic	This API is used to register a topic with the gateway to subscribe to GATT notifications from the device.

Request Format

```
{
  "technology": "ble",
  "ids": [
    "df553860-975c-4d7f-8c1f-b2996f34e26f",
  ],
  "controlApp": "controlApplication",
  "topic": "enterprise/hospital/pulse_oximeter",
  "dataFormat": "default",
  "ble": {
    "type": "gatt",
    "serviceID": "1800",
    "characteristicID": "2A5E"
  }
}
```

Response Format

```
{
  "status": "SUCCESS",
  "topic": "enterprise/hospital/pulse_oximeter",
  "isOnboarded": true
}
```

Connecting to a BLE Device from an AP

API Definition

API	Description
/control/connectivity/connect	This API is used to connect to the BLE device from the AP and discover the services with service UUIDs 1800, 2022, 1822, and 180F.

Request Format

```

{
  "technology": "ble",
  "id": "df553860-975c-4d7f-8c1f-b2996f34e26f",
  "ble": {
    "services": [
      {
        "serviceID": "1800"
      },
      {
        "serviceID": "2022"
      },
      {
        "serviceID": "1822"
      },
      {
        "serviceID": "180F"
      }
    ]
  },
  "controlApp": "controlApplication"
}

```

Response Format

```

{
  "status": "SUCCESS",
  "id": "df553860-975c-4d7f-8c1f-b2996f34e26f",
  "requestID": "75310f89-79c6-4e7b-93cb-f58a8f18fc57",
  "services": [
    {
      "serviceID": "1800",
      "characteristics": [
        {
          "characteristicID": "3443",
          "descriptors": [
            {
              "descriptorID": "9059"
            }
          ],
          "flags": [
            "read",
            "write",
            "notify"
          ]
        }
      ]
    },
    {
      "serviceID": "2022",
      "handle": 1,
      "characteristics": [
        {
          "characteristicID": "8065",
          "descriptors": [
            {
              "descriptorID": "9620"
            }
          ],
          "flags": [
            "read",

```

```

"write",
"notify"
]
}
]
},
{
{
"serviceID": "1822",
"handle": 2,
"characteristics": [
{
"characteristicID": "8912",
"descriptors": [
{
"descriptorID": "1554"
}
],
"flags": [
"read",
"write",
"notify"
]
}
]
},
{
"serviceID": "180F",
"handle": 3,
"characteristics": [
{
"characteristicID": "2810",
"descriptors": [
{
"descriptorID": "1517"
}
],
"flags": [
"read",
"write",
"notify"
]
}
]
}
]
}
]
}
}
}
}

```

Starting Notifications

API Definition

API	Description
/control/data/subscribe	This API enables the GATT notifications in the device using the device ID, GATT service UUID, and characteristic UUID.

Request Format

```
{
  "technology": "ble",
  "id": "df553860-975c-4d7f-8c1f-b2996f34e26f",
  "ble": {
    "serviceID": "1800",
    "characteristicID": "2A5E"
  },
  "controlApp": "controlApplication"
}
```

Response Format

```
{
  "status": "SUCCESS",
  "id": "df553860-975c-4d7f-8c1f-b2996f34e26f",
  "requestID": "12345678-5678-1234-5578-abcdef1234"
}
```

MQTT Subscription Messages

Once the notification is enabled using the subscribe API, the data receiver application starts receiving the GATT notifications once it subscribes to the registered topic.

```
mosquitto_sub -h localhost -p 41883 -t enterprise/hospital/pulse_oximeter -u
https://dataApplication --pw c4e80e0483af0a4394dfb6e3ec5e820b
$26efb024-a052-4279-9b06-5f17e00d84401028f90
18002A5E
$26efb024-a052-4279-9b06-5f17e00d84401028f90
18002A5E
$26efb024-a052-4279-9b06-5f17e00d84401028f90
18002A5E
$26efb024-a052-4279-9b06-5f17e00d84401028f90
18002A5E
$26efb024-a052-4279-9b06-5f17e00d84401028f90
18002A5E
$26efb024-a052-4279-9b06-5f17e00d84401028f90
18002A5E
```



CHAPTER 8

Troubleshooting

- [Troubleshooting, on page 53](#)

Troubleshooting

Issue	Solution	Verification
<p>If the IoT Orchestrator application deployment fails in C9800-CL Wireless Controller.</p>	<p>Verify, if the C9800-CL is provisioned using the App Heavy template for installing and running the IoT Orchestrator application.</p> <p>If not, you need to deploy a new virtual machine using the App Heavy template to run the IoT Orchestrator application.</p>	<p>Once the VM is provisioned using the correct template, use the following command to verify the details:</p> <pre>Device# show platform software cpu alloc CPU alloc information: Control plane cpu aIfllloc: 0-7 Data plane cpu alloc: 14-15 Service plane cpu alloc: 8-13 Platform plane cpu alloc: 0-7 Slow control plane cpu alloc: Template used: CLI-app_heavy <<<<<<<<</pre> <p>If the template used is not APP Heavy, use the following commands:</p> <pre>Device(config)# platform resource app-heavy Device(config)# end Device# write memory Device# reload</pre>

Issue	Solution	Verification
<p>If the Cisco Wireless AP does not show up as Connected in the AP Inventory page in IoT Orchestrator application.</p>	<p>Verify, if the Configure 9800 WLC displays as Success. If not, see the Day 0 - Deploying IoT Orchestrator Application on Cisco Catalyst 9800 Wireless Controller section in <i>Cisco Spaces Connect for IoT Services Configuration Guide, Release 1.0.0</i>.</p>	<p>Verify, if the Cisco Wireless AP is connected to the Cisco Catalyst 9800 Wireless Controller in the IoT Orchestrator running as an IOx application. Verify, the network reachability from the Cisco Wireless AP to the IoT Orchestrator application IP address.</p>
<p>If the API call is rejected by the IoT Orchestrator when the on-premise application is registered using the API key.</p>	<p>Verify, if the application issuing the API call is registered in the IoT Orchestrator application.</p>	<p>For applications with API key-based registration, you will need to verify:</p> <ul style="list-style-type: none"> • If the application issuing the API call has the application name registered in the IoT Orchestrator. • If the IoT Orchestrator application uses the same API key when registering the application.
<p>If the API call is rejected by the IoT Orchestrator when the on-premise application is registered using the certificate name.</p>	<p>Verify, if the application issuing the API call is registered in the IoT Orchestrator application.</p>	<p>For applications with Certificate-based registration, you will need to verify:</p> <ul style="list-style-type: none"> • If the application issuing the API call has the application name registered in the IoT Orchestrator. • If the IoT Orchestrator application uses the same certificate whose canonical name is registered.
<p>If the Connect API call is rejected with the “Control app is not authorized” message.</p>	<p>Verify, if the control application issuing the connect API call for a specific BLE device is specified in the "deviceControlUrl" field of the "endpoints" section in the Onboarding API request for that device.</p>	

Issue	Solution	Verification
<p>If the IoT Orchestrator application is unable to connect to the BLE device.</p>	<p>Verify, if the BLE device can connect and send out BLE advertisements.</p>	<p>If the BLE device does not need pairing, you will need to check, if the onboarded device used the pairing method as “PairingNull”.</p> <p>If the BLE device needs pairing, you will need to check, if the onboarded device used the pairing method as “PairingJustWorks”.</p>
<p>If the MQTT receiver in the application does not receive streaming data from the IoT Orchestrator.</p>	<p>Verify, if the data application is registered using the control application.</p> <p>Verify, if the topic is registered for the data of interest using the control application.</p> <p>Verify, if the subscription for the topic is done using the control application.</p>	
<p>How to determine the real-time logs from the IoT Orchestrator application.</p>	<p>Refer to the Logs section in <i>Cisco Spaces Connect for IoT Services Configuration Guide, Release 1.0.0</i>.</p>	
<p>How can I capture the logs from the Cisco Wireless AP that are connected to the IoT Orchestrator application.</p>		
<p>How can I capture the logs for a specific BLE device from the IoT Orchestrator application and Cisco Wireless AP.</p>		

