Investigating the Overture Maps schemas from an ISO/TC 211 and OGC standards point of view

# Introduction

ISO/TC 211 and OGC have based their standardisation of information models for geospatial information on the Unified Modelling Language (UML) and a model-driven architecture (MDA) approach since 1998 when ISO/TC 211 decided to use UML as conceptual schema language instead of EXPRESS. These UML models lay the fundament for geospatial standards used worldwide, such as OGC CityGML, OGC IndoorGML, the INSPIRE and TN-ITS models in Europe, and national standards like OKSTRA in Germany and SOSI in Norway. Vast amounts of public geospatial data are collected, maintained and shared based on these standards. Database schemas and file implementation schemas are derived from the models through the MDA approach. The Geography Markup Language (GML) has been the official standardised format for information exchange.

Over the last few years, alternative representations have been introduced for information modelling and file exchange in OGC and ISO/TC 211. One example is JSON, which is used as an implementation format for, for example, CityGML (CityJSON) as an alternative to GML. Another example is Semantic Web technologies, especially the Web Ontology Language (OWL) for information modelling. The most prominent example is OGC GeoSPARQL, which is widely used in the Semantic Web.

The new player in this field is the Overture Maps Foundation, which develops schemas for its data themes. Unlike OGC and ISO/TC 211, Overture Maps are developing schemas in YAML, a JSON-related native format. The structure in the YAML files is based on JSON Schema (https://json-schema.org/).

# Methodology

This document aims to investigate the Overture Maps schemas from the perspective of ISO/TC 211 and OGC and find differences and similarities between their approaches.

The approach for the investigation is to apply Python scripts for mapping the Overture Maps YAML files to ISO/TC 211 conformant UML and OWL. The motivation is that such a mapping may provide a more familiar view of the Overture Maps schemas in the GIS domain and enable a mapping between Overture Maps schemas and standardised schemas based on ISO/TC 211 standards.

The work is done as part of the MODI project, with the intention of finding standardised ways of exchanging cross-border and harmonised navigable road networks for automated driving.

The Overture Maps schemas are developed and available on GitHub - <https://github.com/OvertureMaps/schema>.

Scripts and other results from this work are publicly available on GitHub - <https://github.com/jetgeo/OM2UML>.

# Overture Maps schemas

## Documentation

The OvertureMaps schemas are developed and available on GitHub - <https://github.com/OvertureMaps/schema>.

Explanations and a browsable representation of the schemas are available at <https://docs.overturemaps.org/>.

## Schema structure

The Overture Maps schemas are divided into five themes: Base, Administrative boundaries, Buildings, Places, and Transportation. Besides, common properties and types are defined for use across themes.

There is one YAML file for each object type within each theme, besides common properties and types in a separate file (“defs.yaml”).

Note: property definitions may also be described within an individual schema.

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Figure 1 The Overture Maps schema folder structure and the common “defs.yaml” file

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Figure 2. The file structure is within the Overture Maps “admins” folder.

## Common property types and property container types (“defs.yaml”)

The “def.yaml” files define properties and property containers for use across all schemas (the main “defs.yaml” in Figure 1) or schemas within a time (or, for example, the “defs.yaml” within the “admin” folder in Figure 2).

* Property types are defined under the heading “$defs/propertyDefinitions” with a name, followed by property type attributes such as description, type, format and more.
* Property container types are groups of property types and are defined under the heading “$defs/propertyContainers”

## Individual object type schemas

The individual object type schemas (for example, “administrativeBoundary.yaml” in Figure 2) define individual object types and their property types under the heading “properties”. Each property type is defined with a name and additional attributes such as a description, reference to a data type and more. Property types may also be complex, with property types within property types.

Besides, individual object type schemas may also contain property type definitions (“$defs/propertyDefinitions”) and property container types (“$defs/propertyContainers”) for use only on the object type.

# Transforming from YAML to ISO/TC 211 UML

## Basic principles

Scripts and other results from this work are publicly available on GitHub - <https://github.com/jetgeo/OM2UML>

The transformation is implemented in a Python script that connects with an Enterprise Architect repository.

The folders divide the Overture Maps schemas into themes. This is equivalent to packages in UML.

Conversion rule: Each Overture Maps folder (ref Figure 1) is transformed into a UML package with name = Title case (folder name). Besides, the root folder is transformed into a folder named “Common”.

Figure 3 shows the Overture Maps UML packages.

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Figure 3. Overture Maps UML Packages

## Object and data types

The YAML schemas contain three main types of concepts:

1. Property types for the object type in question,
2. property definition types that are either for use in any Overture Maps schema, any schema within an Overture Maps theme, or the object type in question and
3. property container types for use in any Overture Maps schema, schema within an Overture Maps theme, or the object type in question.

An Overture Maps object type is considered equivalent to a UML class and, more specifically, a feature type according to ISO 19109.

Conversion rule: Each Overture Maps object type schema is transformed into a UML class with the stereotype “FeatureType” and with name = Upper Camel Case (schema name).

Property definitions can be considered a list of global property types for use in any class in any Overture Maps schema, any schema within an Overture Maps theme, or the object type in question. In UML, a class owns property types; they cannot exist independently. Property definitions must, therefore, be put into a UML class. For this purpose, the AttributeCatalogue construct from Jetlund et al. (2019) [1] is used, but with an adapted name scheme.

Conversion rule: One abstract UML class with stereotype “FeatureType” is created for each Overture Maps theme where property definitions are defined and one for the root folder (the Common package in UML). The name is set to the package name + “Defs”.

Figure 4 shows all Overture Maps Feature Types.

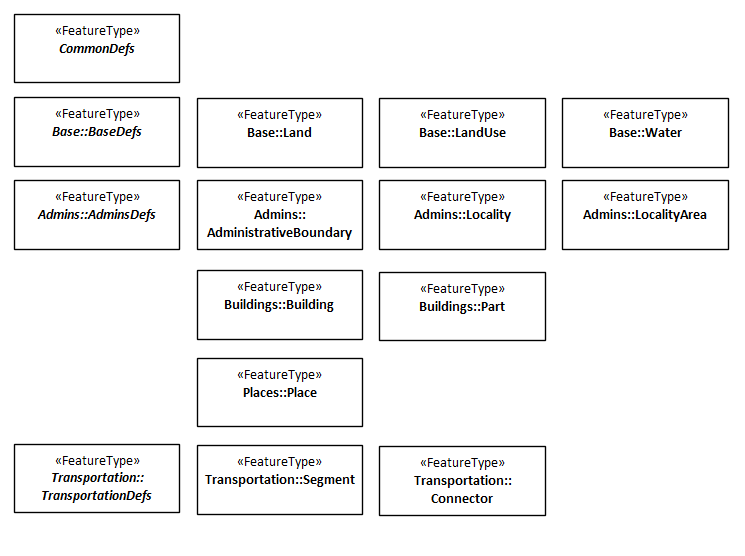


Figure 4. Overture Maps Feature Types, including abstract Def types

Property container types are groups of property types and can be considered equivalent to data types in UML.

Conversion rule: Each Overture Maps property container type is transformed into a UML Data Type

Besides property container types, the Overture Maps schemas also contain complex property definition types or property types with value type “object”, where property types are defined within the property type. These kinds of value types are also considered equivalent to UML data types.

Conversion rule: For Property types with value type “object”, a data type is created with name = Upper Camel Case (property type name + “Type”)

Some property definition types have lists of “enum” values as valid value types. These are equivalent to UML Enumerations, which is a special kind of data type.

Conversion rule: For Property definition types with “enum” values, an enumeration is created with name = Upper Camel Case (property type name + “Enum”).

Besides property definition types with “enum” values, the Overture Maps schemas also contain “enum” values for property types within the specific object type. These must be given a prefix to avoid duplication.

Conversion rule: For Property types with “enum” values, within an object type, an enumeration is created with name = Upper Camel Case (Feature type name + property type name + “Enum”).

Figure 5 shows all classifiers (Feature Types, Data Types and Enumerations) in the Overture Maps Common package. Figure 6 shows all classifiers in the Overture Maps Base package, where different classes have different enumerations for the subtype and class property types.

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Figure 5 All classifiers for the Overture Maps Common package

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Figure 6. All classifiers for the Overture Maps Base package

## Property types

Property types from YAML property definitions, property containers and object types are equivalent to UML attributes.

Conversion rule: Simple property definition types and simple property types are transformed into UML attributes under the abstract “Def” class in question. The name is not changed from YAML.

Conversion rule: property types under property types in complex property definition types and complex property types are transformed to UML attributes under the data type in question. The name is not changed from YAML.

Conversion rule: property types under property containers are transformed into attributes under the data type in question. The name is not changed from YAML.

…conversion of property value type to ISO/TC 211 types…

…array

…min, max, unique, defalt…

…$ref, items…

…geometry…

## Enumeration values

Items in “enum” lists in the YAML schemas are equivalent to values in UML enumeration classifiers.

Conversion rule: Enumeration values are extracted from the YAML lists into values in UML enumeration classifiers.

Figure 7 shows enumeration classifiers and their values from the Overture Maps Common package. Figure 8 shows how the Overture Maps Base package has different enumerations for the property “subtype” in different Feature Types (Land, LandUse and Water).

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Figure 7. Enumerations from the Overture Maps Common package

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Figure 8. Different enumerations for the subtype property type in different Feature Types

# Complete UML diagrams

# Remaining challenges

# References

[1] Jetlund, K., Onstein, E., Huang, L. (2019). Adapted Rules for UML Modelling of Geospatial Information for Model-Driven Implementation as OWL Ontologies*.* *ISPRS International Journal of Geo-Information*, *8(9)*, p. 365,DOI: <https://doi.org/10.3390/ijgi8090365>.