SemSorGrid4Env

FP7-223913

Deliverable

D4.3v2

Sensor network ontology suite v2

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Executive Summary

This deliverable presents an overview of the second version of the SSG4Env ontologies, i.e., the ontologies that are being used for representing the information needed by the prototype being developed in the SSG4Env project.

The deliverable includes an overview of the different ontology modules of the SSG4Env ontologies and detailed descriptions of each module.

Note on Sources and Original Contributions

The SemSorGrid4Env consortium is an inter-disciplinary team, and in order to make deliverables self-contained and comprehensible to all partners, some deliverables thus necessarily include state-of-the-art surveys and associated critical assessment. Where there is no advantage to recreating such materials from first principles, partners follow standard scientific practice and occasionally make use of their own pre-existing intellectual property in such sections. In the interests of transparency, we here identify the main sources of such pre-existing materials in this deliverable:

- Section 3 contains material from the W3C Semantic Sensor Network Incubator Group final report[1]. Specifically, it includes the overview of the Semantic Sensor Network ontology that was written by SSG4Env partners for such report.

[1] http://www.w3.org/2005/Incubator/ssn/wiki/Incubator_Report

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Abstract (for dissemination)	This deliverable presents an overview of the second version of the SSG4Env ontologies, i.e., the ontologies that are being used for representing the information needed by the prototype being developed in the SSG4Env project. The deliverable includes an overview of the different ontology modules of the SSG4Env ontologies and detailed descriptions of each module.			
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1. Introduction

This deliverable presents an overview of the second version of the ontologies that are being used to represent the information needed by the prototype developed in the SSG4Env project. The goal of this deliverable is to complement these ontologies with the documentation needed to facilitate their understanding and use.

As in the previous version, ontology development has been driven by the reuse of existing ontologies and has been performed in collaboration with different groups of people. The Semantic Sensor Network (SSN) ontology has been developed in the scope of the W3C Semantic Sensor Network Incubator Group in consensus with other 17 international institutions and a group of renowned experts. The rest of the ontologies have been developed in direct collaboration with other SSG4Env partners.

Fourteen months have passed from the release of the previous version of the ontologies (in D4.3v1 [GCRRH+09]). Since then, there have been plenty of changes from the previous version for enumerating them here in detail. Below, we present an enumeration of the mayor changes.

- The SSN ontology has significantly changed from the first version of the ontologies to the current one. Besides changes in the conceptualisation, the ontology was extended to cover sensor deployment and sensor capabilities and restrictions; furthermore, an alignment of the SSN ontology to the DOLCE+DnS UltraLite upper ontology was defined.
- New ontologies have been developed to be used in the SSG4Env infrastructure to represent web services and schemas.
- The Coastal Defences ontology has also undergone different changes motivated from facilitating its use in the use cases and from extending it to the specific features of interest and properties used in the prototypes developed in the project.
- New domain ontologies have been developed to include regions not covered by the Ordnance Survey ontologies and to model the different roles involved in the flood use case.

The deliverable is structured as follows. Chapter 2 presents an overview of the SSG4Env ontology network and introduces the different ontologies that compose it. Chapters 3, 4 and 5 describe the ontologies used in the SSG4Env infrastructure, that is, the Semantic Sensor Network, Service and Schema ontologies, respectively. Chapters 6, 7 and 8 describe the domain ontologies used in the SSG4Env prototypes, that is, the Coastal Defences, AdditionalRegions and Role ontologies, respectively. Finally, chapter 9 presents some conclusions derived from this work.

2. Overview

This section presents an overview of the SSG4Env ontology network and introduces the different ontologies that compose it. All these ontologies are available online[1] and have been implemented using the OWL ontology language.

Figure 2.1 illustrates how the ontology network is composed of different ontologies that can be classified in different layers according to whether the ontology represents: domain-specific information required for the use case, information required for the infrastructure, or upper-level information used to facilitate interoperability among the other ontologies.

These ontologies satisfy different knowledge representation requirements extracted during the development of the architecture and of the scenario prototype.

- To represent sensor networks and their observed information about properties of certain features of interest. This is covered by the SSN ontology, developed by the W3C Semantic Sensor Network Incubator Group[2]. The SSN ontology reuses the DOLCE+DnS UltraLite upper ontology[3].
- To represent the web services provided by the infrastructure and the datasets they provide access to. This is covered by the Service module that reuses the SWEET upper ontologies [RP05] and includes concepts from the ISO19119 standard on geographic information services [ISO05].
- To represent schema metadata about relational databases and relational streams. This is covered by the Schema module that extends, and corrects, an ontology for relational data and schema components [PC05].
- To represent the geographic and administrative regions of the south coast of England. This is covered by the Ordnance Survey ontologies[4], which include the regions from Great Britain, and by the Additional Regions ontology, which includes other regions needed in our use case.
- To represent those features of interest and their properties that are specific to the flood use case. This is covered by the Coastal Defences ontology.
- To represent the different roles involved in the flood use case. This is covered by the Role ontology.

The following sections describe each of these ontologies. In these sections, the figures depicting the ontologies will use the legend shown in figure 2.2. Besides, when naming classes or properties, the namespace of the class or property will be used when they belong to an external ontology (e.g., "sw:Dataset").

[1] http://www.semsorgrid4env.eu/ontologies/
[2] http://www.w3.org/2005/Incubator/ssn/
[3] http://www.loa-cnr.it/ontologies/DUL.owl
[4] http://www.ordnancesurvey.co.uk/oswebsite/ontology/

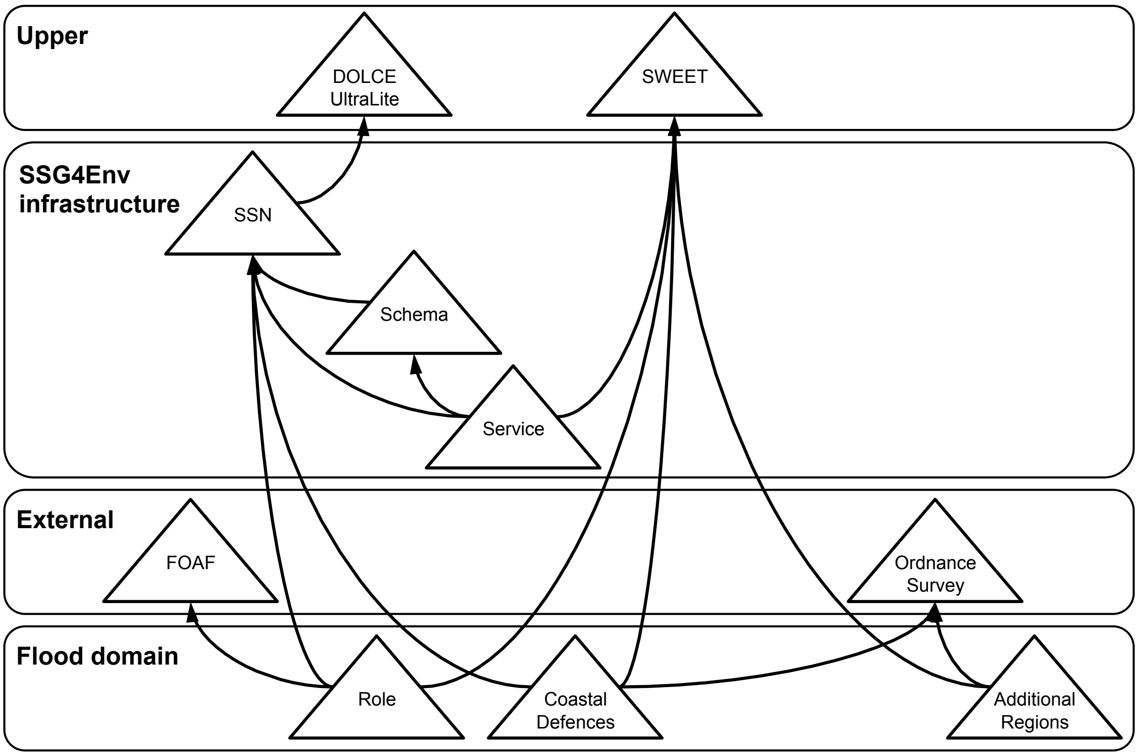

Figure 2.1: Overview of the ontologies used in the SSG4Env project

Ontology module	Module
Class	Class
Individual	Individual
Subclass-of property	↑
Type property	⇡ (dashed)
Object or datatype property	property → Class
Equivalent to a restriction in an object property	= objectProperty only | some - - -> Class
Subclass of a restriction in an object property	objectProperty only | some - - -> Class

Figure 2.2: Legend used in the figures describing the ontologies

3. Semantic Sensor Network ontology

The Semantic Sensor Network ontology[1] revolves around several conceptual modules that cover key sensor concepts. These modules can be seen in figure 3.1 and the relationships between them appear in figure 3.2, which contains an overview of the main classes and properties inside the ontology modules.

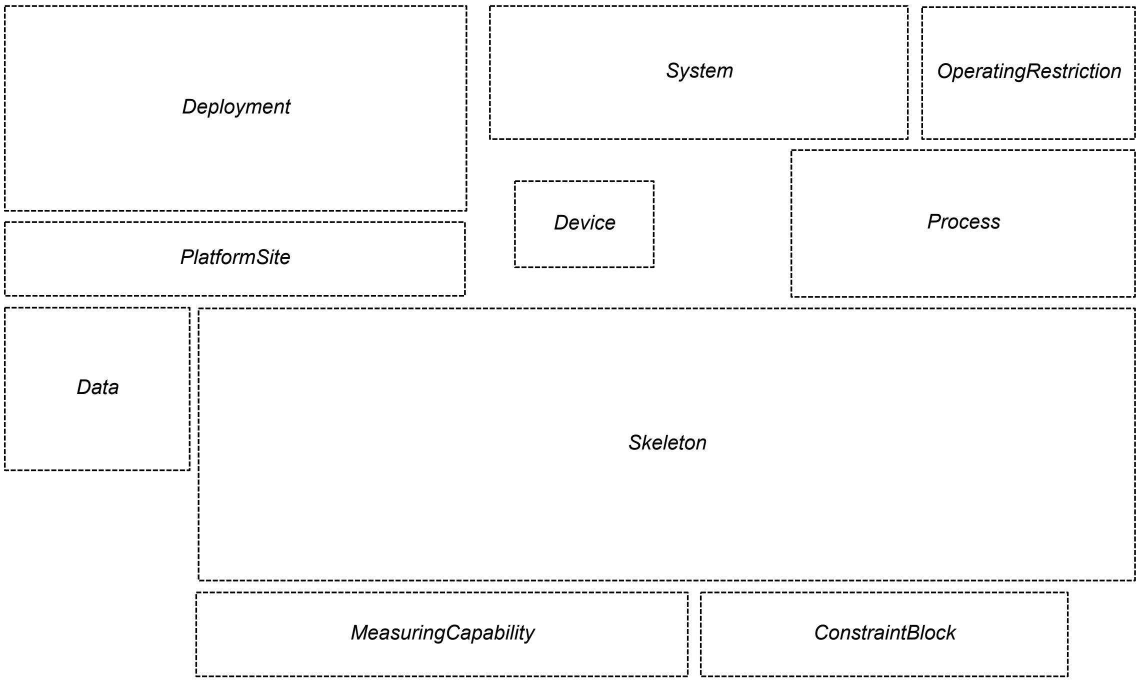

Figure 3.1: Modules used in the SSN ontology

The ontology can be used for a focus on any (or a combination) of a number of perspectives:

- A sensor perspective, with a focus on what senses, how it senses, and what is sensed.
- A data or observation perspective, with a focus on observations and related metadata.
- A system perspective, with a focus on systems of sensors.
- A feature and property perspective, with a focus on features, their properties, and what can sense those properties.

The modules allow further refining or grouping of these views on sensors and sensing. The description of sensors may be detailed or abstract. The ontology does not include a hierarchy of sensor types; these definitions are left for domain experts, and for example could be a simple hierarchy or a more complex set of definitions based on the workings of the sensors.

The modules contain the classes and properties that can be used to represent particular aspects of a sensor or its observations: for example, sensors, observations, features of interest, the process of sensing (i.e., how a sensor operates and observes), how sensors are deployed or attached to platforms, the measuring capabilities of sensors, as well as their environmental, and survival properties of sensors in particular environments (a detailed enumeration of these properties can be found in figure 3.3).

[1] `http://purl.oclc.org/NET/ssnx/ssn`

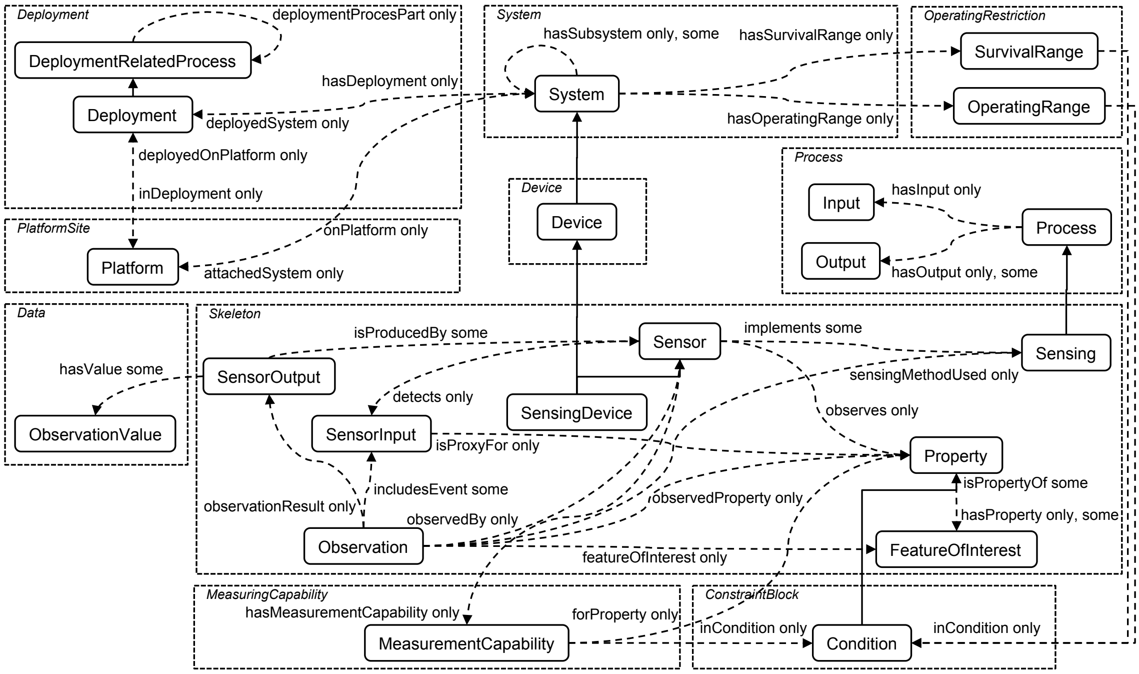

Figure 3.2: Overview of the SSN ontology

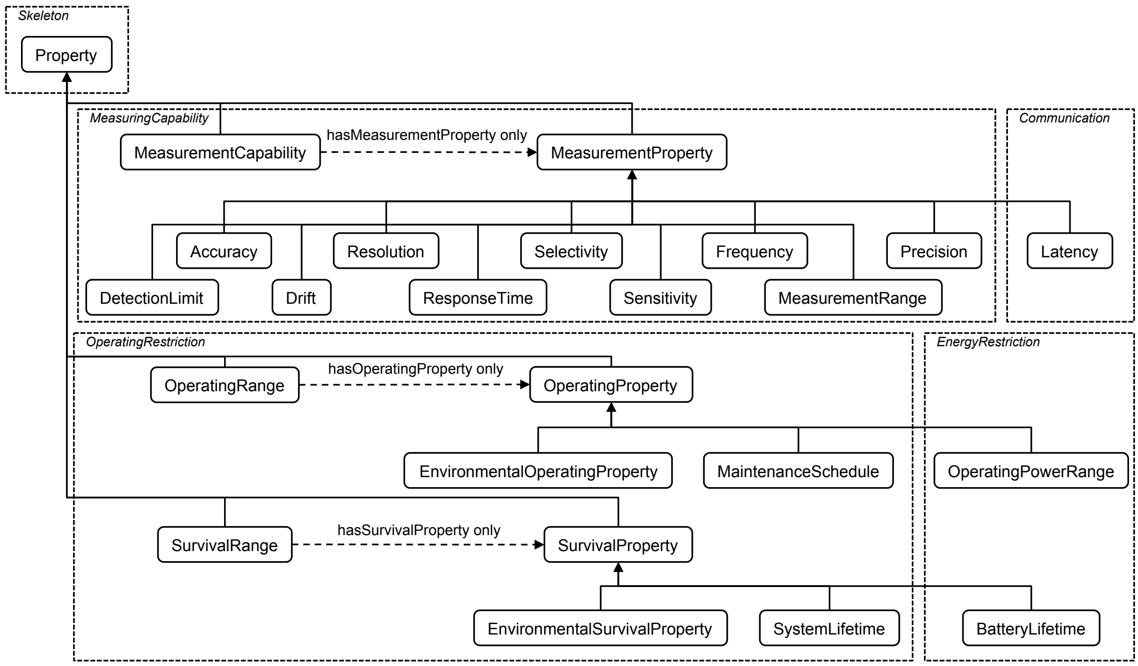

Figure 3.3: Enumeration of the measurement, environmental and survival properties

The main classes of the Semantic Sensor Network ontology have been aligned with classes in the DOLCE+DnS Ultra Lite[2] (DUL) foundational ontology to facilitate reuse and interoperability. Figure 3.4 shows the subclass properties used to align these two ontologies.

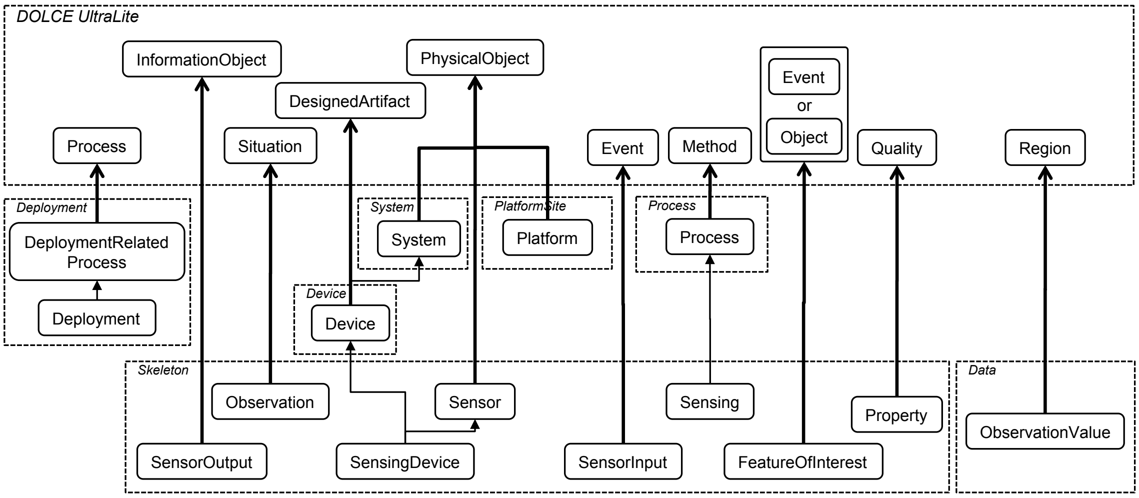

Figure 3.4: Alignment of the SSN ontology with DOLCE+DnS UltraLite

[2] `http://www.loa-cnr.it/ontologies/DUL.owl`

4. Service ontology

The Service ontology is used to represent the web services provided by the SSG4Env infrastructure and the datasets they provide access to.

The main concepts of the Service ontology, which is depicted in figure 4.1, are web services, their interfaces, and the datasets that the web services expose. Next, we will describe in detail how these concepts can be described using the ontology.

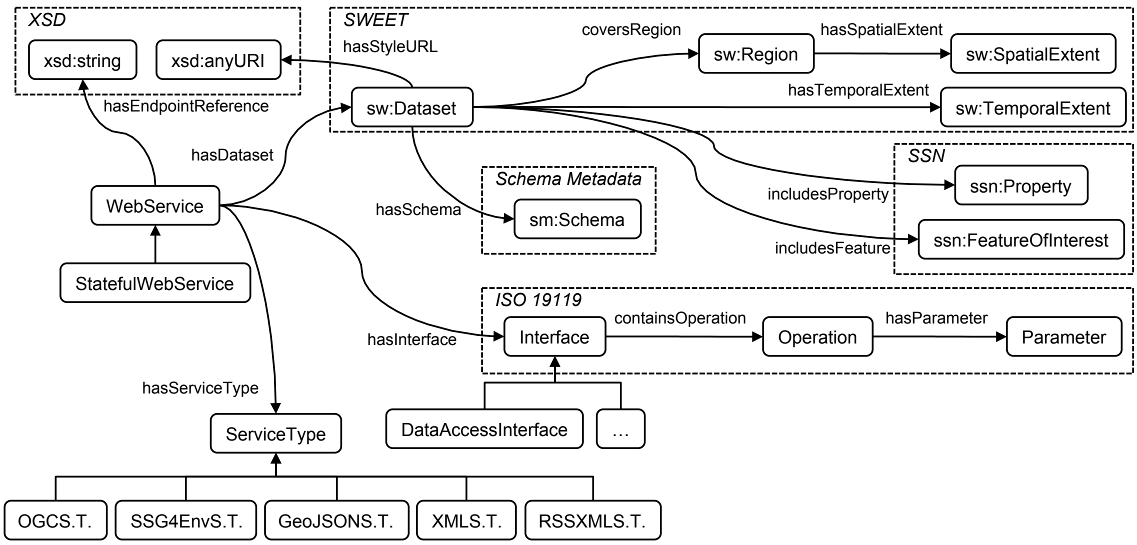

Figure 4.1: Overview of the Service ontology

A web service is described with the endpoint reference that can be used to access it, its interface, the dataset that it exposes, and its service type (currently the service types defined are OGC, SSG4Env, GeoJSON, XML, and RSSXML). The ontology also allows specifying whether a web service is a stateful web service.

A web service interface is described with the operations that it contains and with the parameters of these operations; these three concepts have been extracted from the ISO19119 standard on geographic information services [ISO05]. The ontology allows distinguishing between different types of interfaces, i.e., data access, integration, notification, pull point, query, service, subscription, and subscription manager interfaces.

A dataset is described with the temporal extent and the region (and, correspondingly, the spatial extent of such region) that it covers; all these classes are reused from the SWEET ontologies [RP05]. A dataset is also described with the features of interest and properties for which it includes data (reusing the respective classes from the SSN ontology), with the schema that is has (reusing the Schema Metadata ontology), and with URLs that contain information about the visualisation styles to be used with the dataset.

5. Schema ontology

The Schema ontology is used to represent schemas of relational databases and relational streams. For the development of this ontology, an ontology for relational data and schema components [PC05] was taken as a starting point and adapted to our case.

The main concepts of the Schema ontology, which is depicted in figure 5.1, are schemas, their extents and their corresponding attributes. Next, we will describe in detail how these concepts can be described using the ontology.

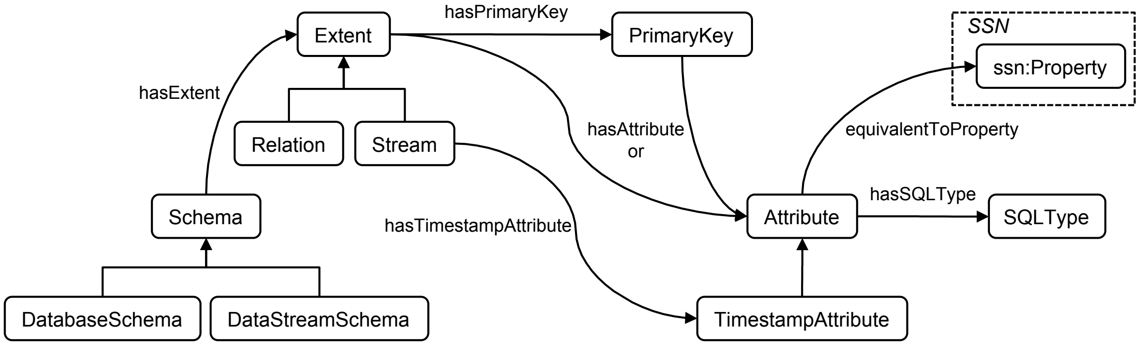

Figure 5.1: Overview of the Schema ontology

A schema, which can be either a database schema or a data stream schema, is described with its extent that, in turn, can be a relation or a stream.

Extents can have primary keys and both extents and primary keys can have attributes.

Attributes are defined with their SQL type (we use the SQL-92 datatypes[1]) and with the WebRowSet metadata attributes[2]. Besides, in order to facilitate the mapping of attributes, attributes are related to the property that they are equivalent to.

Finally, streams have a timestamp attribute, which is a special type of attribute that has a *Timestamp* SQL type.

[1] http://www.contrib.andrew.cmu.edu/~shadow/sql/sql1992.txt
[2] http://download.oracle.com/javase/6/docs/api/javax/sql/rowset/WebRowSet.html

6. Coastal Defences ontology

The Coastal Defences ontology, which is depicted in figure 6.1, is used to represent those features of interest and their properties that are specific to the flood use case.

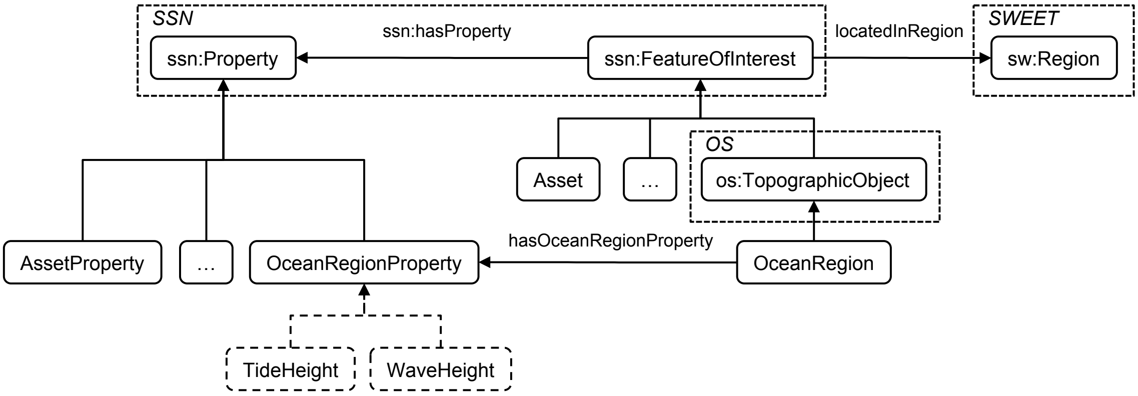

Figure 6.1: Excerpt of the Coastal Defences ontology

Features of interest are located in a certain region and the ontology defines a hierarchy with the features of interest that are relevant to our use case (e.g., ocean regions).

For each type of feature of interest, the ontology defines the properties that it can have using a property category (e.g., ocean region properties) and one individual for each property in that category (e.g., tide height or wave height).

The current version of the Coastal Defences ontology contains the properties and categories listed in table 6.1.

Table 6.1: Features of interest and properties in the Coastal Defences ontology

Feature of interest	**Properties**
Physical atmosphere	• Air temperature • Visibility • Wind direction • Wind speed
Asset	• Class • Condition • Height • Inspection date • Location • Maintainer • Mastermap Identifier • Width
Flood plain	• Water depth
Flood zone	• Flood zone type
Flood defence policy	• Strategic defence option
Ocean region	• Tide height • Wave height
Vessel	• Bearing • Callsign • Estimated Time of Arrival • Location • Name • Size • Speed • Type
Road problem	• Description • Event time • Location • Road identifier

7. Additional Regions ontology

The Additional Regions ontology is used to represent those regions of the south coast of England that are used in the flood use case but are not covered by the Ordnance Survey ontologies[1].

This happens either because specific regions are not included in the Ordnance Survey ontologies (e.g., the Coastal Defence Partnership, which is composed of Gosport, Havant and Portsmouth) or because different services provide different boundaries for the same region (e.g., the boundaries of South East England for the Channel Coastal Observatory are different from those for the BRANCH).

The regions defined in the ontology and the different services that provide boundaries for them are listed in figure 7.1.

Table 7.1: Regions defined in the Additional Regions ontology

Region	**Services**
Coastal Defence Partnership	• Modelled area
Solent	• Modelled area • AIS live
South East England	• BRANCH • Channel Coastal Observatory • Highways Agency
South West England	• Highways Agency
Southern Coastal England	• Channel Coastal Observatory

[1] `http://www.ordnancesurvey.co.uk/oswebsite/ontology/`

8. Role ontology

The Role ontology is used to represent the different roles involved in the flood use case.

The main concepts of the Role ontology, which is depicted in figure 8.1, are duties, organizations and roles. Next, we will describe in detail how these concepts can be described using the ontology.

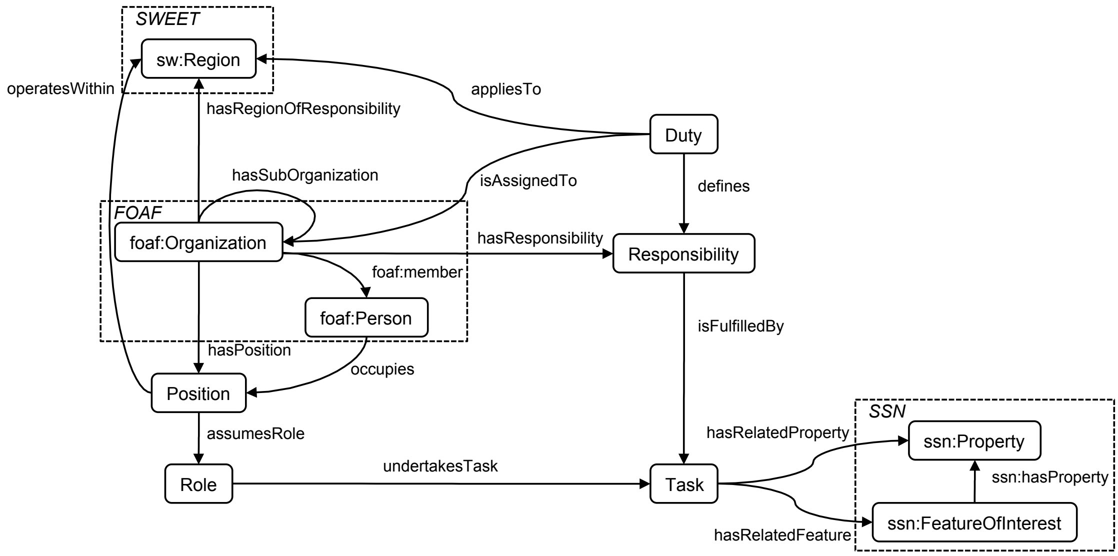

Figure 8.1: Overview of the Role ontology

A main concept in the ontology is that of a duty (e.g., the Flood and Water Management Act 2010). A duty applies to a certain region, is assigned to an organization and defines the set of responsibilities for such organization (e.g., flood coastal erosion risk management). These responsibilities are fulfilled by a set of tasks, which are related to certain features of interest and properties.

Furthermore, an organization has some region of responsibility and can have sub-organizations, each with different regions of responsibility. Besides, an organization has a number of positions that operate within the corresponding region and different members that occupy that positions. Each position in the organization assumes a specific role that defines the different tasks that must be undertaken by that role.

9. Conclusion

This deliverable has presented the second version of the SSG4Env ontologies, which are publicly available in the SSG4Env portal[1].

Even if this version of the ontologies is more stable than the previous one, mainly because it is being used in the different project prototypes, we expect minor changes in the ontologies from here to the end of the project motivated from new requirements.

By reusing existing upper ontologies, we aim to facilitate the interoperability of the SSG4Env infrastructure with other systems. Besides, the separation between the infrastructure and the domain ontologies contributes to making the infrastructure modular and extensible.

[1] http://www.semsorgrid4env.eu/index.php/ontologies

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