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possible further editors

OGC City Geography Markup Language (CityGML) Conceptual Model Standard

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i. Abstract

CityGML is an open data model and XML-based format for the storage and exchange of virtual 3D city models. It is an application schema for the Geography Markup Language version 3.2.1 (GML3), the extendible international standard for spatial data exchange issued by the Open Geospatial Consortium (OGC) and the ISO TC211.

The aim of the development of CityGML is to reach a common definition of the basic entities, attributes, and relations of a 3D city model. This is especially important with respect to the cost-effective sustainable maintenance of 3D city models, allowing the reuse of the same data in different application fields.

ii. Keywords

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

ogcdoc, OGC document, CityGML, 3D city models <tags separated by commas>

iii. Preface

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.

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More content to be provided.

iv. Submitting organizations



This is the official CityGML logo. For current news on CityGML and information about ongoing projects and fields of research in the area of CityGML see <http://www.citygml.org> and <http://www.citygmlwiki.org>

NOTE

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This Document was submitted to the Open Geospatial Consortium (OGC) by the members of the CityGML Standards Working Group of the OGC. Amongst others, this comprises the following organizations:

- To be provided
- ...

v. Submitters

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

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	To be provided	

vi. Participants in development

Table 2. Participants in Development

Name	Institution
	To be provided

The table only lists persons that were involved in the development of CityGML 3.0. CityGML 3.0 is based on extensive previous work that was done for CityGML 2.0. For persons involved in the previous work, please refer to the CityGML 2.0 specification.

vii. Acknowledgements

The editors wish to thank the Special Interest Group 3D (SIG 3D) of the initiative Geodata Infrastructure Germany (GDI-DE) which originally started the development of CityGML, the CityGML Standards Working Group and the 3D Information Management (3DIM) Working Group of the OGC as well as all contributors of change requests and comments.

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Chapter 1. Introduction

1.1. Motivation

An increasing number of cities and companies are building virtual 3D city models for different application areas like urban planning, mobile telecommunication, disaster management, 3D cadastre, tourism, vehicle and pedestrian navigation, facility management and environmental simulations. Furthermore, in the implementation of the European Environmental Noise Directive (END, 2002/49/EC) 3D geoinformation and 3D city models play an important role.

In recent years, most virtual 3D city models have been defined as purely graphical or geometrical models, neglecting the semantic and topological aspects. Thus, these models could almost only be used for visualisation purposes but not for thematic queries, analysis tasks, or spatial data mining. Since the limited reusability of models inhibits the broader use of 3D city models, a more general modelling approach had to be taken in order to satisfy the information needs of the various application fields.

CityGML is a common semantic information model for the representation of 3D urban objects that can be shared over different applications. The latter capability is especially important with respect to the cost-effective sustainable maintenance of 3D city models, allowing the possibility of selling the same data to customers from different application fields. The targeted application areas explicitly include city planning, architectural design, tourist and leisure activities, environmental simulation, mobile telecommunication, disaster management, homeland security, real estate management, vehicle and pedestrian navigation, and training simulators.

CityGML is designed as an open data model and XML-based format for the storage and exchange of virtual 3D city models. It is implemented as an application schema of the Geography Markup Language 3 (GML3), the extendible international standard for spatial data exchange and encoding issued by the Open Geospatial Consortium (OGC) and the ISO TC211. CityGML is based on a number of standards from the ISO 191xx family, the Open Geospatial Consortium, the W3C Consortium, the Web 3D Consortium, and OASIS.

CityGML defines the classes and relations for the most relevant topographic objects in cities and regional models with respect to their geometrical, topological, semantical, and appearance properties. “City” is broadly defined to comprise not just built structures, but also elevation, vegetation, water bodies, “city furniture”, and more. Included are generalisation hierarchies between thematic classes, aggregations, relations between objects, and spatial properties. CityGML is applicable for large areas and small regions and can represent the terrain and 3D objects in different levels of detail simultaneously. Since either simple, single scale models without topology and few semantics or very complex multi-scale models with full topology and fine-grained semantical differentiations can be represented, CityGML enables lossless information exchange between different GI systems and users.

1.2. Historical background

To be provided

1.3. Additions and changes in CityGML 3.0

To be provided

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Chapter 2. Scope

This document is an OGC Encoding Standard for the representation, storage and exchange of virtual 3D city and landscape models. CityGML is implemented as an application schema of the Geography Markup Language version 3.1.1 (GML3).

CityGML models both complex and georeferenced 3D vector data along with the semantics associated with the data. In contrast to other 3D vector formats, CityGML is based on a rich, general purpose information model in addition to geometry and appearance information. For specific domain areas, CityGML also provides an extension mechanism to enrich the data with identifiable features under preservation of semantic interoperability.

Targeted application areas explicitly include urban and landscape planning; architectural design; tourist and leisure activities; 3D cadastres; environmental simulations; mobile telecommunications; disaster management; homeland security; vehicle and pedestrian navigation; training simulators and mobile robotics.

CityGML is considered a source format for 3D portraying. The semantic information contained in the model can be used in the styling process which generates computer graphics represented e.g. as KML/COLLADA or X3D files. The appropriate OGC Portrayal Web Service for this process is the OGC Web 3D Service (W3DS). An image-based 3D portrayal service for virtual 3D landscape and city models is provided by the OGC Web View Service (WVS).

Features of CityGML:

- Geospatial information model (ontology) for urban landscapes based on the ISO 191xx family
- GML3 representation of 3D geometries, based on the ISO 19107 model
- Representation of object surface characteristics (e.g. textures, materials)
- Taxonomies and aggregations
 - Digital Terrain Models as a combination of (including nested) triangulated irregular networks (TINs), regular rasters, break and skeleton lines, mass points
 - Sites (currently buildings, bridges, and tunnels)
 - Vegetation (areas, volumes, and solitary objects with vegetation classification)
 - Water bodies (volumes, surfaces)
 - Transportation facilities (both graph structures and 3D surface data)
 - Land use (representation of areas of the earth's surface dedicated to a specific land use)
 - City furniture
 - Generic city objects and attributes
 - User-definable (recursive) grouping
- Multiscale model with 5 well-defined consecutive Levels of Detail (LOD):
 - LOD0 – regional, landscape
 - LOD1 – city, region

- LOD2 – city districts, projects
- LOD3 – architectural models landmarks
- Multiple representations in different LODs simultaneously; generalisation relations between objects in different LODs
- Optional topological connections between feature (sub)geometries
- Application Domain Extensions (ADE): Specific “hooks” in the CityGML schema allow to define application specific extensions, for example for noise pollution simulation, or to augment CityGML by properties of the new National Building Information Model Standard (NBIMS) in the U.S.

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Chapter 3. Conformance

This standard defines a Conceptual Model which is independent of any encoding or formatting techniques. The Standardization Targets for this standard are Implementation Specifications. These Implementation Specifications specify how the Conceptual Model shall be implemented for specific technologies. Conformant Implementation Specifications provide evidence that they are an accurate representation of the Conceptual Model. This evidence shall include implementations of the abstract tests specified in Annex A (normative) of this document.

Since this standard is agnostic to the implementing technologies, the specific techniques to be used for conformance testing cannot be specified. It is the responsibility of the Implementation Specifications to provide evidence of conformance which is appropriate for the implementing technologies. This evidence should be provided as an annex to the Implementation Specification document.

This standard identifies seventeen (17) conformance classes. One conformance class is defined for each Package in the UML model. Each conformance class is defined by one requirements class. The tests in Annex A are organized by Requirements Class. So an implementation of the *Core* conformance class must pass all tests specified in Annex A for the *Core* requirements class.

Of these seventeen conformance classes, Implementation Specifications are only required to implement the *Core* conformance class. All other conformance classes are optional. In the case where an implemented conformance class has a dependency on another conformance class, that conformance class shall also be implemented.

The CityGML Conceptual Model is defined by the CityGML UML model. This specification is a representation of that UML model in document form. In the case of a discrepancy between the UML model and this document, the UML model is authoritative.

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Chapter 4. References

The following normative documents contain provisions that, through reference in this text, constitute provisions of OGC 20-010. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of OGC 12-019 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

- ISO: ISO 8601:2004, Data elements and interchange formats – Information interchange – Representation of dates and times
- ISO: ISO 19103:2015, Geographic Information – Conceptual Schema Language
- ISO: ISO 19105:2000, Geographic information – Conformance and testing
- ISO: ISO 19107:2003, Geographic Information – Spatial Schema
- ISO: ISO 19109:2015, Geographic Information – Rules for Application Schemas
- ISO: ISO 19111:2019, Geographic information – Referencing by coordinates
- ISO: ISO 19115-1:2014, Geographic information — Metadata — Part 1: Fundamentals
- ISO: ISO 19123:2005, Geographic information — Schema for coverage geometry and functions
- ISO: ISO 19156:2011, Geographic information – Observations and measurements
- ISO: ISO/IEC 19505-2:2012, Information technology — Object Management Group Unified Modeling Language (OMG UML) — Part 2: Superstructure
- ISO/IEC 19507:2012, Information technology — Object Management Group Object Constraint Language (OCL)
- ISO: ISO/IEC 19775-1:2013 Information technology — Computer graphics, image processing and environmental data representation — Extensible 3D (X3D) — Part 1: Architecture and base components
- OGC: The OpenGIS® Abstract Specification Topic 5: Features, OGC document 08-126
- OGC: The OpenGIS™ Abstract Specification Topic 8: Relationships Between Features, OGC document 99-108r2
- OGC: The OpenGIS™ Abstract Specification Topic 10: Feature Collections, OGC document 99-110
- IETF: RFC 2045 & 2046, Multipurpose Internet Mail Extensions (MIME). (November 1996)
- IETF: RFC 3986, Uniform Resource Identifier (URI): Generic Syntax. (January 2005)
- OASIS: extensible Address Language (xAL v2.0)
- Khronos Group Inc.: COLLADA – Digital Asset Schema Release 1.5.0

The following references were listed in the CityGML 2.0 specification. For CityGML 3.0, these references should either be moved to the GML Encoding specification and be updated there or be removed completely:

- OGC: OpenGIS® Abstract Specification Topic 0, Overview, OGC document 04-084

- ISO / TC211: ISO/TS 19139:2007, Geographic Information – Metadata – XML schema implementation
- OGC: OpenGIS® Geography Markup Language Implementation Specification, Version 3.1.1, OGC document 03-105r1
- OGC: OpenGIS® GML 3.1.1 Simple Dictionary Profile, Version 1.0.0, OGC document 05-099r2
- W3C: W3C XLink, XML Linking Language (XLink) Version 1.0. W3C Recommendation (27 June 2001)
- W3C: W3C XMLName, Namespaces in XML. W3C Recommendation (14 January 1999)
- W3C: W3C XMLSchema-1, XML Schema Part 1: Structures. W3C Recommendation (2 May 2001)
- W3C: W3C XMLSchema-2, XML Schema Part 2: Datatypes. W3C Recommendation (2 May 2001)
- W3C: W3C XPointer, XML Pointer Language (XPointer) Version 1.0. W3C Working Draft (16 August 2002)
- W3C: W3C XML Base, XML Base, W3C Recommendation (27 June 2001)
- W3C: W3C XML, Extensible Markup Language (XML) 1.0 (Second Edition), W3C Recommendation (6 October 2000)
- Jelliffe, R: The Schematron Assertion Language 1.5. (2002-10-01)

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Chapter 5. 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 Best Practice.

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

I looked at several standards and copied some relevant definitions. The list needs to be reviewed once all sections have been updated. It needs to be checked, if all important terms are included, if all defined terms actually appear in the text, and if all defined terms are necessary. Also, the formatting should be improved.

2D data

geometry of features is represented in a two-dimensional space

NOTE In other words, the geometry of 2D data is given using (X,Y) coordinates.

[INSPIRE D2.8.III.2, definition 1]

2.5D data

geometry of features is represented in a three-dimensional space with the constraint that, for each (X,Y) position, there is only one Z

[INSPIRE D2.8.III.2, definition 2]

3D data

Geometry of features is represented in a three-dimensional space.

NOTE In other words, the geometry of 2D data is given using (X,Y,Z) coordinates without any constraints.

[INSPIRE D2.8.III.2, definition 3]

conceptual model

model that defines concepts of a universe of discourse

[ISO 19101-1:2014, 4.1.5]

conceptual schema

formal description of a conceptual model

[ISO 19101-1:2014, 4.1.6]

conformance test class

set of conformance test modules that must be applied to receive a single certificate of conformance

[OGC 08-131r3, definition 4.4]

feature

abstraction of real world phenomena

[ISO 19101-1:2014, definition 4.1.11]

feature attribute

characteristic of a feature

[ISO 19101-1:2014, definition 4.1.12]

feature type

class of features having common characteristics

[ISO 19156:2011, definition 4.7]

level of detail

quantity of information that portrays the real world

NOTE The concept comprises data capturing rules of spatial object types, the accuracy and the types of geometries, and other aspects of a data specification. In particular, it is related to the notions of scale and resolution.

[INSPIRE Glossary]

life-cycle information

set of properties of a spatial object that describe the temporal characteristics of a version of a spatial object or the changes between versions

[INSPIRE Glossary]

measurement

set of operations having the object of determining the value of a quantity

[ISO 19101-2:2018, definition 3.21] / [VIM:1993, 2.1]

model

abstraction of some aspects of reality

[ISO 19109:2015, definition 4.15]

observation

act of measuring or otherwise determining the value of a property

[ISO 19156:2011, definition 4.11]

observation procedure

method, algorithm or instrument, or system of these, which may be used in making an observation

[ISO 19156:2011, 4.12]

observation result

estimate of the value of a property determined through a known observation procedure

[ISO 19156:2011, 4.14]

property

facet or attribute of an object referenced by a name.

[ISO 19143:2010, definition 4.21]

requirements class

aggregate of all requirement modules that must all be satisfied to satisfy a conformance test class

[OGC 08-131r3, definition 4.19]

schema

formal description of a model

[ISO 19101-1:2014, definition 4.1.34]

sensor

type of observation procedure that provides the estimated value of an observed property at its

output

[OGC 08-094r1, definition 4.5]

timeseries

sequence of data values which are ordered in time

[OGC 15-043r3]

universe of discourse

view of the real or hypothetical world that includes everything of interest

[ISO 19101-1:2014, definition 4.1.38]

version

Particular variation of a spatial object

[INSPIRE Glossary]

5.1. Abbreviated Terms

The following abbreviated terms are used in this document:

The list of acronyms needs to be reviewed once all sections have been updated.

- 2D Two Dimensional
- 3D Three Dimensional
- AEC Architecture, Engineering, Construction
- ALKIS German National Standard for Cadastral Information
- ATKIS German National Standard for Topographic and Cartographic Information
- B-Rep Boundary Representation
- bSI buildingSMART International
- CAD Computer Aided Design
- COLLADA Collaborative Design Activity
- CSG Constructive Solid Geometry
- DTM Digital Terrain Model
- DXF Drawing Exchange Format
- EuroSDR European Spatial Data Research Organisation
- ESRI Environmental Systems Research Institute
- FM Facility Management
- GDF Geographic Data Files
- GDI-DE Spatial Data Infrastructure Germany (Geodateninfrastruktur Deutschland)
- GDI NRW Geodata Infrastructure North-Rhine Westphalia
- GML Geography Markup Language
- IAI International Alliance for Interoperability (now buildingSMART International (bSI))

- IETF Internet Engineering Task Force
- IFC Industry Foundation Classes
- ISO International Organization for Standardisation
- LOD Level of Detail
- NBIMS National Building Information Model Standard
- OASIS Organisation for the Advancement of Structured Information Standards
- OGC Open Geospatial Consortium
- OSCRE Open Standards Consortium for Real Estate
- SIG 3D Special Interest Group 3D of the GDI-DE
- TC211 ISO Technical Committee 211
- TIC Terrain Intersection Curve
- TIN Triangulated Irregular Network
- UML Unified Modeling Language
- URI Uniform Resource Identifier
- VRML Virtual Reality Modeling Language
- W3C World Wide Web Consortium
- W3DS OGC Web 3D Service
- WFS OGC Web Feature Service
- X3D Open Standards XML-enabled 3D file format of the Web 3D Consortium
- XML Extensible Markup Language
- xAL OASIS extensible Address Language

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Chapter 6. Conventions

6.1. Identifiers

The normative provisions in this document are denoted by the URI

<http://www.opengis.net/spec/CityGML/3.0>

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

6.2. UML Notation

The CityGML standard is presented in this document in diagrams using the Unified Modeling Language (UML) static structure diagram (see Booch et al. 1997). The UML notations used in this standard are described in the diagram below [Figure 1](#).

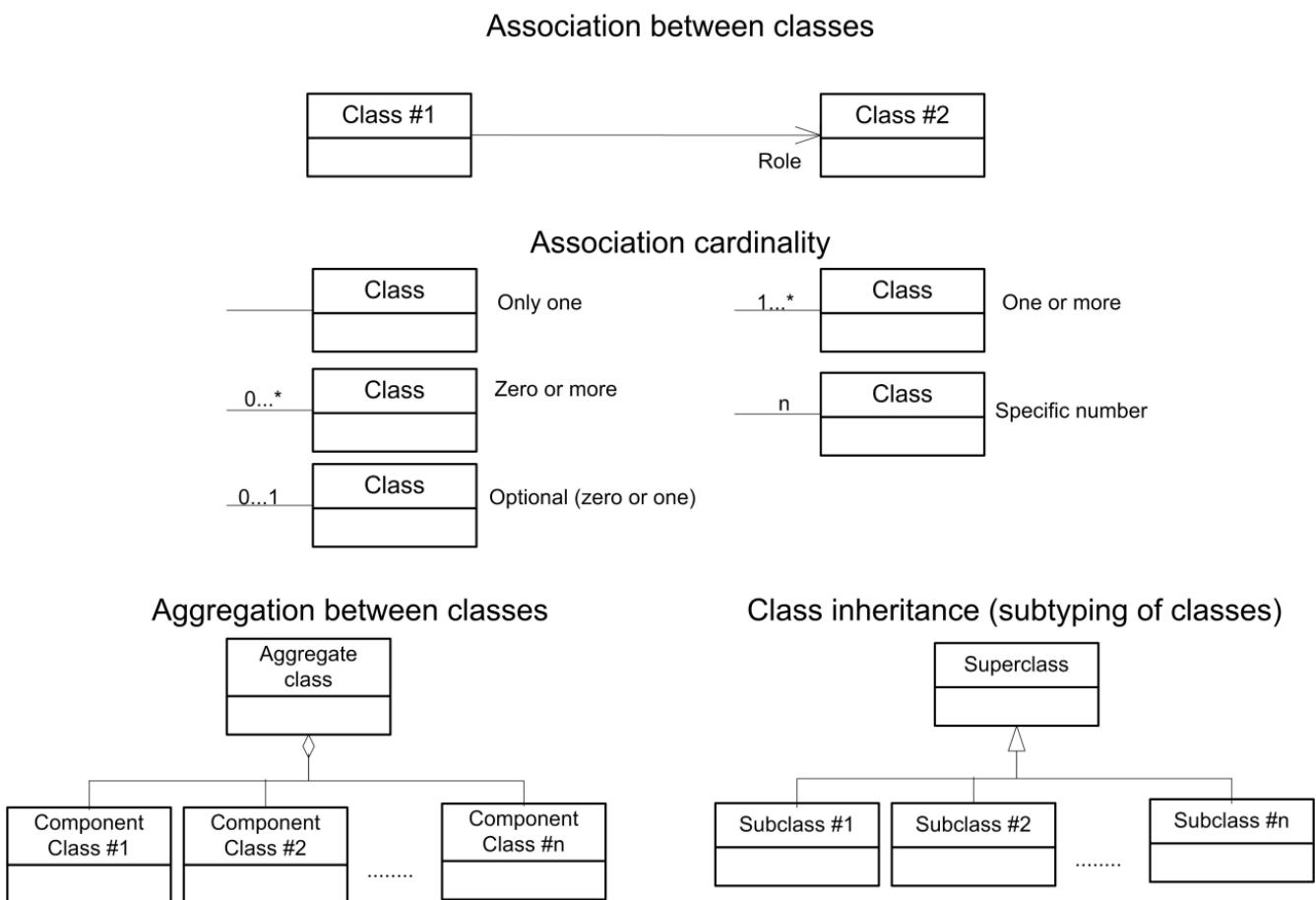


Figure 1. UML notation (see ISO TS 19103, Geographic information - Conceptual schema language).

All associations between model elements in CityGML are uni-directional. Thus, associations in CityGML are navigable in only one direction. The direction of navigation is depicted by an arrowhead. In general, the context an element takes within the association is indicated by its role. The role is displayed near the target of the association. If the graphical representation is ambiguous though, the position of the role has to be drawn to the element the association points to.

The following stereotypes are used:

- <<FeatureType>>
- <<TopLevelFeatureType>>
- <<type>>
- <<ObjectType>>
- <<DataType>> is used as a descriptor of a set of values that lack identity. Data types include primitive pre-defined types and user-definable types. A DataType is thus a class with few or no operations whose primary purpose is to hold the abstract state of another class for transmittal, storage, encoding or persistent storage.
- <<enumeration>> enumerates the valid attribute values in a fixed list of named literal values. Enumerations are specified in the CityGML schema.
- <<BasicType>>
- <<CodeList>> enumerates the valid attribute values. In contrast to Enumeration, the list of values is open and, thus, not given inline the CityGML UML Model. The allowed values can be provided within an external code list.
- <<Union>> is a list of attributes. The semantics are that only one of the attributes can be present at any time.

In order to enhance the readability of the CityGML UML diagrams, classes are depicted in different colors if they belong to different UML packages (see Fig. 8 for an overview of UML packages). The following coloring scheme is applied:

- Classes painted in yellow belong to the UML package which is subject of discussion in that clause of the specification in which the UML diagram is given. For example, in the context of chapter 10.1 which introduces the *CityGML Core* module, the yellow color is used to denote classes which are defined in the *CityGML Core* UML package. Likewise, the yellow classes shown in UML diagrams in chapter 10.3 are associated with the *Building* module which is subject of discussion in that chapter.
- Classes painted in blue belong to a CityGML UML package different to that associated with the yellow color. In order to explicitly denote the UML package of such classes, their class names carry a namespace prefix which is uniquely associated with a CityGML module throughout this specification (cf. section 4.3 for a list of namespaces and prefixes). For example, in the context of the *Building* module, classes from the *CityGML Core* module are painted in blue and their class names are preceded by the prefix *core*.
- Classes painted in green are defined in GML3 and their class names are preceded by the prefix *gml*.

The following example UML diagram demonstrates the UML notation and coloring scheme used throughout this specification. In this example, the yellow classes are associated with the *CityGML Building* module, the blue classes are from the *CityGML Core* module, and the green class depicts a geometry element defined by GML3.

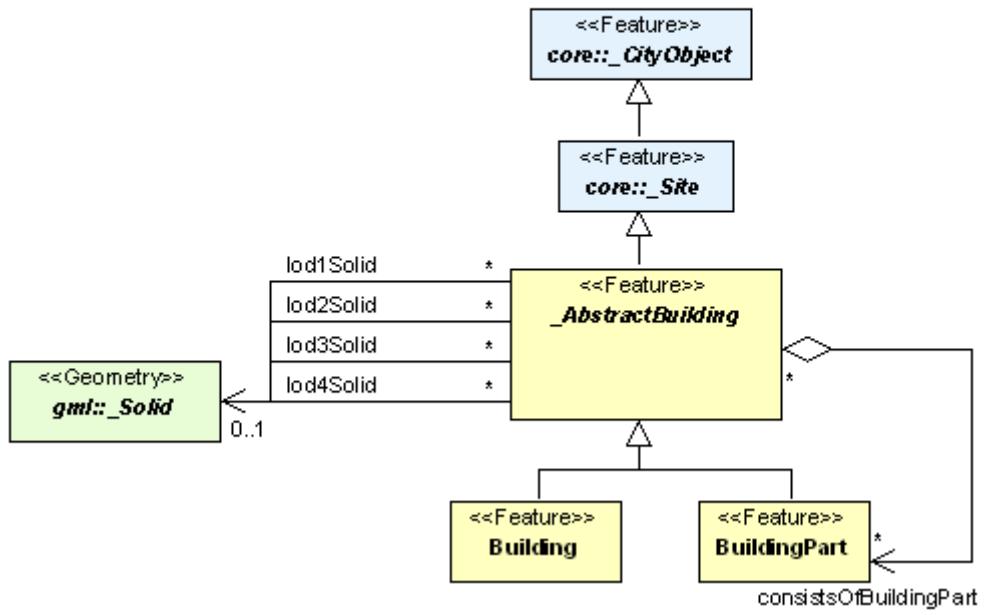


Figure 2. Example UML diagram demonstrating the UML notation and coloring scheme used throughout the CityGML specification.

6.3. XML namespaces and namespace prefixes

The CityGML data model is thematically decomposed into a core module and thematic extension modules. All modules including the core are specified by their own XML schema file, each defining a globally unique XML namespace. The extension modules are based on the core module and, thus, contain (by reference) the CityGML core schema.

Within this document the module namespaces are associated with recommended prefixes. These prefixes are consistently used within the normative parts of this specification, for all UML diagrams and example CityGML instance documents. The CityGML core and extension modules along with their XML namespace identifiers and recommended namespace prefixes are listed in Tab. 1.

Table 3. List of CityGML modules, their associated XML namespace identifiers, and example namespace prefixes.

CityGML module	Namespace identifier	Namespace prefix
CityGML Core	http://www.opengis.net/citygml/2.0	core
Appearance	http://www.opengis.net/citygml/appearance/2.0	app
Bridge	http://www.opengis.net/citygml/bridge/2.0	brid
Building	http://www.opengis.net/citygml/building/2.0	bldg

CityGML module	Namespace identifier	Namespace prefix
CityFurniture	http://www.opengis.net/citygml/cityfurniture/2.0	frn
CityObjectGroup	http://www.opengis.net/citygml/cityobjectgroup/2.0	grp
Generics	http://www.opengis.net/citygml/generics/2.0	gen
LandUse	http://www.opengis.net/citygml/landuse/2.0	luse
Relief	http://www.opengis.net/citygml/relief/2.0	dem
Transportation	http://www.opengis.net/citygml/transportation/2.0	tran
Tunnel	http://www.opengis.net/citygml/tunnel/2.0	tun
Vegetation	http://www.opengis.net/citygml/vegetation/2.0	veg
WaterBody	http://www.opengis.net/citygml/waterbody/2.0	wtr
TexturedSurface [deprecated]	http://www.opengis.net/citygml/texturedsurface/2.0	tex

Further XML Schema definitions relevant to this standard are shown in Tab. 2 along with the corresponding XML namespace identifiers and namespace prefixes consistently used within this document.

Table 4. List of XML Schema definitions, their associated XML namespace identifiers, and example namespace prefixes used within this document.

XML Schema Definition	Namespace identifier	Namespace prefix
Geography Markup Language version 3.1.1 (from OGC)	http://www.opengis.net/gml	gml
Extensible Address Language version 2.0 (from OASIS)	urn:oasis:names:tc:ciq:xsdschema: xAL:2.0	xAL
Schematron Assertion Lan-guage version 1.5	http://www.ascc.net/xml/schematron	sch

NOTE Explanatory text edit 05 for 01.04.2020 release ends here

6.4. Requirements

When referred to in a Requirement or Requirements Class, the boxes contained in UML figures may all be called “Classes” even if they are data types, enumerations, code lists, unions etc. Because this is a Conceptual Model, they all should be interpreted to be concepts (see [Conceptual Modeling](#))

When a Requirement states that “The Requirement Class Classes shown in blue in Figure [nn] shall be provided for by the encoding in a manner consistent with the encoding.”, unless specified otherwise, this means that the encoding must support:

- all classes shown as blue boxes (this Requirements Class) in the figure
- all attributes, attribute cardinalities, and attribute data types of these classes (usually shown in subsequent figures)
- all associations, navigation, roles, and role cardinalities connecting to the blue classes
- all classes shown as beige boxes (another Requirements Class) in the figure connected to the blue box classes by association or used as attribute data types
- all classes shown as pink boxes (another Standard) in the figure connected to the blue box classes by association or used as attribute data types

6.5. Conceptual Modeling (Informative)

ISO 19101 [9] defines universe of discourse to be a view of the real or hypothetical world that includes everything of interest. That standard then defines conceptual model to be a model that defines concepts of a universe of discourse.

The scope of this CityGML Conceptual Model Standard establishes the limits of the universe of discourse for this Standard. The next task is to discover and standardize the concepts within this scope. CityGML will potentially support numerous diverse application software packages covering multiple disciplines and facility life cycle phases. Each conceivably can have its own universe of discourse and their own set of concepts.

The goal of this CityGML Conceptual Model Standard is to establish and document a common set of concepts that spans the applications supported. This does not attempt to redefine application concepts, but merely present a common set of concepts from and to which their concepts can be understood and mapped.

GML and JSON encodings are planned and other encodings are anticipated. Each encoding addresses a specific information community and set of application software packages. However, with the increasing desire to share information between communities and applications having a common conceptual model across all of these encodings is highly advantageous.

An added benefit of the development of a conceptual model results from the rigor involved in achieving consensus. After numerous iterations, the end result is consistent, cohesive, and complete. Updating a conceptual model is far easier than rewriting software code. Further, the iterations help to flesh out details as well as to unearth differences in individual conceptualizations.

Perhaps the greatest benefit of the standards activity is the ability to communicate the resultant

model. This is in part due to using a standardized conceptual modelling language like UML and the agreed OGC and TC211 conventions for using UML. The eventual outcome of being able to provide formal documentation for what is meant by each concept is invaluable in understanding the subsequent encodings and applications.

This will be the first OGC conceptual model standard, without accompanying encodings. Yet the model is presented in a manner consistent with the formalisms adopted for writing OGC standards. This standard follows the OGC Specification Model standard for modular specifications [10] and is consistent with the OGC Naming Authority conventions and recommendations. The target of this Standard are the encoding standards which will follow and not the application software that will implement these encodings. Requirements for the encodings are explicit and grouped into Requirements Classes. Accompanying Conformance Classes are included to determine if an encoding conforms to the conceptual model.

UML has been used as the conceptual modeling language in this Standard. Class Diagrams have been created and inserted as Figures. The boxes in these diagrams (officially “Classifiers” in UML) typically represent classes, data types, enumerations, code lists, unions, etc. and this terminology is used throughout the Standard. However, since this is a Conceptual Model, these should all be interpreted to be “concepts”. For each Requirements Class, an introductory diagram is included which contains all of the concepts relevant to that Requirements Class. However, the boxes are simplified by suppressing attributes. These attributes are provided in a series of context diagrams which follow, each focusing on a particular set of concepts in the Requirements Class.

Though redundant with the UML diagrams, all of the class attributes are repeated in the document text, including attribute definitions not visible in the diagrams. If these differ, the UML takes precedence. Because association roles behave similar to attributes, they appear at the end of the textual attribute listing as if they were attributes. The cardinality of the association is depicted as the attribute cardinality and the associated class as the data type.

NOTE Explanatory text edit 06 for 01.04.2020 release starts here

Chapter 7. Overview of CityGML

CityGML is an open data model and XML-based format for the storage and exchange of virtual 3D city models. It is an application schema for the Geography Markup Language version 3.1.1 (GML3), the extendible international standard for spatial data exchange issued by the Open Geospatial Consortium (OGC) and the ISO TC211.

The aim of the development of CityGML is to reach a common definition of the basic entities, attributes, and relations of a 3D city model. This is especially important with respect to the cost-effective sustainable maintenance of 3D city models, allowing the reuse of the same data in different application fields.

CityGML not only represents the graphical appearance of city models but specifically addresses the representation of the semantic and thematic properties, taxonomies and aggregations. CityGML includes a geometry model and a thematic model. The geometry model allows for the consistent and homogeneous definition of geometrical and topological properties of spatial objects within 3D city models (chapter 8). The base class of all objects is *_CityObject* which is a subclass of the GML class *_Feature*. All objects inherit the properties from *_CityObject*.

The thematic model of CityGML employs the geometry model for different thematic fields like Digital Terrain Models, sites (i.e. buildings, bridges, and tunnels), vegetation (solitary objects and also areal and volumetric biotopes), land use, water bodies, transportation facilities, and city furniture (chapter 10). Further objects, which are not explicitly modelled yet, can be represented using the concept of generic objects and attributes (chapter 6.11). In addition, extensions to the CityGML data model applying to specific application fields can be realised using the Application Domain Extensions (ADE) (chapter 6.12). Spatial objects of equal shape which appear many times at different positions like e.g. trees, can also be modelled as prototypes and used multiple times in the city model (chapter 8.2). A grouping concept allows the combination of single 3D objects, e.g. buildings to a building complex (chapter 6.8). Objects which are not geometrically modelled by closed solids can be virtually sealed in order to compute their volume (e.g. pedestrian underpasses, tunnels, or airplane hangars). They can be closed using *ClosureSurfaces* (chapter 6.4). The concept of the *TerrainIntersectionCurve* is introduced to integrate 3D objects with the Digital Terrain Model at their correct positions in order to prevent e.g. buildings from floating over or sinking into the terrain (chapter 6.5).

CityGML differentiates five consecutive Levels of Detail (LOD), where objects become more detailed with increasing LOD regarding both their geometry and thematic differentiation (chapter 6.2). CityGML files can - but do not have to - contain multiple representations (and geometries) for each object in different LOD simultaneously. Generalisation relations allow the explicit representation of aggregated objects over different scales.

In addition to spatial properties, CityGML features can be assigned appearances. Appearances are not limited to visual data but represent arbitrary observable properties of the feature's surface such as infrared radiation, noise pollution, or earthquake-induced structural stress (chapter 9).

Furthermore, objects can have external references to corresponding objects in external datasets (chapter 6.7). The possible attribute values of enumerative object attributes can be enumerated in code lists defined in external, redefinable dictionaries (chapter 6.6).

NOTE

Explanatory text edit 06 for 01.04.2020 release ends here

Chapter 8. CityGML Conceptual Model

8.1. Structural Overview of Requirements Classes

The Requirements Classes for this standard are structured as UML Packages in [CityGML UML Packages](#). Each Requirements Class is specified in detail in their respective subsections. These subsections include a UML diagram, data dictionary, and the applicable requirements.

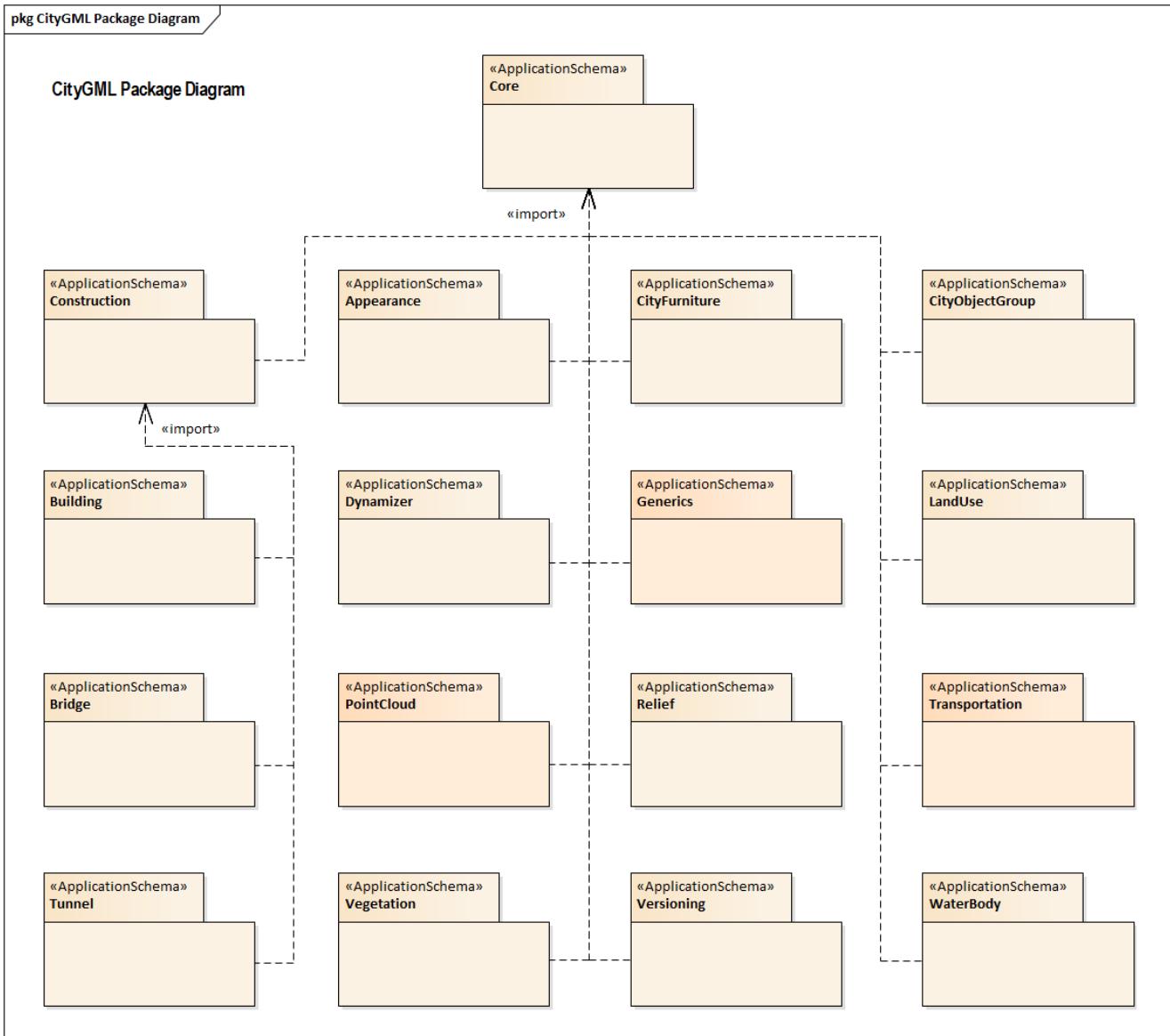


Figure 3. CityGML UML Packages

8.2. General Requirements

The following requirements are not included in a single Requirements Class. Rather, they are common requirements which apply to two or more Requirements Classes. Maintaining them separately assures that they are applied uniformly across all Requirements Classes.

8.3. Core

Requirements Class	
http://www.opengis.net/spec/CityGML/3.0/req/req-class-core	
Target type	Conceptual Model
Dependency	None

The Core module defines the basic concepts and components of city models. This rather large body of work has been divided into five sections. These sections build on each other from the fundamental principles specified by the ISO up through the full CityGML model. These sections are summarized in the [CityGML Core Sections](#) table.

Table 5. CityGML Core Sections

The Use of ISO Standards	Describes the use of ISO 191** standards to provide a foundation to the CityGML model.
Space Concepts	Defines the concepts of space as used in the CityGML model
Geometry and LOD	Defines the geometry and Level Of Detail concepts
CityGML	The core elements of the model. where it all comes together
Basic Types, Enumerations and Codelist	Defines the little things which make this model work.

8.3.1. ISO Dependencies

CityGML builds on the ISO 191** family of standards. The applicable standards are identified in the [Use of ISO Standards in CityGML](#) diagram. Data dictionaries are included for all of the ISO-defined classes explicitly referenced in the CityGML UML model. These data dictionaries are provided for the convenience of the user. The ISO standards are the normative source.

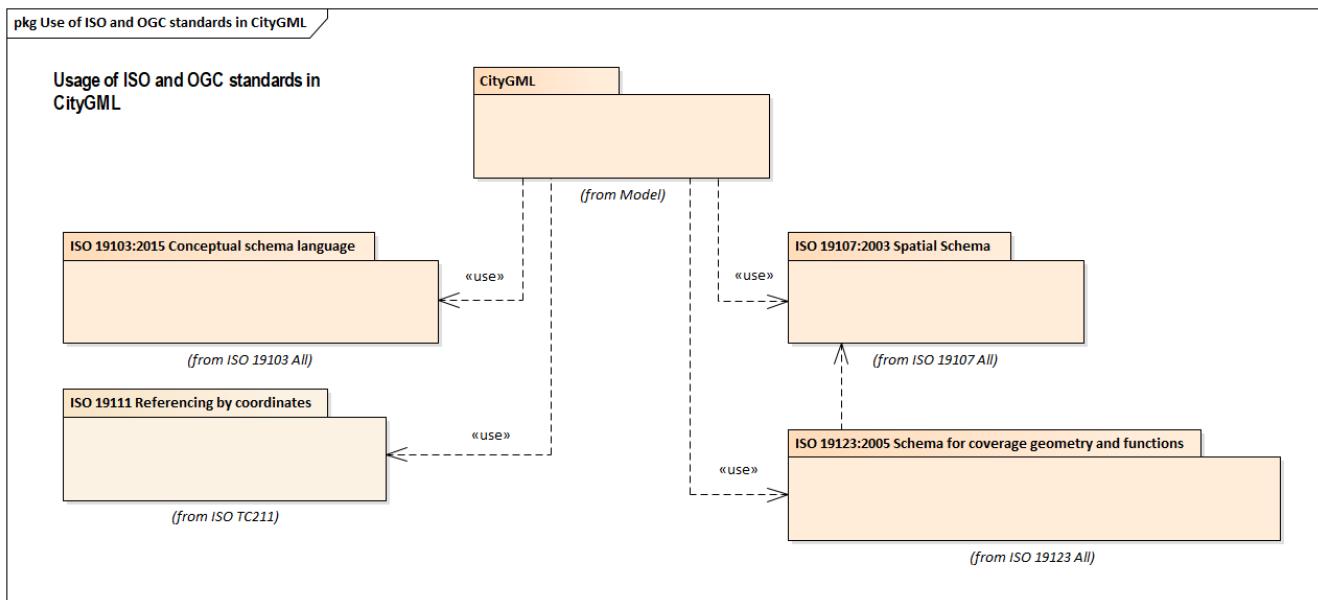


Figure 4. Use of ISO Standards in CityGML

The ISO classes explicitly used in the CityGML UML model are introduced in the [ISO Classes used in CityGML](#) table. More detail about these classes can be found in the [Data Dictionaries](#) section.

Table 6. ISO Classes used in CityGML

Class Name	Description
AnyFeature	A generalization of all feature types
CV_DiscreteGridPointCoverage	
GM_Object	
GM_MultiCurve	
GM_MultiSurface	
GM_Point	
GM_Solid	
GM_Surface	
GM_Tin	
GM_TriangulatedSurface	
SC_CRS	

8.3.2. Spatial Concepts

All city objects are differentiated into spaces and space boundaries. Spaces are entities of volumetric extent in the real world. Buildings, water bodies, trees, rooms, and traffic spaces, for instance, have a volumetric extent. Spaces can be classified into physical spaces and logical spaces. Physical spaces, in turn, can be further classified into occupied spaces and unoccupied spaces.

Space boundaries, in contrast, are entities with a real extent in the real world. Space boundaries

can be differentiated into different types of thematic surfaces, such as wall surfaces and roof surfaces.

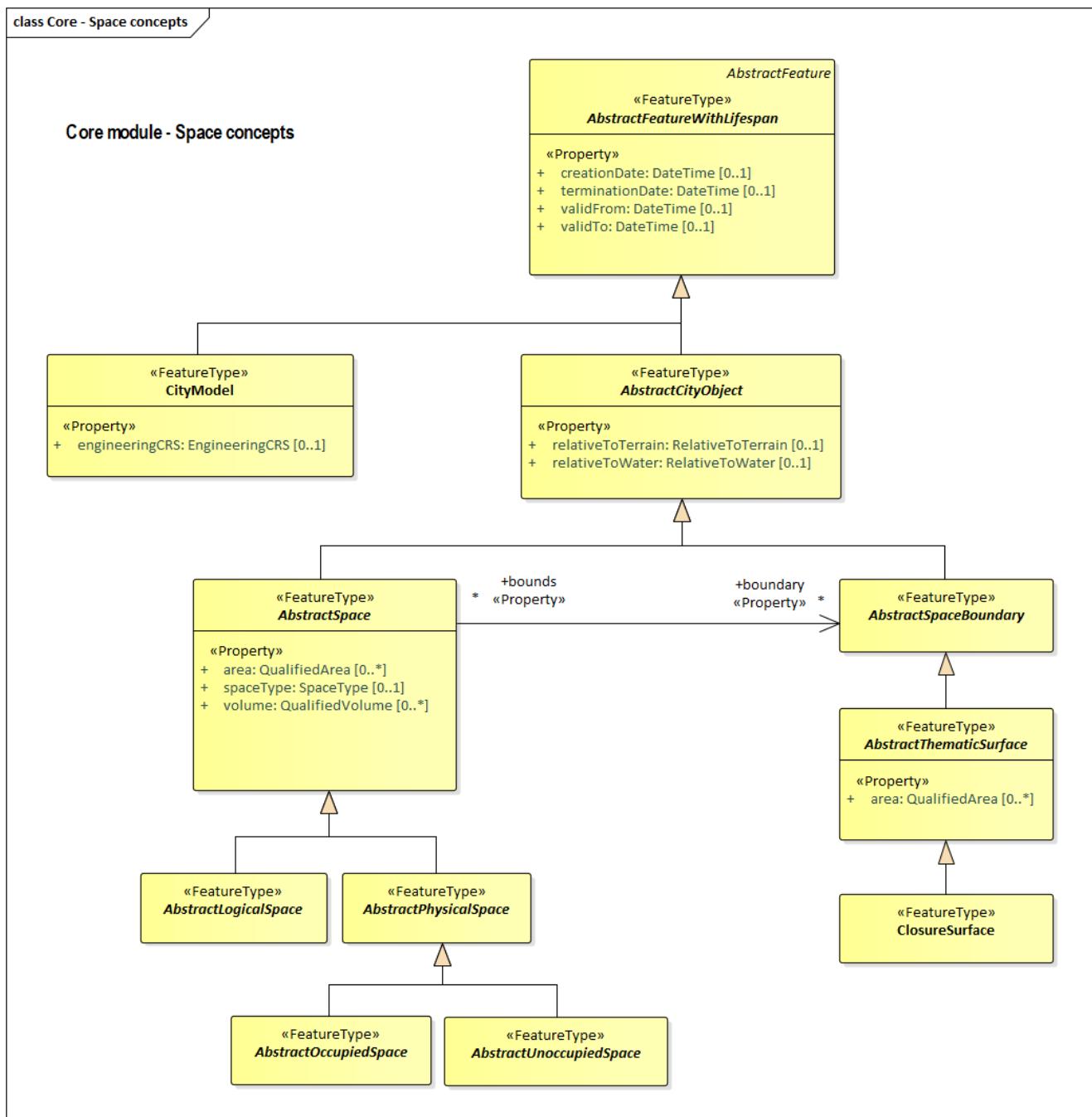


Figure 5. UML Space Concepts

The Space Concept classes defined in the CityGML UML model are introduced in the [Space Concept Classes used in CityGML](#) table. More detail about these classes can be found in the [Data Dictionaries](#) section.

Table 7. Space Concept Classes used in CityGML

Class Name	Description
AbstractCityObject	
AbstractFeatureWithLifespan	

AbstractLogicalSpace	
AbstractOccupiedSpace	
AbstractPhysicalSpace	
AbstractSpace	
AbstractSpaceBoundary	
AbstractThematicSurface	
AbstractUnoccupiedSpace	
CityModel	
ClosureSurface	

8.3.3. Geometry and LOD

Spaces and space boundaries can have various geometry representations depending on the Level of Detail (LOD). Spaces can be spatially represented as single points in LOD0, multi-surfaces in LOD0/2/3, solids in LOD1/2/3, and multi-curves in LOD2/3. Space boundaries can be represented as multi-surfaces in LOD0/2/3 and as multi-curves in LOD2/3. All Levels of Detail allow for the representation of the interior of city objects.

In addition, the geometry can also be represented implicitly, i.e. the shape is stored only once as a prototypical geometry, which then is re-used or referenced, wherever the corresponding feature occurs in the 3D city model.

The thematic classes, such as building, tunnel, road, land use, water body, or city furniture are defined as subclasses of the space and space boundary classes within the thematic modules. Since all city objects in the thematic modules represent subclasses of the space and space boundary classes, they automatically inherit the geometries defined in the Core module.

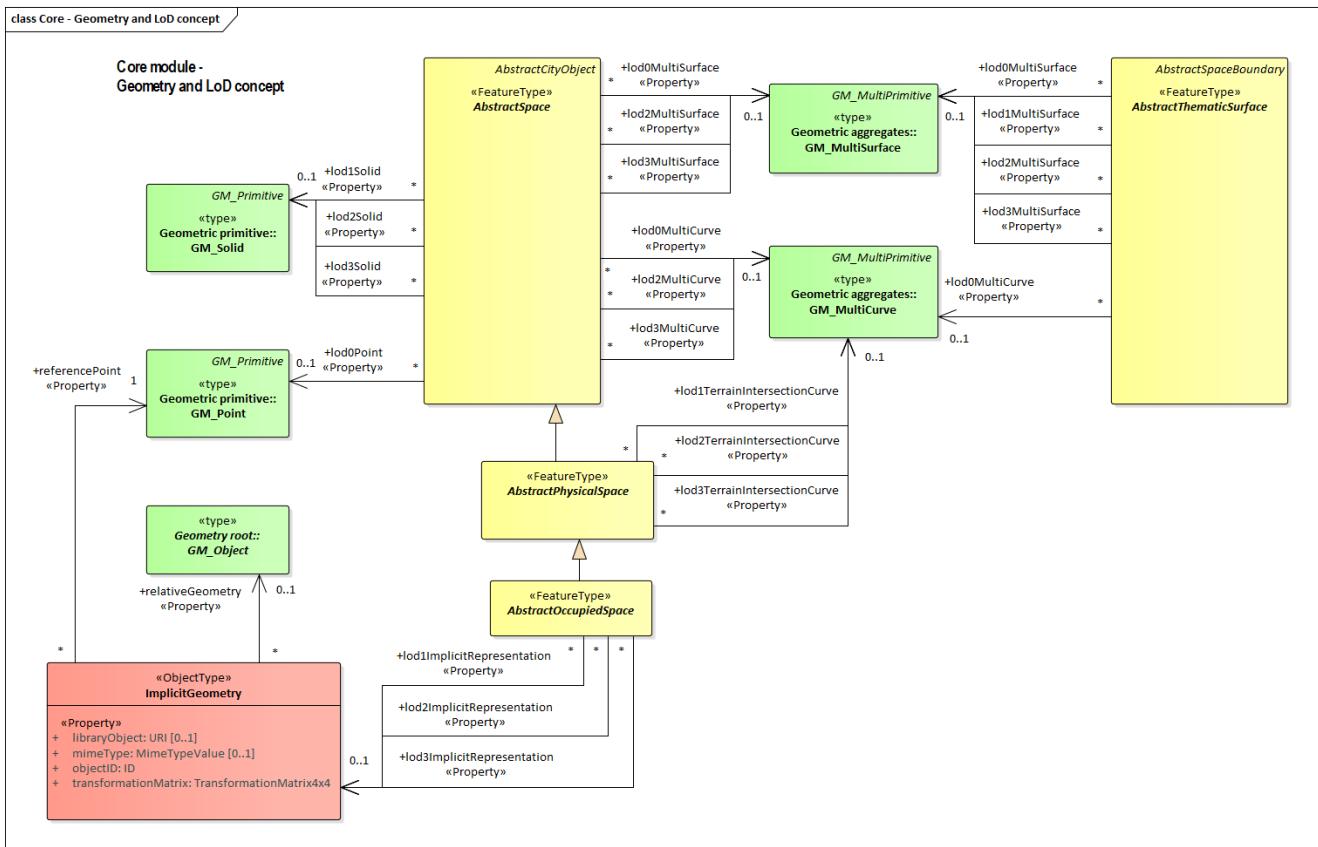


Figure 6. UML Geometry and LoD Concepts

The Geometry and LOD Concept classes defined in the CityGML UML model are introduced in the [Geometry and LOD Classes used in CityGML](#) table. More detail about these classes can be found in the [Data Dictionaries](#) section.

Table 8. Geometry and LOD Classes used in CityGML

Class Name	Description
AbstractOccupiedSpace	
AbstractPhysicalSpace	
AbstractSpace	
AbstractThematicSurface	

8.3.4. CityGML

City models are virtual representations of real-world cities and landscapes. A city model aggregates different types of objects, which can be city objects, appearances, different versions of the city model, transitions between different versions of the city model, and feature objects. All objects defined in CityGML are features with lifespan. This allows the optional specification of the real-world and database times for the existence of each feature, as is required by the Versioning module (cf. Section [Versioning](#)). Features that define thematic concepts related to cities and landscapes, such as building, bridge, water body, or land use, are referred to as city objects.

The UML diagram of the Core module is depicted in the [Core UML Diagram](#).

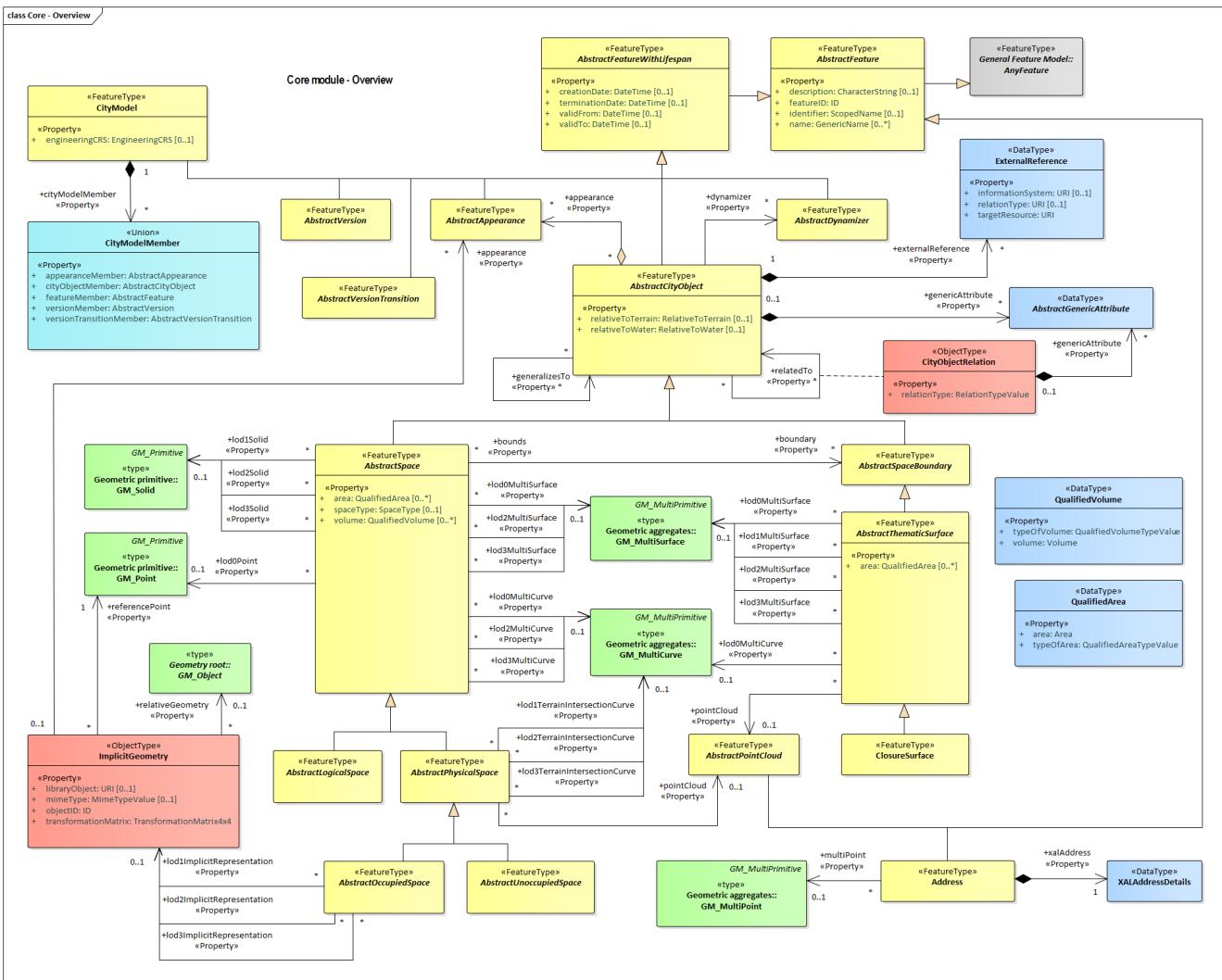


Figure 7. UML diagram of CityGML's core module.

The Geometry and LOD Concept classes defined in the CityGML UML model are introduced in the [Geometry and LOD Classes used in CityGML](#) table. More detail about these classes can be found in the [Data Dictionaries](#) section.

Table 9. Geometry and LOD Classes used in CityGML

Class Name	Description
AbstractAppearance	
AbstractCityObject	
AbstractFeature	
AbstractFeatureWithLifetime	
AbstractLogicalSpace	
AbstractOccupiedSpace	
AbstractPhysicalSpace	
AbstractPointCloud	
AbstractSpace	

AbstractSpaceBoundary	
AbstractThematicSurface	
AbstractUnoccupiedSpace	
AbstractVersion	
AbstractVersionTransition	
Address	
CityModel	
ClosureSurface	

8.3.5. Basic Types, Enumerations, and CodeLists

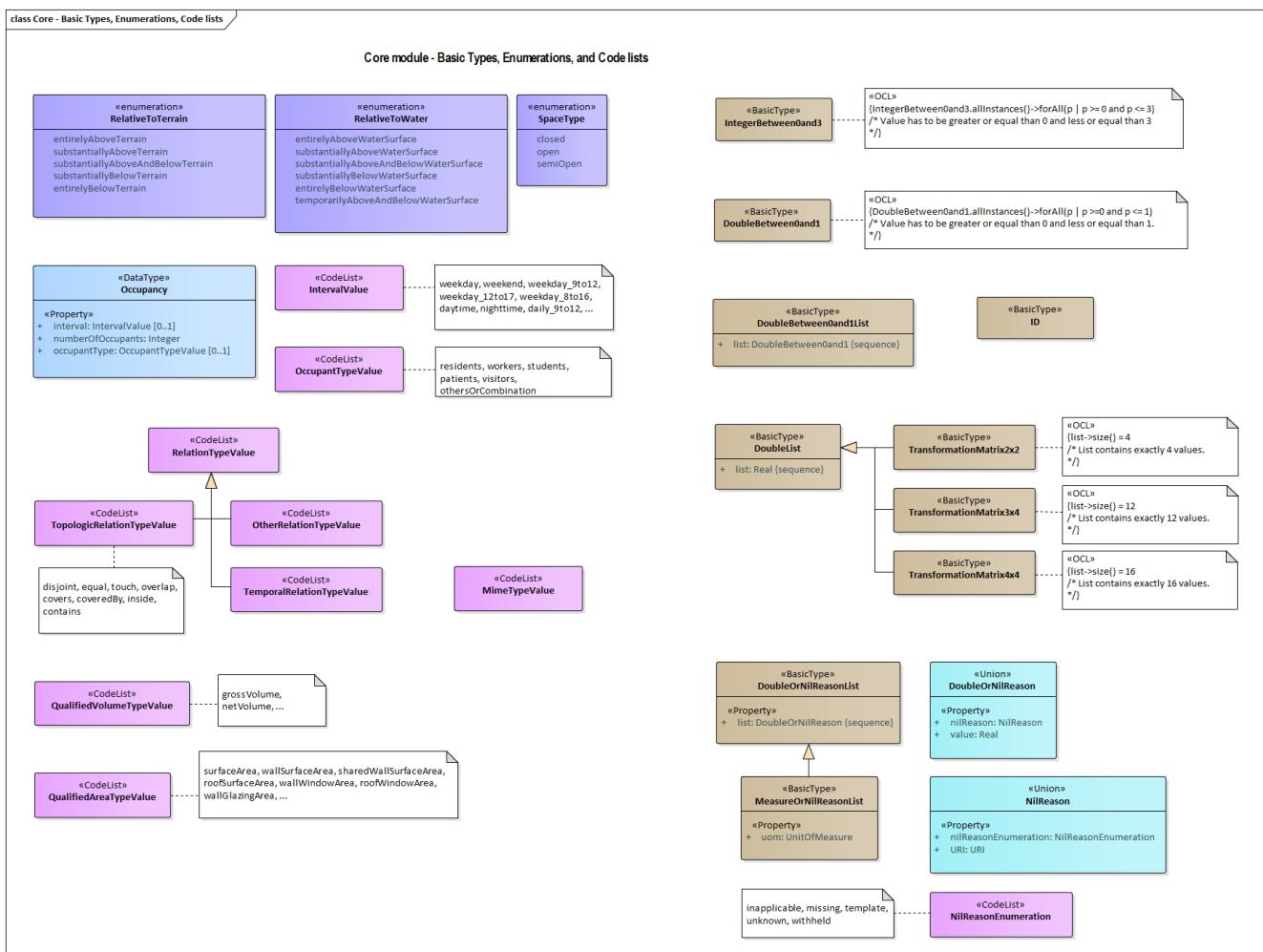


Figure 8. UML Basic Types, Enumerations, and Code Lists

Table 10. Enumeration Classes used in CityGML

Class Name	Description
RelativeToTerrain	

RelativeToWater	
SpaceType	

Table 11. Code List Classes used in CityGML

Class Name	Description
IntervalValue	
MimeTypeValue	
NillReasonEnumeration	
OccupantTypeValue	
OtherRelationTypeValue	
RelationTypeValue	
QualifiedAreaTypeValue	
QualifiedVolumeTypeValue	
TemporalRelationTypeValue	
TopologicalRelationTypeValue	

Table 12. Data Type Classes used in CityGML

Class Name	Description
Occupancy	

Table 13. Basic Type Classes used in CityGML

Class Name	Description
DoubleBetween0and1	
DoubleBetween0and1List	
DoubleList	
DoubleOrNillReasonList	
Id	
IntegerBetween0and3	
MeasureOrNillReasonList	

TransformationMatrix2 x2	
TransformationMartix3 x4	
TrnasformationMatrix4 x4	

Table 14. Union Classes used in CityGML

Class Name	Description
DoubleOrNillReason	
NillReason	

8.3.6. Data Dictionaries

Class AnyFeature (ISO 19109:2015)

AnyFeature	
Definition:	AnyFeature is an abstract class that is the generalization of all feature types. AnyFeature is an instance of the «metaclass» FeatureType [cf. ISO 19109].
Subclass Of:	None
Stereotype:	«FeatureType»

Relations

Role name	Target class and multiplicity	Definition
	FeatureType	

Class CV_DiscreteGridPointCoverage (ISO 19123:2005)

CV_DiscreteGridPointCoverage		
Definition:		
Subclass Of:	CV_DiscreteCoverage	
Stereotype:	«type»	

Relations

Role name	Target class and multiplicity	Definition

PointFunction	CV_GridValuesMatrix	
CoverageFunction	CV_GridPointValuePair	

Class GM_Object (ISO 19107:2003)

GM_Object	
Definition:	GM_Object (Figure 6) is the root class of the geometric object taxonomy and supports interfaces common to all geographically referenced geometric objects. GM_Object instances are sets of direct positions in a particular coordinate reference system. A GM_Object can be regarded as an infinite set of points that satisfies the set operation interfaces for a set of direct positions, TransfiniteSet<DirectPosition>. Since an infinite collection class cannot be implemented directly, a Boolean test for inclusion shall be provided by the GM_Object interface. This international standard concentrates on vector geometry classes, but future work may use GM_Object as a root class without modification. NOTE As a type, GM_Object does not have a well-defined default state or value representation as a data type. Instantiated subclasses of GM_Object will.
Subclass Of:	None
Stereotype:	«type»
Constraint:	dimension() > boundary().dimension (Invariant):
Constraint:	boundary().notEmpty() implies boundary().dimension() = dimension() - 1 (Invariant):
Constraint:	boundary().isEmpty() = isCycle() (Invariant):

Relations

Role name	Target class and multiplicity	Definition
	TransfiniteSet<DirectPosition>	
Coordinate Reference System	CRS	The association "CRS" links this GM_Object to the coordinate reference system, as defined in ISO150456-9, used in its DirectPosition coordinates GM_Object::CRS : CRS NOTE This association shall only be navigable from GM_Object to CRS. This means that the coordinate reference system objects in a data set do not keep a list of GM_Objects that use them. A detailed description of reference systems may be found in ISO 15046 Part 11.

Coordinate Reference System	SC_CRS	The association "CRS" links this GM_Object to the coordinate reference system, as defined in ISO150456-9, used in its DirectPosition coordinates GM_Object::CRS : CRS NOTE This association shall only be navigable from GM_Object to CRS. This means that the coordinate reference system objects in a data set do not keep a list of GM_Objects that use them. A detailed description of reference systems may be found in ISO 15046 Part 11.
SpatialComposition	CV_DomainObject	
	Geometry	

Class GM_MultiCurve (ISO 19107: 2003)

GM_MultiCurve

Definition:

Subclass Of: GM_MultiPrimitive

Stereotype: «type»

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
length	Length	

Class GM_MultiSurface (ISO 19107:2003)

GM_MultiSurface

Definition:

Subclass Of: GM_MultiPrimitive

Stereotype: «type»

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
area	Area	
perimeter	Length	

Class GM_Point (ISO 19107:2003)

GM_Point

Definition:	GM_Point (Figure 9) is the basic data type for a geometric object consisting of one and only one point.
Subclass Of:	GM_Primitive
Stereotype:	«type»

Relations

Role name	Target class and multiplicity	Definition
	Point	
Composition	GM_CompositePoint	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
position	DirectPosition	The attribute "position" shall be the DirectPosition of this GM_Point. GM_Point::position [1] : DirectPosition NOTE In most cases, the state of a GM_Point is fully determined by its position attribute. The only exception to this is if the GM_Point has been subclassed to provide additional non-geometric information such as symbology.

Class GM_Solid (ISO 19107:2003)

GM_Solid

Definition:	GM_Solid (Figure 13), a subclass of GM_Primitive, is the basis for 3-dimensional geometry. The extent of a solid is defined by the boundary surfaces.
Subclass Of:	GM_Primitive
Stereotype:	«type»

Relations

Role name	Target class and multiplicity	Definition

Composition	GM_CompositeSolid	
	Solid	

Class GM_Surface (ISO 19107:2003)

GM_Surface

Definition: GM_Surface (Figure 12) a subclass of GM_Primitive and is the basis for 2-dimensional geometry. Unorientable surfaces such as the Möbius band are not allowed. The orientation of a surface chooses an "up" direction through the choice of the upward normal, which, if the surface is not a cycle, is the side of the surface from which the exterior boundary appears counterclockwise. Reversal of the surface orientation reverses the curve orientation of each boundary component, and interchanges the conceptual "up" and "down" direction of the surface. If the surface is the boundary of a solid, the "up" direction is usually outward. For closed surfaces, which have no boundary, the up direction is that of the surface patches, which must be consistent with one another. Its included GM_SurfacePatches describe the interior structure of a GM_Surface. NOTE Other than the restriction on orientability, no other "validity" condition is required for GM_Surface.

Subclass Of: GM_OrientableSurface

Stereotype: «type»

Relations

Role name	Target class and multiplicity	Definition
GM_Genericsurface		

Class GM_Tin (ISO 19107:2003)

GM_Tin

Definition: A GM_Tin (Figure 21) is a GM_TriangulatedSurface that uses the Delaunay algorithm or a similar algorithm complemented with consideration for breaklines, stoplines and maximum length of triangle sides (Figure 22). These networks satisfy the Delaunay criterion away from the modifications: For each triangle in the network, the circle passing through its vertexes does not contain, in its interior, the vertex of any other triangle.

Subclass Of: GM_TriangulatedSurface

Stereotype: «type»

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
breakLines	GM_LineString	
controlPoint	GM_Position [3..*]	
maxLength	Distance	
stopLines	GM_LineString	

Class GM_TriangulatedSurface (ISO 19107:2003)

GM_TriangulatedSurface	
Definition:	A GM_TriangulatedSurface (Figure 21) is a GM_PolyhedralSurface that is composed only of triangles (GM_Triangle). There is no restriction on how the triangulation is derived.
Subclass Of:	GM_PolyhedralSurface
Stereotype:	«type»

Class SC_CRS (ISO 19111:Edition 2)

SC_CRS	
Definition:	Coordinate reference system which is usually single but may be compound.
Subclass Of:	IO_IdentifiedObjectBase, RS_ReferenceSystem
Stereotype:	«type»

Relations

Role name	Target class and multiplicity	Definition
CoordinateReferenceSystem	CV_ReferenceableGrid	
Target	CC_CoordinateOperation	The "sourceCRS" and "targetCRS" associations are mandatory for coordinate transformations only. Coordinate conversions have a source CRS and a target CRS that are NOT specified through these associations, but through associations from GeneralDerivedCRS to SingleCRS.

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
scope	CharacterString [1..*]	Description of usage, or limitations of usage, for which this CRS is valid. If unknown, enter "not known".

8.3.7. Package

Package Core

Description: The Core module defines the basic components of the CityGML data model. The Core module defines abstract base classes that define the core properties of more specialized thematic classes defined in other modules. The Core module also defines concrete classes that are common to other modules, for example basic data types.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- a) If a stereotype value is "<<-- section,>>", change it to "none"
- b) If a subclass value is not provided, set it to "none"
- c) If a multiplicity value is not provided, set it to "1"
- d) If the Role Name of a relation is not provided, delete the Role Name row
- e) If the stereotype of an attribute is not provided, set it to [\[Property\]](#)

2) For all classes with the "CodeList" stereotype

- a) Copy the name and description into the table in the Code List section
- b) Delete the class

3) If there are no code lists, then delete the Code List section

4) Delete these instructions when done

8.3.8. Classes

Class AbstractAppearance

AbstractAppearance

Definition:	AbstractAppearance is the abstract superclass to represent any kind of appearance objects.
Subclass Of:	AbstractFeatureWithLifespan
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class AbstractCityObject

AbstractCityObject

Definition:	AbstractCityObject is the abstract superclass of all thematic classes within the CityGML data model.
Subclass Of:	AbstractFeatureWithLifespan
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractAppearance	
	AbstractDynamizer	
	AbstractCityObject	
	AbstractCityObject	
	AbstractGenericAttribute	
	ExternalReference	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
relativeToTerrain	RelativeToTerrain [0..1]	Describes the vertical position of the city object relative to the surrounding terrain.
relativeToWater	RelativeToWater [0..1]	Describes the vertical position of the city object relative to the surrounding water surface.

Class AbstractDynamizer

AbstractDynamizer

Definition: AbstractDynamizer is the abstract superclass to represent Dynamizer objects.
 Subclass Of: [AbstractFeatureWithLifespan](#)
 Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class AbstractFeature

AbstractFeature

Definition: AbstractFeature is the abstract superclass of all feature types within the CityGML data model.
 Subclass Of: [AnyFeature](#)
 Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
description	CharacterString [0..1]	Provides further information on the feature.
featureID	ID	Specifies the unique identifier of the feature that is valid in the instance document within which it occurs.
identifier	ScopedName [0..1]	Specifies the unique identifier of the feature that is valid globally.
name	GenericName [0..*]	Specifies the name of the feature.

Class AbstractFeatureWithLifespan

AbstractFeatureWithLifespan

- Definition: [AbstractFeatureWithLifespan](#) is the base class for all CityGML features. It allows the optional specification of the real-world and database times for the existence of each feature.
- Subclass Of: [AbstractFeature](#)
- Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
creationDate	DateTime [0..1]	Indicates the date at which a CityGML feature was added to the CityModel.
terminationDate	DateTime [0..1]	Indicates the date at which a CityGML feature was removed from the CityModel.
validFrom	DateTime [0..1]	Indicates the date at which a CityGML feature started to exist in the real world.
validTo	DateTime [0..1]	Indicates the date at which a CityGML feature ended to exist in the real world.

Class AbstractLogicalSpace

AbstractLogicalSpace

Definition:	AbstractLogicalSpace is the abstract superclass for all types of logical spaces. Logical space refers to spaces that are not bounded by physical surfaces but are defined according to thematic considerations.
Subclass Of:	AbstractSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class AbstractOccupiedSpace

AbstractOccupiedSpace

Definition:	AbstractOccupiedSpace is the abstract superclass for all types of physically occupied spaces. Occupied space refers to spaces that are partially or entirely filled with matter.
Subclass Of:	AbstractPhysicalSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	ImplicitGeometry	
	ImplicitGeometry	
	ImplicitGeometry	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class AbstractPhysicalSpace

AbstractPhysicalSpace

Definition:	AbstractPhysicalSpace is the abstract superclass for all types of physical spaces. Physical space refers to spaces that are fully or partially bounded by physical objects.
Subclass Of:	AbstractSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	GM_MultiCurve	
	AbstractPointCloud	
	GM_MultiCurve	
	GM_MultiCurve	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class AbstractPointCloud

AbstractPointCloud

Definition:	AbstractPointCloud is the abstract superclass to represent PointCloud objects.
Subclass Of:	AbstractFeature
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name Target class and multiplicity Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class AbstractSpace

AbstractSpace

Definition:	AbstractSpace is the abstract superclass for all types of spaces. A space is an entity of volumetric extent in the real world.
Subclass Of:	AbstractCityObject
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	GM_Solid	
	AbstractSpaceBoundary	
	GM_MultiCurve	
	GM_Solid	
	GM_MultiSurface	
	GM_MultiCurve	
	GM_Point	
	GM_Solid	
	GM_MultiSurface	
	GM_MultiSurface	
	GM_MultiCurve	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
area	QualifiedArea [0..*]	Specifies qualified areas related to the space.
spaceType	SpaceType [0..1]	Specifies the degree of openness of a space.
volume	QualifiedVolume [0..*]	Specifies qualified volumes related to the space.

Class AbstractSpaceBoundary

AbstractSpaceBoundary

Definition: AbstractSpaceBoundary is the abstract superclass for all types of space boundaries. A space boundary is an entity with areal extent in the real world. Space boundaries are objects that bound a Space. They also realize the contact between adjacent spaces.

Subclass Of: [AbstractCityObject](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class AbstractThematicSurface

AbstractThematicSurface

Definition: AbstractThematicSurface is the abstract superclass for all types of thematic surfaces.

Subclass Of: [AbstractSpaceBoundary](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

[GM_MultiCurve](#)

[GM_MultiSurface](#)

[GM_MultiSurface](#)

[GM_MultiSurface](#)

[AbstractPointCloud](#)

[GM_MultiSurface](#)

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
area	QualifiedArea [0..*]	Specifies qualified areas related to the thematic surface.

Class AbstractUnoccupiedSpace

AbstractUnoccupiedSpace

Definition: AbstractUnoccupiedSpace is the abstract superclass for all types of physically unoccupied spaces. Unoccupied space refers to spaces that are entirely or mostly free of matter.

Subclass Of: [AbstractPhysicalSpace](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class AbstractVersion

AbstractVersion

Definition: AbstractVersion is the abstract superclass to represent Version objects.

Subclass Of: [AbstractFeatureWithLifespan](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class AbstractVersionTransition

AbstractVersionTransition

Definition:	AbstractVersionTransition is the abstract superclass to represent VersionTransition objects.
Subclass Of:	AbstractFeatureWithLifespan
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name Target class and Definition multiplicity

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class Address

Address

Definition:	Address represents an address of a city object.
Subclass Of:	AbstractFeature
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name Target class and Definition multiplicity

[GM_MultiPoint](#)

[XALAddressDetails](#)

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class CityModel

CityModel

Definition: CityModel is the container for all objects belonging to a city model.

Subclass Of: [AbstractFeatureWithLifespan](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	CityModelMember	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
engineeringCRS	EngineeringCRS [0..1]	Specifies the local coordinate reference system of the CityModel.

Class CityObjectRelation

CityObjectRelation

Definition: CityObjectRelation represents a specific relation from the city object in which it is included to another city object.

Subclass Of: <-- section,>>

Stereotype: «ObjectType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractGenericAttribute	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
relationType	RelationTypeValue	Indicates the specific type of the CityObjectRelation.

Class ClosureSurface

ClosureSurface

Definition: ClosureSurface is a special type of thematic surface used to close holes in volumetric objects. Closure surfaces are virtual (non-physical) surfaces.

Subclass Of: [AbstractThematicSurface](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class DoubleBetween0and1

DoubleBetween0and1

Definition: DoubleBetween0and1 is a basic type for values, which are greater or equal than 0 and less or equal than 1. The type is used for color encoding, for example.

Subclass Of: <-- section,>>

Stereotype: «BasicType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class DoubleBetween0and1List

DoubleBetween0and1List

Definition: DoubleBetween0and1List is a basic type that represents a list of double values greater or equal than 0 and less or equal than 1. The type is used for color encoding, for example.

Subclass Of: <-- section,>>

Stereotype: «BasicType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
list	DoubleBetween0and1	Specifies the list of double values.

Class DoubleList

DoubleList

Definition: DoubleList is an ordered sequence of double values.

Subclass Of: <-- section,>>

Stereotype: «BasicType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
list	Real	Specifies the list of double values.

Class DoubleOrNilReasonList

DoubleOrNilReasonList

Definition:	DoubleOrNilReasonList is a basic type that represents a list of double values and/or nil reasons.
Subclass Of:	<-- section,>>
Stereotype:	«BasicType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
list	DoubleOrNilReason	Specifies the list of double values and/or nil reasons.

Class ID

ID

Definition:	ID is a basic type that represents a unique identifier.
Subclass Of:	<-- section,>>
Stereotype:	«BasicType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class ImplicitGeometry

ImplicitGeometry

Definition:	ImplicitGeometry is a geometry representation where the shape is stored only once as a prototypical geometry, for example a tree or other vegetation object, a traffic light or a traffic sign. This prototypic geometry object can be re-used or referenced many times, wherever the corresponding feature occurs in the 3D city model.
Subclass Of:	<-- section,>>
Stereotype:	«ObjectType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractAppearance	
	GM_Object	
	GM_Point	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
libraryObject	URI [0..1]	Specifies the URI that points to the prototypical geometry stored in an external file.
mimeType	MimeTypeValue [0..1]	Specifies the MIME type of the external file that stores the prototypical geometry.
objectID	ID	Specifies the unique identifier of the ImplicitGeometry.
transformationMatrix	TransformationMatrix4x4	Specifies the mathematical transformation (translation, rotation, and scaling) between the prototypical geometry and the actual spatial position of the object.

Class IntegerBetween0and3

IntegerBetween0and3	
Definition:	IntegerBetween0and3 is a basic type for integer values, which are greater or equal than 0 and less or equal than 3. The type is used for encoding the LOD number.
Subclass Of:	<-- section,>>
Stereotype:	«BasicType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class IntervalValue

IntervalValue

Definition: IntervalValue is a code list used to specify a time period.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class MeasureOrNilReasonList

MeasureOrNilReasonList

Definition: MeasureOrNilReasonList is a basic type that represents a list of double values and/or nil reasons together with a unit of measurement.

Subclass Of: [DoubleOrNilReasonList](#)

Stereotype: «BasicType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
uom	UnitOfMeasure	Specifies the unit of measurement of the double values.

Class MimeTypeValue

MimeTypeValue
Definition: MimeTypeValue is a code list used to specify the MIME type of a referenced resource.
Subclass Of: <-- section,>>
Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class NilReasonEnumeration

NilReasonEnumeration
Definition: NilReasonEnumeration is a code list that enumerates the different nil reasons.
Subclass Of: <-- section,>>
Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class OccupantTypeValue

OccupantTypeValue

Definition: OccupantTypeValue is a code list used to classify occupants.
Subclass Of: <-- section,>>
StereoType: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class OtherRelationTypeValue

OtherRelationTypeValue

Definition:	OtherRelationTypeValue is a code list used to classify other types of city object relations.
Subclass Of:	RelationTypeValue
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class QualifiedAreaTypeValue

QualifiedAreaTypeValue

Definition:	QualifiedAreaTypeValue is a code list used to specify area types.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class QualifiedVolumeTypeValue

QualifiedVolumeTypeValue

Definition:	QualifiedVolumeTypeValue is a code list used to specify volume types.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class RelationTypeValue

RelationTypeValue

Definition:	RelationTypeValue is a code list used to classify city object relations.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TemporalRelationTypeValue

TemporalRelationTypeValue

Definition:	TemporalRelationTypeValue is a code list used to classify temporal city object relations.
Subclass Of:	RelationTypeValue
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TopologicRelationTypeValue

TopologicRelationTypeValue

Definition:	TopologicRelationTypeValue is a code list used to classify topological city object relations.
Subclass Of:	RelationTypeValue
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TransformationMatrix2x2

TransformationMatrix2x2

Definition:	TransformationMatrix2x2 is a 2 by 2 matrix represented as a list of four double values in row major order.
Subclass Of:	DoubleList
Stereotype:	«BasicType»
Constraint:	<code>lengthOfList (OCL): inv: self.list → size() = 4</code>

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TransformationMatrix3x4

TransformationMatrix3x4

Definition:	TransformationMatrix3x4 is a 3 by 4 matrix represented as a list of twelve double values in row major order.
Subclass Of:	DoubleList
Stereotype:	«BasicType»
Constraint:	lengthOfList (OCL): inv: self.list → size() = 12

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TransformationMatrix4x4

TransformationMatrix4x4

Definition:	TransformationMatrix4x4 is a 4 by 4 matrix represented as a list of sixteen double values in row major order.
Subclass Of:	DoubleList
Stereotype:	«BasicType»
Constraint:	lengthOfList (OCL): inv: self.list → size() = 16

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class AbstractGenericAttribute

AbstractGenericAttribute

Definition:	AbstractGenericAttribute is the abstract superclass for all types of generic attributes.
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class CityModelMember

CityModelMember

Definition:	CityModelMember is a union type that enumerates the different types of objects that can occur as members of a city model.
Subclass Of:	<-- section,>>
Stereotype:	«Union»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
appearanceMember	AbstractAppearance	Specifies the appearances of the CityModel.
cityObjectMember	AbstractCityObject	Specifies the city objects that are part of the CityModel.
featureMember	AbstractFeature	Specifies the feature objects that are part of the CityModel. It allows to include objects that are not derived from a class defined in the CityGML data model, but from the ISO 19109 class AnyFeature.

Attribute	Value type and multiplicity	Definition
versionMember	AbstractVersion	Specifies the different versions of the CityModel.
versionTransitionMember	AbstractVersionTransition	Specifies the transitions between the different versions of the CityModel.

Class DoubleOrNilReason

DoubleOrNilReason

- Definition: DoubleOrNilReason is a union type that allows for choosing between a double value and a nil reason.
- Subclass Of: <-- section,>>
- Stereotype: «Union»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
nilReason	NilReason	Specifies the nil reason.
value	Real	Specifies the double value.

Class ExternalReference

ExternalReference

- Definition: ExternalReference is a reference to a corresponding object in another information system, for example in the German cadastre (ALKIS), the German topographic information system (ATKIS), or the OS UK MasterMap®.
- Subclass Of: <-- section,>>
- Stereotype: «DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
informationSystem	URI [0..1]	Specifies the URI that points to the external information system.
relationType	URI [0..1]	Specifies an URI that additionally qualifies the ExternalReference. The URI can point to a definition from an external ontology (e.g. the sameAs relation from OWL) and allows for mapping the ExternalReference to RDF triples.
targetResource	URI	Specifies the URI that points to the object in the external information system.

Class NilReason

NilReason	
Definition:	NilReason is a union type that allows for choosing between two different types of nil reason.
Subclass Of:	<-- section,>>
Stereotype:	«Union»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
nilReasonEnumeration	NilReasonEnumeration	Indicates a nil reason that is provided in a code list.
URI	URI	Specifies a URI that points to a resource that describes the nil reason.

Class Occupancy

Occupancy

Definition:	Occupancy is an application-dependent indication of what is contained by a feature.
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
interval	IntervalValue [0..1]	Indicates the time period the occupants are contained by a feature.
numberOfOccupants	Integer	Indicates the number of occupants contained by a feature.
occupantType	OccupantTypeValue [0..1]	Indicates the specific type of the occupants that are contained by a feature.

Class QualifiedArea

QualifiedArea

Definition:	QualifiedArea is an application-dependent measure of the area of a space or of a thematic surface.
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
area	Area	Specifies the value of the QualifiedArea.
typeOfArea	QualifiedAreaTypeValue	Indicates the specific type of the QualifiedArea.

Class QualifiedVolume

QualifiedVolume

Definition: QualifiedVolume is an application-dependent measure of the volume of a space.

Subclass Of: <-- section,>>

Stereotype: «DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
typeOfVolume	QualifiedVolumeTypeValue	Indicates the specific type of the QualifiedVolume.
volume	Volume	Specifies the value of the QualifiedVolume.

Class RelativeToTerrain

RelativeToTerrain

Definition: RelativeToTerrain enumerates the spatial relations of a city object relative to terrain in a qualitative way.

Subclass Of: <-- section,>>

Stereotype:

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
entirelyAboveTerrain	<-- section,>>	Indicates that the city object is located entirely above the terrain.
substantially AboveTerrain	<-- section,>>	Indicates that the city object is for the most part located above the terrain.
substantially AboveAndBelowTerrain	<-- section,>>	Indicates that the city object is located half above the terrain and half below the terrain.
substantially BelowTerrain	<-- section,>>	Indicates that the city object is for the most part located below the terrain.
entirelyBelowTerrain	<-- section,>>	Indicates that the city object is located entirely below the terrain.

Class RelativeToWater

RelativeToWater	
Definition:	RelativeToWater enumerates the spatial relations of a city object relative to the water surface in a qualitative way.
Subclass Of:	<-- section,>>
Stereotype:	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
entirelyAboveWaterSurface	<-- section,>>	Indicates that the city object is located entirely above the water surface.
substantially AboveWaterSurface	<-- section,>>	Indicates that the city object is for the most part located above the water surface.

Attribute	Value type and multiplicity	Definition
substantially AboveAndBelowWaterSurface	<-- section,>>	Indicates that the city object is located half above the water surface and half below the water surface.
substantially BelowWaterSurface	<-- section,>>	Indicates that the city object is for the most part located below the water surface.
entirelyBelowWaterSurface	<-- section,>>	Indicates that the city object is located entirely below the water surface.
temporarilyAboveAndBelowWaterSurface	<-- section,>>	Indicates that city object is temporarily located above or below the water level, because the height of the water surface is varying.

Class SpaceType

SpaceType

Definition: SpaceType is an enumeration that characterises a space according to its closure properties.

Subclass Of: <-- section,>>

Stereotype:

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
closed	<-- section,>>	Indicates that the space has boundaries at the bottom, at the top, and on all sides.
open	<-- section,>>	Indicates that the space has at maximum a boundary at the bottom.
semiOpen	<-- section,>>	Indicates that the space has a boundary at the bottom and on at least one side.

Class XALAddressDetails

XALAddressDetails

Definition:	XALAddressDetails represents address details according to the OASIS xAL standard.
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

8.3.9. Additional Information

A detailed discussion of the CityGML Core can be found in the CityGML Best Practices document [here](#).

8.4. Appearance

Requirements Class

<http://www.opengis.net/spec/CityGML/3.0/req/req-class-appearance>

Target type	Conceptual Model
Dependency	/req/req-class-core

The Appearance module provides the representation of surface data, i.e. observable properties for surface geometry objects in the form of textures and material. Appearances are not limited to visual data but represent arbitrary categories called themes such as infrared radiation, noise pollution, or earthquake-induced structural stress. A single surface geometry object may have surface data for multiple themes. Similarly, surface data can be shared by multiple surface geometry objects (e.g. road paving).

Surface data that is constant across a surface is modelled as material based on the material definitions from the standards X3D and COLLADA. Surface data that depends on the exact location within the surface is modelled as texture. This can either be a parameterized texture, i.e. a texture that uses texture coordinates or a transformation matrix for parameterization, or a georeferenced texture, i.e. a texture that uses a planimetric projection. Each surface geometry object can have both, a material and a texture per theme and side. This allows for providing a constant

approximation and a complex measurement of a surface's property simultaneously.

The UML diagram of the Appearance module is illustrated in [Appearance UML Diagram](#). A detailed discussion of this Requirements Class can be found in the CityGML Best Practices document [here](#).

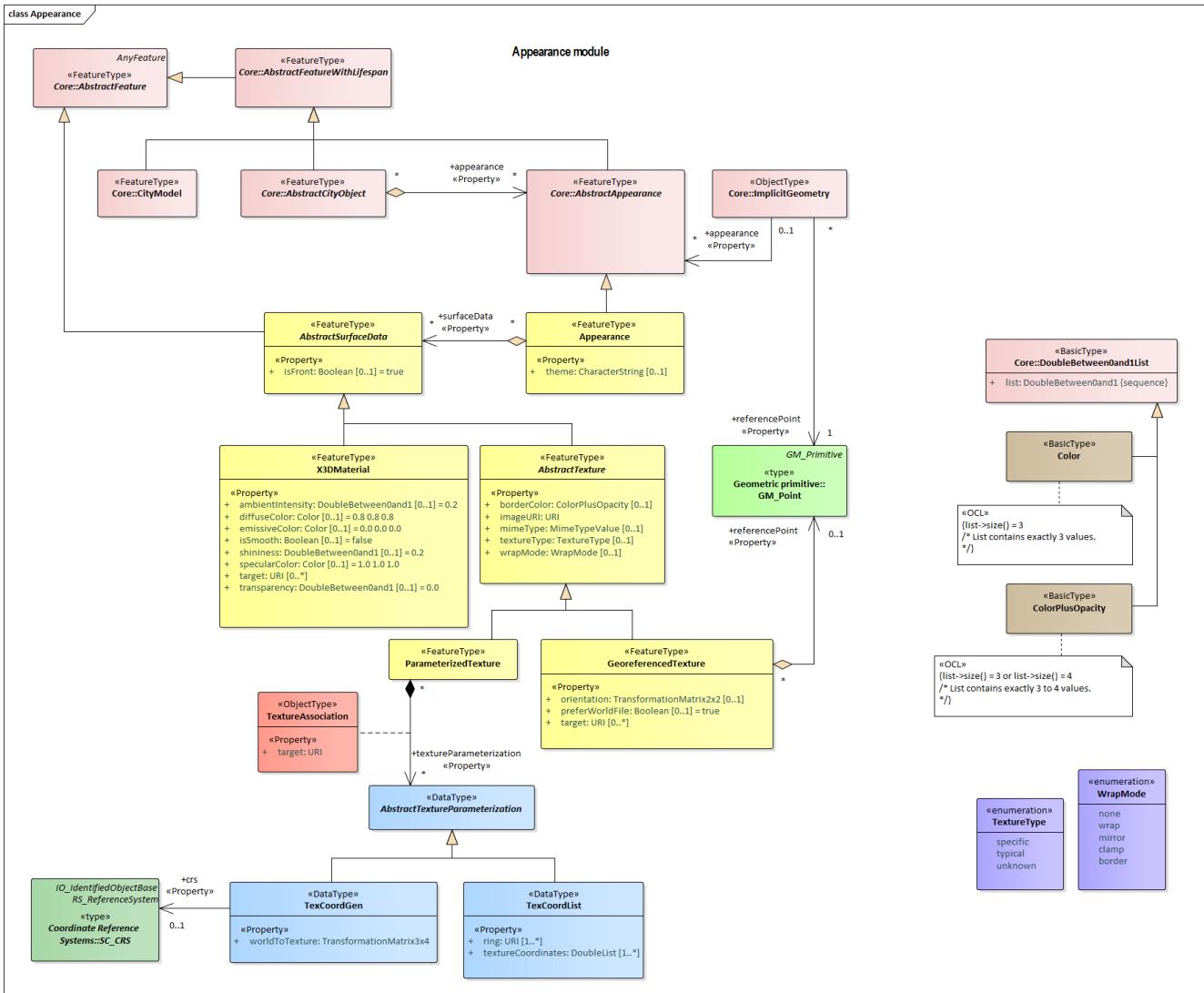


Figure 9. UML diagram of CityGML's appearance model.

8.4.1. Package

Package Appearance

Description: The Appearance module supports the modelling of the observable surface properties of CityGML features in the form of textures and material.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- a) If a stereotype value is "<<-- section,>>", change it to "none"
 - b) If a subclass value is not provided, set it to "none"
 - c) If a multiplicity value is not provided, set it to "1"
 - d) If the Role Name of a relation is not provided, delete the Role Name row
 - e) If the stereotype of an attribute is not provided, set it to [\[Property\]](#)
- 2) For all classes with the "CodeList" stereotype
- a) Copy the name and description into the table in the Code List section
 - b) Delete the class
- 3) If there are no code lists, then delete the Code List section
- 4) Delete these instructions when done

8.4.2. Classes

Class AbstractSurfaceData

AbstractSurfaceData

Definition:	AbstractSurfaceData is the abstract superclass for different kinds of textures and material.
Subclass Of:	AbstractFeature
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
isFront	Boolean [0..1]	Indicates whether the texture or material is assigned to the front side or the back side of the surface geometry object.

Class AbstractTexture

AbstractTexture

Definition:	AbstractTexture is the abstract superclass to represent the common attributes of the classes ParameterizedTexture and GeoreferencedTexture.
Subclass Of:	AbstractSurfaceData
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
borderColor	ColorPlusOpacity [0..1]	Specifies the color of that part of the surface that is not covered by the texture.
imageURI	URI	Specifies the URI that points to the external image data file.
MimeType	MimeTypeValue [0..1]	Specifies the MIME type of the external point cloud file.
textureType	TextureType [0..1]	Indicates the specific type of the texture.
wrapMode	WrapMode [0..1]	Specifies the behaviour of the texture when the texture is smaller than the surface to which it is applied.

Class Appearance

Appearance

Definition:	An Appearance is a collection of surface data, i.e. observable properties for surface geometry objects in the form of textures and material.
Subclass Of:	AbstractAppearance
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractSurfaceData	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
theme	CharacterString [0..1]	Specifies the topic of the Appearance. Each Appearance contains surface data for one theme only. Examples of themes are infrared radiation, noise pollution, or earthquake-induced structural stress.

Class Color

Color
<p>Definition: Color is a list of three double values between 0 and 1 defining an RGB color value.</p> <p>Subclass Of: DoubleBetween0and1List</p> <p>Stereotype: «BasicType»</p> <p>Constraint: lengthOfList (OCL): inv: self.list → size() = 3</p>

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class ColorPlusOpacity

ColorPlusOpacity
<p>Definition: Color is a list of four double values between 0 and 1 defining an RGBA color value. Opacity value of 0 means transparent.</p> <p>Subclass Of: DoubleBetween0and1List</p> <p>Stereotype: «BasicType»</p> <p>Constraint: lengthOfList (OCL): inv: self.list → size() = 3 or self.list → size() = 4</p>

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class GeoreferencedTexture

GeoreferencedTexture	
Definition:	A GeoreferencedTexture is a texture that uses a planimetric projection. It contains an implicit parameterization that is either stored within the image file, an accompanying world file or specified using the orientation and referencePoint elements.
Subclass Of:	AbstractTexture
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	GM_Point	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
orientation	TransformationMatrix2x2 [0..1]	Specifies the rotation and scaling of the image in form of a 2x2 matrix.
preferWorldFile	Boolean [0..1]	Indicates whether the georeference from the image file or the accompanying world file should be preferred.
target	URI [0..*]	Specifies the URI that points to the surface geometry objects to which the texture is applied.

Class ParameterizedTexture

ParameterizedTexture

Definition:	A ParameterizedTexture is a texture that uses texture coordinates or a transformation matrix for parameterization.
Subclass Of:	AbstractTexture
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractTextureParameterization	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TextureAssociation

TextureAssociation		
Definition:	TextureAssociation denotes the relation of a texture to a surface geometry object.	
Subclass Of:	<-- section,>>	
Stereotype:	«ObjectType»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
target	URI	Specifies the URI that points to the surface geometry object to which the texture is applied.

Class X3DMaterial

X3DMaterial

Definition:	X3DMaterial defines properties for surface geometry objects based on the material definitions from the standards X3D and COLLADA.
Subclass Of:	AbstractSurfaceData
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
ambientIntensity	DoubleBetween0and1 [0..1]	Specifies the minimum percentage of diffuseColor that is visible regardless of light sources.
diffuseColor	Color [0..1]	Specifies the color of the light diffusely reflected by the surface geometry object.
emissiveColor	Color [0..1]	Specifies the color of the light emitted by the surface geometry object.
isSmooth	Boolean [0..1]	Specifies which interpolation method is used for the shading of the surface geometry object. If the attribute is set to true, vertex normals should be used for shading (Gouraud shading). Otherwise, normals should be constant for a surface patch (flat shading).
shininess	DoubleBetween0and1 [0..1]	Specifies the sharpness of the specular highlight.
specularColor	Color [0..1]	Specifies the color of the light directly reflected by the surface geometry object.
target	URI [0..*]	Specifies the URI that points to the surface geometry objects to which the material is applied.
transparency	DoubleBetween0and1 [0..1]	Specifies the degree of transparency of the surface geometry object.

Class AbstractTextureParameterization

AbstractTextureParameterization

Definition:	AbstractTextureParameterization is the abstract superclass for different kinds of texture parameterizations.
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TexCoordGen

TexCoordGen

Definition:	TexCoordGen defines texture parameterization using a transformation matrix.
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

[SC_CRS](#)

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
worldToText ure	TransformationMatrix3x4	Specifies the 3x4 transformation matrix that defines the transformation between world coordinates and texture coordinates.

Class TexCoordList

TexCoordList

Definition:	TexCoordList defines texture parameterization using texture coordinates.
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
ring	URI [1..*]	Specifies the URIs that point to the LinearRings that are parameterized using the given texture coordinates.
textureCoordinates	DoubleList [1..*]	Specifies the coordinates of texture used for parameterization. The texture coordinates are provided separately for each LinearRing of the surface geometry object.

Class TextureType

TextureType

Definition:	TextureType enumerates the different texture types.
Subclass Of:	<-- section,>>
Stereotype:	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
specific	<– section,>>	Indicates that the texture is specific to a single surface.
typical	<– section,>>	Indicates that the texture is characteristic of a surface and can be used repeatedly.
unknown	<– section,>>	Indicates that the texture type is not known.

Class WrapMode

WrapMode

Definition: WrapMode enumerates the different fill modes for textures.

Subclass Of: <– section,>>

Stereotype:

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
none	<– section,>>	Indicates that the texture is applied to the surface "as is". The part of the surface that is not covered by the texture is shown fully transparent. [cf. COLLADA]
wrap	<– section,>>	Indicates that the texture is repeated until the surface is fully covered. [cf. COLLADA]
mirror	<– section,>>	Indicates that the texture is repeated and mirrored. [cf. COLLADA]
clamp	<– section,>>	Indicates that the texture is stretched to the edges of the surface. [cf. COLLADA]
border	<– section,>>	Indicates that the texture is applied to the surface "as is". The part of the surface that is not covered by the texture is filled with the RGBA color that is specified in the attribute borderColor. [cf. COLLADA]

8.4.3. Code Lists

Code List	Definition

8.4.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.5. Bridge

Requirements Class

<http://www.opengis.net/spec/CityGML/3.0/req/req-class-bridge>

Target type	Conceptual Model
Dependency	/req/req-class-core

The Bridge module provides the representation of thematic and spatial aspects of bridges. Bridges are movable or unmovable structures that span intervening natural or built elements. In this way, bridges allow the passage of pedestrians, animals, vehicles, and service(s) above obstacles or between two points at a height above ground. Bridges are represented in the UML model by the top-level feature type *Bridge*, which is the main class of the Bridge module. Bridges can physically or functionally be subdivided into bridge parts. In addition, bridges can be decomposed into structural elements, such as pylons, anchorages, cables, slabs, and beams.

The free space inside bridges is represented by rooms, which allows a virtual accessibility of bridges. Bridges can contain installations and furniture. Installations are permanent parts of a bridge that strongly affect the outer or inner appearance of the bridge and that cannot be moved. Examples are stairways, signals, railings, and lamps. Furniture, in contrast, represent moveable objects of a bridge, like signs, art works, and benches. Bridges can be bounded by different types of surfaces. In this way, the outer structure of bridges can be differentiated semantically into wall surfaces, roof surfaces, ground surfaces, outer floor surfaces, and outer ceiling surfaces, whereas the visible surface of rooms can be structured into interior wall surfaces, floor surfaces, and ceiling surfaces. Furthermore, the openings of bridges, i.e. windows and doors, can be represented including their corresponding surfaces.

The UML diagram of the Bridge module is depicted in [Bridge UML Diagram](#). The Bridge module inherits concepts from the Construction module ([cf. Section Construction](#)). The Construction module defines objects that are common to all types of construction, such as the different surface types and the openings. A detailed discussion of Requirements Class Bridge can be found in the CityGML Best Practices document [here](#).

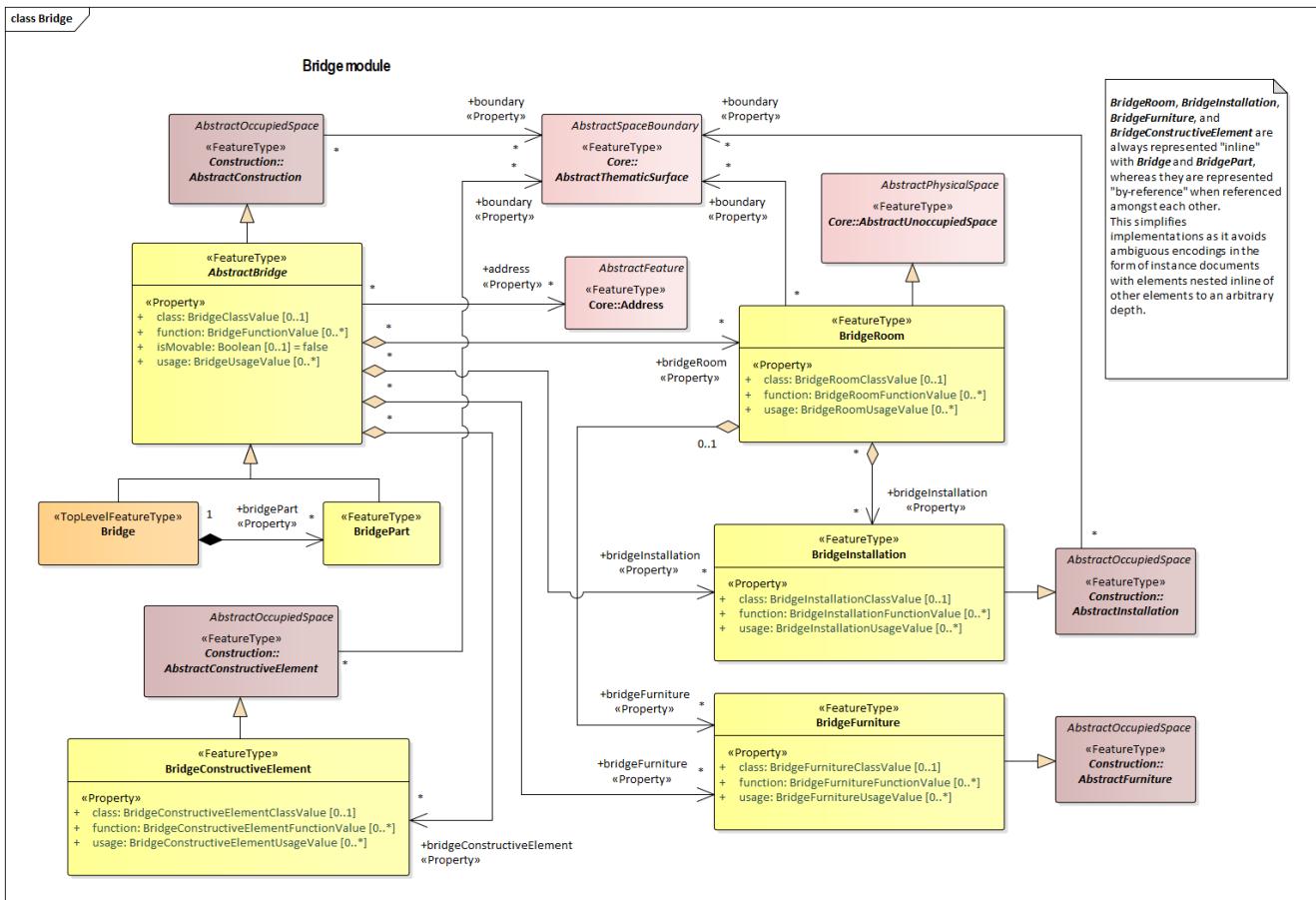


Figure 10. UML diagram of the Bridge Model.

8.5.1. Package

Package Bridge

Description: The Bridge module supports representation of thematic and spatial aspects of bridges, bridge parts, bridge installations, and interior bridge structures.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- If a stereotype value is "<<-- section,>>", change it to "none"
- If a subclass value is not provided, set it to "none"
- If a multiplicity value is not provided, set it to "1"
- If the Role Name of a relation is not provided, delete the Role Name row
- If the stereotype of an attribute is not provided, set it to [Property]

2) For all classes with the "CodeList" stereotype

- Copy the name and description into the table in the Code List section

b) Delete the class
3) If there are no code lists, then delete the Code List section
4) Delete these instructions when done

8.5.2. Classes

Class AbstractBridge

AbstractBridge	
Definition:	AbstractBridge is an abstract superclass representing the common attributes and associations of the classes Bridge and BridgePart.
Subclass Of:	AbstractConstruction
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	BridgeRoom	
	Address	
	BridgeConstructiveElement	
	BridgeInstallation	
	BridgeFurniture	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	BridgeClassName [0..1]	Indicates the specific type of the Bridge or BridgePart.
function	BridgeFunctionName [0..*]	Specifies the intended purposes of the Bridge or BridgePart.
isMovable	Boolean [0..1]	Indicates whether the Bridge or BridgePart can be moved to allow for watercraft to pass.
usage	BridgeUsageName [0..*]	Specifies the actual uses of the Bridge or BridgePart.

Class Bridge

Bridge

Definition: A Bridge represents a structure that affords the passage of pedestrians, animals, vehicles, and service(s) above obstacles or between two points at a height above ground. [cf. ISO 6707-1]

Subclass Of: [AbstractBridge](#)

Stereotype: «TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	BridgePart	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class BridgeClassValue

BridgeClassValue

Definition: BridgeClassValue is a code list used to further classify a Bridge.

Subclass Of: <-- section,-->

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class BridgeConstructiveElement

BridgeConstructiveElement

Definition:	A BridgeConstructiveElement is an element of a bridge which is essential from a structural point of view. Examples are pylons, anchorages, slabs, beams.
Subclass Of:	AbstractConstructiveElement
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	BridgeConstructiveElement classValue [0..1]	Indicates the specific type of the BridgeConstructiveElement.
function	BridgeConstructiveElement functionValue [0..*]	Specifies the intended purposes of the BridgeConstructiveElement.
usage	BridgeConstructiveElement UsageValue [0..*]	Specifies the actual uses of the BridgeConstructiveElement.

Class BridgeConstructiveElementClassValue

BridgeConstructiveElementClassValue

Definition:	BridgeConstructiveElementClassValue is a code list used to further classify a BridgeConstructiveElement.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BridgeConstructiveElementFunctionValue

BridgeConstructiveElementFunctionValue

Definition:	BridgeConstructiveElementFunctionValue is a code list that enumerates the different purposes of a BridgeConstructiveElement.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BridgeConstructiveElementUsageValue

BridgeConstructiveElementUsageValue

Definition:	BridgeConstructiveElementUsageValue is a code list that enumerates the different uses of a BridgeConstructiveElement.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BridgeFunctionValue

BridgeFunctionValue

Definition:	BridgeFunctionValue is a code list that enumerates the different purposes of a Bridge.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BridgeFurniture

BridgeFurniture

Definition:	A BridgeFurniture is an equipment for occupant use, usually not fixed to the bridge. [cf. ISO 6707-1]
Subclass Of:	AbstractFurniture
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	BridgeFurnitureClassValue [0..1]	Indicates the specific type of the BridgeFurniture.
function	BridgeFurnitureFunctionValue [0..*]	Specifies the intended purposes of the BridgeFurniture.
usage	BridgeFurnitureUsageValue [0..*]	Specifies the actual uses of the BridgeFurniture.

Class BridgeFurnitureClassValue

BridgeFurnitureClassValue

Definition: BridgeFurnitureClassValue is a code list used to further classify a BridgeFurniture.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BridgeFurnitureFunctionValue

BridgeFurnitureFunctionValue

Definition: BridgeFurnitureFunctionValue is a code list that enumerates the different purposes of a BridgeFurniture.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BridgeFurnitureUsageValue

BridgeFurnitureUsageValue

Definition:	BridgeFurnitureUsageValue is a code list that enumerates the different uses of a BridgeFurniture.
Subclass Of:	<-- section,-->
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BridgeInstallation

BridgeInstallation

Definition:	A BridgeInstallation is a permanent part of a Bridge (inside and/or outside) which does not have the significance of a BridgePart. In contrast to BridgeConstructiveElements, a BridgeInstallation is not essential from a structural point of view. Examples are stairs, antennas or railways.
Subclass Of:	AbstractInstallation
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	BridgeInstallationClassValue [0..1]	Indicates the specific type of the BridgeInstallation.
function	BridgeInstallationFunctionValue [0..*]	Specifies the intended purposes of the BridgeInstallation.
usage	BridgeInstallationUsageValue [0..*]	Specifies the actual uses of the BridgeInstallation.

Class BridgeInstallationClassValue

BridgeInstallationClassValue

Definition: BridgeInstallationClassValue is a code list used to further classify a BridgeInstallation.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BridgeInstallationFunctionValue

BridgeInstallationFunctionValue

Definition: BridgeInstallationFunctionValue is a code list that enumerates the different purposes of a BridgeInstallation.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BridgeInstallationUsageValue

BridgeInstallationUsageValue

Definition:	BridgeInstallationUsageValue is a code list that enumerates the different uses of a BridgeInstallation.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BridgePart

BridgePart

Definition:	A BridgePart is a physical or functional subdivision of a Bridge. It would be considered a Bridge, if it were not part of a collection of other BridgeParts.
Subclass Of:	AbstractBridge
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BridgeRoom

BridgeRoom

Definition:	A BridgeRoom is a space within a Bridge or BridgePart intended for human occupancy (e.g. a place of work or recreation) and/or containment (storage) of animals or things. A BridgeRoom is bounded physically and/or virtually (e.g. by ClosureSurfaces or GenericSurfaces).
Subclass Of:	AbstractUnoccupiedSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	BridgeInstallation	
	AbstractThematicSurface	
	BridgeFurniture	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	BridgeRoomClassValue [0..1]	Indicates the specific type of the BridgeRoom.
function	BridgeRoomFunctionValue [0..*]	Specifies the intended purposes of the BridgeRoom.
usage	BridgeRoomUsageValue [0..*]	Specifies the actual uses of the BridgeRoom.

Class BridgeRoomClassValue

BridgeRoomClassValue

Definition:	BridgeRoomClassValue is a code list used to further classify a BridgeRoom.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class BridgeRoomFunctionValue

BridgeRoomFunctionValue

Definition: BridgeRoomFunctionValue is a code list that enumerates the different purposes of a BridgeRoom.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class BridgeRoomUsageValue

BridgeRoomUsageValue

Definition: BridgeRoomUsageValue is a code list that enumerates the different uses of a BridgeRoom.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class BridgeUsageValue

BridgeUsageValue

Definition: BridgeUsageValue is a code list that enumerates the different uses of a Bridge.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

8.5.3. Code Lists

Code List	Definition
-----------	------------

8.5.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.6. Building

Requirements Class

<http://www.opengis.net/spec/CityGML/3.0/req/req-class-building>

Target type	Conceptual Model
Dependency	/req/req-class-core

The Building module provides the representation of thematic and spatial aspects of buildings. Buildings are free-standing, self-supporting constructions that are roofed and usually walled, and that can be entered by humans and are normally designed to stand permanently in one place. Buildings are intended for human occupancy (e.g. a place of work or recreation), habitation and/or shelter of humans, animals or things. Buildings are represented in the UML model by the top-level feature type *Building*, which is the main class of the Building module. Buildings can physically or functionally be subdivided into building parts and logically into storeys and building units (e.g. apartments). In addition, buildings can be decomposed into structural elements, such as walls,

slabs, staircases, and beams.

The interior of buildings is represented by rooms. This allows a virtual accessibility of buildings, e.g. for visitor information in a museum (“Location Based Services”), the examination of accommodation standards or the presentation of daylight illumination of a building. Buildings can contain installations and furniture. Installations are permanent parts of a building that strongly affect the outer or inner appearance of the building and that cannot be moved. Examples are balconies, chimneys, dormers or stairs. Furniture, in contrast, represent moveable objects inside a building, like tables and chairs. Buildings can be bounded by different types of surfaces. In this way, the outer façade of buildings can be differentiated semantically into wall surfaces, roof surfaces, ground surfaces, outer floor surfaces, and outer ceiling surfaces, whereas the visible surface of rooms can be structured into interior wall surfaces, floor surfaces, and ceiling surfaces. Furthermore, the openings of buildings, i.e. windows and doors, can be represented including their corresponding surfaces.

The UML diagram of the building module is depicted in [Building UML Diagram](#). The Building module inherits concepts from the Construction module (cf. [Section Construction](#)). The Construction module defines objects that are common to all types of construction, such as the different surface types and the openings. A detailed discussion of the Requirements Class Building can be found in the CityGML Best Practices document [here](#).

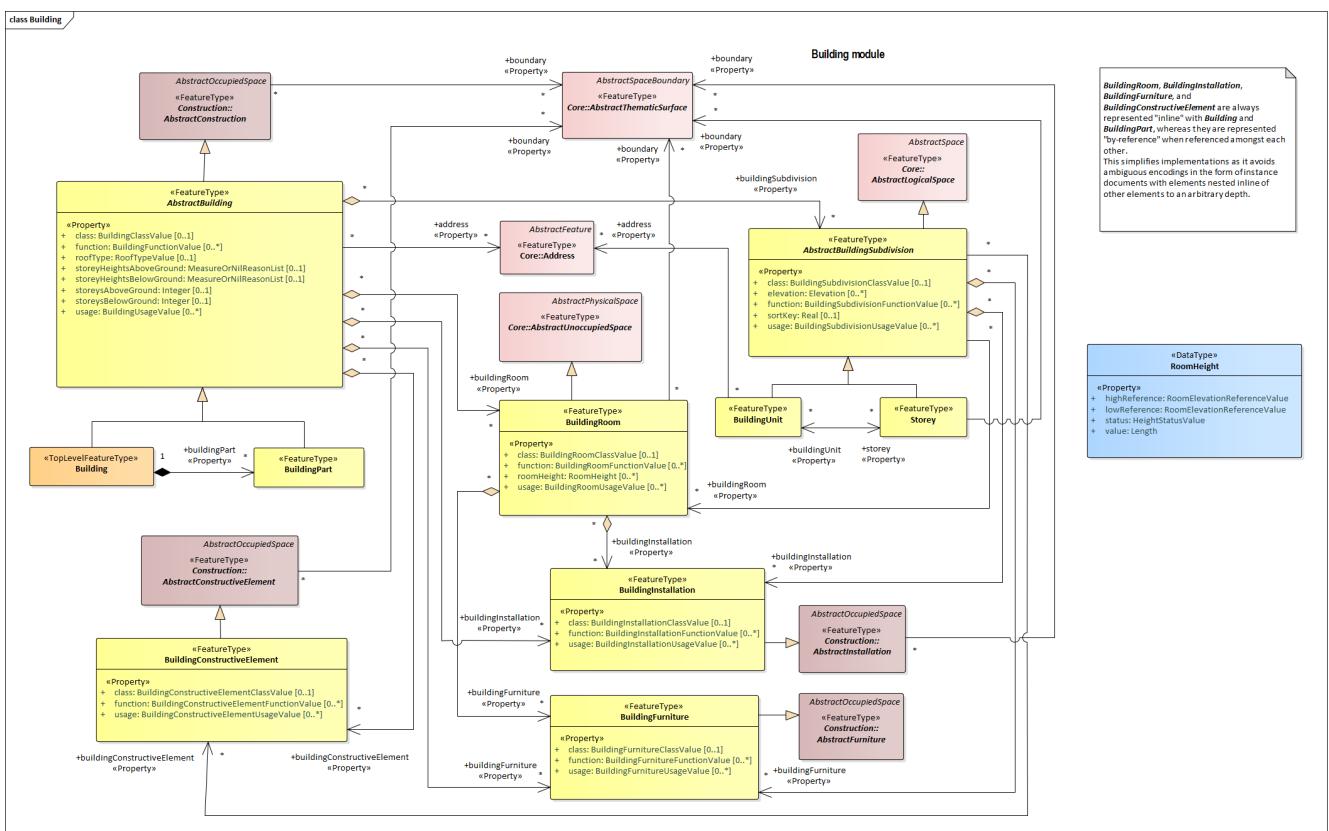


Figure 11. UML diagram of CityGML’s building model.

8.6.1. Package

Package Building

Description:	The Building module supports representation of thematic and spatial aspects of buildings, building parts, building installations, building subdivisions, and interior building structures.
Parent Package:	CityGML
Stereotype:	«ApplicationSchema»

Editing instructions:

- 1) For all classes
 - a) If a stereotype value is "<<-- section,>>", change it to "none"
 - b) If a subclass value is not provided, set it to "none"
 - c) If a multiplicity value is not provided, set it to "1"
 - d) If the Role Name of a relation is not provided, delete the Role Name row
 - e) If the stereotype of an attribute is not provided, set it to [Property]
- 2) For all classes with the "CodeList" stereotype
 - a) Copy the name and description into the table in the Code List section
 - b) Delete the class
- 3) If there are no code lists, then delete the Code List section
- 4) Delete these instructions when done

8.6.2. Classes

Class AbstractBuilding

AbstractBuilding

Definition:	AbstractBuilding is an abstract superclass representing the common attributes and associations of the classes Building and BuildingPart.
Subclass Of:	AbstractConstruction
StereoType:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	BuildingConstructiveElement	
	Address	

	AbstractBuildingSubdivision	
	BuildingFurniture	
	BuildingRoom	
	BuildingInstallation	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	BuildingClassValue [0..1]	Indicates the specific type of the Building or BuildingPart.
function	BuildingFunctionValue [0..*]	Specifies the intended purposes of the Building or BuildingPart.
roofType	RoofTypeValue [0..1]	Indicates the shape of the roof of the Building or BuildingPart.
storeyHeights AboveGround	MeasureOrNilReasonList [0..1]	Lists the heights of each storey above ground. The first value in the list denotes the height of the storey closest to the ground level, the last value denotes the height furthest away.
storeyHeights BelowGround	MeasureOrNilReasonList [0..1]	Lists the height of each storey below ground. The first value in the list denotes the height of the storey closest to the ground level, the last value denotes the height furthest away.
storeysAbove Ground	Integer [0..1]	Indicates the number of storeys positioned above ground level.
storeysBelow Ground	Integer [0..1]	Indicates the number of storeys positioned below ground level.
usage	BuildingUsageValue [0..*]	Specifies the actual uses of the Building or BuildingPart.

Class AbstractBuildingSubdivision

AbstractBuildingSubdivision

Definition: AbstractBuildingSubdivision is the abstract superclass for different kinds of logical building subdivisions.

Subclass Of: [AbstractLogicalSpace](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	BuildingInstallation	
	BuildingFurniture	
	BuildingRoom	
	BuildingConstructiveElement	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	BuildingSubdivisionClassValue [0..1]	Indicates the specific type of the building subdivision.
elevation	Elevation [0..*]	Specifies qualified elevations of the building subdivision in relation to a well-defined surface which is commonly taken as origin (e.g. geoid or water level). [cf. INSPIRE]
function	BuildingSubdivisionFunctionValue [0..*]	Specifies the intended purposes of the building subdivision.
sortKey	Real [0..1]	Defines an order among the objects that belong to the building subdivision. An example is the sorting of storeys.
usage	BuildingSubdivisionUsageValue [0..*]	Specifies the actual uses of the building subdivision.

Class Building

Building	
Definition:	A Building is a free-standing, self-supporting construction that is roofed, usually walled, and can be entered by humans and is normally designed to stand permanently in one place. It is intended for human occupancy (e.g. a place of work or recreation), habitation and/or shelter of humans, animals or things.
Subclass Of:	AbstractBuilding
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	BuildingPart	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class BuildingClassValue

BuildingClassValue		
Definition:	BuildingClassValue	is a code list used to further classify a Building.
Subclass Of:	<-- section,>>	
Stereotype:	«CodeList»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class BuildingConstructiveElement

BuildingConstructiveElement		
Definition:	A BuildingConstructiveElement	is an element of a Building which is essential from a structural point of view. Examples are walls, slabs, staircases, beams.
Subclass Of:	AbstractConstructiveElement	
Stereotype:	«FeatureType»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	BuildingConstructiveElement tClassValue [0..1]	Indicates the specific type of the BuildingConstructiveElement.
function	BuildingConstructiveElement tFunctionValue [0..*]	Specifies the intended purposes of the BuildingConstructiveElement.
usage	BuildingConstructiveElement tUsageValue [0..*]	Specifies the actual uses of the BuildingConstructiveElement.

Class BuildingConstructiveElementClassValue

BuildingConstructiveElementClassValue

Definition: BuildingConstructiveElementClassValue is a code list used to further classify a BuildingConstructiveElement.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BuildingConstructiveElementFunctionValue

BuildingConstructiveElementFunctionValue

Definition: BuildingConstructiveElementFunctionValue is a code list that enumerates the different purposes of a BuildingConstructiveElement.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class BuildingConstructiveElementUsageValue

BuildingConstructiveElementUsageValue

- Definition: BuildingConstructiveElementUsageValue is a code list that enumerates the different uses of a BuildingConstructiveElement.
- Subclass Of: <-- section,>>
- Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class BuildingFunctionValue

BuildingFunctionValue

- Definition: BuildingFunctionValue is a code list that enumerates the different purposes of a Building.
- Subclass Of: <-- section,>>
- Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
Class BuildingFurniture		
BuildingFurniture		
Definition:	A BuildingFurniture is an equipment for occupant use, usually not fixed to the building. [cf. ISO 6707-1]	
Subclass Of:	AbstractFurniture	
Stereotype:	«FeatureType»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	BuildingFurnitureClassValue [0..1]	Indicates the specific type of the BuildingFurniture.
function	BuildingFurnitureFunctionValue [0..*]	Specifies the intended purposes of the BuildingFurniture.
usage	BuildingFurnitureUsageValue [0..*]	Specifies the actual uses of the BuildingFurniture.

Class BuildingFurnitureClassValue

BuildingFurnitureClassValue

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class BuildingFurnitureFunctionValue

BuildingFurnitureFunctionValue		
Definition:	BuildingFurnitureFunctionValue	is a code list that enumerates the different purposes of a BuildingFurniture.
Subclass Of:	<-- section,>>	
Stereotype:	«CodeList»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class BuildingFurnitureUsageValue

BuildingFurnitureUsageValue		
Definition:	BuildingFurnitureUsageValue	is a code list that enumerates the different uses of a BuildingFurniture.
Subclass Of:	<-- section,>>	
Stereotype:	«CodeList»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
Class BuildingInstallation		
BuildingInstallation		
Definition:	A BuildingInstallation is a permanent part of a Building (inside and/or outside) which has not the significance of a BuildingPart. Examples are stairs, antennas, balconies or small roofs.	
Subclass Of:	AbstractInstallation	
Stereotype:	«FeatureType»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	BuildingInstallationClassValue [0..1]	Indicates the specific type of the BuildingInstallation.
function	BuildingInstallationFunctionValue [0..*]	Specifies the intended purposes of the BuildingInstallation.
usage	BuildingInstallationUsageValue [0..*]	Specifies the actual uses of the BuildingInstallation.

Class BuildingInstallationClassValue

BuildingInstallationClassValue

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class BuildingInstallationFunctionValue

BuildingInstallationFunctionValue

Definition:	BuildingInstallationFunctionValue is a code list that enumerates the different purposes of a BuildingInstallation.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class BuildingInstallationUsageValue

BuildingInstallationUsageValue

Definition:	BuildingInstallationUsageValue is a code list that enumerates the different uses of a BuildingInstallation.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
Class BuildingPart		
BuildingPart		
Definition:	A BuildingPart is a physical or functional subdivision of a Building. It would be considered a Building, if it were not part of a collection of other BuildingParts.	
Subclass Of:	AbstractBuilding	
Stereotype:	«FeatureType»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
Attributes		

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
Class BuildingRoom		
BuildingRoom		
Definition:	A BuildingRoom is a space within a Building or BuildingPart intended for human occupancy (e.g. a place of work or recreation) and/or containment of animals or things. A BuildingRoom is bounded physically and/or virtually (e.g. by ClosureSurfaces or GenericSurfaces).	
Subclass Of:	AbstractUnoccupiedSpace	
Stereotype:	«FeatureType»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	BuildingFurniture	

	AbstractThematicSurface	
	BuildingInstallation	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	BuildingRoomClassValue [0..1]	Indicates the specific type of the BuildingRoom.
function	BuildingRoomFunctionValue [0..*]	Specifies the intended purposes of the BuildingRoom.
roomHeight	RoomHeight [0..*]	Specifies qualified heights of the BuildingRoom.
usage	BuildingRoomUsageValue [0..*]	Specifies the actual uses of the BuildingRoom.

Class BuildingRoomClassValue

BuildingRoomClassValue	
Definition:	BuildingRoomClassValue is a code list used to further classify a BuildingRoom.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class BuildingRoomFunctionValue

BuildingRoomFunctionValue	

Definition:	BuildingRoomFunctionValue is a code list that enumerates the different purposes of a BuildingRoom.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BuildingRoomUsageValue

BuildingRoomUsageValue

Definition:	BuildingRoomUsageValue is a code list that enumerates the different uses of a BuildingRoom.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BuildingSubdivisionClassValue

BuildingSubdivisionClassValue

Definition:	BuildingSubdivisionClassValue is a code list used to further classify a BuildingSubdivision.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BuildingSubdivisionFunctionValue

BuildingSubdivisionFunctionValue

Definition:	BuildingSubdivisionFunctionValue is a code list that enumerates the different purposes of a BuildingSubdivision.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class BuildingSubdivisionUsageValue

BuildingSubdivisionUsageValue

Definition:	BuildingSubdivisionUsageValue is a code list that enumerates the different uses of a BuildingSubdivision.
Subclass Of:	<-- section,-->
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class BuildingUnit

BuildingUnit

Definition:	A BuildingUnit is a logical subdivision of a Building. BuildingUnits are formed according to some homogeneous property like function, ownership, management, or accessibility. They may be separately sold, rented out, inherited, managed, etc.
Subclass Of:	AbstractBuildingSubdivision
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	Address	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class BuildingUsageValue

BuildingUsageValue

Definition:	BuildingUsageValue is a code list that enumerates the different uses of a Building.
Subclass Of:	<-- section,-->
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class RoofTypeValue

RoofTypeValue

Definition:	RoofTypeValue is a code list that enumerates different roof types.
Subclass Of:	<-- section,-->
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class RoomElevationReferenceValue

RoomElevationReferenceValue

Definition:	RoomElevationReferenceValue is a code list that enumerates the different elevation reference levels used to measure room heights.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class Storey

Storey

Definition:	A Storey is a horizontal section of a Building.
Subclass Of:	AbstractBuildingSubdivision
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	BuildingUnit	
	AbstractThematicSurface	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class RoomHeight

RoomHeight

Definition:	The RoomHeight represents a vertical distance (measured or estimated) between a low reference and a high reference. [cf. INSPIRE]
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
highReference	RoomElevationReferenceValue	Indicates the high point used to calculate the value of the room height.
lowReference	RoomElevationReferenceValue	Indicates the low point used to calculate the value of the room height.
status	HeightStatusValue	Indicates the way the room height has been captured.
value	Length	Specifies the value of the room height.

8.6.3. Code Lists

Code List	Definition

8.6.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.7. City Furniture

Requirements Class

<http://www.opengis.net/spec/CityGML/3.0/req/req-class-cityfurniture>

Target type	Conceptual Model
Dependency	/req/req-class-core

The CityFurniture module provides the representation of objects or pieces of equipment that are installed in the outdoor environment for various purposes, such as decoration, explanation or control. City furniture objects are relatively small, immovable objects and usually are of

stereotypical form. Examples include road signs, traffic signals, bicycle racks, street lamps, fountains, flower buckets, advertising columns, and benches.

City furniture is represented in the UML model by the top-level feature type *CityFurniture*, which is also the only class of the CityFurniture module.

The UML diagram of the CityFurniture module is depicted in the [City Furniture UML Diagram](#). A detailed discussion of this Requirements Class can be found in the CityGML Best Practices document [here](#).

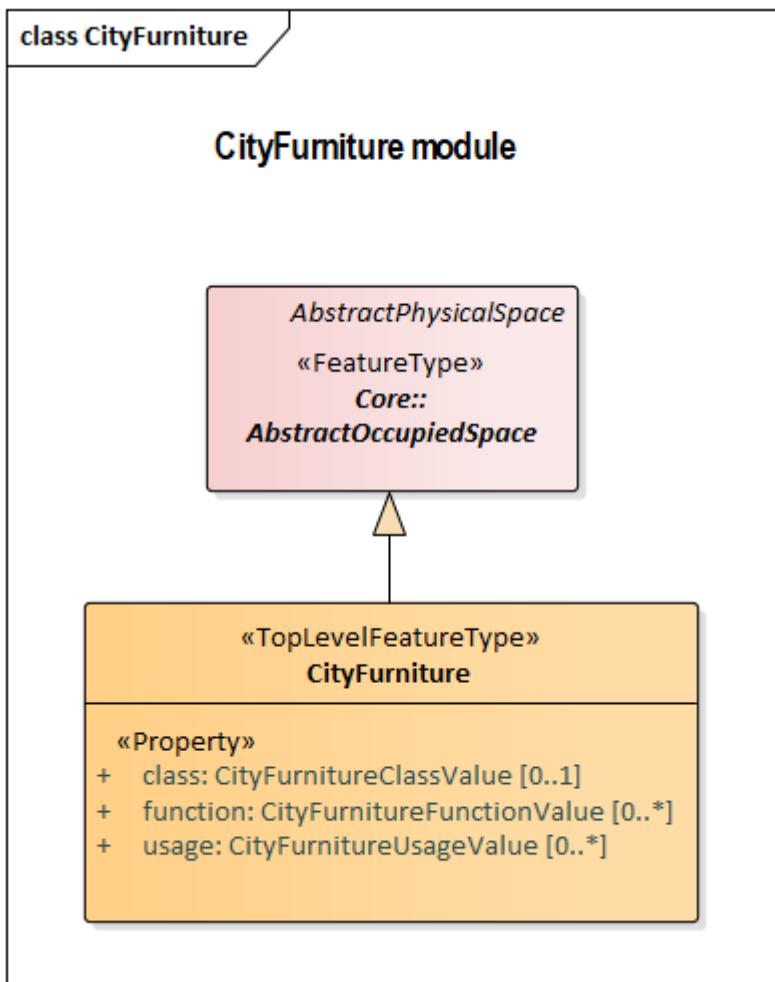


Figure 12. UML diagram of CityGML's City Furniture model.

8.7.1. Package

Package CityFurniture

Description: The CityFurniture module supports representation of city furniture objects. City furniture objects are immovable objects like lanterns, traffic signs, advertising columns, benches, or bus stops that can be found in traffic areas, residential areas, on squares, or in built-up areas.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- a) If a stereotype value is "<<-- section,>>", change it to "none"
- b) If a subclass value is not provided, set it to "none"
- c) If a multiplicity value is not provided, set it to "1"
- d) If the Role Name of a relation is not provided, delete the Role Name row
- e) If the stereotype of an attribute is not provided, set it to [Property]

2) For all classes with the "CodeList" stereotype

- a) Copy the name and description into the table in the Code List section

- b) Delete the class

3) If there are no code lists, then delete the Code List section

4) Delete these instructions when done

8.7.2. Classes

Class CityFurniture

CityFurniture

Definition: CityFurniture is an object or piece of equipment installed in the outdoor environment for various purposes. Examples include street signs, traffic signals, street lamps, benches, fountains.

Subclass Of: [AbstractOccupiedSpace](#)

Stereotype: «TopLevelFeatureType»

Constraint: sdf (OCL): inv: function='sdf'

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	CityFurnitureClassValue [0..1]	Indicates the specific type of the CityFurniture.
function	CityFurnitureFunctionValue [0..*]	Specifies the intended purposes of the CityFurniture.

Attribute	Value type and multiplicity	Definition
usage	CityFurnitureUsageValue [0..*]	Specifies the actual uses of the CityFurniture.

Class CityFurnitureClassValue

CityFurnitureClassValue

Definition: CityFurnitureClassValue is a code list used to further classify a CityFurniture.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class CityFurnitureFunctionValue

CityFurnitureFunctionValue

Definition: CityFurnitureFunctionValue is a code list that enumerates the different purposes of a CityFurniture.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class CityFurnitureUsageValue

CityFurnitureUsageValue

Definition: CityFurnitureUsageValue is a code list that enumerates the different uses of a CityFurniture.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

8.7.3. Code Lists

Code List	Definition
-----------	------------

8.7.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.8. City Object Group

Requirements Class

<http://www.opengis.net/spec/CityGML/3.0/req/req-class-cityobjectgroup>

Target type	Conceptual Model
Dependency	/req/req-class-core

The CityObjectGroup module provides the application-specific aggregation of city objects according to some user-defined criteria. Examples for groups are the buildings in a specific region, the result of a query, or objects put together for visualization purposes. Each member of a group may be qualified by a role name, reflecting the role each city object plays in the context of the group. City object groups are represented in the UML model by the top-level feature type *CityObjectGroup*, which is the main class of the CityObjectGroup module.

City object groups can be linked to other city objects, the so-called parent objects, which allows for modelling a generic hierarchical grouping concept. In addition, as city object groups represent city objects themselves, a group may become a member of another group realizing recursive aggregation in this way.

The UML diagram of the CityObjectGroup module is depicted in [City Object Group UML Diagram](#). A detailed discussion of this Requirements Class can be found in the CityGML Best Practices document [here](#).

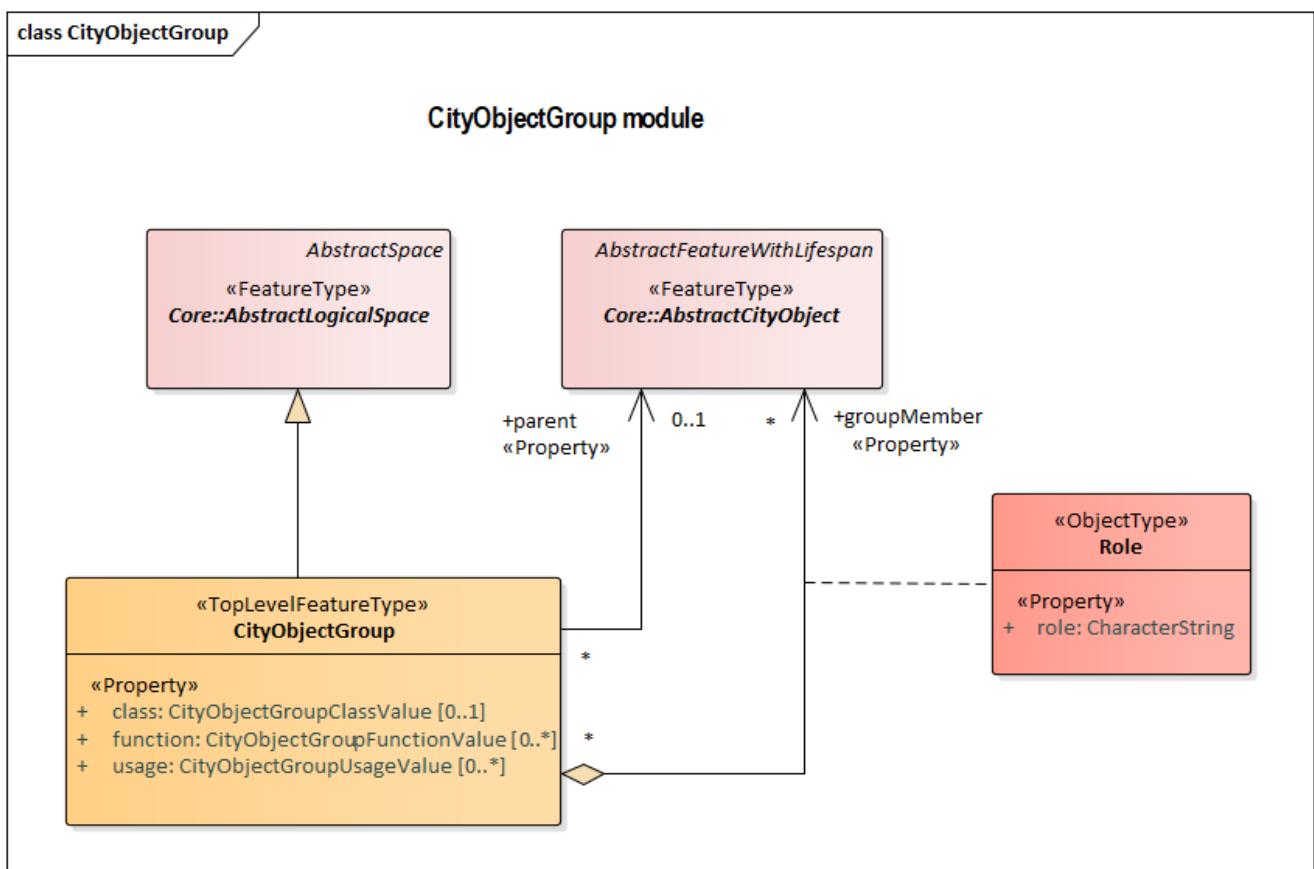


Figure 13. UML diagram of the City Object Group Model.

8.8.1. Package

Package CityObjectGroup

Description: The CityObjectGroup module supports grouping of city objects. Arbitrary city objects may be aggregated in groups according to user-defined criteria. A group may be further classified by application-specific attributes.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

a) If a stereotype value is "<<-- section,>>", change it to "none"

- b) If a subclass value is not provided, set it to "none"
 - c) If a multiplicity value is not provided, set it to "1"
 - d) If the Role Name of a relation is not provided, delete the Role Name row
 - e) If the stereotype of an attribute is not provided, set it to [Property]
- 2) For all classes with the "CodeList" stereotype
- a) Copy the name and description into the table in the Code List section
 - b) Delete the class
- 3) If there are no code lists, then delete the Code List section
- 4) Delete these instructions when done

8.8.2. Classes

Class CityObjectGroup

CityObjectGroup

Definition:	A CityObjectGroup represents an application-specific aggregation of city objects according to some user-defined criteria. Examples for groups are the buildings in a specific region, the result of a query, or objects put together for visualization purposes. Each member of a group may be qualified by a role name, reflecting the role each city object plays in the context of the group.
Subclass Of:	AbstractLogicalSpace
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractCityObject	
	AbstractCityObject	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	CityObjectGroupClassValue [0..1]	Indicates the specific type of the CityObjectGroup.
function	CityObjectGroupFunctionVal ue [0..*]	Specifies the intended purposes of the CityObjectGroup.

Attribute	Value type and multiplicity	Definition
usage	CityObjectGroupUsageValue [0..*]	Specifies the actual usages of the CityObjectGroup.

Class CityObjectGroupClassValue

CityObjectGroupClassValue

Definition: CityObjectGroupClassValue is a code list used to further classify a CityObjectGroup.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class CityObjectGroupFunctionValue

CityObjectGroupFunctionValue

Definition: CityObjectGroupFunctionValue is a code list that enumerates the different purposes of a CityObjectGroup.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class CityObjectGroupUsageValue

CityObjectGroupUsageValue

Definition: CityObjectGroupUsageValue is a code list that enumerates the different uses of a CityObjectGroup.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class Role

Role

Definition: Role qualifies the function of a city object within the CityObjectGroup.

Subclass Of: <-- section,>>

Stereotype: «ObjectType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
role	CharacterString	Describes the role the city object plays within the CityObjectGroup.

8.8.3. Code Lists

Code List	Definition

8.8.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.9. Construction

Requirements Class	
http://www.opengis.net/spec/CityGML/3.0/req/req-class-construction	
Target type	Conceptual Model
Dependency	/req/req-class-core

The Construction module defines concepts that are common to all kinds of constructions. Constructions are objects that are manufactured by humans from construction materials, are connected to earth and are intended to be permanent. The Construction module focuses on as-built representations of constructions and integrates all concepts that are similar over different types of constructions, in particular buildings, bridges, and tunnels. In addition, for representing man-made structures that are neither buildings, nor bridges, nor tunnels so-called other constructions (e.g. large chimneys or city walls) can be defined.

Furniture, installations, and constructive elements are further concepts that are defined in the Construction module. Installations are permanent parts of a construction that strongly affect the outer or inner appearance of the construction and that cannot be moved (e.g. balconies, chimneys, or stairs), whereas furniture represent moveable objects of a construction (e.g. tables and chairs). Constructive elements allow for decomposing a construction into volumetric components, such as walls, beams, and slabs. Constructions and constructive elements can be bounded by different types of surfaces. In this way, the outer structure of constructions and constructive elements can be differentiated semantically into wall surfaces, roof surfaces, ground surfaces, outer floor surfaces, and outer ceiling surfaces, whereas the visible surface of interior spaces can be structured into interior wall surfaces, floor surfaces, and ceiling surfaces. Furthermore, the openings of constructions, i.e. windows and doors, can be represented as so-called filling elements including their corresponding filling surfaces.

The UML diagram of the Construction module is depicted in [Construction UML Diagram](#). The Construction module defines concepts that are inherited and, where necessary, are specialized by the modules Building, Bridge, and Tunnel (cf. sections [Building](#), [Bridge](#), and [Tunnel](#)). A detailed discussion of the Requirements Class Construction can be found in the CityGML Best Practices document [here](#).

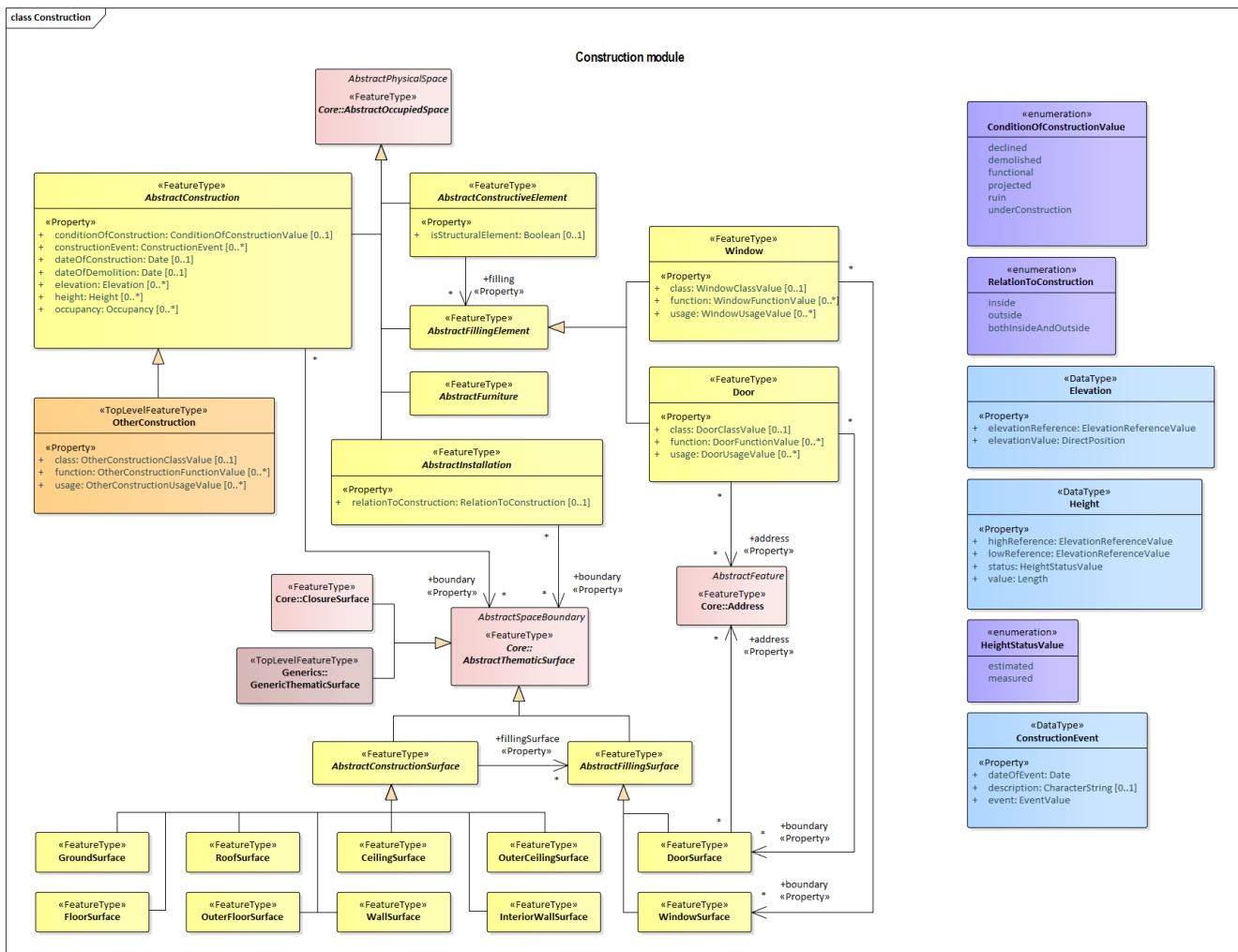


Figure 14. UML diagram of the Construction Model.

8.9.1. Package

Package Construction

Description: The Construction module supports representation of key elements of different types of constructions. These key elements include construction surfaces (e.g floor and ceiling), windows and doors, constructive elements (e.g. beams and slabs), installations, and furniture.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- If a stereotype value is "<<-- section,>>", change it to "none"
- If a subclass value is not provided, set it to "none"
- If a multiplicity value is not provided, set it to "1"
- If the Role Name of a relation is not provided, delete the Role Name row

- | |
|--|
| e) If the stereotype of an attribute is not provided, set it to [Property] |
| 2) For all classes with the "CodeList" stereotype |
| a) Copy the name and description into the table in the Code List section |
| b) Delete the class |
| 3) If there are no code lists, then delete the Code List section |
| 4) Delete these instructions when done |

8.9.2. Classes

Class AbstractConstruction

AbstractConstruction

Definition: AbstractConstruction is the abstract superclass for objects that are manufactured by humans from construction materials, are connected to earth and are intended to be permanent. A connection with the ground also exists when the construction rests by its own weight on the ground or is moveable limited on stationary rails or if the construction is intended to be used mainly stationary.

Subclass Of: [AbstractOccupiedSpace](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractThematicSurface	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
conditionOfConstruction	ConditionOfConstructionValue [0..1]	Indicates the life-cycle status of the construction. [cf. INSPIRE]
constructionEvent	ConstructionEvent [0..*]	Describes specific events in the life-time of the construction.
dateOfConstruction	Date [0..1]	Indicates the date at which the construction was completed.

Attribute	Value type and multiplicity	Definition
dateOfDemolition	Date [0..1]	Indicates the date at which the construction was demolished.
elevation	Elevation [0..*]	Specifies qualified elevations of the construction in relation to a well-defined surface which is commonly taken as origin (e.g. geoid or water level). [cf. INSPIRE]
height	Height [0..*]	Specifies qualified heights of the construction above ground or below ground. [cf. INSPIRE]
occupancy	Occupancy [0..*]	Provides qualified information on the residency of persons, animals, or other moveable objects in the construction.

Class AbstractConstructionSurface

AbstractConstructionSurface

Definition: AbstractConstructionSurface is the abstract superclass for different kinds of surfaces that bound a construction.

Subclass Of: [AbstractThematicSurface](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractFillingSurface	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class AbstractConstructiveElement

AbstractConstructiveElement

Definition:	AbstractConstructiveElement is the abstract superclass for the representation of volumetric elements of a construction. Examples are walls, beams, slabs.
Subclass Of:	AbstractOccupiedSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractFillingElement	
	AbstractThematicSurface	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
isStructuralElement	Boolean [0..1]	Indicates whether the constructive element is essential from a structural point of view. A structural element cannot be omitted without collapsing of the construction. Examples are pylons and anchorages of bridges.

Class AbstractFillingElement

AbstractFillingElement		
Definition:	AbstractFillingElement is the abstract superclass for different kinds of elements that fill the openings of constructive elements.	
Subclass Of:	AbstractOccupiedSpace	
Stereotype:	«FeatureType»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class AbstractFillingSurface

AbstractFillingSurface

Definition: AbstractFillingSurface is the abstract superclass for different kinds of surfaces that seal openings filled by filling elements.

Subclass Of: [AbstractThematicSurface](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class AbstractFurniture

AbstractFurniture

Definition: AbstractFurniture is the abstract superclass for the representation of furniture objects of a construction.

Subclass Of: [AbstractOccupiedSpace](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class AbstractInstallation

AbstractInstallation

Definition:	AbstractInstallation is the abstract superclass for the representation of installation objects of a construction.
Subclass Of:	AbstractOccupiedSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractThematicSurface	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
relationToConstruction	RelationToConstruction [0..1]	Indicates whether the installation is located inside and/or outside of the construction.

Class CeilingSurface

CeilingSurface		
Definition:	A CeilingSurface is a surface that represents the interior ceiling of a construction. An example is the ceiling of a room.	
Subclass Of:	AbstractConstructionSurface	
Stereotype:	«FeatureType»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class Door

Door

Definition: A Door is a construction for closing an opening intended primarily for access or egress or both. [cf. ISO 6707-1]

Subclass Of: [AbstractFillingElement](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	DoorSurface	
	Address	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	DoorClassValue [0..1]	Indicates the specific type of the Door.
function	DoorFunctionValue [0..*]	Specifies the intended purposes of the Door.
usage	DoorUsageValue [0..*]	Specifies the actual uses of the Door.

Class DoorClassValue

DoorClassValue

Definition: DoorClassValue is a code list used to further classify a Door.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class DoorFunctionValue

DoorFunctionValue

Definition:	DoorFunctionValue is a code list that enumerates the different purposes of a Door.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class DoorSurface

DoorSurface

Definition:	A DoorSurface is either a boundary surface of a Door feature or a surface that seals an opening filled by a door.
Subclass Of:	AbstractFillingSurface
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	Address	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class DoorUsageValue

DoorUsageValue

Definition: DoorUsageValue is a code list that enumerates the different uses of a Door.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class ElevationReferenceValue

ElevationReferenceValue

Definition: ElevationReferenceValue is a code list that enumerates the different elevation reference levels used to measure construction heights.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class EventValue

EventValue

Definition:	EventValue is a code list that enumerates the different events of a construction.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class FloorSurface

FloorSurface

Definition:	A FloorSurface is surface that represents the interior floor of a construction. An example is the floor of a room.
Subclass Of:	AbstractConstructionSurface
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class GroundSurface

GroundSurface

Definition:	A GroundSurface is a surface that represents the ground plate of a construction. The polygon defining the ground plate is congruent with the footprint of the construction.
Subclass Of:	AbstractConstructionSurface
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class InteriorWallSurface

InteriorWallSurface

Definition:	An InteriorWallSurface is a surface that is visible from inside a construction. An example is the wall of a room.
Subclass Of:	AbstractConstructionSurface
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class OtherConstruction

OtherConstruction

Definition: An OtherConstruction is a construction that is not covered by any of the other subclasses of AbstractConstruction.

Subclass Of: [AbstractConstruction](#)

Stereotype: «TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	OtherConstructionClassValue [0..1]	Indicates the specific type of the OtherConstruction.
function	OtherConstructionFunctionValue [0..*]	Specifies the intended purposes of the OtherConstruction.
usage	OtherConstructionUsageValue [0..*]	Specifies the actual uses of the OtherConstruction.

Class OtherConstructionClassValue

OtherConstructionClassValue

Definition: OtherConstructionClassValue is a code list used to further classify an OtherConstruction.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class OtherConstructionFunctionValue

OtherConstructionFunctionValue

Definition:	OtherConstructionFunctionValue is a code list that enumerates the different purposes of an OtherConstruction.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class OtherConstructionUsageValue

OtherConstructionUsageValue

Definition:	OtherConstructionUsageValue is a code list that enumerates the different uses of an OtherConstruction.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class OuterCeilingSurface

OuterCeilingSurface

Definition:	An OuterCeilingSurface is a surface that belongs to the outer building shell with the orientation pointing downwards. An example is the ceiling of a loggia.
Subclass Of:	AbstractConstructionSurface
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class OuterFloorSurface

OuterFloorSurface

Definition:	An OuterFloorSurface is a surface that belongs to the outer construction shell with the orientation pointing upwards. An example is the floor of a loggia.
Subclass Of:	AbstractConstructionSurface
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class RoofSurface

RoofSurface

Definition:	A RoofSurface is a surface that delimits major roof parts of a construction.
Subclass Of:	AbstractConstructionSurface
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class WallSurface

WallSurface

Definition:	A WallSurface is a surface that is part of the building facade visible from the outside.
Subclass Of:	AbstractConstructionSurface
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class Window

Window

Definition:	A Window is a construction for closing an opening in a wall or roof, primarily intended to admit light and/or provide ventilation. [cf. ISO 6707-1]
Subclass Of:	AbstractFillingElement
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	WindowSurface	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	WindowClassName [0..1]	Indicates the specific type of the Window.
function	WindowFunctionName [0..*]	Specifies the intended purposes of the Window.
usage	WindowUsageName [0..*]	Specifies the actual uses of the Window.

Class WindowClassName

WindowClassName

Definition:	WindowClassName is a code list used to further classify a Window.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class WindowFunctionName

WindowFunctionValue

Definition:	WindowFunctionValue is a code list that enumerates the different purposes of a Window.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class WindowSurface

WindowSurface

Definition:	A WindowSurface is either a boundary surface of a Window feature or a surface that seals an opening filled by a window.
Subclass Of:	AbstractFillingSurface
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class WindowUsageValue

WindowUsageValue

Definition:	WindowUsageValue is a code list that enumerates the different uses of a Window.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class ConditionOfConstructionValue

ConditionOfConstructionValue

Definition:	ConditionOfConstructionValue enumerates different conditions of a construction. [cf. INSPIRE]
Subclass Of:	<-- section,>>
Stereotype:	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
declined	<-- section,>>	Indicates that the construction cannot be used under normal conditions, though its main elements (walls, roof) are still present. [cf. INSPIRE]
demolished	<-- section,>>	Indicates that the construction has been demolished. There are no more visible remains. [cf. INSPIRE]
functional	<-- section,>>	Indicates that the construction is functional. [cf. INSPIRE]

Attribute	Value type and multiplicity	Definition
projected	<-- section,>>	Indicates that the construction is being designed. Construction works have not yet started. [cf. INSPIRE]
ruin	<-- section,>>	Indicates that the construction has been partly demolished and some main elements (roof, walls) have been destroyed. There are some visible remains of the construction. [cf. INSPIRE]
underConstruction	<-- section,>>	Indicates that the construction is under construction and not yet functional. This applies only to the initial construction works of the construction and not to maintenance work. [cf. INSPIRE]

Class ConstructionEvent

ConstructionEvent

Definition:	A ConstructionEvent is a data type used to describe a specific event that is associated with a construction. Examples are the issuing of a building permit or the renovation of a building.
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
dateOfEvent	Date	Specifies the date at which the event took or will take place.
description	CharacterString [0..1]	Provides additional information on the event.
event	EventValue	Indicates the specific event type.

Class Elevation

Elevation

Definition:	Elevation is a data type that includes the elevation value itself and information on how this elevation was measured. [cf. INSPIRE]
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
elevationReference	ElevationReferenceValue	Specifies the level from which the elevation was measured. [cf. INSPIRE]
elevationValue	DirectPosition	Specifies the value of the elevation. [cf. INSPIRE]

Class Height

Height

Definition:	Height represents a vertical distance (measured or estimated) between a low reference and a high reference. [cf. INSPIRE]
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
highReference	ElevationReferenceValue	Indicates the high point used to calculate the value of the height. [cf. INSPIRE]

Attribute	Value type and multiplicity	Definition
lowReference	ElevationReferenceValue	Indicates the low point used to calculate the value of the height. [cf. INSPIRE]
status	HeightStatusValue	Indicates the way the height has been captured. [cf. INSPIRE]
value	Length	Specifies the value of the height above or below ground. [cf. INSPIRE]

Class HeightStatusValue

HeightStatusValue

Definition: HeightStatusValue enumerates the different methods used to capture a height. [cf. INSPIRE]

Subclass Of: <-- section,>>

Stereotype:

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
estimated	<-- section,>>	Indicates that the height has been estimated and not measured. [cf. INSPIRE]
measured	<-- section,>>	Indicates that the height has been (directly or indirectly) measured. [cf. INSPIRE]

Class RelationToConstruction

RelationToConstruction

Definition: RelationToConstruction is an enumeration used to describe whether an installation is positioned inside and/or outside of a construction.

Subclass Of: <-- section,>>

Stereotype:

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
inside	<– section,>>	Indicates that the installation is positioned inside of the construction.
outside	<– section,>>	Indicates that the installation is positioned outside of the construction.
bothInsideAndOutside	<– section,>>	Indicates that the installation is positioned inside as well as outside of the construction.

8.9.3. Code Lists

Code List	Definition

8.9.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.10. Dynamizer

Requirements Class	
http://www.opengis.net/spec/CityGML/3.0/req/req-class-dynamizer	
Target type	Conceptual Model
Dependency	/req/req-class-core

The Dynamizer module provides the concepts that allow for representing time-varying data for city object properties as well as for integrating sensors with 3D city models. Dynamizers are objects that inject timeseries data for an individual attribute of the city object in which it is included. The timeseries data overrides the static value of the referenced city object attribute in order to represent dynamic, i.e. time-dependent, variations of its value.

The dynamic values may be given by retrieving observation results directly from external sensor/IoT services using a sensor connection (e.g. OGC SensorThings API, Sensor Observation Service, or other sensor data platforms including MQTT). Alternatively, the dynamic values may be provided as atomic timeseries that represent time-varying data of a specific data type for a single contiguous time interval. The data can be provided in external tabulated files, such as CSV or Excel sheets, in external files that format timeseries data according to the OGC TimeseriesML or OGC

Observations & Measurements standards, or inline as embedded time-value-pairs. Furthermore, timeseries data can also be aggregated to form composite timeseries with non-overlapping time intervals.

By using the Dynamizer module, fast changes over a short or longer time period with respect to cities and city models can be represented. This includes variations of spatial properties, i.e. change of a feature's geometry, both in respect to shape and to location (e.g. moving objects), variations of thematic attributes, i.e. changes of physical quantities like energy demands, temperatures, solar irradiation, traffic density, pollution concentration, or overpressure on building walls, and variations with respect to sensor or real-time data resulting from simulations or measurements.

The UML diagram of the Dynamizer module is depicted in [Dynamizer UML Diagram](#). A detailed discussion of this Requirements Class can be found in the CityGML Best Practices document [here](#).

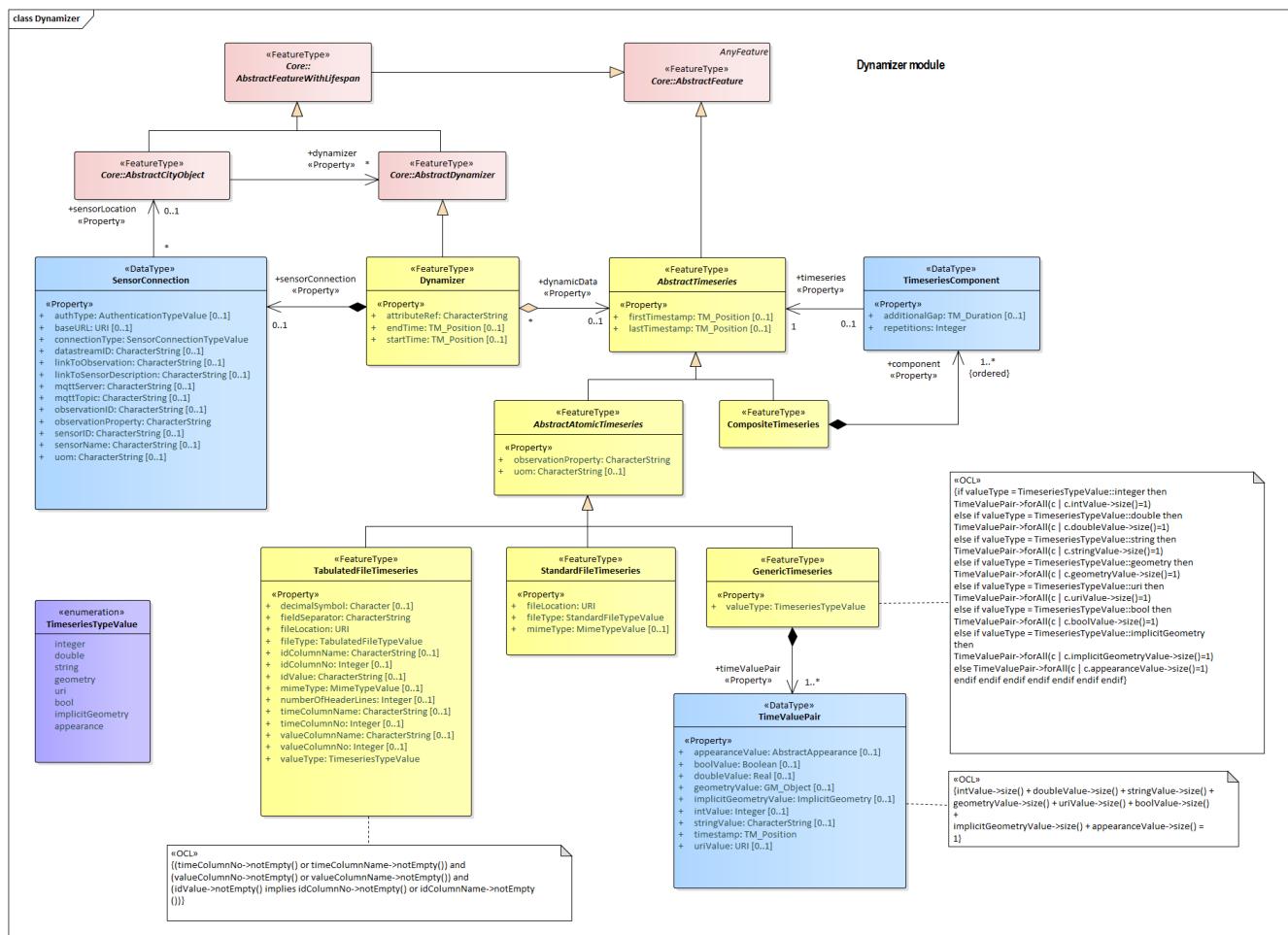


Figure 15. UML diagram of the Dynamizer Model.

8.10.1. Package

Package Dynamizer

Description:	The Dynamizer module supports the injection of timeseries data for individual attributes of CityGML features. Timeseries data can either be retrieved from external Sensor APIs (e.g. OGC SensorThings API, OGC Sensor Observation Services, MQTT, proprietary platforms), external standardized timeseries files (e.g. OGC TimeseriesML or OGC Observations & Measurements), external tabulated files (e.g CSV) or can be represented inline as basic time-value pairs.
Parent Package:	CityGML
Stereotype:	«ApplicationSchema»

Editing instructions:

1) For all classes

- a) If a stereotype value is "<<-- section,>>", change it to "none"
- b) If a subclass value is not provided, set it to "none"
- c) If a multiplicity value is not provided, set it to "1"
- d) If the Role Name of a relation is not provided, delete the Role Name row
- e) If the stereotype of an attribute is not provided, set it to [Property]

2) For all classes with the "CodeList" stereotype

- a) Copy the name and description into the table in the Code List section
- b) Delete the class

3) If there are no code lists, then delete the Code List section

4) Delete these instructions when done

8.10.2. Classes

Class AbstractAtomicTimeseries

AbstractAtomicTimeseries

Definition:	AbstractAtomicTimeseries represents the attributes and relationships that are common to all kinds of atomic timeseries (GenericTimeseries, TabulatedFileTimeseries, StandardFileTimeseries). An atomic timeseries represents time-varying data of a specific data type for a single contiguous time interval.
Subclass Of:	AbstractTimeseries
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
observationP roperty	CharacterString	Specifies the phenomenon for which the atomic timeseries provides observation values.
uom	CharacterString [0..1]	Specifies the unit of measurement of the observation values.

Class AbstractTimeseries

AbstractTimeseries	
Definition:	AbstractTimeseries is the abstract superclass representing any type of timeseries data.
Subclass Of:	AbstractFeature
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
firstTimesta mp	TM_Position [0..1]	Specifies the beginning of the timeseries.
lastTimestamp p	TM_Position [0..1]	Specifies the end of the timeseries.

Class AuthenticationTypeValue

AuthenticationTypeValue

Definition:	AuthenticationTypeValue is a code list used to specify the authentication method to be used to access the referenced sensor service. Each value shall provide enough information such that a software application could determine the required access credentials.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class CompositeTimeseries

CompositeTimeseries

Definition:	A CompositeTimeseries is a (possibly recursive) aggregation of atomic and composite timeseries. The components of a composite timeseries must have non-overlapping time intervals.
Subclass Of:	AbstractTimeseries
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	TimeseriesComponent	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class Dynamizer

Dynamizer

Definition:	A Dynamizer is an object that injects timeseries data for an individual attribute of the city object in which it is included. The timeseries data overrides the static value of the referenced city object attribute in order to represent dynamic, i.e. time-dependent, variations of its value.
Subclass Of:	AbstractDynamizer
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractTimeseries	
	SensorConnection	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
attributeRef	CharacterString	Specifies the attribute of a CityGML feature whose value is overridden or replaced by the (dynamic) values specified by the Dynamizer.
endTime	TM_Position [0..1]	Specifies the end of the time span for which the Dynamizer provides dynamic values.
startTime	TM_Position [0..1]	Specifies the beginning of the time span for which the Dynamizer provides dynamic values.

Class GenericTimeseries

GenericTimeseries

Definition:	A GenericTimeseries represents time-varying data in the form of embedded time-value-pairs of a specific data type for a single contiguous time interval.
Subclass Of:	AbstractAtomicTimeseries
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	TimeValuePair	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
valueType	TimeseriesTypeValue	Indicates the specific type of all time-value-pairs that are part of the GenericTimeseries.

Class SensorConnectionTypeValue

SensorConnectionTypeValue	
Definition:	SensorConnectionTypeValue is a code list used to specify the type of the referenced sensor service. Each value shall provide enough information such that a software application would be able to identify the API type and version.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class StandardFileTimeseries

StandardFileTimeseries	

Definition:	A StandardFileTimeseries represents time-varying data for a single contiguous time interval. The data is provided in an external file referenced in the StandardFileTimeseries. The data within the external file shall be encoded according to a dedicated format for the representation of timeseries data, for example, the OGC TimeseriesML or OGC Observations & Measurements standard. The data type of the data has to be specified within the external file.
Subclass Of:	AbstractAtomicTimeseries
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
fileLocation	URI	Specifies the URI that points to the external timeseries file.
fileType	StandardFileTypeValue	Specifies the format used to represent the timeseries data.
MimeType	MimeTypeValue [0..1]	Specifies the MIME type of the external timeseries file.

Class StandardFileTypeValue

StandardFileTypeValue

Definition:	StandardFileTypeValue is a code list used to specify the type of the referenced external timeseries data file. Each value shall provide information about the standard and version.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
Class TabulatedFileTimeseries		
TabulatedFileTimeseries		
Definition:		A TabulatedFileTimeseries represents time-varying data of a specific data type for a single contiguous time interval. The data is provided in an external file referenced in the TabulatedFileTimeseries. The file shall contain table structured data using an appropriate file format like comma separated values (CSV), Microsoft Excel (XLSX) or Google Spreadsheet. The timestamps and the values are given in specific columns of the table. Each row represents a single time-value-pair. A subset of rows can be selected using the idColumn and idValue attributes.
Subclass Of:		AbstractAtomicTimeseries
Stereotype:		«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
decimalSymbol	Character [0..1]	Indicates which symbol is used to separate the integer part from the fractional part of a decimal number.
fieldSeparator	CharacterString	Indicates which symbol is used to separate the individual values in the tabulated file.
fileLocation	URI	Specifies the URI that points to the external timeseries file.
fileType	TabulatedFileTypeValue	Specifies the format used to represent the timeseries data.
idColumnName	CharacterString [0..1]	Specifies the name of the column that stores the identifier of the time-value-pair.
idColumnNo	Integer [0..1]	Specifies the number of the column that stores the identifier of the time-value-pair.

Attribute	Value type and multiplicity	Definition
idValue	CharacterString [0..1]	Specifies the value of the identifier for which the time-value-pairs are to be selected.
MimeType	MimeTypeValue [0..1]	Specifies the MIME type of the external timeseries file.
numberOfHeaderLines	Integer [0..1]	Indicates the number of lines at the beginning of the tabulated file that represent headers.
timeColumnName	CharacterString [0..1]	Specifies the name of the column that stores the timestamp of the time-value-pair.
timeColumnNo	Integer [0..1]	Specifies the number of the column that stores the timestamp of the time-value-pair.
valueColumnName	CharacterString [0..1]	Specifies the name of the column that stores the value of the time-value-pair.
valueColumnNo	Integer [0..1]	Specifies the number of the column that stores the value of the time-value-pair.
valueType	TimeseriesTypeValue	Indicates the specific type of the timeseries data.

Class TabulatedFileTypeValue

TabulatedFileTypeValue

Definition: TabulatedFileTypeValue is a code list used to specify the data format of the referenced external tabulated data file.

Subclass Of: <-- section,-->

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class SensorConnection

SensorConnection

Definition:	A SensorConnection provides all details that are required to retrieve a specific datastream from an external sensor web service. It comprises the service type (e.g. OGC SensorThings API, OGC Sensor Observation Services, MQTT, proprietary platforms), the URL of the sensor service, the identifier for the sensor or thing and its observed property as well as information about the required authentication method.
Subclass Of:	<-- section,-->
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractCityObject	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
authType	AuthenticationTypeValue [0..1]	Specifies the type of authentication required to be able to access the Sensor API.
baseURL	URI [0..1]	Specifies the base URL of the Sensor API request.
connectionType	SensorConnectionTypeValue	Indicates the type of Sensor API to which the SensorConnection refers.
datastreamID	CharacterString [0..1]	Specifies the datastream that is retrieved by the SensorConnection.
linkToObservation	CharacterString [0..1]	Specifies the complete URL to the observation request.
linkToSensorDescription	CharacterString [0..1]	Specifies the complete URL to the sensor description request.
mqttServer	CharacterString [0..1]	Specifies the name of the MQTT Server. This attribute is relevant when the MQTT Protocol is used to connect to a Sensor API.
mqttTopic	CharacterString [0..1]	Names the specific datastream that is retrieved by the SensorConnection.
observationID	CharacterString [0..1]	Specifies the unique identifier of the observation that is retrieved by the SensorConnection.
observationProperty	CharacterString	Specifies the phenomenon for which the SensorConnection provides observations.

Attribute	Value type and multiplicity	Definition
sensorID	CharacterString [0..1]	Specifies the unique identifier of the sensor from which the SensorConnection retrieves observations.
sensorName	CharacterString [0..1]	Specifies the name of the sensor from which the SensorConnection retrieves observations.
uom	CharacterString [0..1]	Specifies the unit of measurement of the observations.

Class TimeseriesComponent

TimeseriesComponent

Definition: TimeseriesComponent represents an element of a CompositeTimeseries.
 Subclass Of: <-- section,>>
 Stereotype: «DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractTimeseries	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
additionalGap	TM_Duration [0..1]	Specifies how much extra time is added after all repetitions as an additional gap.
repetitions	Integer	Specifies how often the timeseries that is referenced by the TimeseriesComponent should be iterated.

Class TimeseriesTypeValue

TimeseriesTypeValue

Definition: TimeseriesTypeValue enumerates the possible value types for GenericTimeseries and TimeValuePair.
 Subclass Of: <-- section,>>
 Stereotype:

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
integer	<-- section,>>	Indicates that the values of the GenericTimeseries are of type "Integer".
double	<-- section,>>	Indicates that the values of the GenericTimeseries are of type "Double".
string	<-- section,>>	Indicates that the values of the GenericTimeseries are of type "String".
geometry	<-- section,>>	Indicates that the values of the GenericTimeseries are geometries.
uri	<-- section,>>	Indicates that the values of the GenericTimeseries are of type "URI".
bool	<-- section,>>	Indicates that the values of the GenericTimeseries are of type "Boolean".
implicitGeometry	<-- section,>>	Indicates that the values of the GenericTimeseries are of type "ImplicitGeometry".
appearance	<-- section,>>	Indicates that the values of the GenericTimeseries are of type "Appearance".

Class TimeValuePair

TimeValuePair	
Definition:	A TimeValuePair represents a value that is valid for a given timepoint. For each TimeValuePair only one of the value properties can be used mutually exclusive. Which value property has to be provided depends on the selected value type in the GenericTimeSeries feature, in which the TimeValuePair is included.
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
appearanceValue	AbstractAppearance [0..1]	Specifies the "Appearance" value of the TimeValuePair.
boolValue	Boolean [0..1]	Specifies the "Boolean" value of the TimeValuePair.
doubleValue	Real [0..1]	Specifies the "Double" value of the TimeValuePair.
geometryValue	GM_Object [0..1]	Specifies the geometry value of the TimeValuePair.
implicitGeometryValue	ImplicitGeometry [0..1]	Specifies the "ImplicitGeometry" value of the TimeValuePair.
intValue	Integer [0..1]	Specifies the "Integer" value of the TimeValuePair.
stringValue	CharacterString [0..1]	Specifies the "String" value of the TimeValuePair.
timestamp	TM_Position	Specifies the timepoint at which the value of the TimeValuePair is valid.
uriValue	URI [0..1]	Specifies the "URI" value of the TimeValuePair.

8.10.3. Code Lists

Code List	Definition

8.10.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.11. Generics

Requirements Class	
http://www.opengis.net/spec/CityGML/3.0/req/req-class-generics	
Target type	Conceptual Model
Dependency	/req/req-class-core

The Generics module provides the representation of generic city objects, i.e. city objects that are not covered by any explicitly modelled thematic class within CityGML, and of generic attributes, i.e. attributes that are not explicitly represented in CityGML. In order to avoid problems concerning semantic interoperability, generic city objects and generic attributes shall only be used if

appropriate thematic classes and attributes are not provided by any other CityGML module.

In accordance with the CityGML Space concept defined in the Core module (cf. Section Core) generic city objects can be represented as generic logical spaces, generic occupied spaces, generic unoccupied spaces, and generic thematic surfaces. In this way, spaces and surfaces can be defined that are not represented by any explicitly modelled class within CityGML that is a subclass of the classes `AbstractLogicalSpace`, `AbstractOccupiedSpace`, `AbstractUnoccupiedSpace` or `AbstractThematicSurface`, respectively. Generic city objects are represented in the UML model by the top-level feature types `GenericLogicalSpace`, `GenericOccupiedSpace`, `GenericUnoccupiedSpace` and `GenericThematicSurface`.

Generic attributes are defined as name-value pairs and are always associated with a city object. Generic attributes can be of type String, Integer, Double, Date, URI, and Measure. In addition, generic attributes can be grouped under a common name as generic attribute sets.

The UML diagram of the Generics module is depicted in [Generics UML Diagram](#). A detailed discussion of this Requirements Class can be found in the CityGML Best Practices document [here](#).

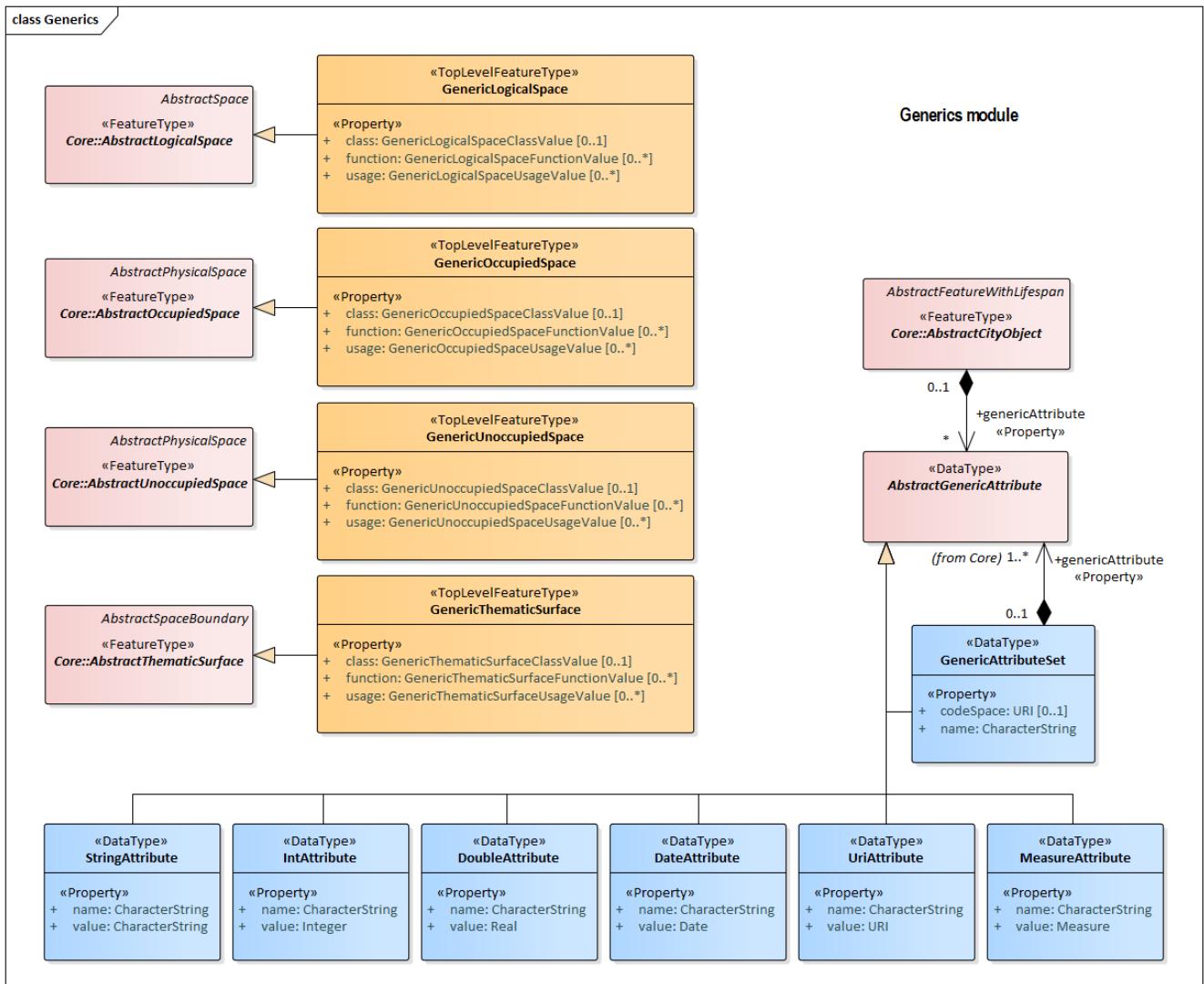


Figure 16. UML diagram of the Generics Model.

8.11.1. Package

Package Generics

Description: The Generics module supports application-specific extensions to the CityGML data model. These extensions may be used to model and exchange additional attributes and features not covered by the predefined thematic classes of CityGML. Generic extensions shall only be used if appropriate thematic classes or attributes are not provided by any other CityGML module.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- a) If a stereotype value is "<<-- section,>>", change it to "none"
- b) If a subclass value is not provided, set it to "none"
- c) If a multiplicity value is not provided, set it to "1"
- d) If the Role Name of a relation is not provided, delete the Role Name row
- e) If the stereotype of an attribute is not provided, set it to [\[Property\]](#)

2) For all classes with the "CodeList" stereotype

- a) Copy the name and description into the table in the Code List section
- b) Delete the class

3) If there are no code lists, then delete the Code List section

4) Delete these instructions when done

8.11.2. Classes

Class GenericLogicalSpace

GenericLogicalSpace

Definition: A GenericLogicalSpace is a space that is not represented by any explicitly modelled AbstractLogicalSpace subclass within CityGML.

Subclass Of: [AbstractLogicalSpace](#)

Stereotype: «TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	GenericLogicalSpaceClassValue [0..1]	Indicates the specific type of the GenericLogicalSpace.
function	GenericLogicalSpaceFunctionValue [0..*]	Specifies the intended purposes of the GenericLogicalSpace.
usage	GenericLogicalSpaceUsageValue [0..*]	Specifies the actual uses of the GenericLogicalSpace.

Class GenericLogicalSpaceClassValue

GenericLogicalSpaceClassValue

Definition: GenericLogicalSpaceClassValue is a code list used to further classify a GenericLogicalSpace.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class GenericLogicalSpaceFunctionValue

GenericLogicalSpaceFunctionValue

Definition: GenericLogicalSpaceFunctionValue is a code list that enumerates the different purposes of a GenericLogicalSpace.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class GenericLogicalSpaceUsageValue

GenericLogicalSpaceUsageValue

Definition:	GenericLogicalSpaceUsageValue is a code list that enumerates the different uses of a GenericLogicalSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class GenericOccupiedSpace

GenericOccupiedSpace

Definition:	A GenericOccupiedSpace is a space that is not represented by any explicitly modelled AbstractOccupiedSpace subclass within CityGML.
Subclass Of:	AbstractOccupiedSpace
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	GenericOccupiedSpaceClass Value [0..1]	Indicates the specific type of the GenericOccupiedSpace.
function	GenericOccupiedSpaceFunctionValue [0..*]	Specifies the intended purposes of the GenericOccupiedSpace.
usage	GenericOccupiedSpaceUsage Value [0..*]	Specifies the actual uses of the GenericOccupiedSpace.

Class GenericOccupiedSpaceClassValue

GenericOccupiedSpaceClassValue	
Definition:	GenericOccupiedSpaceClassValue is a code list used to further classify a GenericOccupiedSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class GenericOccupiedSpaceFunctionValue

GenericOccupiedSpaceFunctionValue	
Definition:	GenericOccupiedSpaceFunctionValue is a code list that enumerates the different purposes of a GenericOccupiedSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class GenericOccupiedSpaceUsageValue

GenericOccupiedSpaceUsageValue

Definition:	GenericOccupiedSpaceUsageValue is a code list that enumerates the different uses of a GenericOccupiedSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class GenericThematicSurface

GenericThematicSurface

Definition:	A GenericThematicSurface is a surface that is not represented by any explicitly modelled AbstractThematicSurface subclass within CityGML.
Subclass Of:	AbstractThematicSurface
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	GenericThematicSurfaceClassValue [0..1]	Indicates the specific type of the GenericThematicSurface.
function	GenericThematicSurfaceFunctionValue [0..*]	Specifies the intended purposes of the GenericThematicSurface.
usage	GenericThematicSurfaceUsageValue [0..*]	Specifies the actual uses of the GenericThematicSurface.

Class GenericThematicSurfaceClassName

GenericThematicSurfaceClassName

Definition: GenericThematicSurfaceClassName is a code list used to further classify a GenericThematicSurface.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class GenericThematicSurfaceFunctionName

GenericThematicSurfaceFunctionName

Definition: GenericThematicSurfaceFunctionName is a code list that enumerates the different purposes of a GenericThematicSurface.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class GenericThematicSurfaceUsageValue

GenericThematicSurfaceUsageValue

Definition:	GenericThematicSurfaceUsageValue is a code list that enumerates the different uses of a GenericThematicSurface.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class GenericUnoccupiedSpace

GenericUnoccupiedSpace

Definition:	A GenericUnoccupiedSpace is a space that is not represented by any explicitly modelled AbstractUnoccupiedSpace subclass within CityGML.
Subclass Of:	AbstractUnoccupiedSpace
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	GenericUnoccupiedSpaceClassValue [0..1]	Indicates the specific type of the GenericUnoccupiedSpace.
function	GenericUnoccupiedSpaceFunctionValue [0..*]	Specifies the intended purposes of the GenericUnoccupiedSpace.
usage	GenericUnoccupiedSpaceUsageValue [0..*]	Specifies the actual uses of the GenericUnoccupiedSpace.

Class GenericUnoccupiedSpaceClassValue

GenericUnoccupiedSpaceClassValue

Definition: GenericUnoccupiedSpaceClassValue is a code list used to further classify a GenericUnoccupiedSpace.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class GenericUnoccupiedSpaceFunctionValue

GenericUnoccupiedSpaceFunctionValue

Definition: GenericUnoccupiedSpaceFunctionValue is a code list that enumerates the different purposes of a GenericUnoccupiedSpace.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class GenericUnoccupiedSpaceUsageValue

GenericUnoccupiedSpaceUsageValue

Definition:	GenericUnoccupiedSpaceUsageValue is a code list that enumerates the different uses of a GenericUnoccupiedSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class DateAttribute

DateAttribute

Definition:	DateAttribute is a data type used to define generic attributes of type "Date".
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
name	CharacterString	Specifies the name of the DateAttribute.
value	Date	Specifies the "Date" value.

Class DoubleAttribute

DoubleAttribute

- Definition: DoubleAttribute is a data type used to define generic attributes of type "Double".
- Subclass Of: <-- section,>>
- Stereotype: «DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
name	CharacterString	Specifies the name of the DoubleAttribute.
value	Real	Specifies the "Double" value.

Class GenericAttributeSet

GenericAttributeSet

- Definition: A GenericAttributeSet is a named collection of generic attributes.
- Subclass Of: <-- section,>>
- Stereotype: «DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

	AbstractGenericAttribute	
--	--	--

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
codeSpace	URI [0..1]	Associates the GenericAttributeSet with an authority that maintains the collection of generic attributes.
name	CharacterString	Specifies the name of the GenericAttributeSet.

Class IntAttribute

IntAttribute
Definition: IntAttribute is a data type used to define generic attributes of type "Integer".
Subclass Of: <-- section,>>
Stereotype: «DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
name	CharacterString	Specifies the name of the IntAttribute.
value	Integer	Specifies the "Integer" value.

Class MeasureAttribute

MeasureAttribute
Definition: MeasureAttribute is a data type used to define generic attributes of type "Measure".
Subclass Of: <-- section,>>
Stereotype: «DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
name	CharacterString	Specifies the name of the MeasureAttribute.
value	Measure	Specifies the value of the MeasureAttribute. The value is of type "Measure", which can additionally provide the units of measure. [cf. ISO 19103]

Class StringAttribute

StringAttribute	
Definition:	StringAttribute is a data type used to define generic attributes of type "String".
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
name	CharacterString	Specifies the name of the StringAttribute.
value	CharacterString	Specifies the "String" value.

Class UriAttribute

UriAttribute	

Definition:	UriAttribute is a data type used to define generic attributes of type "URI".
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
name	CharacterString	Specifies the name of the UriAttribute.
value	URI	Specifies the "URI" value.

8.11.3. Code Lists

Code List	Definition

8.11.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.12. Land Use

Requirements Class	
http://www.opengis.net/spec/CityGML/3.0/req/req-class-landuse	
Target type	Conceptual Model
Dependency	/req/req-class-core

The LandUse module defines objects that can be used to describe areas of the earth's surface dedicated to a specific land use or having a specific land cover with or without vegetation, such as sand, rock, mud flats, forest, grasslands, or wetlands (i.e. the physical appearance). Land use and land cover are different concepts; the first describes human activities on the earth's surface, the second describes its physical and biological cover. However, the two concepts are interlinked and often mixed in practice. Land use objects in CityGML support both concepts: They can be employed to represent parcels, spatial planning objects, recreational objects and objects describing the physical characteristics of an area in 3D. Land use objects are represented in the UML model by the top-level feature type *LandUse*, which is also the only class of the LandUse module.

The UML diagram of the LandUse module is depicted in [Land Use UML Diagram](#). A detailed discussion of this Requirements Class can be found in the CityGML Best Practices document [here](#).

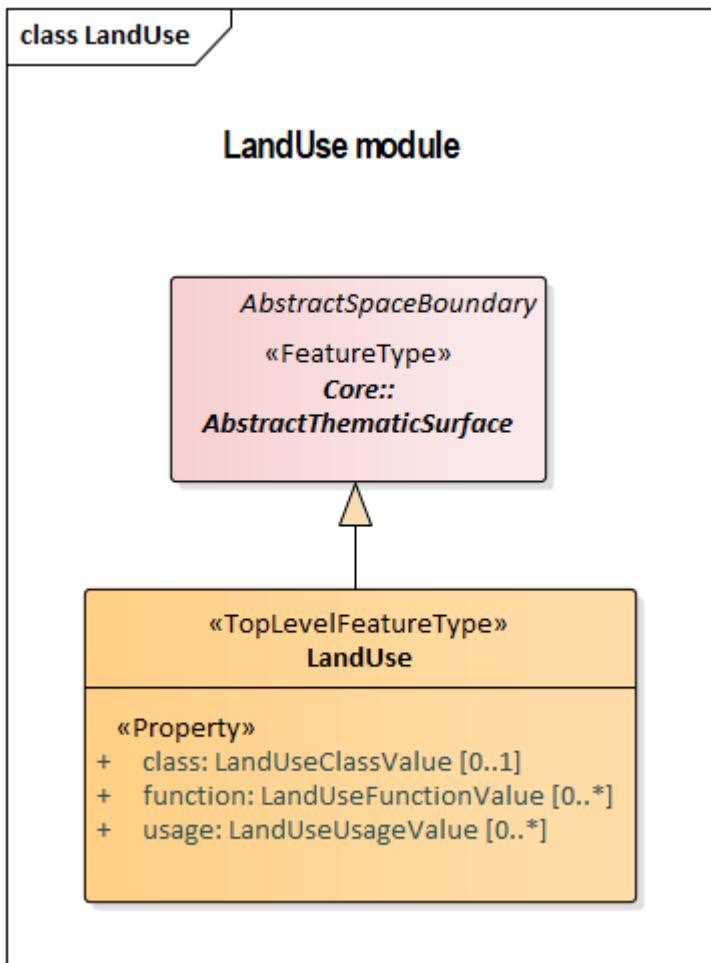


Figure 17. UML diagram of the Land Use Model.

8.12.1. Package

Package LandUse

Description: The LandUse module supports representation of areas of the earth's surface dedicated to a specific land use.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- a) If a stereotype value is "<<-- section,>>", change it to "none"
- b) If a subclass value is not provided, set it to "none"
- c) If a multiplicity value is not provided, set it to "1"
- d) If the Role Name of a relation is not provided, delete the Role Name row

- | |
|--|
| e) If the stereotype of an attribute is not provided, set it to [Property] |
| 2) For all classes with the "CodeList" stereotype |
| a) Copy the name and description into the table in the Code List section |
| b) Delete the class |
| 3) If there are no code lists, then delete the Code List section |
| 4) Delete these instructions when done |

8.12.2. Classes

Class LandUse

LandUse	
Definition:	A LandUse object is an area of the earth's surface dedicated to a specific land use or having a specific land cover with or without vegetation, such as sand, rock, mud flats, forest, or grasslands.
Subclass Of:	AbstractThematicSurface
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	LandUseClassValue [0..1]	Indicates the specific type of the LandUse.
function	LandUseFunctionValue [0..*]	Specifies the intended purposes of the LandUse.
usage	LandUseUsageValue [0..*]	Specifies the actual uses of the LandUse.

Class LandUseClassValue

LandUseClassValue

Definition:	LandUseClassValue is a code list used to further classify a LandUse.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class LandUseFunctionValue

LandUseFunctionValue

Definition:	LandUseFunctionValue is a code list that enumerates the different purposes of a LandUse.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class LandUseUsageValue

LandUseUsageValue

Definition:	LandUseUsageValue is a code list that enumerates the different uses of a LandUse.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

8.12.3. Code Lists

Code List	Definition
-----------	------------

8.12.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.13. Point Cloud

Requirements Class	
http://www.opengis.net/spec/CityGML/3.0/req/req-class-pointcloud	
Target type	Conceptual Model
Dependency	/req/req-class-core

The PointCloud module offers the possibility to provide the geometry of physical spaces and of thematic surfaces by 3D point clouds. In this way, the building hull, a room within a building or a single wall surface can be spatially represented by a point cloud only. The same applies to all other thematic feature types including transportation objects, vegetation, city furniture, etc. Point clouds can either be provided inline within a CityGML file or as reference to external point cloud files of common file types such as LAS or LAZ. Point clouds are represented in the UML model by the feature type *PointCloud*, which is also the only class of the PointCloud module.

The UML diagram of the PointCloud module is depicted in [Point Cloud UML Diagram](#). A detailed discussion of this Requirements Class can be found in the CityGML Best Practices document [here](#).

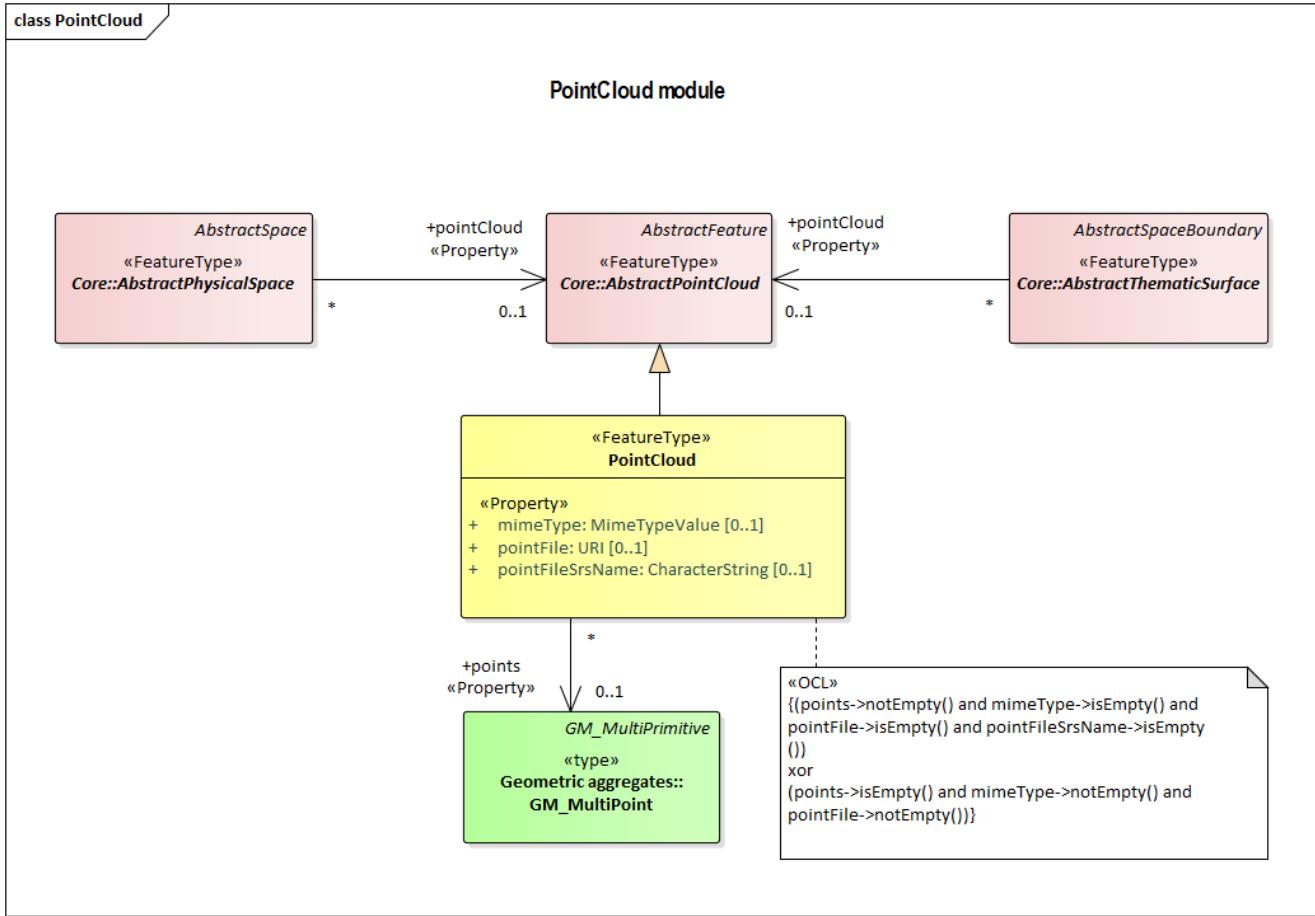


Figure 18. UML diagram of the Point Cloud Model.

8.13.1. Package

Package PointCloud

Description: The PointCloud module supports representation of CityGML features by a collection of points.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- a) If a stereotype value is "<<-- section,>>", change it to "none"
- b) If a subclass value is not provided, set it to "none"
- c) If a multiplicity value is not provided, set it to "1"
- d) If the Role Name of a relation is not provided, delete the Role Name row
- e) If the stereotype of an attribute is not provided, set it to [Property]

2) For all classes with the "CodeList" stereotype

- a) Copy the name and description into the table in the Code List section

- | |
|--|
| b) Delete the class |
| 3) If there are no code lists, then delete the Code List section |
| 4) Delete these instructions when done |

8.13.2. Classes

Class PointCloud

PointCloud

Definition:	A PointCloud is an unordered collection of points that is a sampling of the geometry of a space or space boundary.
Subclass Of:	AbstractPointCloud
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	GM_MultiPoint	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
mimeType	MimeTypeValue [0..1]	Specifies the MIME type of the external point cloud file.
pointFile	URI [0..1]	Specifies the URI that points to the external point cloud file.
pointFileSrsName	CharacterString [0..1]	Indicates the coordinate reference system used by the external point cloud file.

8.13.3. Code Lists

Code List	Definition

8.13.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.14. Digital Terrain Model

Requirements Class

<http://www.opengis.net/spec/CityGML/3.1/req/req-class-relief>

Target type	Conceptual Model
Dependency	/req/req-class-core

The Relief module provides the representation of terrain which is an essential part of city models. In CityGML, the terrain is modelled by relief features. They are represented in the UML model by the top-level feature type *ReliefFeature*, which is the main class of the Relief module. The relief features, in turn, are collections of relief components that describe the Earth's surface, a.k.a. the Digital Terrain Model. The relief components can have different terrain representations which can coexist. Each relief component may be specified as a regular raster or grid, as a TIN (Triangulated Irregular Network), by break lines, or by mass points. In addition, the validity of the relief components may be restricted to certain areas.

The UML diagram of the Relief module is depicted in [Relief UML Diagram](#). A detailed discussion of this Requirements Class can be found in the CityGML Best Practices document [here](#).

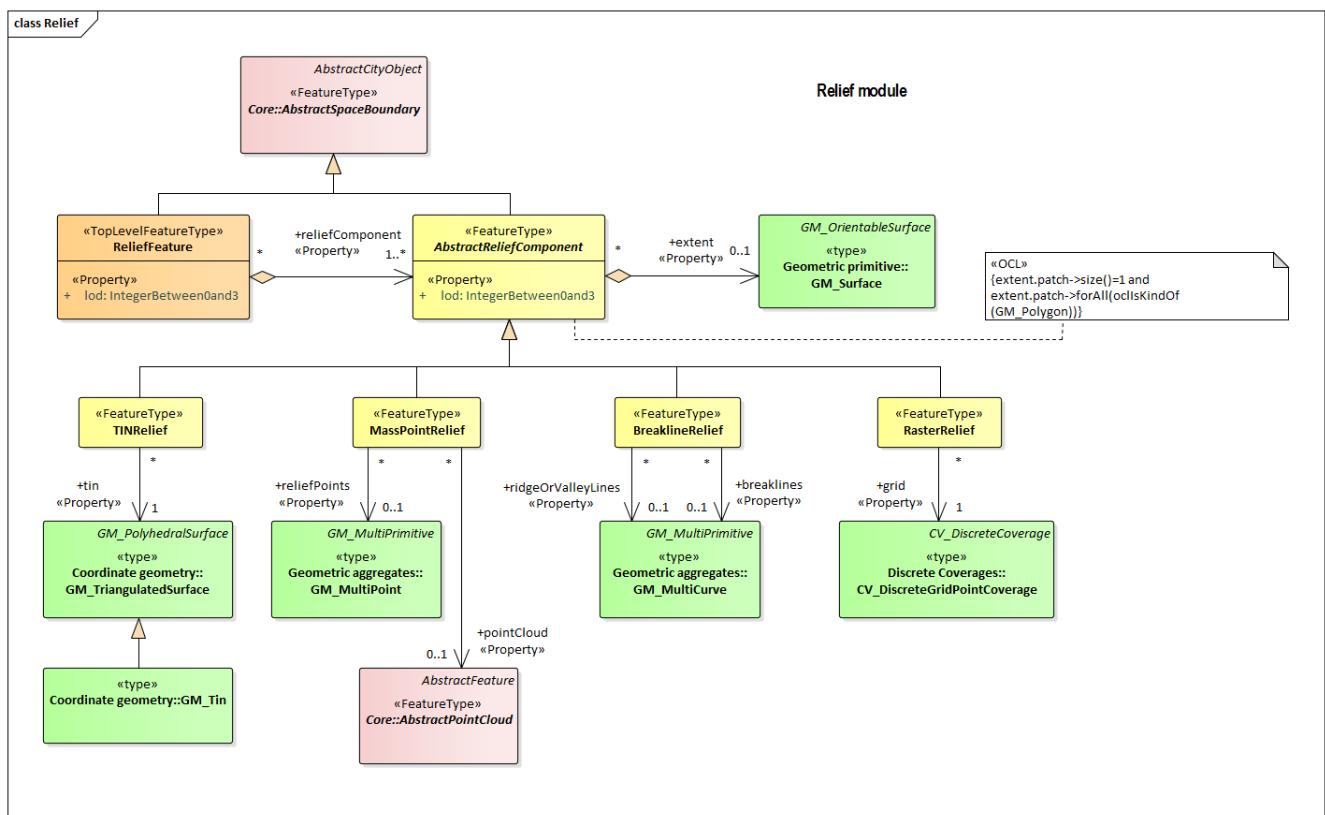


Figure 19. UML diagram of Relief module.

8.14.1. Package

Package Relief

Description: The Relief module supports representation of the terrain. CityGML supports terrain representations at different levels of detail, reflecting different accuracies or resolutions. Terrain may be specified as a regular raster or grid, as a TIN, by break lines, and/or by mass points.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- a) If a stereotype value is "<<-- section,>>", change it to "none"
- b) If a subclass value is not provided, set it to "none"
- c) If a multiplicity value is not provided, set it to "1"
- d) If the Role Name of a relation is not provided, delete the Role Name row
- e) If the stereotype of an attribute is not provided, set it to [\[Property\]](#)

2) For all classes with the "CodeList" stereotype

- a) Copy the name and description into the table in the Code List section
- b) Delete the class

3) If there are no code lists, then delete the Code List section

4) Delete these instructions when done

8.14.2. Classes

Class AbstractReliefComponent

AbstractReliefComponent

Definition: An AbstractReliefComponent represents an element of the terrain surface - either a TIN, a Grid, mass points or break lines.

Subclass Of: [AbstractSpaceBoundary](#)

Stereotype: «FeatureType»

Constraint: polygonGeometry (OCL): inv: self.extent.patch → size()=1 and self.extent.patch → forAll(oclIsKindOf(GM_Polygon))

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
lod	IntegerBetween0and3	Indicates the Level of Detail of the terrain component.

Class BreaklineRelief

BreaklineRelief

Definition: A BreaklineRelief represents a terrain component with 3D lines. These lines denote break lines or ridge/valley lines.

Subclass Of: [AbstractReliefComponent](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	GM_MultiCurve	
	GM_MultiCurve	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class MassPointRelief

MassPointRelief

Definition: A MassPointRelief represents a terrain component as a collection of 3D points.

Subclass Of: [AbstractReliefComponent](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	GM_MultiPoint	
	AbstractPointCloud	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class RasterRelief

RasterRelief		
Definition:	A RasterRelief represents a terrain component as a regular raster or grid.	
Subclass Of:	AbstractReliefComponent	
Stereotype:	«FeatureType»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	CV_DiscreteGridPointCoverage	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class ReliefFeature

ReliefFeature		
Definition:	A ReliefFeature is a collection of terrain components representing the Earth's surface, a.k.a. the Digital Terrain Model.	
Subclass Of:	AbstractSpaceBoundary	
Stereotype:	«TopLevelFeatureType»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractReliefComponent	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
lod	IntegerBetween0and3	Indicates the Level of Detail of the ReliefFeature.

Class TINRelief

TINRelief	
Definition:	A TINRelief represents a terrain component as a triangulated irregular network.
Subclass Of:	AbstractReliefComponent
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	GM_TriangulatedSurface	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

8.14.3. Code Lists

Code List	Definition

8.14.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.15. Transportation

Requirements Class

<http://www.opengis.net/spec/CityGML/3.0/req/req-class-transportation>

Target type	Conceptual Model
Dependency	/req/req-class-core

The Transportation module defines central elements of the traffic infrastructure. This includes the transportation objects road, track, and square for the movement of vehicles, bicycles, and pedestrians, the transportation object railway for the movement of wheeled vehicles on rails, as well as the transportation object waterway for the movement of vessels upon or within water bodies. The transportation objects are represented in the UML model by the top-level feature types *Road*, *Track*, *Square*, *Railway*, and *Waterway*, which are the main classes of the Transportation module. Transportation objects can be subdivided into sections, which can be regular road, track or railway legs, into intersection areas, and into roundabouts.

For each transportation object, traffic spaces and auxiliary traffic spaces can be provided, which are bounded at the bottom by traffic areas and auxiliary traffic areas, respectively. Traffic areas are elements that are important in terms of traffic usage, such as driving lanes, sidewalks, and cycle lanes, whereas auxiliary traffic areas describe further elements, such as kerbstones, middle lanes, and green areas. The corresponding spaces define the free space above the areas. In addition, each traffic space can have an optional clearance space. The transportation objects can be represented in different levels of granularity, either as a single area, split up into individual lanes or even decomposed into individual (carriage)ways. Furthermore, holes in the surfaces of roads, tracks or squares, such as road damages, manholes or drains, can be represented including their corresponding boundary surfaces. In addition, markings for the structuring or restriction of traffic can be added to the transportation areas. Examples are road markings and markings related to railway or waterway traffic.

The UML diagram of the Transportation module is depicted in [Transportation UML Diagram](#). A detailed discussion of this Requirements Class can be found in the CityGML Best Practices document [here](#).

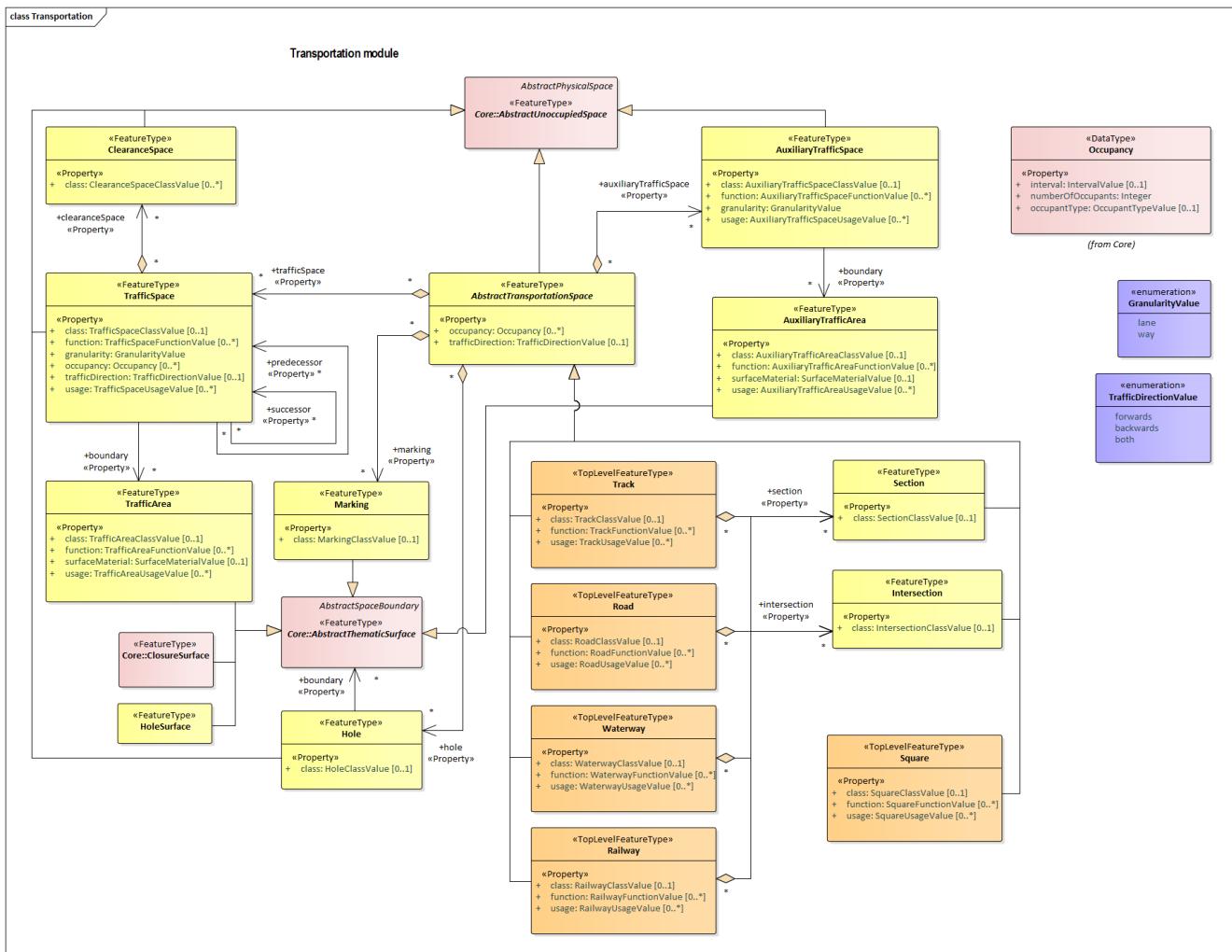


Figure 20. UML diagram of the Transportation Model.

8.15.1. Package

Package Transportation

Description: The Transportation module supports representation of the transportation infrastructure. Transportation features include roads, tracks, waterways, railways, and squares. Transportation features may be represented as a network and/or as a collection of spaces or surface elements embedded in a three-dimensional space.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- If a stereotype value is "<<← section,>>", change it to "none"
- If a subclass value is not provided, set it to "none"
- If a multiplicity value is not provided, set it to "1"

- | |
|---|
| d) If the Role Name of a relation is not provided, delete the Role Name row |
| e) If the stereotype of an attribute is not provided, set it to [Property] |
| 2) For all classes with the "CodeList" stereotype |
| a) Copy the name and description into the table in the Code List section |
| b) Delete the class |
| 3) If there are no code lists, then delete the Code List section |
| 4) Delete these instructions when done |

8.15.2. Classes

Class AbstractTransportationSpace

AbstractTransportationSpace

Definition:	AbstractTransportationSpace is the abstract superclass of transportation objects such as Roads, Tracks, Railways, Waterways or Squares.
Subclass Of:	AbstractUnoccupiedSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	TrafficSpace	
	Hole	
	AuxiliaryTrafficSpace	
	Marking	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
occupancy	Occupancy [0..*]	Provides information on the residency of persons, vehicles, or other moving features in the transportation space.
trafficDirection	TrafficDirectionValue [0..1]	Indicates the direction of traffic flow relative to the corresponding linear geometry representation.

Class AuxiliaryTrafficArea

AuxiliaryTrafficArea

Definition:	An AuxiliaryTrafficArea is the ground surface of an AuxiliaryTrafficSpace.
Subclass Of:	AbstractThematicSurface
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	AuxiliaryTrafficAreaClassValue [0..1]	Indicates the specific type of the AuxiliaryTrafficArea.
function	AuxiliaryTrafficAreaFunctionValue [0..*]	Specifies the intended purposes of the AuxiliaryTrafficArea.
surfaceMaterial	SurfaceMaterialValue [0..1]	Specifies the type of pavement of the AuxiliaryTrafficArea.
usage	AuxiliaryTrafficAreaUsageValue [0..*]	Specifies the actual uses of the AuxiliaryTrafficArea.

Class AuxiliaryTrafficAreaClassValue

AuxiliaryTrafficAreaClassValue

Definition:	AuxiliaryTrafficAreaClassValue is a code list used to further classify an AuxiliaryTrafficArea.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class AuxiliaryTrafficAreaFunctionValue

AuxiliaryTrafficAreaFunctionValue

Definition: AuxiliaryTrafficAreaFunctionValue is a code list that enumerates the different purposes of an AuxiliaryTrafficArea.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class AuxiliaryTrafficAreaUsageValue

AuxiliaryTrafficAreaUsageValue

Definition: AuxiliaryTrafficAreaUsageValue is a code list that enumerates the different uses of an AuxiliaryTrafficArea.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class AuxiliaryTrafficSpace

AuxiliaryTrafficSpace

Definition:	An AuxiliaryTrafficSpace is a space within the transportation space not intended for traffic purposes.
Subclass Of:	AbstractUnoccupiedSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AuxiliaryTrafficArea	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	AuxiliaryTrafficSpaceClassValue [0..1]	Indicates the specific type of the AuxiliaryTrafficSpace.
function	AuxiliaryTrafficSpaceFunctionValue [0..*]	Specifies the intended purposes of the AuxiliaryTrafficSpace.
granularity	GranularityValue	Defines whether auxiliary traffic spaces are represented by individual ways or by individual lanes, depending on the desired level of detail.
usage	AuxiliaryTrafficSpaceUsageValue [0..*]	Specifies the actual uses of the AuxiliaryTrafficSpace.

Class AuxiliaryTrafficSpaceClassValue

AuxiliaryTrafficSpaceClassValue

Definition:	AuxiliaryTrafficSpaceClassValue is a code list used to further classify an AuxiliaryTrafficSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class AuxiliaryTrafficSpaceFunctionValue

AuxiliaryTrafficSpaceFunctionValue		
Definition:	AuxiliaryTrafficSpaceFunctionValue	is a code list that enumerates the different purposes of an AuxiliaryTrafficSpace.
Subclass Of:	<-- section,>>	
Stereotype:	«CodeList»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class AuxiliaryTrafficSpaceUsageValue

AuxiliaryTrafficSpaceUsageValue		
Definition:	AuxiliaryTrafficSpaceUsageValue	is a code list that enumerates the different uses of an AuxiliaryTrafficSpace.
Subclass Of:	<-- section,>>	
Stereotype:	«CodeList»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class ClearanceSpace

ClearanceSpace

Definition: A ClearanceSpace represents the actual free space above a TrafficArea within which a mobile object can move without contacting an obstruction.

Subclass Of: [AbstractUnoccupiedSpace](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	ClearanceSpaceClassValue [0..*]	Indicates the specific type of the ClearanceSpace.

Class ClearanceSpaceClassValue

ClearanceSpaceClassValue

Definition: ClearanceSpaceClassValue is a code list used to further classify a ClearanceSpace.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class Hole

Hole

Definition:	A Hole is an opening in the surface of a Road, Track or Square such as road damages, manholes or drains. Holes can span multiple transportation objects.
Subclass Of:	AbstractUnoccupiedSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractThematicSurface	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	HoleClassName [0..1]	Indicates the specific type of the Hole.

Class HoleClassName

HoleClassName

Definition:	HoleClassName is a code list used to further classify a Hole.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class HoleSurface

HoleSurface

Definition:	A HoleSurface is a representation of the ground surface of a hole.
Subclass Of:	AbstractThematicSurface
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class Intersection

Intersection

Definition:	An Intersection is a transportation space that is a shared segment of multiple Road, Track, Railway, or Waterway objects (e.g. a crossing of two roads or a level crossing of a road and a railway).
Subclass Of:	AbstractTransportationSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	IntersectionClassValue [0..1]	Indicates the specific type of the Intersection.

Class IntersectionClassValue

IntersectionClassValue

Definition: IntersectionClassValue is a code list used to further classify an Intersection.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class Marking

Marking

Definition: A Marking is a visible pattern on a transportation area relevant to the structuring or restriction of traffic. Examples are road markings and markings related to railway or waterway traffic.

Subclass Of: [AbstractThematicSurface](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	MarkingClassValue [0..1]	Indicates the specific type of the Marking.

Class MarkingClassValue

MarkingClassValue

Definition:	MarkingClassValue is a code list used to further classify a Marking.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class Railway

Railway

Definition:	A Railway is a transportation space used by wheeled vehicles on rails.
Subclass Of:	AbstractTransportationSpace
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	Section	
	Intersection	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	RailwayClassValue [0..1]	Indicates the specific type of the Railway.
function	RailwayFunctionValue [0..*]	Specifies the intended purposes of the Railway.
usage	RailwayUsageValue [0..*]	Specifies the actual uses of the Railway.

Class RailwayClassValue

RailwayClassValue

Definition: RailwayClassValue is a code list used to further classify a Railway.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class RailwayFunctionValue

RailwayFunctionValue

Definition: RailwayFunctionValue is a code list that enumerates the different purposes of a Railway.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class RailwayUsageValue

RailwayUsageValue

Definition:	RailwayUsageValue is a code list that enumerates the different uses of a Railway.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class Road

Road

Definition:	A Road is a transportation space used by vehicles, bicycles and/or pedestrians.
Subclass Of:	AbstractTransportationSpace
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	Intersection	
	Section	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	RoadClassValue [0..1]	Indicates the specific type of the Road.
function	RoadFunctionValue [0..*]	Specifies the intended purposes of the Road.
usage	RoadUsageValue [0..*]	Specifies the actual uses of the Road.

Class RoadClassValue

RoadClassValue

Definition: RoadClassValue is a code list used to further classify a Road.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class RoadFunctionValue

RoadFunctionValue

Definition: RoadFunctionValue is a code list that enumerates the different purposes of a Road.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class RoadUsageValue

RoadUsageValue

Definition:	RoadUsageValue is a code list that enumerates the different uses of a Road.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class Section

Section

Definition:	A Section is a transportation space that is a segment of a Road, Railway, Track, or Waterway.
Subclass Of:	AbstractTransportationSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	SectionClassValue [0..1]	Indicates the specific type of the Section.

Class SectionClassValue

SectionClassValue

Definition:	SectionClassValue is a code list used to further classify a Section.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class Square

Square

Definition:	A Square is a transportation space for unrestricted movement for vehicles, bicycles and/or pedestrians. This includes plazas as well as large sealed surfaces such as parking lots.
Subclass Of:	AbstractTransportationSpace
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	SquareClassValue [0..1]	Indicates the specific type of the Square.
function	SquareFunctionValue [0..*]	Specifies the intended purposes of the Square.
usage	SquareUsageValue [0..*]	Specifies the actual uses of the Square.

Class SquareClassValue

SquareClassValue

Definition:	SquareClassValue is a code list used to further classify a Square.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class SquareFunctionValue

SquareFunctionValue

Definition:	SquareFunctionValue is a code list that enumerates the different purposes of a Square.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class SquareUsageValue

SquareUsageValue

Definition:	SquareUsageValue is a code list that enumerates the different uses of a Square.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class SurfaceMaterialValue

SurfaceMaterialValue

Definition:	SurfaceMaterialValue is a code list that enumerates the different surface materials.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class Track

Track

Definition: A Track is a small path mainly used by pedestrians. Tracks can be segmented into Sections and Intersections.

Subclass Of: [AbstractTransportationSpace](#)

Stereotype: «TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	Section	
	Intersection	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	TrackClassValue [0..1]	Indicates the specific type of the Track.
function	TrackFunctionValue [0..*]	Specifies the intended purposes of the Track.
usage	TrackUsageValue [0..*]	Specifies the actual uses of the Track.

Class TrackClassValue

TrackClassValue

Definition: TrackClassValue is a code list used to further classify a Track.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class TrackFunctionValue

TrackFunctionValue

Definition:	TrackFunctionValue is a code list that enumerates the different purposes of a Track.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class TrackUsageValue

TrackUsageValue

Definition:	TrackUsageValue is a code list that enumerates the different uses of a Track.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class TrafficArea

TrafficArea

Definition:	A TrafficArea is the ground surface of a TrafficSpace. Traffic areas are the surfaces upon which traffic actually takes place.
Subclass Of:	AbstractThematicSurface
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	TrafficAreaClassValue [0..1]	Indicates the specific type of the TrafficArea.
function	TrafficAreaFunctionValue [0..*]	Specifies the intended purposes of the TrafficArea.
surfaceMaterial	SurfaceMaterialValue [0..1]	Specifies the type of pavement of the TrafficArea.
usage	TrafficAreaUsageValue [0..*]	Specifies the actual uses of the TrafficArea.

Class TrafficAreaClassValue

TrafficAreaClassValue

Definition:	TrafficAreaClassValue is a code list used to further classify a TrafficArea.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TrafficAreaFunctionValue

TrafficAreaFunctionValue

Definition:	TrafficAreaFunctionValue is a code list that enumerates the different purposes of a TrafficArea.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TrafficAreaUsageValue

TrafficAreaUsageValue

Definition:	TrafficAreaUsageValue is a code list that enumerates the different uses of a TrafficArea.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TrafficSpace

TrafficSpace

Definition:	A TrafficSpace is a space in which traffic takes place. Traffic includes the movement of entities such as trains, vehicles, pedestrians, ships, or other transportation types.
Subclass Of:	AbstractUnoccupiedSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	ClearanceSpace	
	TrafficSpace	
	TrafficArea	
	TrafficSpace	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	TrafficSpaceClassValue [0..1]	Indicates the specific type of the TrafficSpace.
function	TrafficSpaceFunctionValue [0..*]	Specifies the intended purposes of the TrafficSpace.
granularity	GranularityValue	Defines whether traffic spaces are represented by individual ways or by individual lanes, depending on the desired level of detail.
occupancy	Occupancy [0..*]	Provides information on the residency of persons, vehicles, or other moving features in the TrafficSpace.
trafficDirection	TrafficDirectionValue [0..1]	Indicates the direction of traffic flow relative to the corresponding linear geometry representation.
usage	TrafficSpaceUsageValue [0..*]	Specifies the actual uses of the TrafficSpace.

Class TrafficSpaceClassValue

TrafficSpaceClassValue

Definition:	TrafficSpaceClassValue is a code list used to further classify a TrafficSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class TrafficSpaceFunctionValue

TrafficSpaceFunctionValue

Definition:	TrafficSpaceFunctionValue is a code list that enumerates the different purposes of a TrafficSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class TrafficSpaceUsageValue

TrafficSpaceUsageValue

Definition:	TrafficSpaceUsageValue is a code list that enumerates the different uses of a TrafficSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TransportationSpaceClassValue

TransportationSpaceClassValue

Definition:	TransportationSpaceClassValue is a code list used to further classify a TransportationSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TransportationSpaceFunctionValue

TransportationSpaceFunctionValue

Definition:	TransportationSpaceFunctionValue is a code list that enumerates the different purposes of a TransportationSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TransportationSpaceUsageValue

TransportationSpaceUsageValue

Definition:	TransportationSpaceUsageValue is a code list that enumerates the different uses of a TransportationSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class Waterway

Waterway

Definition:	A Waterway is a transportation space used for the movement of vessels upon or within a water body.
Subclass Of:	AbstractTransportationSpace
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	Section	
	Intersection	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	WaterwayClassValue [0..1]	Indicates the specific type of the Waterway.
function	WaterwayFunctionValue [0..*]	Specifies the intended purposes of the Waterway.
usage	WaterwayUsageValue [0..*]	Specifies the actual uses of the Waterway.

Class WaterwayClassValue

WaterwayClassValue

Definition:	WaterwayClassValue is a code list used to further classify a Waterway.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class WaterwayFunctionValue

WaterwayFunctionValue

Definition:	WaterwayFunctionValue is a code list that enumerates the different purposes of a Waterway.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class WaterwayUsageValue

WaterwayUsageValue

Definition:	WaterwayUsageValue is a code list that enumerates the different uses of a Waterway.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class GranularityValue

GranularityValue

Definition:	GranularityValue enumerates the different levels of granularity in which transportation objects are represented.
Subclass Of:	<-- section,>>
Stereotype:	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
lane	<-- section,>>	Indicates that the individual lanes of the transportation object are represented.
way	<-- section,>>	Indicates that the individual (carriage)ways of the transportation object are represented.

Class TrafficDirectionValue

TrafficDirectionValue

Definition:	TrafficDirectionValue enumerates the allowed directions of travel of a mobile object.
Subclass Of:	<-- section,>>
Stereotype:	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
forwards	<-- section,>>	Indicates that traffic flows in the direction of the corresponding linear geometry.

Attribute	Value type and multiplicity	Definition
backwards	<-- section,>>	Indicates that traffic flows in the opposite direction of the corresponding linear geometry.
both	<-- section,>>	Indicates that traffic flows in both directions.

8.15.3. Code Lists

Code List	Definition

8.15.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model

8.16. Tunnel

Requirements Class	
http://www.opengis.net/spec/CityGML/3.1/req/req-class-tunnel	
Target type	Conceptual Model
Dependency	/req/req-class-core

The Tunnel module provides the representation of thematic and spatial aspects of tunnels. Tunnels are horizontal or sloping enclosed passage ways of a certain length, mainly underground or underwater. Tunnels are intended for passing obstacles such as mountains, waterways or other traffic routes by humans, animals or goods. Tunnels are represented in the UML model by the top-level feature type *Tunnel*, which is the main class of the Tunnel module. Tunnels can physically or functionally be subdivided into tunnel parts. In addition, tunnels can be decomposed into structural elements, such as walls, slabs, staircases, and beams.

The interior of tunnels is represented by hollow spaces. This allows a virtual accessibility of tunnels, e.g. for driving through a tunnel, for simulating disaster management or for presenting the light illumination within a tunnel. Tunnels can contain installations and furniture. Installations are permanent parts of a tunnel that strongly affect the outer or inner appearance of the tunnel and that cannot be moved. Examples are stairs, railings, radiators or pipes. Furniture, in contrast, represent moveable objects inside a tunnel, like movable equipment in control areas. Tunnels can be bounded by different types of surfaces. In this way, the outer structure of tunnels can be differentiated semantically into wall surfaces, roof surfaces, ground surfaces, outer floor surfaces, and outer ceiling surfaces, whereas the visible surface of hollow spaces can be structured into interior wall surfaces, floor surfaces, and ceiling surfaces. Furthermore, the openings of tunnels, i.e. windows and doors, can be represented including their corresponding surfaces.

The UML diagram of the Tunnel module is depicted in [Tunnel UML Diagram](#). The Tunnel module inherits concepts from the Construction module ([cf. Section Construction](#)). The Construction module defines objects that are common to all types of construction, such as the different surface

types and the openings. A detailed discussion of the Requirements Class Tunnel can be found in the CityGML Best Practices document [here](#).

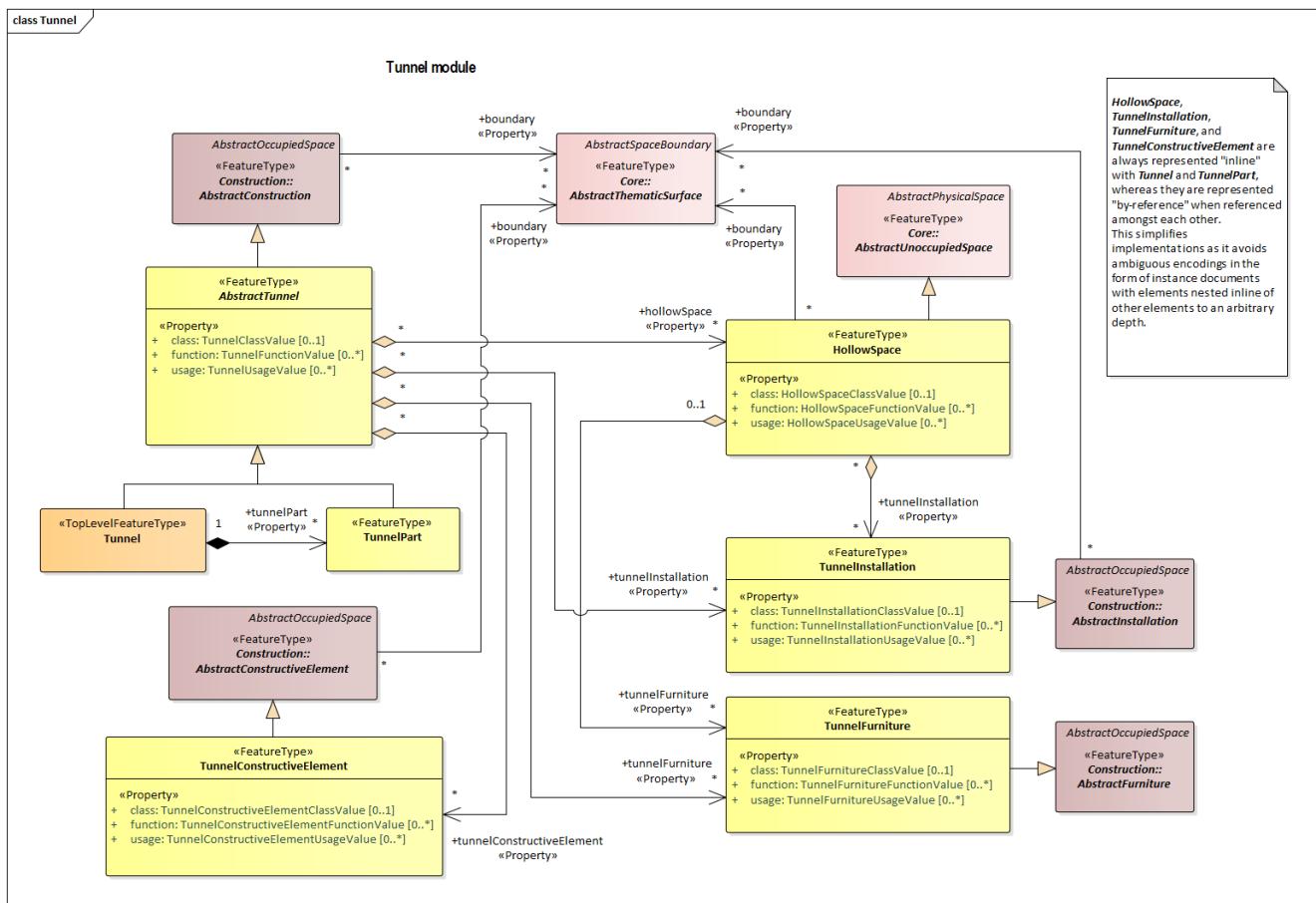


Figure 21. UML diagram of the Tunnel Model.

8.16.1. Package

Package Tunnel

Description:	The Tunnel module supports representation of thematic and spatial aspects of tunnels, tunnel parts, tunnel installations, and interior tunnel structures.
Parent Package:	CityGML
Stereotype:	«ApplicationSchema»

Editing instructions:

1) For all classes

- a) If a stereotype value is "<<← section,>>", change it to "none"
 - b) If a subclass value is not provided, set it to "none"
 - c) If a multiplicity value is not provided, set it to "1"
 - d) If the Role Name of a relation is not provided, delete the Role Name row
 - e) If the stereotype of an attribute is not provided, set it to [Property]

2) For all classes with the "CodeList" stereotype
a) Copy the name and description into the table in the Code List section
b) Delete the class
3) If there are no code lists, then delete the Code List section
4) Delete these instructions when done

8.16.2. Classes

Class AbstractTunnel

AbstractTunnel	
Definition:	AbstractTunnel is an abstract superclass representing the common attributes and associations of the classes Tunnel and TunnelPart.
Subclass Of:	AbstractConstruction
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	TunnelFurniture	
	TunnelInstallation	
	TunnelConstructiveElement	
	HollowSpace	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	TunnelClassValue [0..1]	Indicates the specific type of the Tunnel or TunnelPart.
function	TunnelFunctionValue [0..*]	Specifies the intended purposes of the Tunnel or TunnelPart.
usage	TunnelUsageValue [0..*]	Specifies the actual uses of the Tunnel or TunnelPart.

Class HollowSpace

HollowSpace

Definition:	A HollowSpace is a space within a Tunnel or TunnelPart intended for certain functions (e.g. transport or passage ways, service rooms, emergency shelters). A HollowSpace is bounded physically and/or virtually (e.g. by ClosureSurfaces or GenericSurfaces).
Subclass Of:	AbstractUnoccupiedSpace
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractThematicSurface	
	TunnelFurniture	
	TunnelInstallation	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	HollowSpaceClassValue [0..1]	Indicates the specific type of the HollowSpace.
function	HollowSpaceFunctionValue [0..*]	Specifies the intended purposes of the HollowSpace.
usage	HollowSpaceUsageValue [0..*]	Specifies the actual uses of the HollowSpace.

Class HollowSpaceClassValue

HollowSpaceClassValue

Definition:	HollowSpaceClassValue is a code list used to further classify a HollowSpace.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class HollowSpaceFunctionValue

HollowSpaceFunctionValue		
Definition:	HollowSpaceFunctionValue	is a code list that enumerates the different purposes of a HollowSpace.
Subclass Of:	<-- section,>>	
Stereotype:	«CodeList»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class HollowSpaceUsageValue

HollowSpaceUsageValue		
Definition:	HollowSpaceUsageValue	is a code list that enumerates the different uses of a HollowSpace.
Subclass Of:	<-- section,>>	
Stereotype:	«CodeList»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class Tunnel

Tunnel

Definition: A Tunnel represents a horizontal or sloping enclosed passage way of a certain length, mainly underground or underwater. [cf. ISO 6707-1]

Subclass Of: [AbstractTunnel](#)

Stereotype: «TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

	TunnelPart	
--	------------	--

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TunnelClassValue

TunnelClassValue

Definition: TunnelClassValue is a code list used to further classify a Tunnel.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TunnelConstructiveElement

TunnelConstructiveElement

Definition: A TunnelConstructiveElement is an element of a Tunnel which is essential from a structural point of view. Examples are walls, slabs, beams.

Subclass Of: [AbstractConstructiveElement](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	TunnelConstructiveElement ClassValue [0..1]	Indicates the specific type of the TunnelConstructiveElement.
function	TunnelConstructiveElement FunctionValue [0..*]	Specifies the intended purposes of the TunnelConstructiveElement.
usage	TunnelConstructiveElement UsageValue [0..*]	Specifies the actual uses of the TunnelConstructiveElement.

Class TunnelConstructiveElementClassValue

TunnelConstructiveElementClassValue

Definition: TunnelConstructiveElementClassValue is a code list used to further classify a TunnelConstructiveElement.

Subclass Of: <-- section,-->

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class TunnelConstructiveElementFunctionValue

TunnelConstructiveElementFunctionValue

Definition: TunnelConstructiveElementFunctionValue is a code list that enumerates the different purposes of a TunnelConstructiveElement.

Subclass Of: <– section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name Target class and Definition multiplicity

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class TunnelConstructiveElementUsageValue

TunnelConstructiveElementUsageValue

Definition: TunnelConstructiveElementUsageValue is a code list that enumerates the different uses of a TunnelConstructiveElement.

Subclass Of: <– section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name Target class and Definition multiplicity

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class TunnelFunctionValue

TunnelFunctionValue

Definition:	TunnelFunctionValue is a code list that enumerates the different purposes of a Tunnel.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TunnelFurniture

TunnelFurniture

Definition:	A TunnelFurniture is an equipment for occupant use, usually not fixed to the tunnel. [cf. ISO 6707-1]
Subclass Of:	AbstractFurniture
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	TunnelFurnitureClassValue [0..1]	Indicates the specific type of the TunnelFurniture.
function	TunnelFurnitureFunctionValue [0..*]	Specifies the intended purposes of the TunnelFurniture.

Attribute	Value type and multiplicity	Definition
usage	TunnelFurnitureUsageValue [0..*]	Specifies the actual uses of the TunnelFurniture.

Class TunnelFurnitureClassValue

TunnelFurnitureClassValue	
Definition:	TunnelFurnitureClassValue is a code list used to further classify a TunnelFurniture.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class TunnelFurnitureFunctionValue

TunnelFurnitureFunctionValue	
Definition:	TunnelFurnitureFunctionValue is a code list that enumerates the different purposes of a TunnelFurniture.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition

Class TunnelFurnitureUsageValue

TunnelFurnitureUsageValue

Definition:	TunnelFurnitureUsageValue is a code list that enumerates the different uses of a TunnelFurniture.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class TunnelInstallation

TunnelInstallation

Definition:	A TunnelInstallation is a permanent part of a Tunnel (inside and/or outside) which does not have the significance of a TunnelPart. In contrast to TunnelConstructiveElement, a TunnelInstallation is not essential from a structural point of view. Examples are stairs, antennas or railings.
Subclass Of:	AbstractInstallation
Stereotype:	«FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	TunnelInstallationClassValue e [0..1]	Indicates the specific type of the TunnelInstallation.

Attribute	Value type and multiplicity	Definition
function	TunnelInstallationFunctionValue [0..*]	Specifies the intended purposes of the TunnelInstallation.
usage	TunnelInstallationUsageValue [0..*]	Specifies the actual uses of the TunnelInstallation.

Class TunnelInstallationClassValue

TunnelInstallationClassValue

Definition: TunnelInstallationClassValue is a code list used to further classify a TunnelInstallation.
 Subclass Of: <-- section,>>
 Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class TunnelInstallationFunctionValue

TunnelInstallationFunctionValue

Definition: TunnelInstallationFunctionValue is a code list that enumerates the different purposes of a TunnelInstallation.
 Subclass Of: <-- section,>>
 Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class TunnelInstallationUsageValue

TunnelInstallationUsageValue

Definition: TunnelInstallationUsageValue is a code list that enumerates the different uses of a TunnelInstallation.

Subclass Of: <– section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name Target class and Definition multiplicity

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class TunnelPart

TunnelPart

Definition: A TunnelPart is a physical or functional subdivision of a Tunnel. It would be considered a Tunnel, if it were not part of a collection of other TunnelParts.

Subclass Of: [AbstractTunnel](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name Target class and Definition multiplicity

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute Value type and multiplicity Definition

Class TunnelUsageValue

TunnelUsageValue

Definition: TunnelUsageValue is a code list that enumerates the different uses of a Tunnel.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

8.16.3. Code Lists

Code List	Definition
-----------	------------

8.16.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.17. Vegetation

Requirements Class

<http://www.opengis.net/spec/CityGML/3.1/req/req-class-vegetation>

Target type	Conceptual Model
Dependency	/req/req-class-core

The Vegetation module defines the concepts to represent vegetation within city models. Vegetation can be represented either as solitary vegetation objects, such as trees, bushes and ferns, or as vegetation areas that are covered by plants of a given species or a typical mixture of plant species, such as forests, steppes and wet meadows. Vegetation is represented in the UML model by the top-level feature types *SolitaryVegetationObject* and *PlantCover*, which are also the only classes of the Vegetation module.

The UML diagram of the Vegetation module is depicted in [Vegetation UML Diagram](#). A detailed discussion of this Requirements Class can be found in the CityGML Best Practices document [here](#).

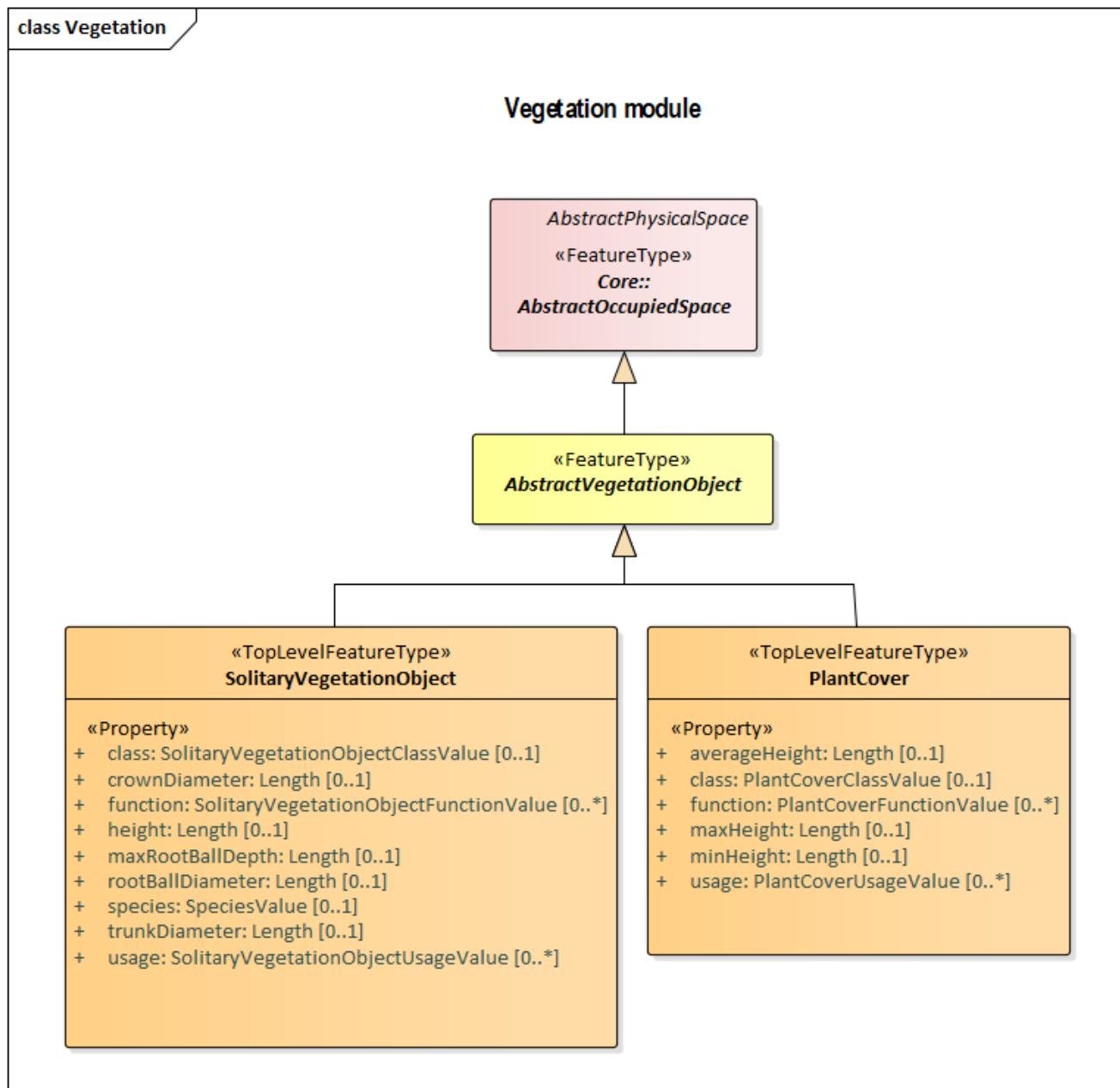


Figure 22. UML diagram of the Vegetation Model.

8.17.1. Package

Package Vegetation

Description: The Vegetation module supports representation of vegetation objects with vegetation-specific thematic classes. CityGML's vegetation model distinguishes between solitary vegetation objects like trees, and vegetation areas which represent biotopes like forests or other plant communities.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- a) If a stereotype value is "<<-- section,>>", change it to "none"
- b) If a subclass value is not provided, set it to "none"
- c) If a multiplicity value is not provided, set it to "1"
- d) If the Role Name of a relation is not provided, delete the Role Name row
- e) If the stereotype of an attribute is not provided, set it to [\[Property\]](#)

2) For all classes with the "CodeList" stereotype

- a) Copy the name and description into the table in the Code List section

- b) Delete the class

3) If there are no code lists, then delete the Code List section

4) Delete these instructions when done

8.17.2. Classes

Class AbstractVegetationObject

AbstractVegetationObject

Definition: AbstractVegetationObject is the abstract superclass for all kinds of vegetation objects.

Subclass Of: [AbstractOccupiedSpace](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class PlantCover

PlantCover

Definition:	A PlantCover represents a space covered by vegetation.
Subclass Of:	AbstractVegetationObject
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
averageHeight	Length [0..1]	Specifies the average height of the PlantCover.
class	PlantCoverClassValue [0..1]	Indicates the specific type of the PlantCover.
function	PlantCoverFunctionValue [0..*]	Specifies the intended purposes of the PlantCover.
maxHeight	Length [0..1]	Specifies the maximum height of the PlantCover.
minHeight	Length [0..1]	Specifies the minimum height of the PlantCover.
usage	PlantCoverUsageValue [0..*]	Specifies the actual uses of the PlantCover.

Class PlantCoverClassValue

PlantCoverClassValue

Definition:	PlantCoverClassValue is a code list used to further classify a PlantCover.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class PlantCoverFunctionValue

PlantCoverFunctionValue

Definition:	PlantCoverFunctionValue is a code list that enumerates the different purposes of a PlantCover.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class PlantCoverUsageValue

PlantCoverUsageValue

Definition:	PlantCoverUsageValue is a code list that enumerates the different uses of a PlantCover.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class SolitaryVegetationObject

SolitaryVegetationObject

Definition:	A SolitaryVegetationObject represents individual vegetation objects, e.g. trees or bushes.
Subclass Of:	AbstractVegetationObject
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	SolitaryVegetationObjectClassValue [0..1]	Indicates the specific type of the SolitaryVegetationObject.
crownDiameter	Length [0..1]	Specifies the diameter of the SolitaryCityObject's crown.
function	SolitaryVegetationObjectFunctionValue [0..*]	Specifies the intended purposes of the SolitaryVegetationObject.
height	Length [0..1]	Distance between the highest point of the vegetation object and the lowest point of the terrain at the bottom of the object.
maxRootBallDepth	Length [0..1]	Specifies the vertical distance between the lowest point of the SolitaryVegetationObject's root ball and the terrain surface.
rootBallDiameter	Length [0..1]	Specifies the diameter of the SolitaryCityObject's root ball.
species	SpeciesValue [0..1]	Indicates the botanical name of the SolitaryVegetationObject.
trunkDiameter	Length [0..1]	Specifies the diameter of the SolitaryCityObject's trunk.
usage	SolitaryVegetationObjectUsageValue [0..*]	Specifies the actual uses of the SolitaryVegetationObject.

Class SolitaryVegetationObjectClassValue

SolitaryVegetationObjectClassValue

Definition:	SolitaryVegetationObjectClassValue is a code list used to further classify a SolitaryVegetationObject.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class SolitaryVegetationObjectFunctionValue

SolitaryVegetationObjectFunctionValue

Definition:	SolitaryVegetationObjectFunctionValue is a code list that enumerates the different purposes of a SolitaryVegetationObject.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class SolitaryVegetationObjectUsageValue

SolitaryVegetationObjectUsageValue

Definition:	SolitaryVegetationObjectUsageValue is a code list that enumerates the different uses of a SolitaryVegetationObject.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class SpeciesValue

SpeciesValue

Definition:	A SpeciesValue is a code list that enumerates the species of a SolitaryVegetationObject.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

8.17.3. Code Lists

Code List	Definition
-----------	------------

8.17.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.18. Versioning

Requirements Class	
http://www.opengis.net/spec/CityGML/3.0/req/req-class-versioning	
Target type	Conceptual Model
Dependency	/req/req-class-core

The Versioning module provides the concepts that allow for representing multiple versions of a city model. A specific version represents a defined state of a city model consisting of the dedicated versions of all city object instances that belong to the respective city model version. Each version can be complemented by version transitions that describe the change of the state of a city model from one version to another and that give the reason for the change and the modifications applied. In addition, the Versioning module introduces bitemporal timestamps for all objects. This allows for providing all objects with information on the time period a specific version of an object is an integral part of the 3D city model and on the lifespan a specific version of an object exists in the real world.

By using the Versioning module, slow changes over a long time period with respect to cities and city models can be represented. This includes the creation and termination of objects (e.g. construction or demolition of sites, planting of trees, construction of new roads), structural changes of objects (e.g. raising of buildings), and changes in the status of an object (e.g. change of building owner, change of the traffic direction of a road to a one-way street). In this way, the history or evolution of cities and city models can be modelled, parallel or alternative versions of cities and city models can be managed, and changes of geometries and thematic properties of individual city objects over time can be tracked.

The UML diagram of the Versioning module is depicted in [Versioning UML Diagram](#). A detailed discussion of this Requirements Class can be found in the CityGML Best Practices document [here](#).

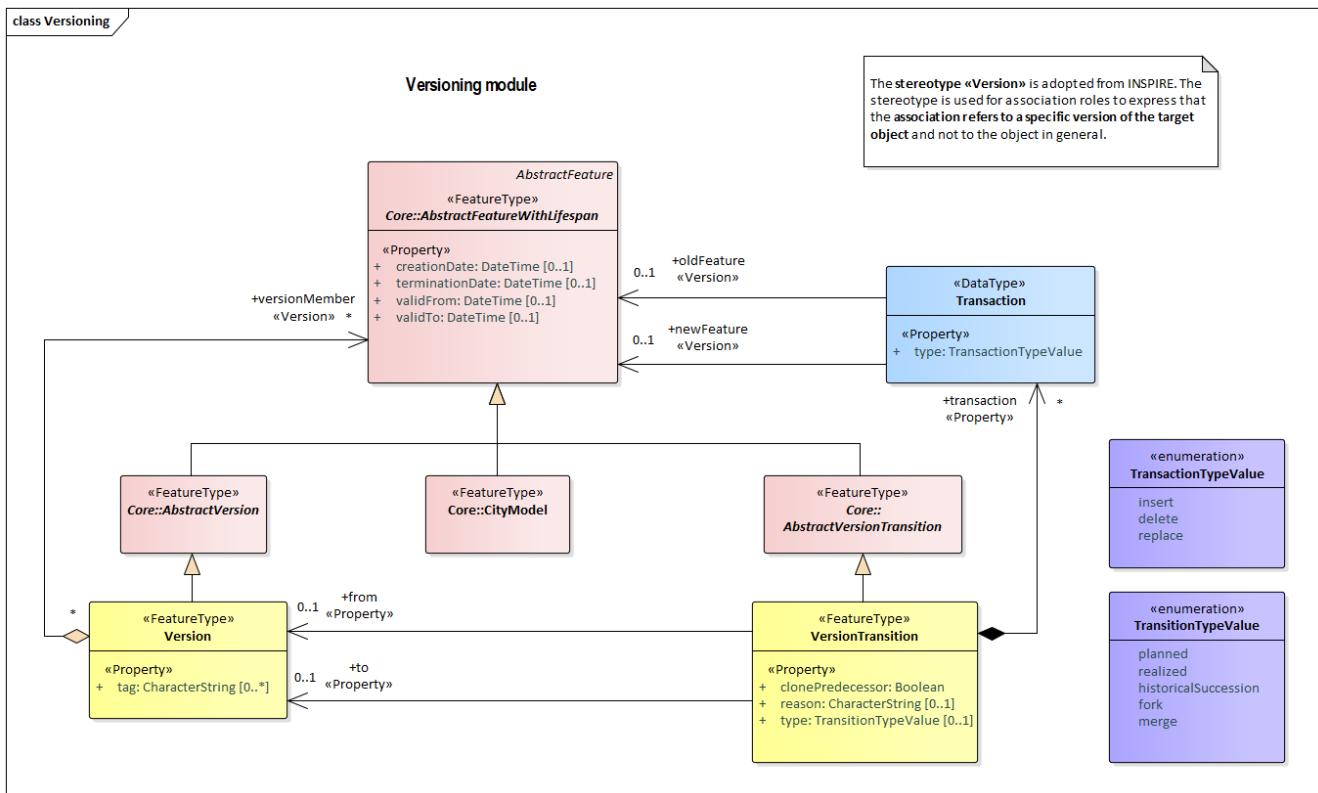


Figure 23. UML diagram of the Versioning Model.

8.18.1. Package

Package Versioning

Description: The Versioning module supports representation of multiple versions of CityGML features within a single CityGML model. In addition, also the version transitions and transactions that lead to the different versions can be represented.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- If a stereotype value is "<<-- section,>>", change it to "none"
- If a subclass value is not provided, set it to "none"
- If a multiplicity value is not provided, set it to "1"
- If the Role Name of a relation is not provided, delete the Role Name row
- If the stereotype of an attribute is not provided, set it to [Property]

2) For all classes with the "CodeList" stereotype

- Copy the name and description into the table in the Code List section

- b) Delete the class
- 3) If there are no code lists, then delete the Code List section
- 4) Delete these instructions when done

8.18.2. Classes

Class Version

Version

Definition: Version represents a defined state of a city model consisting of the dedicated versions of all city object instances that belong to the respective city model version. Versions can have names, a description and can be labeled with an arbitrary number of user defined tags.

Subclass Of: [AbstractVersion](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractFeatureWithLifetime	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
tag	CharacterString [0..*]	Allows for adding keywords to the city model version.

Class VersionTransition

VersionTransition

Definition: VersionTransition describes the change of the state of a city model from one version to another. Version transitions can have names, a description and can be further qualified by a type and a reason.

Subclass Of: [AbstractVersionTransition](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	Transaction	
	Version	
	Version	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
clonePredecessor	Boolean	Indicates whether the set of city object instances belonging to the successor version of the city model is either explicitly enumerated within the successor version object (attribute clonePredecessor=false), or has to be derived from the modifications of the city model provided as a list of transactions on the city object versions contained in the predecessor version (attribute clonePredecessor=true).
reason	CharacterString [0..1]	Specifies why the VersionTransition has been carried out.
type	TransitionTypeValue [0..1]	Indicates the specific type of the VersionTransition.

Class Transaction

Transaction	
Definition:	Transaction represents a modification of the city model by the creation, termination, or replacement of a specific city object. While the creation of a city object also marks its first object version, the termination marks the end of existence of a real world object and, hence, also terminates the final version of a city object. The replacement of a city object means that a specific version of it is replaced by a new version.
Subclass Of:	<-- section,>>
Stereotype:	«DataType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition

	AbstractFeatureWithLifespan	
	AbstractFeatureWithLifespan	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
type	TransactionTypeValue	Indicates the specific type of the Transaction.

Class TransactionTypeValue

TransactionTypeValue	
Definition:	TransactionTypeValue enumerates the three possible types of transactions: insert, delete, or replace.
Subclass Of:	<-- section,>>
Stereotype:	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
insert	<-- section,>>	Indicates that the feature referenced from the Transaction via the "newFeature" association has been newly created; the association "oldFeature" is empty in this case.
delete	<-- section,>>	Indicates that the feature referenced from the Transaction via the "oldFeature" association ceases to exist; the association "newFeature" is empty in this case.
replace	<-- section,>>	Indicates that the feature referenced from the Transaction via the "oldFeature" association has been replaced by the feature referenced via the "newFeature" association.

Class TransitionTypeValue

TransitionTypeValue

Definition: TransitionTypeValue enumerates the different kinds of version transitions. “planned” and “fork” should be used in cases when from one city model version multiple successor versions are being created. “realized” and “merge” should be used when different city model versions are converging into a common successor version.

Subclass Of: <– section,>>

Stereotype:

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
planned	<– section,>>	Indicates that the successor version of the city model represents a planning state for a possible future of the city.
realized	<– section,>>	Indicates that the predecessor version is the chosen one from a number of possible planning versions.
historicalSuccession	<– section,>>	Indicates that the successor version reflects updates on the city model over time (historical timeline). It shall only be used for at most one version transition outgoing from a city model version.
fork	<– section,>>	Indicates other reasons to create alternative city model versions, for example, when different parties are updating parts of the city model or to reflect the results of different simulation runs.
merge	<– section,>>	Indicates other reasons to converge multiple versions back into a common city model version.

8.18.3. Code Lists

Code List	Definition

8.18.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

8.19. Water Body

Requirements Class

<http://www.opengis.net/spec/CityGML/3.1/req/req-class-waterbody>

Target type	Conceptual Model
Dependency	/req/req-class-core

The WaterBody module provides the representation of significant and permanent or semi-permanent accumulations of surface water, usually covering a part of the Earth. Examples of such water bodies that can be modelled with CityGML are rivers, canals, lakes, and basins. Water bodies are represented in the UML model by the top-level feature type *WaterBody*, which is the main class of the WaterBody module.

Water bodies can be bounded by water surfaces, which represent the upper exterior interface between the water body and the atmosphere, and by water ground surfaces, which represent the exterior boundary surfaces of the submerged bottom of a water body (e.g. DTM or floor of a 3D basin object). Water surfaces are dynamic surfaces, thus, the visible water surface can regularly as well as irregularly change in height and covered area due to natural forces such as tides and floods.

The UML diagram of the WaterBody module is depicted in [Water Body UML Diagram](#). A detailed discussion of this Requirements Class can be found in the CityGML Best Practices document [here](#).

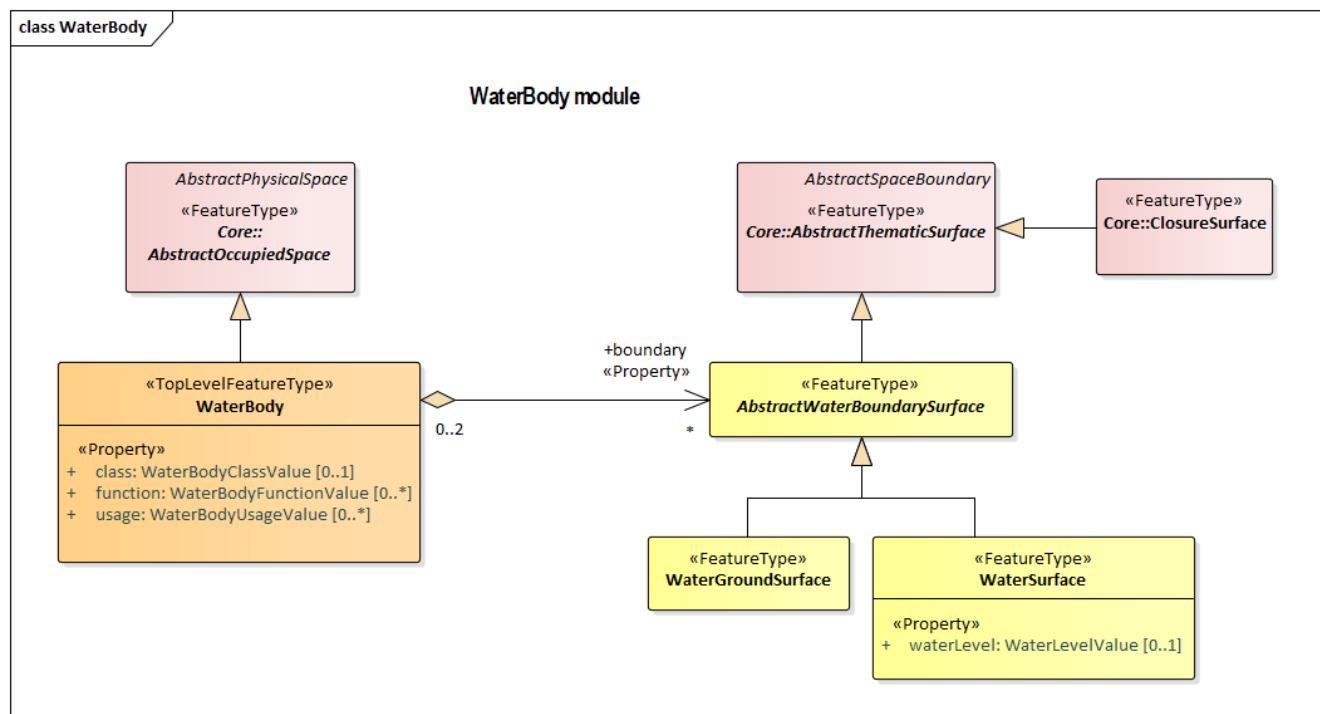


Figure 24. UML diagram of the Water Body Model.

8.19.1. Package

Package WaterBody

Description: The WaterBody module supports representation of the thematic aspects and 3D geometry of rivers, canals, lakes, and basins. It does, however, not inherit any hydrological or other dynamic aspects of fluid flow.

Parent Package: CityGML

Stereotype: «ApplicationSchema»

Editing instructions:

1) For all classes

- a) If a stereotype value is "<<-- section,>>", change it to "none"
- b) If a subclass value is not provided, set it to "none"
- c) If a multiplicity value is not provided, set it to "1"
- d) If the Role Name of a relation is not provided, delete the Role Name row
- e) If the stereotype of an attribute is not provided, set it to [\[Property\]](#)

2) For all classes with the "CodeList" stereotype

- a) Copy the name and description into the table in the Code List section
- b) Delete the class

3) If there are no code lists, then delete the Code List section

4) Delete these instructions when done

8.19.2. Classes

Class AbstractWaterBoundarySurface

AbstractWaterBoundarySurface

Definition: AbstractWaterBoundarySurface is the abstract superclass for all kinds of thematic surfaces bounding a water body.

Subclass Of: [AbstractThematicSurface](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
-----------	-----------------------------	------------

Class WaterBody

WaterBody

Definition:	A WaterBody represents significant and permanent or semi-permanent accumulations of surface water, usually covering a part of the Earth.
Subclass Of:	AbstractOccupiedSpace
Stereotype:	«TopLevelFeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
	AbstractWaterBoundarySurface	

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
class	WaterBodyClassValue [0..1]	Indicates the specific type of the WaterBody.
function	WaterBodyFunctionValue [0..*]	Specifies the intended purposes of the WaterBody.
usage	WaterBodyUsageValue [0..*]	Specifies the actual uses of the WaterBody.

Class WaterBodyClassValue

WaterBodyClassValue

Definition:	WaterBodyClassValue is a code list used to further classify a WaterBody.
Subclass Of:	<-- section,>>
Stereotype:	«CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class WaterBodyFunctionValue

WaterBodyFunctionValue		
Definition:	WaterBodyFunctionValue	is a code list that enumerates the different purposes of a WaterBody.
Subclass Of:	<-- section,>>	
Stereotype:	«CodeList»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class WaterBodyUsageValue

WaterBodyUsageValue		
Definition:	WaterBodyUsageValue	is a code list that enumerates the different uses of a WaterBody.
Subclass Of:	<-- section,>>	
Stereotype:	«CodeList»	

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class WaterGroundSurface

WaterGroundSurface

Definition: A WaterGroundSurface represents the exterior boundary surface of the submerged bottom of a water body.

Subclass Of: [AbstractWaterBoundarySurface](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class WaterLevelValue

WaterLevelValue

Definition: WaterLevelValue is a code list that enumerates the different levels of a water surface.

Subclass Of: <-- section,>>

Stereotype: «CodeList»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
------------------	--------------------------------------	-------------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
------------------	------------------------------------	-------------------

Class WaterSurface

WaterSurface

Definition: A WaterSurface represents the upper exterior interface between a water body and the atmosphere.

Subclass Of: [AbstractWaterBoundarySurface](#)

Stereotype: «FeatureType»

Relations

Unless otherwise specified, all attributes have the stereotype «Property».

Role name	Target class and multiplicity	Definition
-----------	-------------------------------	------------

Attributes

Unless otherwise specified, all attributes have the stereotype «Property».

Attribute	Value type and multiplicity	Definition
waterLevel	WaterLevelValue [0..1]	Specifies the level of the WaterSurface.

8.19.3. Code Lists

Code List	Definition

8.19.4. Additional Information

The following sections provide additional information which may not be readily available through the UML Model.

Chapter 9. Media Types for any data encoding(s)

A section describing the MIME-types to be used is mandatory for any standard involving data encodings. If no suitable MIME type exists in <http://www.iana.org/assignments/media-types/index.html> then this section may be used to define a new MIME type for registration with IANA.

Annex A: Conformance Class Abstract Test Suite (Normative)

Annex B: Revision History

Date	Release	Editor	Primary clauses modified	Description
2016-04-28	0.1	G. Editor	all	initial version

Chapter 10. Change Log for CityGML 3.0

CityGML 3.0 is the baseline version. Changes appearing in versions following 3.0 will be listed in this section.

Feature Class / Data Type	Property	New	Changed	Deleted	Description of Change

Annex C: Changelog for CityGML 3.0

The following table lists all feature types, properties, and data types which have been added or changed for CityGML 3.0.

Feature Class / Data Type	Property	New	Changed	Deleted	Description of Change

Annex D: Bibliography

Example Bibliography (Delete this note).

The TC has approved Springer LNCS as the official document citation type.

Springer LNCS is widely used in technical and computer science journals and other publications

NOTE

- For citations in the text please use square brackets and consecutive numbers:
[1], [2], [3]

– Actual References:

[n] Journal: Author Surname, A.: Title. Publication Title. Volume number, Issue number, Pages Used (Year Published)

[n] Web: Author Surname, A.: Title, <http://Website-Url>

[1] OGC: OGC Testbed 12 Annex B: Architecture. (2015).