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i. **Abstract**

The OGC SensorThings API [OGC 15-078r6] 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 functions and each function is handled by the Sensing part or 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 taskable IoT devices, such as individual sensors and actuators, composite consumer/commercial/industrial/smart cities *in-situ* platforms, mobile and wearable devices, or even unmanned systems platforms such as drones, satellites, connected and autonomous vehicles, etc. This document specifies core of the SensorThings Tasking part.

ii. **Keywords**

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

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

iii. **Preface**

The OGC SensorThings API is an open standard. This means that anyone can implement the standard on a non-discriminatory, royalty-free basis. The standard is also platform independent. Although SensorThings is a new standard, the requirements build on a rich set of proven-working and widely-adopted open standards, such as 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]. As a result, the OGC SensorThings API is extensible and can be applied to not only simple but also complex use cases.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The Open Geospatial Consortium shall not be held responsible for identifying any or all such patent rights.

*Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the standard set forth in this document, and to provide supporting documentation.*

iv. **Submitting organizations**

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

- SensorUp Inc., Canada
- University of Calgary, Canada
• Fraunhofer-Gesellschaft, Germany
• CGI Federal, USA

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steve Liang</td>
<td>University of Calgary / SensorUp Inc.</td>
</tr>
<tr>
<td>Tania Khalafbeigi</td>
<td>University of Calgary / SensorUp Inc.</td>
</tr>
<tr>
<td>Kan Luo</td>
<td>University of Calgary</td>
</tr>
<tr>
<td>Brian Miles</td>
<td>CGI Federal</td>
</tr>
<tr>
<td>Hylke van der Schaaf</td>
<td>Fraunhofer-Gesellschaft</td>
</tr>
<tr>
<td>Michael Jacoby</td>
<td>Fraunhofer-Gesellschaft</td>
</tr>
<tr>
<td>Marcus Alzona</td>
<td>Keys</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 (IoT) devices, data, and applications over the Web. The Tasking part provides a standard way for parameterizing - also called tasking - of taskable IoT devices, such as individual sensors and actuators, composite consumer / commercial / industrial / smart cities in-situ platforms, mobile and wearable devices, or even unmanned systems platforms such as drones, satellites, connected and autonomous vehicles, etc. This document is the core of the SensorThings Tasking part. This document follows the CRUD functions, semantics and also query options from OGC SensorThings API part 1: Sensing.

2. Conformance

Conformance with this standard shall be checked using all the relevant tests specified in Annex A (normative) of this document. All requirements-classes and conformance-classes described in this document are owned by the standard(s) identified.

The following table lists the requirements classes defined in this standard.

NOTE: The content of Requirements column in the following table is the path fragment that appended to the following URI: http://www.opengis.net/spec/iot_tasking/1.0/, and it provides the URI that can be used to unambiguously identify the requirement and the conformance class.
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.

OGC: OGC 08-094r1, OGC SWE Common Data Model Encoding Standard, 2011
OGC: OGC 17-011r2, JSON Encoding Rules SWE Common / SensorML, 2018
OASIS: OASIS MQTT Version 3.1.1, 2014
ISO: ISO 8601:2004 Data elements and interchange formats – Information interchange - Representation of dates and times, 2004
OASIS: OASIS OData Version 4.0 Part 2: URL Conventions Plus Errata 02, 2014
OASIS: OASIS OData JSON Format Version 4.0 Plus Errata 02, 2014
OASIS: OASIS OData ABNF Construction Rules Errata 02, 2014
4. Terms and Definitions

This document uses the terms defined in Sub-clause 5.3 of [OGC 06-121r9], 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.

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

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

4.3 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.

4.4 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]

4.5 (Internet of) Thing
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]

4.6 Measurement
A set of operations having the object of determining the value of a quantity [OGC 10-004r3 / ISO 19156:2011]
4.7 Observation
Act of measuring or otherwise determining the value of a property [OGC 10-004r3 / ISO 19156:2011]

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

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

4.10 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. [OGC 15-078r6]

4.11 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]

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

API  Application Programming Interface
CAV  Connected and Autonomous Vehicles
CRUD Create, Read, Update, and Delete
HTML HyperText Markup Language
HTTP Hypertext Transfer Protocol
IoT  Internet of Things
ISO  International Organization for Standardization
JSON JavaScript Object Notation
MQTT Message Queuing Telemetry Transport
OData the Open Data Protocol
OGC  Open Geospatial Consortium
REST REpresentational State Transfer
SensorML Sensor Model Language
SWE  Sensor Web Enablement
UML  Unified Modeling Language
UxS  Unmanned Systems (aerial, underwater, and other unmanned vehicle platforms)
XML  eXtensible Markup Language

7. The SensorThings API Tasking Entities

TaskingCapability, Actuator, and Task are the main entities for Tasking core. These entities SHALL be listed in the response to a GET request to the root URL as described Sensing part. In case the server implementation only has Tasking part, the index SHALL contain Things, TaskingCapabilities, Tasks, and Actuators.

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

### 7.1.1 Thing

This entity is from Sensing part. We add the information here to make this documentation complete in case a server is only implementing the Tasking core. Please note that if the server is implementing both Sensing and Tasking parts, the direct relationship for Thing entity is the combination of the relationship defined in this document with the relationships defined in the Sensing part.

The OGC SensorThings API follows the ITU-T definition, i.e., with regard to the Internet of Things, 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].

<table>
<thead>
<tr>
<th>Requirements Class</th>
<th><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/thing">http://www.opengis.net/spec/iot_tasking/1.0/req/thing</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/thing">http://www.opengis.net/spec/iot_sensing/1.0/req/thing</a></td>
</tr>
<tr>
<td>Requirement</td>
<td><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/thing/properties">http://www.opengis.net/spec/iot_tasking/1.0/req/thing/properties</a></td>
</tr>
</tbody>
</table>

Each **Thing** 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/thing/relations |
Each Thing entity SHALL have the direct relation between a Thing entity and other entity types listed in Table 2.

### Table 1 Properties of a Thing entity

<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 Thing 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 Thing entity.</td>
<td>CharacterString</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>properties</td>
<td>A JSON Object containing user-annotated properties as key-value pairs.</td>
<td>JSON Object</td>
<td>Zero-to-one</td>
</tr>
</tbody>
</table>

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

<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>A Thing MAY have zero-to-many TaskingCapabilities.</td>
</tr>
</tbody>
</table>

**Example 1** an example of a Thing entity implementing the Tasking core

```json
{
    "@iot.id": 1,
    "@iot.selfLink": "http://example.org/v1.0/Things(1)",
    "TaskingCapabilities@iot.navigationLink": "Things(1)/TaskingCapabilities",
    "name": "LinkitSmart with LED",
    "description": "LinkitSmart device with the LED that can be turned on/off and the color can be changed."
}
```

### 7.1.2 TaskingCapability

The TaskingCapability entity contains information about the capabilities of the taskable device. It contains all the parameters that can be used for controlling the device. SWE Common JSON encoding rules [OGC17-011r2] are used to define these parameters for TaskingCapability.

<table>
<thead>
<tr>
<th>Requirements Class</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><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></td>
<td></td>
</tr>
<tr>
<td><strong>Target type</strong></td>
<td>Web Service</td>
</tr>
<tr>
<td><strong>Dependency</strong></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><strong>Dependency</strong></td>
<td><a href="http://www.opengis.net/doc/BP/SWE-JSON/1.0/req">http://www.opengis.net/doc/BP/SWE-JSON/1.0/req</a></td>
</tr>
<tr>
<td><strong>Dependency</strong></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><strong>Requirement</strong></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 3.

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 4.

Table 3 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>
<tr>
<td>taskingParameters</td>
<td>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 17-011r2 to define taskingParameters.</td>
<td>SWE Common JSON Object</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>properties</td>
<td>A JSON Object containing user-annotated properties as key-value pairs.</td>
<td>JSON Object</td>
<td>Zero-to-one</td>
</tr>
</tbody>
</table>

Table 4 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 2 an example of a TaskCapability entity

```
{
    "@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": "status",
      "label": "On/Off status",
      "description": "Specifies turning the light On or Off",
      "type": "Category",
      "constraint": {
        "type": "AllowedTokens",
        "value": [
          "on","off"
        ]
      }
    },
    {
      "name": "color",
      "label": "Light Color",
      "description": "Specifies the light color in RGB HEX format. Example: #FF11A0",
      "type": "Text",
      "constraint": {
        "type": "AllowedTokens",
      }
    }
  ]
}
7.1.3 Task

Task entity contains the parameter detail of the control action that should be run on the task-able device.

<table>
<thead>
<tr>
<th>Requirements Class</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/task">http://www.opengis.net/spec/iot_tasking/1.0/req/task</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Target type</th>
<th>Web Service</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Dependency</th>
<th><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></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Dependency</th>
<th><a href="http://www.opengis.net/doc/IS/SWE/2.0">http://www.opengis.net/doc/IS/SWE/2.0</a></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Requirement</th>
<th><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></th>
</tr>
</thead>
</table>

*Each Task entity SHALL have the mandatory properties and MAY have the optional properties listed in Table 5.*

<table>
<thead>
<tr>
<th>Requirement</th>
<th><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/task">http://www.opengis.net/spec/iot_tasking/1.0/req/task</a> /relations</th>
</tr>
</thead>
</table>

*Each Task entity SHALL have the direct relation between a Task entity and other entity types listed in Table 6.*

### Table 5 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 for SWE Common data block defined in OGC 08-094r1 to define taskingParameters. taskingParameters is a SWE Common data block and MUST have key-value pairs in a JSON object. Key MUST be the name</td>
<td>SWE Common JSON Object</td>
<td>One (mandatory)</td>
</tr>
</tbody>
</table>
Table 6 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 3** 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": {
        "status": "on",
        "color": "#FF0000"
    }
}
```

### 7.1.4 Actuator

An **Actuator** is a device that can be controlled/tasked. The **Actuator** entity contains information and metadata about taskable actuator. Each **TaskingCapability** has one **Actuator** and defines the parameters that can be set/tasked for the **Actuator**.

<table>
<thead>
<tr>
<th>Requirements Class</th>
<th>Target type</th>
<th>Dependency</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>
<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>
<td>Each Actuator entity SHALL have the mandatory properties and MAY have the optional properties listed in Table 7.</td>
</tr>
<tr>
<td>Requirement</td>
<td><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/actuator/relations">http://www.opengis.net/spec/iot_tasking/1.0/req/actuator/relations</a></td>
<td></td>
</tr>
</tbody>
</table>
Each Actuator entity SHALL have the direct relation between a Task entity and other entity types listed in Table 8.

Table 7 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 9 for the available ValueCode ).</td>
<td>Any (depending on the value of the encodingType)</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>metadata</td>
<td>The detailed description of the Actuator. The metadata type is defined by encodingType.</td>
<td>Any (depending on the value of the encodingType)</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>properties</td>
<td>A JSON Object containing user-annotated properties as key-value pairs.</td>
<td>JSON Object</td>
<td>Zero-to-one</td>
</tr>
</tbody>
</table>

Table 8 Direct relation between an Actuator and other entity types

<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 9 List of some code values used for identifying types for the encodingType of the Actuator entity

<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(s). Currently, the 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 4 an example of an Actuator entity

```json
{
    "@iot.id": 3,
    "@iot.selfLink": "http://example.org/v1.0/Actuators(3)",
```
8. SensorThings Tasking Create

The SensorThings API Tasking part SHALL support creating Task entities. The server checks the taskingParameters to be compliant to the corresponding TaskingCapability. If the taskingParameters are correct, the Task will be created.

This specification contains only the core functionalities for Tasking part. All other entities than Task, including TaskingCapabilities, Actuators, and Things are pre-provisioned to the Server and the client can only create Tasks.

<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 10.

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 10 Integrity constraints when creating a Task entity
<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 TaskingCapability entity</td>
</tr>
</tbody>
</table>

8.1 Link to existing entities when creating a Task entity

Each Task has one TaskingCapability. There are two approaches to create a Task. (1) The corresponding TaskingCapability is specified in the request with its @iot.id; and (2) The corresponding TaskingCapability is specified in the POST URL, i.e., /v1.0/TaskingCapabilities({id})/Tasks.

**HTTP Method:** POST

**URI Pattern:** SERVICE_ROOT_URI/Tasks

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

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

Example 5 create a Task entity, which links to an existing TaskingCapability entity (whose id is 1).

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

{
    "taskingParameters": {
        "status": "on",
        "color": "#FF0000"
    },
    "TaskingCapability": {
        "@iot.id": 1
    }
}
```

**HTTP Method:** POST

**URI Pattern:** SERVICE_ROOT_URI/TaskingCapabilities({id})/Tasks

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

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

Example 6 create a Task entity, which links to an existing TaskingCapability entity (whose id is 1) by specifying TaskingCapability id in URL.
9. SensorThings Tasking MQTT Extension

In addition to support HTTP protocol, a SensorThings service MAY support the Message Queuing Telemetry Transport (MQTT) protocol\(^1\) 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

<table>
<thead>
<tr>
<th>Requirements Class</th>
<th><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/create-tasks-via-mqtt">http://www.opengis.net/spec/iot_tasking/1.0/req/create-tasks-via-mqtt</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/mqtt/mqtt/v3.1.1/mqtt-v3.1.1.html">http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/mqtt-v3.1.1.html</a></td>
</tr>
<tr>
<td>Requirement</td>
<td><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/create-tasks-via-mqtt/tasks-creation">http://www.opengis.net/spec/iot_tasking/1.0/req/create-tasks-via-mqtt/tasks-creation</a></td>
</tr>
</tbody>
</table>

In order to allow clients to create Tasks with MQTT Publish, a service SHALL support the creation of Tasks with MQTT as defined in Section 9.1.

The 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.

\(^1\) MQTT version 3.1.1 is an OASIS Standard. http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/os/mqtt-v3.1.1-os.html
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 follows the integrity constraints for creating Task as listed in Table 10.

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 specified in Section 8 are applied.

9.2 Receive updates with MQTT Subscribe

<table>
<thead>
<tr>
<th>Requirements Class</th>
<th><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/receive-updates-via-mqtt">http://www.opengis.net/spec/iot_tasking/1.0/req/receive-updates-via-mqtt</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/mqtt/mqtt/v3.1.1/mqtt-v3.1.1.html">http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/mqtt-v3.1.1.html</a></td>
</tr>
<tr>
<td>Requirement Requirement</td>
<td><a href="http://www.opengis.net/spec/iot_tasking/1.0/req/receive-updates-via-mqtt">http://www.opengis.net/spec/iot_tasking/1.0/req/receive-updates-via-mqtt</a></td>
</tr>
</tbody>
</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 are updated, a client can send a MQTT Subscribe request to the SensorThings service. The SensorThings API defines the following 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 the Sensing part.

When the 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.

![Sequence diagram of Actuator communication to SensorThings via MQTT](image.png)

**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

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

Test Purpose: Check if each TaskingCapability entity has the mandatory properties and mandatory relations as defined in this standard.

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

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

Test Purpose: Check if each Task entity has the mandatory properties and mandatory relations as defined in this standard.

Test Methods:
- Inspect the full JSON object of the Task 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: Actuator Entity

Requirements
- http://www.opengis.net/spec/iot_tasking/1.0/conf/actuator/properties
- http://www.opengis.net/spec/iot_tasking/1.0/conf/actuator/relations

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

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 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

Requirements
- http://www.opengis.net/spec/iot_sensing/1.0/req/create-update-delete/create-entity

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

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test purpose</td>
<td>Check if the service supports the creation of Task entity via MQTT as defined in this standard.</td>
</tr>
<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 standard.</td>
</tr>
</tbody>
</table>

A.2.2  Test: Receiving Updates for Tasks via MQTT

Conformance class id: http://www.opengis.net/spec/iot_tasking/1.0/conf/receive-updates-via-mqtt

Dependencies:

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

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test purpose</td>
<td>Check if a client can receive notifications for the creation of Task entity with MQTT.</td>
</tr>
<tr>
<td>Test method</td>
<td>Subscribe to Task entity set with MQTT Subscribe. Then create a new Task. Check if a complete JSON representation of the newly created entity through MQTT is received.</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>2017-11-30</td>
<td>0.1.0</td>
<td>Steve Liang</td>
<td></td>
<td>Initial draft of SensorThings: Tasking</td>
</tr>
<tr>
<td>2017-11-30</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>2018-01-08</td>
<td>0.1.2</td>
<td>Steve Liang</td>
<td></td>
<td>Fixed some inconsistencies between this draft and SensorThings Sensing part.</td>
</tr>
<tr>
<td>2018-04-02</td>
<td>1.0r1</td>
<td>Tania Khalafbeigi</td>
<td></td>
<td>Updated based on public comments.</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