OGC SensorThings API

Part 2 – Tasking Core

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i. Abstract
The OGC SensorThings API provides an open, geospatial-enabled and unified way to interconnect the Internet of Things (IoT) devices, data, and applications over the Web. At a high level the OGC SensorThings API provides two main functionalities and each function is handled by a part. The two parts are the Sensing part and the Tasking part. The Sensing part provides a standard way to manage and retrieve observations and metadata from heterogeneous IoT sensor systems. The Tasking part provides a standard way for parameterizing - also called tasking - of task-able IoT devices, such as sensors, actuators, drones or even satellites. This document is the core of the SensorThings API part 2 – Tasking.

ii. Keywords
The following are keywords to be used by search engines and document catalogues.

ogcdoc, OGC document, ogdocr, ogc documents, iot, internet of things, sensor things, sensors, swe, sensor webs, sensor web enablement, sensor networks

iii. Preface
The OGC SensorThings API provides an open, geospatial-enabled and unified way to interconnect the Internet of Things devices, data, and applications over the Web. The OGC SensorThings API is an open standard, and that means it is non-proprietary, platform-independent, and perpetual royalty-free. Although it is a new standard, it builds on a rich set of proven-working and widely-adopted open standards, such as the Web protocols and the OGC Sensor Web Enablement (SWE) standards, including the ISO/OGC Observation and Measurement data model [OGC 10-004r3 and ISO 19156:2011]. That also means the OGC SensorThings API is extensible and can be applied to not only simple but also complex use cases.

At a high level the OGC SensorThings API provides two main functionalities and each function is handled by a part. The two parts are the Part I - Sensing and the Part II - Tasking. The Sensing part provides a standard way to manage and retrieve observations and metadata from heterogeneous IoT sensor systems. The Tasking part provides a standard way for parameterizing - also called tasking - of task-able IoT devices, such as sensors or actuators.

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iv. Submitting organizations
The following organizations submitted this Document to the Open Geospatial Consortium (OGC):

a. University of Calgary, Canada
b. SensorUp Inc., Canada
c. CGI Federal, Canada
d. Fraunhofer, Germany
e. Compusult, Canada
f. GeoConnections, Canada
v. **Submitters**

All questions regarding this submission should be directed to the editor or the submitters:

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steve Liang</td>
<td>University of Calgary, Canada / SensorUp Inc.</td>
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<td>University of Calgary, Canada / SensorUp Inc.</td>
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<td>CGI Federal</td>
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<td>Hylke van der Schaaf</td>
<td>Fraunhofer</td>
</tr>
<tr>
<td>Chris Clark</td>
<td>Compusult</td>
</tr>
<tr>
<td>Marcus Alzona</td>
<td>Noblis</td>
</tr>
</tbody>
</table>
1 Scope

The OGC SensorThings API provides an open standard-based and geospatial-enabled framework to interconnect the Internet of Things devices, data, and applications over the Web. The Tasking part provides a standard way for parameterizing - also called tasking - of task-able IoT devices, such as sensors, actuators, drones or even satellites. This document is the core of the SensorThings API part 2 – Tasking Core.

2 Conformance

Conformance with this standard shall be checked using all the relevant tests specified in Annex A (normative) of this document. The framework, concepts, and methodology for testing, and the criteria to be achieved to claim conformance are specified in the OGC Compliance Testing Policies and Procedures and the OGC Compliance Testing web site1.

All requirements-classes and conformance-classes described in this document are owned by the standard(s) identified.

The following table list the requirements classes defined by this standard.

<table>
<thead>
<tr>
<th>Requirements class id</th>
<th>Requirements</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>req/tasking-capability</td>
<td>• req/tasking-capability/properties</td>
<td>TakingCapability entity</td>
</tr>
<tr>
<td></td>
<td>• req/tasking-capability/relations</td>
<td></td>
</tr>
<tr>
<td>req/task</td>
<td>• req/task/properties</td>
<td>Task entity</td>
</tr>
<tr>
<td></td>
<td>• req/task/relations</td>
<td></td>
</tr>
<tr>
<td>req/actuator</td>
<td>• req/actuator/properties</td>
<td>Actuator entity</td>
</tr>
<tr>
<td></td>
<td>• req/actuator/relations</td>
<td></td>
</tr>
<tr>
<td>req/create-tasks</td>
<td>• req/create-tasks/task-creation</td>
<td>creating Task entity</td>
</tr>
<tr>
<td>req/create-tasks-via-mqtt</td>
<td>• req/create-tasks-via-mqtt/task-creation</td>
<td>creating Tasks through MQTT</td>
</tr>
<tr>
<td>req/receive-updates-via-mqtt</td>
<td>• req/receive-updates-via-mqtt/receive-updated</td>
<td>Receiving Tasks updates through MQTT</td>
</tr>
</tbody>
</table>

1 www.opengeospatial.org/cite
3 References

The following normative documents contain provisions that, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

<table>
<thead>
<tr>
<th>Document</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>OGC® SWE Common Data Model,</td>
<td><a href="http://www.opengis.net/doc/IS/SWE/2.0">http://www.opengis.net/doc/IS/SWE/2.0</a></td>
</tr>
</tbody>
</table>

4 Terms and Definitions

This document uses the terms defined in Sub-clause 5.3 of [OGC 06-121r8], which is based on the ISO/IEC Directives, Part 2, Rules for the structure and drafting of International Standards. In particular, the word “shall” (not “must”) is the verb form used to indicate a requirement to be strictly followed to conform to this standard.

For the purposes of this document, the following additional terms and definitions apply.

Collection

Sets of Resources, which can be retrieved in whole or in part. [RFC5023]

Entity

Entities are instances of entity types. [OASIS OData Version 4.0 Part 1: Protocol Plus Errata 02]

Note: Thing, Actuator, Task are some example entity types of the OGC SensorThings API.

Entity sets

Entity sets are named collections of entities (e.g. Tasks is an entity set containing Task entities). An entity's key uniquely identifies the entity within an entity set. Entity sets provide entry points into an OGC SensorThings API service. [OASIS OData Version 4.0 Part 1: Protocol Plus Errata 02]

(I)nternet of (Th)ing

A thing is an object of the physical world (physical things) or the information world (virtual things) that is capable of being identified and integrated into communication networks. [ITU-T Y.2060]

Measurement

A set of operations having the object of determining the value of a quantity [OGC 10-004r3 / ISO 19156:2011]

Observation
Act of measuring or otherwise determining the value of a property [OGC 10-004r3 / ISO 19156:2011]

**Observation Result**

Estimate of the value of a property determined through a known observation procedure [OGC 10-004r3 / ISO 19156:2011]

**Resource**

A network-accessible data object or service identified by an URI, as defined in [RFC 2616]

**REST**

The Representational State Transfer (REST) style is an abstraction of the architectural elements within a distributed hypermedia system. REST focuses on the roles of components, the constraints upon their interaction with other components, and their interpretation of significant data elements. It encompasses the fundamental constraints upon components, connectors, and data that define the basis of the Web architecture, and thus the essence of its behavior as a network-based application. An API that conforms to the REST architectural principles/constraints is called a RESTful API.

**Sensor**

An entity capable of observing a phenomenon and returning an observed value. Type of observation procedure that provides the estimated value of an observed property at its output. [OGC 12-000]

**Actuator**

A type of transducer that converts a signal to some real-world action or phenomenon. [OGC 12-000]

5 Conventions

This section provides details and examples for any conventions used in the document. Examples of conventions are symbols, abbreviations, use of XML schema, or special notes regarding how to read the document.

5.1 Identifiers

The normative provisions in this specification are denoted by the URI

http://www.opengis.net/spec/iot_tasking/1.0/

All requirements and conformance tests that appear in this document are denoted by partial URIs which are relative to this base.

6 Symbols (and abbreviated terms)

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>CS-W</td>
<td>Catalog Service Web</td>
</tr>
<tr>
<td>CRUD</td>
<td>Create, Read, Update, and Delete</td>
</tr>
</tbody>
</table>
7 The SensorThings API Tasking Entities

7.1 The Tasking Entities
The SensorThings API Tasking part’s Entities are depicted in Figure 1.
In this section, we explain the properties in each entity type and the direct relation to the other entity types. In addition, for each entity type, we show an example of the associated JSON encoding.

### 7.1.1 TaskingCapability

<table>
<thead>
<tr>
<th>Requirements Class</th>
<th><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/tasking-capability">http://www.opengis.net/spec/iot_tasking/1.0/req/tasking-capability</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Target type</td>
<td>Web Service</td>
</tr>
<tr>
<td>Dependency</td>
<td><a href="http://www.opengis.net/spec/iot_sensing/1.0/req/entity-control-information">http://www.opengis.net/spec/iot_sensing/1.0/req/entity-control-information</a></td>
</tr>
<tr>
<td>Dependency</td>
<td><a href="http://www.opengis.net/doc/BP/SWE-JSWE/JSON/1.0/req">http://www.opengis.net/doc/BP/SWE-JSWE/JSON/1.0/req</a></td>
</tr>
<tr>
<td>Dependency</td>
<td><a href="http://www.opengis.net/doc/IS/SWE/2.0">http://www.opengis.net/doc/IS/SWE/2.0</a></td>
</tr>
<tr>
<td>Requirement</td>
<td><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/tasking-capability/properties">http://www.opengis.net/spec/iot_tasking/1.0/req/tasking-capability/properties</a></td>
</tr>
</tbody>
</table>

Each TaskingCapability entity SHALL have the mandatory properties and MAY have the optional properties listed in Table 1.

| Requirement        | http://www.opengis.net/spec/iot_tasking/1.0/req/tasking-capability/relations |

Each TaskingCapability entity SHALL have the direct relation between a TaskingCapability entity and other entity types listed in Table 2.

#### Table 1 Properties of a TaskingCapability

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity and use</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>A property provides a label for the entity, commonly a descriptive name.</td>
<td>CharacterString</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>description</td>
<td>This is a short description of the corresponding entity.</td>
<td>CharacterString</td>
<td>One (mandatory)</td>
</tr>
</tbody>
</table>
The `taskingParameters` property describes optional and mandatory tasking parameters. Clients use the definition to provide corresponding tasking parameter values. To ensure common understanding between client and server, a common exchange protocol is used to express both descriptions and tasking parameter values.

SensorThings uses the JSON encoding defined in OGC 17-011 to define `taskingParameters`.

<table>
<thead>
<tr>
<th>properties</th>
<th>A JSON Object containing user-annotated properties as key-value pairs.</th>
<th>JSON Object</th>
<th>Zero-to-one</th>
</tr>
</thead>
</table>

### Table 2 Direct relation between a TaskCapability and other entity types

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Relation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task</td>
<td>One mandatory to many optional</td>
<td>A TaskingCapability has zero-to-many Tasks. A Task has one-and-only-one TaskingCapability.</td>
</tr>
<tr>
<td>Thing</td>
<td>Many optional to one mandatory</td>
<td>A TaskingCapability has one-and-only-one Thing. A Thing has zero-to-many TaskingCapabilities.</td>
</tr>
<tr>
<td>Actuator</td>
<td>Many optional to one mandatory</td>
<td>A TaskingCapability has one-and-only-one Actuator. An Actuator has zero-to-many TaskingCapabilities.</td>
</tr>
</tbody>
</table>

### Example 1 an example of a TaskCapability entity

```json
{
    "@iot.id": 1,
    "@iot.selfLink": "http://example.org/v1.0/TaskingCapabilities(1)",
    "Thing@iot.navigationLink": "TaskingCapabilities(1)/Thing",
    "Actuator@iot.navigationLink": "TaskingCapabilities(1)/Actuator",
    "Tasks@iot.navigationLink": "TaskingCapabilities(1)/Tasks",
    "name": "Control Light",
    "description": "Turn the light on and off, as well as specifying light color.",
    "taskingParameters": {
        "type": "DataRecord",
        "field": [
            {
                "name": "On/Off",
                "description": "Specifies to turn the light On or Off",
                "type": "Category",
                "AllowedTokens": {
                    "value": [
                        "on",
                        "off"
                    ]
                }
            },
            {
                "name": "Color",
                "description": "Specifies the light color in RGB HEX format. Example: #FF11A0",
                "type": "Text",
                "AllowedTokens": {
                    "pattern": "^[A-Fa-f0-9]{6}|[A-Fa-f0-9]{3}$"
                }
            }
        ]
    }
}
```
7.1.2 Task

Requirements Class
http://www.opengis.net/spec/iot_tasking/1.0/req/task

<table>
<thead>
<tr>
<th>Target type</th>
<th>Web Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependency</td>
<td><a href="http://www.opengis.net/spec/iot_sensing/1.0/req/entity-control-information/common-control-information">http://www.opengis.net/spec/iot_sensing/1.0/req/entity-control-information/common-control-information</a></td>
</tr>
<tr>
<td>Dependency</td>
<td><a href="http://www.opengis.net/doc/IS/SWE/2.0">http://www.opengis.net/doc/IS/SWE/2.0</a></td>
</tr>
<tr>
<td>Requirement</td>
<td><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/task/properties">http://www.opengis.net/spec/iot_tasking/1.0/req/task/properties</a></td>
</tr>
</tbody>
</table>

Each Task entity SHALL have the mandatory properties and MAY have the optional properties listed in Table 3.

| Requirement | http://www.opengis.net/spec/iot_tasking/1.0/req/task/relations |

Each Task entity SHALL have the direct relation between a Task entity and other entity types listed in Table 4.

### Table 3 Properties of a Task

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity and use</th>
</tr>
</thead>
<tbody>
<tr>
<td>taskingParameters</td>
<td>The taskingParameters property describes values for optional and mandatory tasking parameters. Clients use the definition to provide corresponding tasking parameter values. To ensure common understanding between client and server, a common exchange protocol is used to express both descriptions and tasking parameter values. SensorThings uses the JSON encoding defined in OGC 17-011 to define taskingParameters. Each field of the taskingParameters MUST have a name and a value. name specifies the parameter’s name as described in TaskingCapability’s taskingParameters and value is the value of that parameter for this Task.</td>
<td>SWE Common JSON Object</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>creationTime</td>
<td>The time when the Task is created. This time SHALL only be added automatically by the service.</td>
<td>TM_Instant (ISO-8601 Time String)</td>
<td>One (mandatory)</td>
</tr>
</tbody>
</table>

### Table 4 Direct relation between a Task and other entity types
<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Relation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TaskingCapability</td>
<td>Many optional to one mandatory</td>
<td>A Task has one-and-only-one TaskingCapability. A TaskingCapability has zero-to-many Tasks.</td>
</tr>
</tbody>
</table>

Example 2 an example of a Task entity

```json
{
    "@iot.id": 2,
    "@iot.selfLink": "http://example.org/v1.0/Tasks(1)",
    "TaskingCapability@iot.navigationLink": "Tasks(2)/TaskingCapability",
    "creationTime": "2017-01-01T00:00:00.000Z",
    "taskingParameters": {
        "type": "DataRecord",
        "field": [
            {
                "name": "On/Off",
                "value": "on"
            },
            {
                "name": "Color",
                "value": "#FF0000"
            }
        ]
    }
}
```

7.1.3 Actuator

<table>
<thead>
<tr>
<th>Requirements Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/actuator">http://www.opengis.net/spec/iot_tasking/1.0/req/actuator</a></td>
<td>Web Service</td>
</tr>
<tr>
<td>Dependency</td>
<td><a href="http://www.opengis.net/spec/iot_sensing/1.0/req/entity-control-information/common-control-information">http://www.opengis.net/spec/iot_sensing/1.0/req/entity-control-information/common-control-information</a></td>
</tr>
<tr>
<td>Requirement</td>
<td><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/actuator/properties">http://www.opengis.net/spec/iot_tasking/1.0/req/actuator/properties</a></td>
</tr>
<tr>
<td>Requirement</td>
<td>Each Actuator entity SHALL have the direct relation between a Task entity and other entity types listed in Table 6.</td>
</tr>
</tbody>
</table>

### Table 5 Properties of an Actuator

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity and use</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>A property provides a label for the entity, commonly a descriptive name.</td>
<td>CharacterString</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>description</td>
<td>The description of the Actuator entity</td>
<td>CharacterString</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>encodingType</td>
<td>The encoding type of the metadata property. Its value is one of the ValueCode enumeration (see for Table 7 for the available ValueCode).</td>
<td>Any (depending on the value of the encodingType)</td>
<td>One (mandatory)</td>
</tr>
</tbody>
</table>
metadata | The detailed description of the Actuator. The metadata type is defined by encodingType. | Any (depending on the value of the encodingType) | One (mandatory)
---|---|---|---

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Relation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TaskingCapabilities</td>
<td>One mandatory to many optional</td>
<td>An Actuator has zero-to-many TaskingCapabilities. A TaskingCapability has one-and-only-one Actuator.</td>
</tr>
</tbody>
</table>

| Table 6 Direct relation between an Actuator and other entity types |
|---|---|---|

<table>
<thead>
<tr>
<th>Actuator encodingType</th>
<th>ValueCode Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDF</td>
<td>application/pdf</td>
</tr>
<tr>
<td>SensorML</td>
<td><a href="http://www.opengis.net/doc/IS/SensorML/2.0">http://www.opengis.net/doc/IS/SensorML/2.0</a></td>
</tr>
</tbody>
</table>

The Actuator encodingType allows clients to know how to interpret metadata's value. Currently SensorThings API defines two common Actuator metadata encodingTypes. Most sensor manufacturers provide their sensor datasheets in a PDF format. As a result, PDF is a Sensor encodingType supported by SensorThings API. The second Sensor encodingType is SensorML.

Example 3 an example of an Actuator entity

```
{
  "@iot.id": 3,
  "@iot.selfLink": "http://example.org/v1.0/Actuators(3)",
  "TaskingCapabilities@iot.navigationLink": "Actuators(3)/TaskingCapabilities",
  "name": "Linkit Smart 7688 Duo Board with LED",
  "description": "Linkit Smart 7688 Duo Board that has an LED which can be tasked as on/off with different color.",
  "encodingType": "application/pdf",
  "metadata": "http://example.org/linkit_7688.pdf"
}
```

8 SensorThings Tasking Create

The SensorThings API Tasking part SHALL support creating Task entities.

<table>
<thead>
<tr>
<th>Requirements Class</th>
<th><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/create-tasks">http://www.opengis.net/spec/iot_tasking/1.0/req/create-tasks</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Target type</td>
<td>Web Service</td>
</tr>
<tr>
<td>Dependency</td>
<td><a href="http://docs.oasis-open.org/odata/odata/v4.0/errata02/os/complete/part1-protocol/odata-v4.0-errata02-os-part1-protocol-complete.html#_Toc406398326">http://docs.oasis-open.org/odata/odata/v4.0/errata02/os/complete/part1-protocol/odata-v4.0-errata02-os-part1-protocol-complete.html#_Toc406398326</a></td>
</tr>
<tr>
<td>Requirement</td>
<td><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/create-tasks/task-creation">http://www.opengis.net/spec/iot_tasking/1.0/req/create-tasks/task-creation</a></td>
</tr>
</tbody>
</table>

To create a Task in a collection, the client SHALL send a HTTP POST request to Task collection's URL. The POST body SHALL contain a single valid Task representation.
When clients create Tasks in a SensorThings service, they SHALL follow the integrity constraints listed in Table 8.

When a SensorThings service receives a create Task request, the service SHALL set the createdTime property of the entity to current server time.

SensorThings API services SHALL support linking new Task entities to existing entities upon creation. To create a new Task with links to existing entities, the client SHALL include the unique identifiers of the related entities associated with the corresponding navigation properties in the request body.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Integrity Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create a Task entity</td>
<td>SHALL link to a TakingCapability entity</td>
</tr>
</tbody>
</table>

### 8.1 Link to existing entities when creating a Task entity

**HTTP Method:** POST

**URI Pattern:** SERVICE_ROOT_URI/Tasks

**Header:** Content-Type: application/json

**Message Body:** A single valid Task entity representation.

Example 4 create a Task entity, which links to an existing Actuator entity (whose id is 1), an existing TakingCapability entity (whose id is 2).

```json
POST /v1.0/Tasks HTTP/1.1
Host: example.org/
Content-Type: application/json

{  
    "taskingParameters": {  
        "type": "DataRecord",  
        "field": [  
            {  
                "name": "On/Off",  
                "value": "on"  
            },  
            {  
                "name": "Color",  
                "value": "#FF0000"  
            }  
        ]  
    },  
    "TakingCapability": {  
        "@iot.id": 2  
    }  
}
```
9 SensorThings Tasking MQTT Extension

In addition to support HTTP protocol, a SensorThings service MAY support MQTT protocol to enhance the SensorThings service publish and subscribe capabilities. This section describes the SensorThings MQTT extension.

9.1 Create a SensorThings Task with MQTT Publish

SensorThings MQTT extension provides the capability of creating Task entity using MQTT protocol. To create a Task entity in MQTT, the client sends a MQTT Publish request to the SensorThings service and the MQTT topic is the Tasks resource path. The MQTT application message contains a single valid Task entity representation. Figure 2 contains the sequence diagram for creating Task using MQTT publish as well as MQTT sending notifications for Task creation.

---

**Figure 2 Creating Tasks using MQTT publish, and receive notifications for Tasks with MQTT**
If the MQTT topic for the Task is a navigationLink from TaskingCapability, the new Task entity is automatically linked to that TaskingCapability respectively.

Similar to creating Tasks with HTTP POST, creating Tasks with MQTT Publish follow the integrity constraints for creating Task listed in Table 8.

9.1.1 Link to existing entities when creating a Task entity
To link to existing entities when creating a Task entity with MQTT, the conditions in Section 8 is applied.

9.2 Receive updates with MQTT Subscribe

<table>
<thead>
<tr>
<th>Requirements Class</th>
<th>Target type</th>
<th>Dependency</th>
<th>Requirement</th>
</tr>
</thead>
</table>

To allow clients to receive notifications for the updates of SensorThings tasking entities with MQTT, a service SHALL support the receiving updates with MQTT Subscribe as defined in Section 9.2.

To receive notifications from a SensorThings service when some tasking entities updated, a client can send a MQTT Subscribe request to the SensorThings service. SensorThings API defined the following four MQTT subscription use cases.

Receiving notifications from a SensorThings service follows the requirement http://www.opengis.net/spec/iot_sensing/1.0/req/receive-updates-via-mqtt of Sensing part, but for entities is Tasking part.

When SensorThings MQTT extension is being used for controlling an Actuator, the actuator (gateway) can subscribe to Tasks and whenever it receives a Task over MQTT, it can perform it. Figure 3 shows a sequence diagram of this process.
Figure 3 Actuator communication to SensorThings via MQTT
Annex A : Conformance Class Abstract Test Suite (Normative)

A.1 SensorThings Tasking Core Tests

A.1.1 Conformance class: SensorThings API TaskingCapability Entity

Conformance class id: http://www.opengis.net/spec/iot_tasking/1.0/conf/tasking-capability

Test: TaskingCapability Entity

| Requirements | http://www.opengis.net/spec/iot_tasking/1.0/conf/tasking-capability/properties  
|              | http://www.opengis.net/spec/iot_tasking/1.0/conf/tasking-capability/relations |
| Test Purpose | Check if each TaskingCapability entity has the mandatory properties and mandatory relations as defined in this specification. |
| Test Methods | Inspect the full JSON object of the TaskingCapability entity sets (i.e., without $select) to identify, if each entity has the mandatory properties defined in the corresponding requirement. |
|              | Inspect the full JSON object of each TaskingCapabilities entity set (i.e., without using the $select query option) to identify, if each entity has the mandatory relations (i.e., @iot.navigationLink) defined in the corresponding requirement. |

A.1.2 Conformance class: SensorThings API Task Entity

Conformance class id: http://www.opengis.net/spec/iot_tasking/1.0/conf/task

Test: Task Entity

| Requirements | http://www.opengis.net/spec/iot_tasking/1.0/conf/task/properties  
|              | http://www.opengis.net/spec/iot_tasking/1.0/conf/task/relations |
| Test Purpose | Check if each Task entity has the mandatory properties and mandatory relations as defined in this specification. |
| Test Methods | Inspect the full JSON object of the Tasks entity sets (i.e., without $select) to identify, if each entity has the mandatory properties defined in the corresponding requirement. |
|              | Inspect the full JSON object of each Tasks entity set (i.e., without using the $select query option) to identify, if each entity has the mandatory relations (i.e., @iot.navigationLink) defined in the corresponding requirement. |
A.1.3 Conformance class: SensorThings API Actuator Entity

Conformance class id: http://www.opengis.net/spec/iot_tasking/1.0/conf/actuator

Test: TaskingCapability Entity

<table>
<thead>
<tr>
<th>Requirements</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• <a href="http://www.opengis.net/spec/iot_tasking/1.0/conf/actuator/properties">http://www.opengis.net/spec/iot_tasking/1.0/conf/actuator/properties</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• <a href="http://www.opengis.net/spec/iot_tasking/1.0/conf/actuator/relations">http://www.opengis.net/spec/iot_tasking/1.0/conf/actuator/relations</a></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test Purpose
Check if each Actuator entity has the mandatory properties and mandatory relations as defined in this specification.

Test Methods
Inspect the full JSON object of the Actuator entity sets (i.e., without $select) to identify, if each entity has the mandatory properties defined in the corresponding requirement.

Inspect the full JSON object of each Actuator entity set (i.e., without using the $select query option) to identify, if each entity has the mandatory relations (i.e., @iot.navigationLink) defined in the corresponding requirement.

A.1.4. Conformance class: SensorThings API Create Task

Conformance class id: http://www.opengis.net/spec/iot_tasking/1.0/conf/create-entity

Dependencies:

- http://www.opengis.net/spec/iot_tasking/1.0/conf/task
- http://www.opengis.net/spec/iot_sensing/1.0/conf/resource-path

<table>
<thead>
<tr>
<th>Requirements</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• <a href="http://www.opengis.net/spec/iot_sensing/1.0/req/create-update-delete/create-entity">http://www.opengis.net/spec/iot_sensing/1.0/req/create-update-delete/create-entity</a></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test purpose
Check if the service supports the creation of Task as defined in this specification.

Test method
Create a Task entity instance by following the integrity constraints and link to the existing related entities with a single request, check if the Task entity instance is successfully created and the server responds as defined in this specification.

Issue a Task entity creation request that does not follow the integrity constraints, check if the service fails the request without creating the Task and responds the appropriate HTTP status code.

A.2. SensorThings Tasking MQTT Extension

A.2.1 Test: SensorThings API Task Creation via MQTT

Conformance class id: http://www.opengis.net/spec/iot_tasking/1.0/conf/create-tasks-via-mqtt
Dependencies:

- [http://www.opengis.net/spec/iot_tasking/1.0/conf/task](http://www.opengis.net/spec/iot_tasking/1.0/conf/task)

<table>
<thead>
<tr>
<th>Requirements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
<td><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/create-tasks-via-mqtt/task-creation">http://www.opengis.net/spec/iot_tasking/1.0/req/create-tasks-via-mqtt/task-creation</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test purpose</th>
<th>Check if the service supports the creation of Task entity via MQTT as defined in this Specification.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test method</td>
<td>Create a Task entity instance containing binding information for navigation properties using MQTT Publish, check if the server responds as defined in this specification</td>
</tr>
</tbody>
</table>
Annex B: Revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Release</th>
<th>Author</th>
<th>Paragraph modified</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>30/11/17</td>
<td>0.1.0</td>
<td>Steve Liang</td>
<td></td>
<td>Initial draft of SensorThings: Tasking</td>
</tr>
<tr>
<td>30/11/17</td>
<td>0.1.1</td>
<td>Steve Liang</td>
<td></td>
<td>Fixed some typos, corrected some inconsistencies between UML and text</td>
</tr>
<tr>
<td>08/01/18</td>
<td>0.1.2</td>
<td>Steve Liand</td>
<td></td>
<td>Fixed some inconsistencies between this draft and SensorThings Sensing part.</td>
</tr>
</tbody>
</table>
Annex C: Bibliography


OGC 08-094r1, OGC® SWE Common Data Model Encoding Standard. Available Online: http://www.opengeospatial.org/standards/swecommon

OGC 17-011r1, JSON Encoding Rules for SWE Common and SensorML. Available Online: https://portal.opengeospatial.org/files/?artifact_id=75258&version=1