Vendor Requirements for Device Certification

This document provides guidance on which requirements a connector/agent needs to fulfill to be successfully certifiable using the Cumulocity IoT certification tool. The device certification process requires all connectors / agents that run on devices to follow standards and integration best practices. This means that more fields are mandatory for a certified device compared to platform minimum requirements. The following section, Device Registration, covers the registration processes for connectors/agents using either the MQTT API or the REST API. The mandatory capabilities are described in section Foundation Capabilities. All advanced capabilities are part of the section Extended Capabilities.

Device Registration

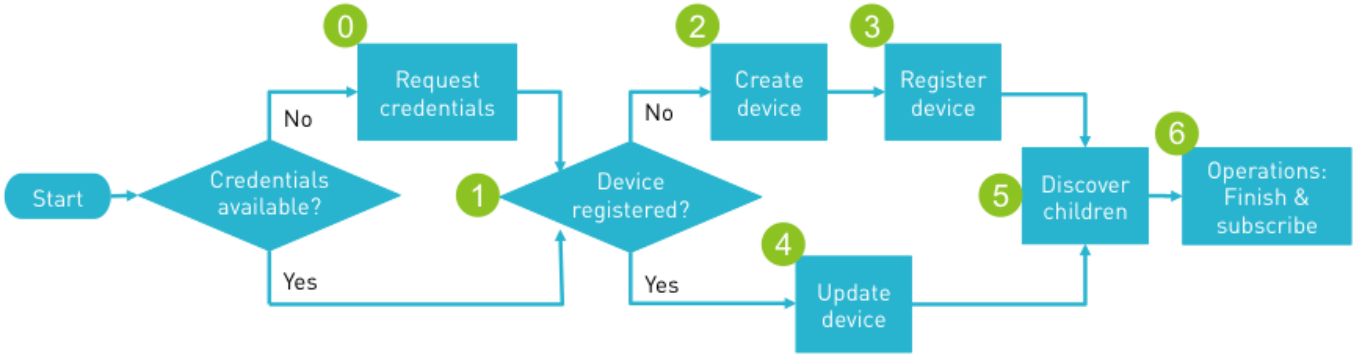
The chapter Device Behavior describes how a connector/agent that runs on a device registers to Cumulocity IoT. The connector/agent must send a mandatory minimum of information to be certifiable. This is covered in the section Foundation Capabilities.

Device Behavior

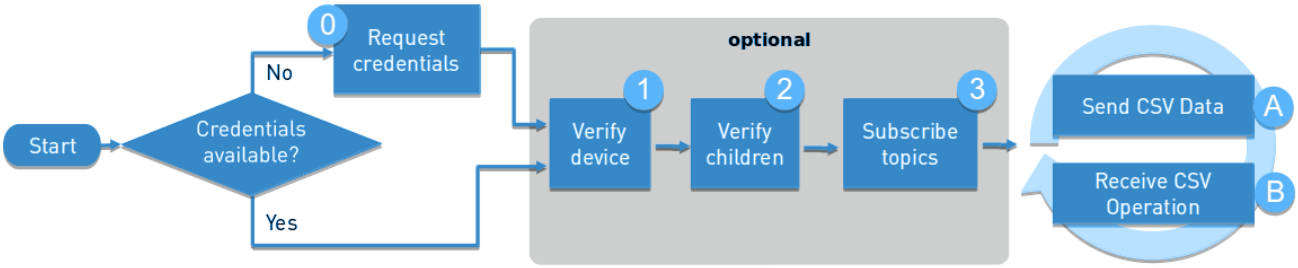
When started, the device follows the process flow defined for REST or MQTT based integration respectively.

Please read and follow one of these guides:

For *REST Based Integrations Cumulocity IoT Documentation*:



For *MQTT Based Integrations Cumulocity IoT Documentation* (using Smart-Rest 2 is recommended):



Helpful MQTT Info

- MQTT Cheat Sheet (Comprehensive)
- MQTT Quick Reference Cumulocity IoT Documentation
- MQTT Static Templates Cumulocity IoT Documentation

Certificates

Cypher Suits:

Cumulocity IoT fulfills SSL Labs A+ rating and therefore supports exclusively the following cypher suits from release Release 10.10:

- rsa_pkcs1_sha256
- dsa_sha256
- ecdsa_secp256r1_sha256
- rsa_pkcs1_sha384
- ecdsa_secp384r1_sha384
- rsa_pkcs1_sha512
- ecdsa_secp521r1_sha512
- rsa_pss_rsae_sha256
- rsa_pss_rsae_sha384
- rsa_pss_rsae_sha512
- ed25519 ed448
- rsa_pss_pss_sha256
- rsa_pss_pss_sha384
- rsa_pss_pss_sha512

Certification of Devices and Aggregation as Products

When a connector/agent registers on Cumulocity IoT, it becomes a device listed in the Device Management application. When using the self-certification tool, one certificate can be created for each combination of the connector (c8y_Agent), the Hardware (c8y_Hardware) and the Firmware (c8y_Firmware). If any of these values change, a new device-certificate can be created. The Cumulocity IoT device certification API makes the certification information available for our Device Partner Portal. Entries on the Device Partner Portal represent

devices from a sales/user perspective, which is therefore defined as a product. Products can only be segregated by their names. To link the product from the Device Partner Portal with the more granular differentiation of a device on Cumulocity IoT, we have incorporated this as manual steps within the Cumulocity IoT certification tool. Device certificates therefore need to be clustered to products, so all the device certificates related to that product can then be displayed under the same product on the Device Partner Portal. The product to device relation is 1:n.

Foundation Capabilities for Vendor Device Certification (mandatory)

For details and examples, see the Metadata Cumulocity IoT Documentation section of the Cumulocity IoT Open API documentation as well as the detail sections below.

Fragment	Description	Mandatory
`c8y_Agent`	Information about the agent run on the device	Yes
`c8y_IsDevice`	Empty fragment. Defines the managed object created through the Inventory API to be a Device	Yes
`name`	Sets the name of the device used e.g. in 'all devices' and 'device info' views	Yes
`type`	Functional type of device e.g. water meter, pump, Gateway, environmental sensor	Yes
`c8y_RequiredAvailability`	Minimal communication interval to determine if device is offline	No
`c8y_Firmware`	Firmware information about the device	Yes
`c8y_Hardware`	Hardware information about the device	Yes
`externalIds`	Used to identify a device with a unique information from the physical world	Yes

Information about one physical device is stored within multiple managed objects each accessible through one endpoint of the Cumulocity IoT API. All general device information must be stored in one managed object that can be accessed via the inventory endpoint. The following JSON structure represents a typical managed object of a device accessible through the inventory API endpoints (e.g. `GET {{url}}/inventory/managedObjects/{{deviceId}}`):

```
"c8y_IsDevice": {},
"com_cumulocity_model_Agent": {},
"name": "edge-agent-eabdcf5d344b4a52a4ffab13fe3d11cb",
"type": "c8y_EdgeAgent",
"c8y_Agent": {
    "name": "DeviceAgent",
    "version": "1.0",
    "url": ""
```

```
},
"c8y_RequiredAvailability": {
    "responseInterval": 6
},
"c8y_Firmware": {
    "name": "raspberrypi-bootloader",
    "version": "1.20140107-1",
    "url": "31aab9856861b1a587e2094690c2f6e272712cb1"
},
"c8y_Hardware": {
    "model": "BCM2708",
    "revision": "000e",
    "serialNumber": "00000000e2f5ad4d"
}
```

Agent Information

The term “agent” refers to the piece of software that connects a device with Cumulocity IoT. This document provides guidance for integration developers to develop this agent. The fragments `c8y_Agent` must be sent to the inventory endpoint of the API to add it to the device managed object. For details and examples, compare *What is an agent? Cumulocity IoT Documentation*.

c8y_Agent

The device certificate will be issued for a device by the properties `c8y_Agent.name`, `c8y_Agent.version`, `c8y_Hardware.model`, `c8y_Hardware.revision`, `c8y_Firmware.name`, and `c8y_Firmware.version`. Developers of this agent are free to chose the name and version.

Example of an “agent” named “c8yMQTT”.

Fragment	Mandatory
`name`	Yes
`version`	Yes
`url`	No

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_Agent": {
    "name": "myCustomAgent",
    "version": "1.2.34",
    "url": "https//link-to-agent-repo.url"
}
```

Basic Device Information

The fragments `c8y_IsDevice`, `name`, `type`, `c8y_RequiredAvailability`, `c8y_Firmware`, and `c8y_Hardware` must be present in the managed object accessible through the inventory API endpoints.

name

The Cumulocity IoT UI uses the device `name`. Here, `name` sets the name of the device used, e.g. in 'all devices' and 'device info' views.

Fragment	Mandatory
`name`	Yes

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"name": "ExampleDeviceName"
```

c8y_IsDevice

`c8y_IsDevice` is an empty fragment that declares the managed object accessible through the inventory API endpoints as a device.

Fragment	Mandatory
`c8y_IsDevice`	Yes

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_IsDevice": {}
```

type

The fragment `type` can be interpreted as `_device class_`. Meaning, devices with the same `type` can receive the same types of configuration, software, firmware, and operations. Cumulocity IoT UI uses the device `type` often for filtering purposes like sending a software package to all devices of one specific `type`. Based on the device `type` Cumulocity can assign Dashboards to the same `type`.

Fragment	Mandatory
`type`	Yes

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"type": "c8y_EdgeAgent"
```

c8y_RequiredAvailability

Minimal communication interval to determine if device is offline. For details and examples, see Device Availability Cumulocity IoT Documentation.

Fragment	Mandatory
`responseInterval`	No

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_RequiredAvailability": {
    "responseInterval": 6
}
```

Hardware Information

Hardware information can be stored within the fragment `c8y_Hardware` that is part of the inventory managed object accessible through the inventory API endpoints. The device certificate will be issued for device defined by: `c8y_Hardware.model`, `c8y_Hardware.revision`, `c8y_Firmware.name`, `c8y_Firmware.version`, `c8y_Agent.name`, and `c8y_Agent.version`. These fragments will also be used in future versions of Device Partner Portal. It displays one "Device" entry in the overview device list per `c8y_Hardware.model` and a dropdown menu in the device detail view for each `c8y_Hardware.revision`.

c8y_Hardware

Fragment	Meaning in Device Partner Portal	Mandatory
`model`	Device in list view	Yes
`revision`	Dropdown inside device detail view to select device revision or version	Yes
`serialNumber`	Not used in Device Partner Portal	Yes

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_Hardware": {
    "model": "BCM2708",
    "revision": "000e",
    "serialNumber": "00000000e2f5ad4d"
}
```

Firmware Information

Firmware information can be stored within the fragment `c8y_Firmware` that is part of the inventory managed object accessible through the inventory API endpoints. The device certificate will be issued for device defined by: `c8y_Hardware.model`, `c8y_Hardware.revision`, `c8y_Firmware.name`, `c8y_Firmware.version`, `c8y_Agent.name`, and `c8y_Agent.version`.

c8y_Firmware

Fragment	Mandatory
`name`	Yes
`version`	Yes
`url`	No

Example structure in inventory managed object accessible through the inventory API endpoints:

```
"c8y_Firmware": {
    "name": "raspberrypi-bootloader",
    "version": "1.20140107-1",
    "url": "31aab9856861b1a587e2094690c2f6e272712cb1"
}
```

External ID

The External ID is displayed by the UI in the tab "Identity". The fragments `externalId` and `type` must be present in the managed object accessible via identity API endpoints.

Used to identify the device in Cumulocity by its unique serial number, MAC, IMEI or similar unique identification string. If you don't want to specify a type, its recommend to use `c8y_Serial`.

Fragment	Mandatory
`externalId`	Yes
`type`	Yes

Example structure of an external ID -managed object accessible through the identity API endpoints:

```
{
  "externalId": "simulator_145074_0",
  "type": "c8y_Serial"
}
```

NOTE: The externalID is not stored in the managed object through the inventory endpoint of the API but the identity API endpoints.

Sending Operational Data

Sending measurements, events, and alarms are basic capabilities of any IoT enabled device. Therefore vendors should aim to support all three. However, there might be some instances where devices only send events (e.g. basic switches) or only measurements (e.g. basic sensor). It is only mandatory to send either measurements or events or alarms in order to get certified, although we recommend to implement all three capabilities.

Functionality	Content	Mandatory

Functionality	Content	Mandatory
Measurements (M), Events (E), Alarms (A)	Information send from the device to the platform	Yes, at least one of the three

Measurements

It is only mandatory to send either measurements or events or alarms in order to get certified, although we recommend to implement all three capabilities. For details and examples, see Measurements Cumulocity IoT Documentation.

The device creates measurements with the following content:

Fragment	Content	Mandatory for Measurements
`source`	Device ID	Yes
`type`	Type of measurement	Yes
`time`	Date and time when the measurement was made	Yes
Measurement Fragment	The category of measurement	Yes
Measurement Fragment Series	The name of the measurement series. Contains at least the `value` fragment, optionally the `unit` fragment	Yes

Measurement names must be written in camel-case. Cumulocity IoT UI inserts a blank space between a lower-case and an upper-case letter. Two or more consecutive upper-case letters are not separated with blank spaces. The UI also hides the prefix of a measurement name that is ending with a "_" (underline) symbol.

Important: ☐ ( ) @ $ / ''

Example POST body:

```
{
  "source": {
    "id": "251982",
  },
  "type": "c8y_TemperatureMeasurement",
  "time": "2021-10-19T12:03:27.845Z",
  "c8y_Steam": {
    // Measurement Fragment
    "Temperature": {
      // Measurement Fragment Series
      "unit": "C",
      "value": "100",
    },
  },
}
```

The _Measurement Fragment_ and _Measurement Fragment Series_ are used in the Cumulocity IoT UI in the following way: Measurement Fragment and Series in UI](./media/measurement-fragmentand-series-in-ui.png)

The following _Measurement Fragments_ are standard measurement fragments in Cumulocity IoT: c8y_AccelerationMeasurement, c8y_AccelerationSensor, c8y_Battery, c8y_CPUMeasurement, c8y_CurrentMeasurement, c8y_CurrentSensor, c8y_DistanceMeasurement, c8y_DistanceSensor, c8y_HumidityMeasurement, c8y_HumiditySensor, c8y_LightMeasurement, c8y_LightSensor, c8y_MeasurementPollFrequencyOperation, c8y_MeasurementRequestOperation, c8y_MemoryMeasurement, c8y_MotionMeasurement, c8y_MotionSensor, c8y_MoistureMeasurement, c8y_SignalStrength, c8y_SinglePhaseEnergyMeasurement, c8y_SinglePhaseEnergySensor, c8y_Steam, c8y_Temperature, c8y_TemperatureSensor, c8y_TemperatureMeasurement, c8y_ThreePhaseEnergyMeasurement,c8y_ThreePhaseElectricitySensor, c8y_VoltageMeasurement,

Events

It is only mandatory to send either measurements, or events, or alarms in order to get certified while it is still recommended to implement all three capabilities. For details and examples, see Events Cumulocity IoT Documentation.

The device creates events with the following content:

Fragment	Content	Mandatory for Events
source	Device ID	Yes
type	Type of event	Yes
time	Date and time when the event was created	Yes
text	Description of the event	Yes

Example POST body:

```
{
  "source": {
    "id": "251982",
  },
  "type": "Intrusion detection",
  "text": "Door sensor was triggered",
  "time": "2021-10-19T12:03:27.845Z",
}
```

Alarms

It is only mandatory to send either measurements, or events, or alarms in order to get certified while it is still recommended to implement all three capabilities. For details and examples, see Alarms Cumulocity IoT Documentation.

The device creates alarms with the following content:

Fragment	Content	Mandatory for Alarms
`source`	Device ID	Yes
`type`	Type of alarm	Yes
`time`	Date and time when the alarm was created	Yes
`text`	Description of the alarm	Yes
`severity`	One of the following severities: `CRITICAL`, `MAJOR`, `MINOR`, `WARNING`	Yes
`status`	`ACTIVE` or `CLEARED`. If not specified, a new alarm will be created as `ACTIVE`. The state `ACKNOWLEDGED` is only set by the user, not by the device. The state `CLEARED` is set by the device if the problem is gone and it can be set manually by a user in the platform	No

Example POST body:

```
{
  "source": {
    "id": "251982",
  },
  "type": "Operational State Alarms",
  "text": "Machine stopped unexpectedly with exit reason 3",
  "severity": "MAJOR",
  "status": "ACTIVE",
  "time": "2021-10-19T12:03:27.845Z",
}
```

Extended Capabilities for Vendor Device Certification (optional)

The device certification process requires the device to follow integration best practices. This means that more fields are mandatory for a certified device compared to platform minimum requirements. This section describes the extended capabilities and expected device behavior. The extended capabilities require the Foundation Capabilities for Vendor Device Certification (mandatory).

All sections below are optional. If a device partner decides to certify extended capabilities, they are documented in the certificate and publicly displayed on the Device Partner Portal. Customer can filter and search for devices that support certain capabilities. Therefore, it is recommended to certify all capabilities (aka. "extended capabilities") offered by the device. The capabilities are listed below in descending order of importance based on Software AG's experience. To indicate that a device wants to certify extended capabilities, it has to add the respective element to the list of supported operations in the inventory object of the device. All extended capabilities that receive operations require the fragment `com_cumulocity_model_Agent` have to be present in the managed object accessible through the inventory API endpoints.

Info: Before using the Self-Certification Tool make sure all operations were successfully executed by the agent. The tool does not trigger any operations but checks that Cumulocity IoT receive them from the devices.

Fragment / Extended Capability	Content	Required for extended capability
c8y_SupportedOperations	Many extended operations are directly triggering the dynamic UI by invoking the respective operation tabs	Yes, if the Extended Capability is an operation
com_cumulocity_model_Agent	Empty fragment. Declares that the device is able to receive operations	Yes, for root devices and gateways that support operations; No, for devices and gateways that don't support operations; Must not be used for child devices;
Child Device Management	Cumulocity uses the concept of child device types to distinguish the capabilities of child devices behind a gateway device.	is an Extended Capability
Log file Retrieval	Device capability to upload (filtered) log files to C8Y.	is an Extended Capability
Device Configuration	Device capability that enables text- and / or profile-based device configuration. Text based configuration is the more basic approach. File based configuration allows to have multiple types of configurations (e.g. one file for defining polling intervals and another to configure the internal log-levels).	is an Extended Capability
Software Management	Device capability that enables software management. Firmware Management and Software Management are handled separately in Cumulocity IoT and follow different concepts.	is an Extended Capability
Firmware Management	Device capability that enables firmware management. Firmware Management and Software Management are handled separately in Cumulocity IoT and follow different concepts.	is an Extended Capability

Fragment / Extended Capability	Content	Required for extended capability
Device Profile	Device capability to manage device profiles. Device profiles represent a combination of a firmware version, one or multiple software packages and one or multiple configuration files which can be deployed on a device.	is an Extended Capability
Restart	Device capability to restart the device	is an Extended Capability
Measurement Request	Device capability to send an updated set of measurements on user request. This can be usefully for devices, that send measurements infrequently.	is an Extended Capability
Shell	Device capability to send any command to the device. The feature is often used to send shell commands to the device and receive the output as result.	is an Extended Capability
Cloud Remote Access	Device capability to initiate a remote connection via VNC or SSH.	is an Extended Capability
Location & Tracking	Device capability to display and update location information.	is an Extended Capability
Network	Device capability to display and update network information.	is an Extended Capability

The following JSON structure represents a typical managed object of a device accessible through the inventory API endpoints (e.g. `GET {{url}}/inventory/managedObjects/{{deviceId}}`):

```
"c8y_IsDevice": {},
"com_cumulocity_model_Agent": {},
"name": "edge-agent-eabdcf5d344b4a52a4ffab13fe3d11cb",
"type": "c8y_EdgeAgent",
"c8y_Agent": {
    "name": "DeviceAgent",
    "version": "1.0",
    "url": ""
},
"c8y_RequiredAvailability": {
    "responseInterval": 6
},
"c8y_Firmware": {
    "name": "raspberrypi-bootloader",
    "version": "1.20140107-1",
    "url": "31aab9856861b1a587e2094690c2f6e272712cb1"
},
```

```
"c8y_Hardware": {
    "model": "BCM2708",
    "revision": "000e",
    "serialNumber": "00000000e2f5ad4d"
},
"c8y_SupportedOperations": [
    "c8y_Software",
    "c8y_Firmware",
    "c8y_LogfileRequest",
    "c8y_Configuration",
    "c8y_SendConfiguration"
],
"c8y_Position": {
        "lng": 8.6449,
        "lat": 49.819199
},
"c8y_SoftwareList": [{
    "name": "pi",
    "version": "3.1418",
    "url": ""
}],
"c8y_Configuration": {
    "config": "mmyParam: myValue\nmyOtherParam: myOtherValue"
},
"c8y_SupportedLogs": [
        "agentlog"
]
```

c8y_SupportedOperations

The fragment `c8y_SupportedOperations` is used to identify which operations (and hence certifiable extended capabilities) are supported by the device. This fragment is optional. If not present, the extended capabilities will not be certified.

Fragment	Mandatory
`c8y_SupportedOperations`	Yes, for devices that receive operations

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_SupportedOperations": [
    "c8y_Software",
    "c8y_Firmware"
]
```

com_cumulocity_model_Agent

The fragment `com_cumulocity_model_Agent` is an empty fragment stored in the device managed object using the inventory API endpoints. It declares that the device is able to receive operations extended

capabilities). This fragment is optional. If not present, the extended capabilities will not be certified.

Fragment	Mandatory
`com_cumulocity_model_Agent`	Yes, for devices that receive operations

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"com_cumulocity_model_Agent": {}
```

Child Device Management

For details and examples, compare Child Operations Cumulocity IoT Documentation section of the documentation. The `type` of the root device is recommended to be `Gateway`.

Child Device Types

Cumulocity uses the concept of *child device types* to distinguish the capabilities of child devices *behind* a gateway device. For example, a child device connected via a simple analog wire connection (like a temperature sensor) may only be able to send measurements (the temperature), while a child device connected via OPC-UA is able to send measurements, events, alarms, and log files in addition to the ability to process incoming requests to upgrade its firmware. In this case, the child device type `Analog` is only supporting the minimum requirements for certification without any *extended capabilities*. The child device type `OPC-UA` is supporting the *foundation capabilities* as well at the Extended Capabilities `Logs` and `Firmware`.

Child device types can be freely named, however, here are some examples as orientation:.

Fragment	Content	Required for extended capability
`c8y_SupportedChildDeviceTypes`	List contains supported child device types	Yes

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_SupportedChildDeviceTypes": [
    "Analog",
    "Canbus",
    "CanOpen",
    "Modbus",
    "OPCUA",
    "Profibus",
    "Sigfox",
    "SNMP"
]
```

Log File Retrieval

Device capability to upload (filtered) log files to C8Y. For details and examples, compare chapter `c8y_LogfileRequest` of section Miscellaneous Cumulocity IoT Documentation.

The following fragments are related to the extended device capability with a remark if they are required for the capability to work:

Fragment	Content	Required for extended capability
`com_cumulocity_model_Agent`	Must be present in the managed object accessible via the inventory API endpoints; Enables a device to receive operations	Yes
`c8y_SupportedOperations`	List contains element `c8y_LogfileRequest`	Yes
`c8y_SupportedLogs`	List of supported log file types; Must be present in the device managed object in the inventory;	Yes (at least 1 type)

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_SupportedOperations": [
    "c8y_LogfileRequest"
],
"c8y_SupportedLogs": [
    "syslog",
    "dmesg"
]
```

Example operation `c8y_LogfileRequest` as it is sent to the device:

```
"c8y_LogfileRequest": {
    "logFile": "syslog",
    "dateFrom": "2016-01-27T13:45:24+0100",
    "dateTo": "2016-01-28T13:45:24+0100",
    "searchText": "sms",
    "maximumLines": 1000
}
```

When the device receives the operation `c8y_LogfileRequest`, the following steps are executed:

Step	Action	Documentation
0.	Listen for operation created by platform with `"status" : "PENDING"`	Real-Time Notifications Cumulocity IoT Documentation

Step	Action	Documentation
1.	Update operation `"status" : "EXECUTING"` on the platform	Update Operation Cumulocity IoT Documentation
2.	Internally retrieve log file and filter w.r.t. criteria found in operation	
3.	Create an event with `"type": "c8y_LogfileRequest"`	Create Event Cumulocity IoT Documentation
4.	Upload the log file as attachment to the event	Attach File To Event Cumulocity IoT Documentation
5.	Update operation accordingly by adding the URL of the log file `"status": "SUCCESSFUL", "c8y_LogfileRequest": {"file": "https://<TENANT_DOMAIN>/event/events/{id}/binaries"}`	Update Operation Cumulocity IoT Documentation

Example operation after the URL was added by the device:

```
{
   "status": "SUCCESSFUL",
   "c8y_LogfileRequest": {
       "searchText": "kernel",
       "logFile": "syslog",
       "dateTo": "2021-09-22T11:40:27+0200",
       "dateFrom": "2021-09-21T11:40:27+0200",
       "maximumLines": 1000,
       "file": "https://demos.cumulocity.com/event/events/157700/binaries"
   }
}
```

NOTE: On REST the entire fragment `c8y_LogfileRequest` in the operation must be repeated because top level fragments can only be replaced completely. In-place editing of fragments isn't possible with Cumulocity IoT REST API.

Device Configuration

Device capability that enables text- and / or profile-based device configuration. They are similar concepts that allow the device to upload its configuration to the platform and users can install a new configuration on the device. The UI will automatically be available to use the implemented capability.

For a successful certification of the Device Configuration capability, either Text Based Configuration or File Based Configuration or both have to be implemented. The certificate will state which configuration methods is supported as information.

Text Based Configuration

Text based configuration is the more basic approach. It provides a plain text box in the UI to retrieve, edit, and send a configuration text to the device. The text is sent as one string using UTF-8 characters, however, it can be structured using JSON, xml, key-value pairs, SmartRest Data Format Cumulocity IoT Documentation, or any other markup that the device is able to parse. The current configuration state of the device is communicated with the `c8y_Configuration` fragment in the device's own managed object in the inventory. It contains the complete configuration including all control characters as a string. It is recommended to use text based configuration for small configurations that are human readable.

The following fragments are related to the extended device capability with a remark if they are required for the capability to work:

Fragment	Content	Required for extended capability
`com_cumulocity_model_Agent`	Must be present in the managed object using the inventory API endpoints; Enables a device to receive operations	Yes
`c8y_Configuration`	List of the current `config` of the device in the managed object accessible via the inventory API endpoints	Yes
`c8y_SupportedOperations`	List contains element `c8y_Configuration`	Yes
`c8y_SupportedOperations`	List contains element `c8y_SendConfiguration`	No

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_SupportedOperations": [
    "c8y_Configuration",
    "c8y_SendConfiguration"
],
"c8y_Configuration": {
        "config": "myParam: myValue\nmyOtherParam: myOtherValue"
},
```

Example operation `c8y_Configuration: {}` as it is sent to the device:

```
    "creationTime": "2021-09-20T13:10:25.933Z",
    "deviceId": "181119",
    "self": "https://t635974191.eu-
latest.cumulocity.com/devicecontrol/operations/440452",
    "id": "440452",
    "status": "PENDING",
    "c8y_Configuration": {
        "config": "myParam: myValue\nmyOtherParam: myOtherValue"
    },
    "description": "Configuration update"
```

When the device receives the operation `c8y_Configuration`, the following steps are executed:

Step	Action	Documentation
0.	Listen for operation created by platform with `"status" : "PENDING"`	Real-Time Notifications Cumulocity IoT Documentation
1.	Update operation `"status" : "EXECUTING"` on the platform	Update Operation Cumulocity IoT Documentation
2.	Internally interpret transmitted string and execute configuration	
3.	Update the fragment `c8y_Configuration` of the managed object in the inventory API so it represents the current configuration of the device	
4.	Update operation accordingly `"status": "SUCCESSFUL"`	Update Operation Cumulocity IoT Documentation

It is also recommended to upload the device configuration after every change. If the volume of data transfer from the device is limited, the configuration can be uploaded on demand. The configuration upload can be triggered from the UI, if the connector supports the operation `c8y_SendConfiguration`. NOTE: On REST the entire fragment `c8y_Configuration` in the managed object accessible via the inventory API must be repeated, because top level fragments can only be replaced completely. In-place editing of fragments isn't possible with Cumulocity IoT REST API.

NOTE: If the configuration upload is only triggered through the UI and there is no automated upload, please consider the case, that of a user forgets to trigger the upload mechanism before sending a new configuration to the device.

Example operation `c8y_SendConfiguration: {}` as it is sent to the device from Cumulocity IoT:

```
creationTime: "2021-09-20T13:53:29.419Z", deviceName: "123456789", deviceId:
"440366",…
c8y_SendConfiguration: {}
creationTime: "2021-09-20T13:53:29.419Z"
description: "Requested current configuration"
deviceId: "440366"
deviceName: "123456789"
id: "440472"
self: "https://t635974191.eu-
latest.cumulocity.com/devicecontrol/operations/440472"
status: "PENDING"
```

When the device receives the operation `c8y_SendConfiguration`, the following steps are executed:

Step	Action	Documentation
0.	Listen for operation created by platform with `"status" : "PENDING"`	Real-Time Notifications Cumulocity IoT Documentation
1.	Update operation `"status" : "EXECUTING"` on the platform	Update Operation Cumulocity IoT Documentation
2.	Internally get current configuration and update the fragment `c8y_Configuration` of the device managed object using the inventory API	Update Managed Object Cumulocity IoT Documentation
3.	Update operation accordingly `"status": "SUCCESSFUL"`	Update Operation Cumulocity IoT Documentation

File Based Configuration

File based configuration allows to have multiple *types* of configurations (e.g. one file for defining polling intervals and another to configure the internal log-levels).
For details and examples, compare configuration Management Cumulocity IoT Documentation section in the documentation. The following fragments are related to the Extended Capability with a remark if they are required for the capability to work:

Fragment	Content	Required for extended capability
`com_cumulocity_model_Agent`	Must be present in the managed object accessible via the inventory API endpoints; Enables a device to receive operations	Yes
`c8y_SupportedOperations`	List contains element `c8y_DownloadConfigFile`	Yes
`c8y_SupportedOperations`	List contains element `c8y_UploadConfigFile`	Yes
`c8y_SupportedConfigurations`	List of supported configuration file types	Yes (at least 1 type)

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_SupportedOperations": [
    "c8y_DownloadConfigFile",
    "c8y_UploadConfigFile"
    ],
"c8y_SupportedConfigurations":[
    "config1",
    "config2"
    ]
```

When the device receives the operation `c8y_DownloadConfigFile`, the following steps are executed:

Step	Action	Documentation
0.	Listen for operation created by platform with `"status" : "PENDING"`	Real-time Notifications Cumulocity IoT Documentation
1.	Update operation `"status" : "EXECUTING"` on the platform	Update Operation Cumulocity IoT Documentation
2.	Download referenced binary and internally apply configuration	
3.	Update operation `"status": "SUCCESSFUL"`	Update Operation Cumulocity IoT Documentation

Example operation sent to the device for `c8y_DownloadConfigFile`:

```
"c8y_DownloadConfigFile": {
    "url": "<download url>"
}
```

When the device receives the operation `c8y_UploadConfigFile`, the following steps are executed:

Step	Action	Documentation
0.	Listen for operation created by platform with `"status" : "PENDING"`	Real-Time Notifications Cumulocity IoT Documentation
1.	Update operation `"status" : "EXECUTING"` on the platform	Update Operation Cumulocity IoT Documentation
2.	Internally retrieve the configuration type requested in operation e.g. `"c8y_UploadConfigFile": {"type": "someConfig"}`	
3.	Create an event with the same `type` e.g. `"type": "someConfig"`	Create Event Cumulocity IoT Documentation
4.	Upload the configuration as attachment to the event	Attach File to Event Cumulocity IoT Documentation
5.	Update operation accordingly `"status": "SUCCESSFUL"`	Update Operation Cumulocity IoT Documentation

Example operation sent to the device for `c8y_UploadConfigFile`:

```
    "creationTime": "2021-12-22T16:29:31.791Z",
    "deviceId": "5081547",
    "deviceName": "config test",
    "self": "https://t635974191.eu-
latest.cumulocity.com/devicecontrol/operations/6670102",
    "id": "6670102",
    "status": "PENDING",
    "description": "Retrieve configuration snapshot from device config test",
    "c8y_UploadConfigFile": {}
```

Software Management

Device capability to manage and deploy software packages to the device. For details and examples, compare c8y_SoftwareList Cumulocity IoT Documentation section in the documentation .

Note: *Firmware Management* and *Software Management* are handled separately in Cumulocity IoT and follow different concepts. A device can support one ore both capabilities.

Firmware

- The firmware is the base operating system of a device
- A device can only have 1 firmware installed at a time
- When the firmware is changed, the device usually flashes itself
- Usually used by small / embedded devices

Software

- Software is an extended component executed on the device
- A device can have multiple software installed at a time
- Software can be installed or removed independently of other software and the firmware
- Usually used by larger / more powerfully devices

Info: `"c8y_SupportedOperations": ["c8y_SoftwareList"]` (not to be confused with the *inventory fragment* `c8y_SoftwareList`) and `"c8y_SupportedOperations": ["c8y_Software"]` are deprecated and should not be used for new agent implementations.

The following fragments are related to the extended device capability with a remark if they are required for the capability to work:

Fragment	Content	Required for extended capability
`com_cumulocity_model_Agent`	Must be present in the inventory; Enables a device to receive operations	Yes
`c8y_SupportedOperations`	List contains element `c8y_SoftwareUpdate`	Yes

Fragment	Content	Required for extended capability
`c8y_SoftwareList`	List of currently installed software on the device in the managed object accessible via the inventory API endpoints	Yes

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_SupportedOperations": [
    "c8y_SoftwareUpdate"
],
"c8y_SoftwareList": [
    {
        "name": "Software A",
        "version": "1.0.1",
        "url": "www.some-external-url.com"
    },
    {
        "name": "Software B",
        "version": "2.1.0",
        "url": "mytenant.cumulocity.com/inventory/binaries/12345"
    }
]
```

Example operation sent to the device:

```
"c8y_SoftwareUpdate": [
    {
        "name": "mySoftware1",
        "version": "1.0.0",
        "url": "http://www.example.com",
        "action": "install"
    },
    {
        "name": "mySoftware2",
        "version": "1.1.0",
        "url": "http://www.example.com",
        "action": "update"
    },
        {
        "name": "mySoftware2",
        "version": "1.1.0",
        "url": "http://www.example.com",
        "action": "uninstall"
    }
]
```

When the device receives the operation `c8y_SoftwareUpdate`, the following steps are executed:

Step	Action	Documentation
0.	Listen for operation created by platform with `"status" : "PENDING"`	Real-Time Notifications Cumulocity IoT Documentation
1.	Update operation `"status" : "EXECUTING"` on the platform	Update Operation Cumulocity IoT Documentation
2.	Execute the given `"action"` (install, update, uninstall) specified by the operation `c8y_SoftwareUpdate`	
3.	Update `c8y_SoftwareList` fragment in the inventory object of the device	Update Managed Object Cumulocity IoT Documentation
4.	Update operation accordingly `"status": "SUCCESSFUL"`	Update Operation Cumulocity IoT Documentation

Firmware Management

Device capability that enables firmware management. For details and examples, compare Device Information Cumulocity IoT Documentation.

Note: *Firmware Management* and *Software Management* are handled separately in Cumulocity IoT and follow different concepts. A device can support one ore both capabilities.

Firmware

- The firmware is the base operating system of a device
- A device can only have 1 firmware installed at a time
- When the firmware is changed, the device usually flashes itself
- Usually used by small / embedded devices

Software

- Software is an extended component executed on the device
- A device can have multiple software installed at a time
- Software can be installed or removed independently of other software and the firmware
- Usually used by larger / more powerfully devices

The following fragments are related to the extended device capability with a remark if they are required for the capability to work:

Fragment	Content	Required for extended capability
`com_cumulocity_model_Agent`	Must be present in the managed object accessible via the inventory API endpoints; Enables a device to receive operations	Yes

Fragment	Content	Required for extended capability
`c8y_SupportedOperations`	List contains element `c8y_Firmware`	Yes

Firmware tab will be visible on the device page only if `c8y_Firmware` is listed in the device's supported operations.

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_SupportedOperations": [
    "c8y_Firmware"
]

"c8y_Firmware": {
    "name": "raspberrypi-bootloader",
    "version": "1.20140107-1",
    "url": "31aab9856861b1a587e2094690c2f6e272712cb1"
}
```

Example operation sent to the device:

```
"c8y_Firmware": {
    "name": "firmware_a",
    "version": "2.0.24.3",
    "dependency": "2.0.23.0",
    "url": " ",
    "isPatch": true
}
```

When the device receives the operation having `c8y_Firmware`, the following steps are executed:

Step	Action	Documentation
0.	Listen for operation created by platform with `"status" : "PENDING"`	Real-Time Notifications Cumulocity IoT Documentation
1.	Update operation `"status" : "EXECUTING"` on the platform	Update Operation Cumulocity IoT Documentation

Step	Action	Documentation
2.	Compare name and version stored in the fragment `c8y_Firmware` in the inventory object of the device with the name and version stored in the received operation fragment `c8y_Firmware`. If the name and/or version are differing download from the (device specific) firmware repository referenced in the URL and install.	Device Information Cumulocity IoT Documentation
3.	Update the fragment `c8y_Firmware` of the inventory object of the device.	
4.	Update operation accordingly `"status": "SUCCESSFUL"`	Update Operation Cumulocity IoT Documentation

Device Profile

Device capability to manage device profiles. Device profiles represent a combination of a firmware version, one or multiple software packages and one or multiple configuration files which can be deployed on a device. Based on device profiles, users can deploy a specific target configuration on devices by using bulk operations. For details and examples, compare Managing device data Cumulocity IoT Documentation.

The following fragments are related to the extended device capability with a remark if they are required for the capability to work:

Fragment	Content	Required for extended capability
`com_cumulocity_model_Agent`	Must be present in the managed object accessible via the inventory API endpoints; Enables a device to receive operations	Yes
`c8y_SupportedOperations`	List contains element `c8y_DeviceProfile`	Yes
`c8y_Profile`	List contains element `profileName`, `profileId`, and `profileExecuted`	Yes

Device profile tab will be visible on the device page only if `c8y_DeviceProfile` is listed in the device's supported operations.

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_SupportedOperations": [
    "c8y_DeviceProfile"
]
"c8y_Profile": {
    "profileName": "Device_Profile",
    "profileId": "60238",
    "profileExecuted": true
}
```

Example operation sent to the device:

```
"c8y_DeviceProfile": {
    "software": [
        {
            "name": "asd",
            "action": "install",
            "version": "1.0",
            "url": "aURL"
        }
    ],
    "configuration": [],
    "firmware": {
        "name": "aName",
        "version": "aVersion",
        "url": "aURL"
    },
    "description": "Assign device profile Device_Profile to device Device_Name",
    "deviceId": "437604",
    "profileId": "60238",
    "profileName": "Device_Profile"
}
```

When the device receives operation `c8y_DeviceProfile` it will execute the following steps:

Step	Action	Documentation
0.	Listen for operation created by platform with `"status" : "PENDING"`	Real-Time Notifications Cumulocity IoT Documentation
1.	Update operation `"status" : "EXECUTING"` on the platform	Update Operation Cumulocity IoT Documentation
2.	Use the information stored in the operation `c8y_DeviceProfile` regarding software, firmware and configuration to execute changes as described in respective sections.	
3.	Update the fragment `c8y_Profile` of the inventory object of the device by adding the nested fragments `"profileName”:"Device_Profile"`, `"profileId": "60238"` and `"profileExecuted": true/false`.	
3.	Update operation accordingly `"status": "SUCCESSFUL"`	Update Operation Cumulocity IoT Documentation

Restart

Device capability to restart the device. For details and examples, compare Miscellaneous Cumulocity IoT Documentation section of the documentation.

The following fragments are related to the extended device capability with a remark if they are required for the capability to work:

Fragment	Content	Required for extended capability
`com_cumulocity_model_Agent`	Must be present in the managed object accessible via the inventory API endpoints; Enables a device to receive operations	Yes
`c8y_SupportedOperations`	List contains element `c8y_Restart`	Yes

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_SupportedOperations": [
    "c8y_Restart"
]
```

When the device receives the operation `c8y_Restart` the following steps are executed:

Step	Action	Documentation
0.	Listen for operations created by platform with `"status" : "PENDING"`	Real-time notifications
1.	Update operation `c8y_Restart` to `"status" : "EXECUTING"`	Update operation
2.	Restart the device	
3.	Query all operations in `"status" : "EXECUTING"` to continue processing them	Real-time notifications
4.	Query operations by agent ID and `"status" : "EXECUTING"` to clean up them. This includes the update of `c8y_Restart` to `"status" : "SUCCESSFUL"`	Device Integration, Update operation
5.	Listen to new operations created in Cumulocity IoT	Real-time notifications

Measurement Request

Device capability to send an updated set of measurements on user request. This can be usefully for devices, that send measurements infrequently.

The following fragments are related to the extended device capability with a remark if they are required for the capability to work:

Fragment	Content	Required for extended capability
`com_cumulocity_model_Agent`	Must be present in the managed object accessible via the inventory API endpoints; Enables a device to receive operations	Yes
`c8y_SupportedOperations`	List contains element `c8y_MeasurementRequestOperation`	Yes

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_SupportedOperations": [
    "c8y_MeasurementRequestOperation"
]
```

When the device receives the operation `c8y_MeasurementRequestOperation: {"requestName": "LOG"}` the following steps are executed:

Note: For legacy reasons, the `c8y_MeasurementRequestOperation` operation contains the fragment `"requestName": "LOG"`. This is to be ignored by the device. The device vendor can decide if all or a useful subset of measurements are send as response to this operation.

Step	Action	Documentation
0.	Listen for operation created by platform with `"status" : "PENDING"`	Real-Time Notifications Cumulocity IoT Documentation
1.	Update operation `"status" : "EXECUTING"` on the platform	Update operation
2.	Send all or a useful subset of measurements	Create Measurement Cumulocity IoT Documentation
3.	Update operation `"status": "SUCCESSFUL"`	Update Operation Cumulocity IoT Documentation

Shell

Device capability to send any command to the device. The feature is often used to send shell commands to the device and receive the output as result. For details and examples, compare Miscellaneous Cumulocity IoT Documentation section of the documentation.

The following fragments are related to the extended device capability with a remark if they are required for the capability to work:

Fragment	Content	Required for extended capability
`com_cumulocity_model_Agent`	Must be present in the managed object accessible via the inventory API endpoints; Enables a device to receive operations	Yes
`c8y_SupportedOperations`	List contains element `c8y_Command`	Yes

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_SupportedOperations": [
    "c8y_Command"
]
```

Example operation sent to the device for `c8y_Command`:

```
"c8y_Command": {
    "text": "get uboot.sn"
}
```

When the device receives the operation `c8y_Command`, the following steps are executed:

Step	Action	Documentation
0.	Listen for operation created by platform with `"status" : "PENDING"`	Real-Time Notifications Cumulocity IoT Documentation
1.	Update operation `"status" : "EXECUTING"` on the platform	Update Operation Cumulocity IoT Documentation
2.	Locally execute the command and	Miscellaneous/Shell Cumulocity IoT Documentation
3.	Update operation `"status": "SUCCESSFUL"` add the result to the operation in the fragment `result`	Update Operation Cumulocity IoT Documentation

Example operation after it has been executed and fragment `result` has been added to `c8y_Command`:

```
"c8y_Command": {
    "text": "get uboot.sn",
    "result": "123456"
}
```

NOTE: On REST the entire fragment must be repeated because top level fragments can only be replaced completely. In-place editing of fragments isn't possible with Cumulocity IoT REST API.

Cloud Remote Access

Device capability to initiate a remote connection via VNC or SSH. For details and examples, compare Cloud Remote Access Cumulocity IoT Documentation section of the documentation.

NOTE: Telnet is considered as unsecure and is therefore not certifiable.

The following fragments are related to the extended device capability with a remark if they are required for the capability to work:

Fragment	Content	Required for extended capability
`com_cumulocity_model_Agent`	Must be present in the managed object accessible via the inventory API endpoints; Enables a device to receive operations	Yes
`c8y_SupportedOperations`	List contains element `c8y_RemoteAccessConnect`	Yes
`c8y_RemoteAccessList`	List of supported remote access types	Yes (at least 1 type)

Example JSON structure of a managed object accessible through the inventory API endpoints: (NOTE: The fragment "c8y_RemoteAccessList" is created by the Cumulocity IoT UI and must not be created by the agent/connector)

```
"c8y_SupportedOperations": [
    "c8y_RemoteAccessConnect"
]
"c8y_RemoteAccessList": [
    {
        "Id": 3234,
        "name": "My Connection",
        "hostname": "10.0.0.67",
        "port": 5900,
        "protocol": "VNC",
        "credentials": {
            "username": "someUser",
            "password":  "{cipher
        }SwRUVOR0gKHmPUuKLulIIM3EMGvxFTg22had6b",
    "privateKey": null,
        "publicKey": null,
        "hostKey": null,
        "type": "PASS_ONLY"
    }
}
]
```

Example operation sent to the device for `c8y_RemoteAccessConnect`:

```
{
    "creationTime": "2022-01-25T10:54:40.037Z",
    "deviceId": "1184255",
    "deviceName": "dm-example-device-adjusted-8893a9f33a8c",
    "self": "https://t769416337.eu-
latest.cumulocity.com/devicecontrol/operations/3978710",
    "id": "3978710",
    "status": "PENDING",
    "description": "Opening remote access tunnel to 'RealSSH'",
    "c8y_RemoteAccessConnect": {
        "hostname": "127.0.0.1", // Endpoint on local network to connect to
                "port": 22, // Port to be used on local network endpoint
                "connectionKey": "5d49dd41-a843-4ee5-ae22-6a1e308fda65" // Shared
secret to authenticate the connection request from device side
            }
```

When the device receives the operation `c8y_RemoteAccessConnect`, the following steps are executed:

Step	Action	Documentation
0.	Listen for operation created by platform with `"status" : "PENDING"`	Real-time Notifications Cumulocity IoT Documentation
1.	Update operation `"status" : "EXECUTING"` on the platform	Update Operation Cumulocity IoT Documentation
2.	Connect to the device WebSocket endpoint of the remote access microservice `wss://<c8y host>/service/remoteaccess/device/<connectionKey>`	
3.	Establish local socket connection to the specified `hostname` and `port`	
4.	Start forwarding binary packets between the TCP connection and the WebSocket in both directions	
5.	Update operation `"status": "SUCCESSFUL"`	Update Operation Cumulocity IoT Documentation
6.	Whenever one of these connections is terminated the device considers the session as ended and will also terminate the second connection. Even if the connection was not terminated gracefully by any of the involved components, the operation status must stay in SUCCESSFUL	

Location & Tracking

Device capability to display and update location information. For details and examples, compare Location Capabilities Cumulocity IoT Documentation section of the documentation.

The following fragments are related to the extended device capability with a remark if they are required for the capability to work:

Fragment	Content	Required for extended capability
`c8y_Position`	Position information of the device	Yes
`c8y_Position.lat`	Latitude	Yes
`c8y_Position.lng`	Longitude	Yes
`c8y_Position.alt`	Altitude in meters	No
`c8y_Position.trackingProtocol`	Technology used for position acquisition (e.g. GPS, Galileo, TELIC)	No
`c8y_Position.reportReason`	Reason why the position update was send (e.g. triggered by schedule, action)	No

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
"c8y_Position": {
    "lat": 51.211977,
    "lng": 6.15173,
    "alt": 67
}
```

Whenever the location shall be updated, the device executes the following steps:

Step	Action	Documentation
1.	Send a an event of type "c8y_LocationUpdate" for the device that carries the new position in the fragment "c8y_Position"	Create event
2.	Update the c8y_Position fragment in device inventory	Update Managed Object Cumulocity IoT Documentation

Example location update event:

```
{
  "source": {
    "id": 4036, // device ID for which you want to update the position
```

```
    },
    "type": "c8y_LocationUpdate", // must be c8y_LocationUpdate
    "text": "Location updated", // field mandatory but content can be changed
    "time": "2021-09-07T14:04:27.845Z'",
    "c8y_Position": {
      "lat": 51.211977,
      "lng": 6.15173,
      "alt": 67,
    },
  }
```

Network

Under Construction - not to be followed yet

Device capability to either display or display and manage the WAN, Lan, and DHCP settings. Information is shown under tab 'Network' if the fragment 'c8y_Network' is present in the device managed object accessible via the inventory API endpoints. For details and examples, compare Network Cumulocity IoT Documentation section of the documentation.

The following fragments are related to the extended device capability with a remark if they are required for the capability to work:

Fragment / Property	Content	Required for extended capability
`com_cumulocity_model_Agent`	Enables a device to receive operations; Send to device managed object via inventory API;	Yes
`c8y_SupportedOperations`	List contains element `c8y_Network`; Send to device managed object via inventory API;	Yes
`c8y_Network`	List of the properties `c8y_WAN`, `c8y_LAN`, or `c8y_DHCP`; Send to device managed object via inventory API;	Yes

Display Network Settings

The device can displays any network setting, all properties are optional.

Fragment / Property	Content	Required for extended capability
`c8y_Network.c8y_WAN`	Lists the properties `password`, `simStatus`, `authType`, `apn`, `username`	No
`c8y_Network.c8y_WAN.password`	Password (String)	No
`c8y_Network.c8y_WAN.simStatus`	simStatus (String)	No

Fragment / Property	Content	Required for extended capability
`c8y_Network.c8y_WAN.authType`	authType (String)	No
`c8y_Network.c8y_WAN.apn`	APN (String)	No
`c8y_Network.c8y_WAN.username`	username (String)	No
`c8y_Network.c8y_LAN`	Lists the properties `netmask`, `ip`, `name`, `enabled`, `mac`	Yes, if c8y_Wan and c8y_DHCP are not present
`c8y_Network.c8y_DHCP`	Lists the properties `dns2`, `dns1`, `domainName`, `addressRange.start`, `addressRange.end`, `enabled`,	Yes, if c8y_Wan and c8y_Lan are not present

Example JSON structure of a managed object accessible through the inventory API endpoints:

```
{
"c8y_SupportedOperations": [
    "c8y_Network"
],

"c8y_Network": {
       "c8y_LAN": {
           "netmask": "255.255.255.0",
           "ip": "192.168.128.1",
           "name": "br0",
           "enabled": 1,
           "mac": "00:60:64:dd:a5:c3"
       },
       "c8y_WAN": {
           "password": "user-password",
           "simStatus": "SIM OK",
           "authType": "chap",
           "apn": "example.apn.com",
           "username": "test"
       },
       "c8y_DHCP": {
           "dns2": "1.1.1.1",
           "dns1": "8.8.8.8",
           "domainName": "my.domain",
           "addressRange": {
               "start": "192.168.128.100",
               "end": "192.168.128.199"
           },
           "enabled": 1
       }
   }
```

```
}
```

Example operation `c8y_Network` to update the LAN information as it is sent from Cumulocity IoT to the device:

```
"c8y_Network": {
       "c8y_LAN": {
           "netmask": "255.255.255.0",
           "ip": "192.168.128.1",
           "enabled": 1
       }
   }
```

Example operation `c8y_Network` to update the DHCP information as it is sent from Cumulocity IoT to the device:

```
"c8y_Network": {
       "c8y_DHCP": {
           "dns2": "1.1.1.1",
           "dns1": "8.8.8.8",
           "domainName": "my.domain",
           "addressRange": {
               "start": "192.168.128.100",
               "end": "192.168.128.199"
           },
           "enabled": 1
       }
   }
```

Example operation `c8y_Network` to update the WAN information as it is sent from Cumulocity IoT to the device:

```
"c8y_Network": {
       "c8y_WAN": {
           "password": "user-password",
           "authType": "chap",
           "apn": "example.apn.com",
           "username": "ee"
       },
   }
```

When the device receives the operation `c8y_Network`, the following steps are executed:

Step	Action	Documentation
0.	Listen for operation created by platform with `"status" : "PENDING"`	Real-Time Notifications
1.	Update operation `"status" : "EXECUTING"` on the platform	Update Operation Cumulocity IoT Documentation
2.	Apply WAN, LAN, or DHCP configuration	
3.	Set new network configuration status the inventory managed object accessible via the inventory API endpoints	
4.	Update operation `"status": "SUCCESSFUL"`	Update Operation Cumulocity IoT Documentation

NOTE: On REST the entire fragment `c8y_Network` in the managed object accessible via the inventory API must be repeated, because top level fragments can only be replaced completely. In-place editing of fragments isn't possible with Cumulocity IoT REST API.

Currently Testable Device Capabilities of Self-Service Certification Microservice

- [x] Foundation Capabilities
  - [x] c8y_Agent
  - [x] Device Information
    - [x] c8y_IsDevice
    - [x] name
    - [x] type
    - [x] c8y_Hardware
    - [x] c8y_Firmware
    - [x] c8y_RequiredAvailability
    - [x] c8y_SupportedOperations
  - [x] External ID
  - [x] Sending Operational Data
    - [x] Measurements
    - [x] Events
    - [x] Alarms
- [ ] Extended Capabilities
  - [x] Child Device Management
    - [x] Child Device Types
  - [x] Logfile Retrieval
  - [x] Device Configuration
    - [x] Text Based Configuration
    - [x] File Based Configuration

- [x] Managing Device Software
- [x] Managing Device Firmware
- [x] Device Profile
- [x] Restart
- [ ] Measurement Request
- [x] Shell
- [ ] Cloud Remote Access
- [x] Location & Tracking
- [ ] Mobile
- [x] Network

##MD file change Log

Date	Chapter	Severity
30/09/2021	Added MD file change log	minor
22/10/2021	Added cypher suites information	medium
01/11/2021	shell: Example added, measurements section: Naming convention added; sending operational data: table added with mandatory information; Device Information: com_cumulocity_model_agent mandatory rule changed and externalIds added	medium
03/11/2021	`com_cumulocity_model_agent` added as mandatory for each extended agent capability that relies on receiving operations; Moved supported child device types to extended capabilities;	major
08/11/2021	Updated broken links	minor
09/11/2021	Updated broken links, added Currently Supported Device Capabilities of Self-Service Certification Microservice	minor
10/11/2021	Added some common measurement names for reference	minor
15/11/2021	Changed structure	medium
22/11/2021	Examples of managed objects using the inventory API made clearer; "Optional modules" renamed to "Extended Capabilities", Overview table of all "Extended Capabilities" created.	medium
29/11/2021	Added a product definition	minor
01/11/2021	Inserted more precise formulation for info stored on the managed object using inventory API; Updated Currently Testable Device Capabilities	minor
01/11/2021	Text Based Configuration: The mandatory flag of the Supported Operation "c8y_SendConfiguration" was changed from "Yes" to "No"	major
03/11/2021	Text Based Configuration: Inserted step 3 - update "c8y_Configuration" in inventory to reflect current device configuration	major
14/01/2021	Many small adjustments; Updated currently testable capabilities	medium

Date	Chapter	Severity
07/02/2021	Improved inaccurate wordings around managed objects and Cumulocity API	minor