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City Geography Markup Language (CityGML) Conceptual Model Standard

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Table of Contents

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, <tags separated by commas>

iii. Preface

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

[OGC Logo] | *images/OGC_Logo.png*

OGC work on CityGML is discussed and coordinated by the OGC 3D Information Management (3DIM) Working Group. CityGML was initally implemented and evaluated as part of the OGC Web Services Testbed, Phase 4 (OWS-4) in the CAD/GIS/BIM thread.

Version 3.0 of this standards document was prepared by the OGC CityGML Standards Working Group (SWG). For further information see the CityGML SWG project on the OGC Portal.

CityGML also continues to be developed by the members of the Special Interest Group 3D (SIG 3D) of the GDI-DE Geodateninfrastruktur Deutschland (Spatial Data Infrastructure Germany) in joint cooperation with the 3DIM Working Group and the CityGML SWG within OGC. For further information see the SIG 3D Web Site.

The preparation of the English document version and the European discussion has been supported by the European Spatial Data Research Organization (EuroSDR; formerly known as OEEPE) in an EuroSDR Commission III project. For further information see their Web Site.

NOTE

Insert Preface Text here. Give OGC specific commentary: describe the technical content, reason for document, history of the document and precursors, and plans for future work. > Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The Open Geospatial Consortium shall not be held responsible for identifying any or all such patent rights.

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

iv. Submitting organizations

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

Organization name(s)

v. Submitters

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

Name Affiliation

Chapter 1. Scope

NOTE Insert Scope text here. Give the subject of the document and the aspects of that scope covered by the document.

Chapter 2. Conformance

This standard defines XXXX.

Requirements for N standardization target types are considered: * AAAA * BBBB

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

In order to conform to this OGC® interface standard, a software implementation shall choose to implement: * Any one of the conformance levels specified in Annex A (normative). * Any one of the Distributed Computing Platform profiles specified in Annexes TBD through TBD (normative).

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

Chapter 3. References

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

Insert References here. If there are no references, state “There are no normative references”.

References are to follow the Springer LNCS style, with the exception that optional information may be appended to references: DOIs are added after the date and web resource references may include an access date at the end of the reference in parentheses. See examples from Springer and OGC below.

Smith, T.F., Waterman, M.S.: Identification of Common Molecular Subsequences. J. Mol. Biol. 147, 195–197 (1981)

May, P., Ehrlich, H.C., Steinke, T.: ZIB Structure Prediction Pipeline: Composing a Complex Biological Workflow through Web Services. In: Nagel, W.E., Walter, W.V., Lehner, W. (eds.) Euro-Par 2006. LNCS, vol. 4128, pp. 1148–1158. Springer, Heidelberg (2006)

Foster, I., Kesselman, C.: The Grid: Blueprint for a New Computing Infrastructure. Morgan Kaufmann, San Francisco (1999)

Czajkowski, K., Fitzgerald, S., Foster, I., Kesselman, C.: Grid Information Services for Distributed Resource Sharing. In: 10th IEEE International Symposium on High Performance Distributed Computing, pp. 181–184. IEEE Press, New York (2001)

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Foster, I., Kesselman, C., Nick, J., Tuecke, S.: The Physiology of the Grid: an Open Grid Services Architecture for Distributed Systems Integration. Technical report, Global Grid Forum (2002)

National Center for Biotechnology Information, http://www.ncbi.nlm.nih.gov

ISO / TC 211: ISO 19115-1:2014 Geographic information — Metadata — Part 1: Fundamentals (2014)

ISO / TC 211: ISO 19157:2013 Geographic information — Data quality (2013)

ISO / TC 211: ISO 19139:2007 Geographic information — Metadata — XML schema implementation (2007)

ISO / TC 211: ISO 19115-3: Geographic information — Metadata — Part 3: XML schemas (2016)

OGC: OGC 15-097 OGC Geospatial User Feedback Standard. Conceptual Model (2016)

OGC: OGC 12-019, OGC City Geography Markup Language (CityGML) Encoding Standard (2012)

OGC: OGC 14-005r3, OGC IndoorGML (2014)

Chapter 4. Terms and Definitions

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

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

4.1. term name

text of the definition

Chapter 5. Conventions

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

5.1. Identifiers

The normative provisions in this standard are denoted by the URI

http://www.opengis.net/spec/{standard}/{m.n}

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

Chapter 6. Clauses not Containing Normative Material

Paragraph

6.1. Clauses not containing normative material sub-clause 1

Paragraph

6.2. Clauses not containing normative material sub-clause 2

Chapter 7. CityGML Conceptual Model Requirements

Discussion about how the UML model is the definitive source for the Conceptual Model. This section will provide an overview of the UML model and the requirements for applying that model for the creation of an encoding standard.

7.1. Requirement Class Core

Brief intro to the core class

UML models as needed with description of key classes (should be taked from the class description)

For more information, see the CityGML Concetual Model Best Practices.

Requirements Class	
http://www.opengis.net/spec/CityGML/3.1/req/req-class-core	
Target type	Instance Document
Dependency	TBD
Dependency	TBD

Requirement 1	**/req/core/base**
A	The CityModel element (type: CityModelType, substitutionGroup: gml:_FeatureCollection) shall only contain cityObjectMember elements (type: gml:FeaturePropertyType), app:appearanceMember ele-ments (type: app:AppearancePropertyType), and gml:featureMember elements (type: gml:FeaturePropertyType) as feature members.
B	The type ExternalObjectReference introduces the two elements name (type: xs:string) and uri (type: xs:anyURI). The external reference may be specified by either of them. However, if the informationSys-tem property element (type: xs:anyURI) of the type ExternalReferenceType is not provided, the uri ele-ment of ExternalObjectReference must be given.
C	In order to represent address information about a feature, the corresponding thematic class of the feature shall define a property of the type AddressPropertyType. Thus, for all CityGML extension modules on-ly the type AddressPropertyType shall be used for elements providing address information.
D	Since the concept of implicit geometries (cf. chapter 8.2) is part of the CityGML Core module, the con-formance requirements introduced for implicit geometries (cf. chapter 8.3.3) are part of the conform-ance requirements of the core.

Requirement 2	/req/core/refIntegrity
A	The cityObjectMember element (type: gml:FeaturePropertyType) may contain a _CityObject element, which typically is an object from a derived subclass like bldg:Building, inline or an XLink reference to a remote _CityObject element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the cityObjectMember element may only point to a remote _CityObject element (where re-mote _CityObject elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
B	The type AddressPropertyType may contain an Address element inline or an XLink reference to a re-mote Address element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the corresponding element of type AddressPropertyType may only point to a remote Address element (where remote Address elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

7.2. Requirement Class Relief

Brief intro to the core class

UML models as needed with description of key classes (should be taked from the class description)

For more information, see the CityGML Concetual Model Best Practices.

Requirements Class	
http://www.opengis.net/spec/CityGML/3.1/req/req-class-relief	
Target type	Instance Document
Dependency	TBD
Dependency	TBD

Requirement 3	/req/relief/base
A	The gml:Polygon geometry element describing the extent of validity of a _ReliefComponent element us-ing the extent property (type: gml:PolygonPropertyType) of _ReliefComponent shall be given as 2D footprint polygon which may have inner holes.

Requirement 4	/req/relief/refIntegrity

A	The reliefComponent property (type: ReliefComponentPropertyType) of the element ReliefFeature may contain a _ReliefComponent element inline or an XLink reference to a remote _ReliefComponent ele-ment using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the reliefCom-ponent property may only point to a remote _ReliefComponent element (where remote _ReliefComponent elements are located in another document or elsewhere in the same document). Ei-ther the contained element or the reference must be given, but neither both nor none.
B	The tin property (type: tinPropertyType) of the element TINRelief may contain a gml:TriangulatedSurface element inline or an XLink reference to a remote gml:TriangulatedSurface el-ement using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the tin prop-erty may only point to a remote gml:TriangulatedSurface element (where remote gml:TriangulatedSurface elements are located in another document or elsewhere in the same docu-ment). Either the contained element or the reference must be given, but neither both nor none.
C	The grid property (type: gridPropertyType) of the element RasterRelief may contain a gml:RectifiedGridCoverage element inline or an XLink reference to a remote gml:RectifiedGridCoverage element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the grid property may only point to a remote gml:RectifiedGridCoverage element (where remote gml:RectifiedGridCoverage elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

7.2.1. Requirement Class Building

Brief intro to the core class

UML models as needed with description of key classes (should be taked from the class description)

For more information, see the CityGML Concetual Model Best Practices.

Unresolved directive in clause_7_core.adoc - include::requirements/requirements_class_building.adoc[]

Requirement 5	**/req/building/base**

A	If a building only consists of one (homogeneous) part, it shall be represented by the element Building. However, if a building is composed of individual structural segments, it shall be modelled as a Building element having one or more additional BuildingPart elements. Only the geometry and non-spatial prop-erties of the main part of the building should be represented within the aggregating Building element.

Requirement 6	**/req/building/restrictions**
A	The gml:MultiSurface geometries that are associated using the lod0FootPrint and lod0RoofEdge prop-erties must have 3D coordinates. For each surface, the height values of the coordinate tuples belonging to the same surface shall be identical.
B	The lodXSolid and lodXMultiSurface, X [1..4], properties (gml:SolidPropertyType resp. gml:MultiSurfacePropertyType) of _AbstractBuilding may be used to geometricllay represent the exte-rior shell of a building (as volume or surface model) within each LOD. For LOD1, either lod1Solid or lod1MultiSurface must be used, but not both. Starting from LOD2, both properties may be modelled in-dividually and complementary.
C	Starting from LOD2, the exterior shell of an _AbstractBuilding may be semantically decomposed into _BoundarySurface elements using the boundedBy property (type: BoundarySurfacePropertyType) of _AbstractBuilding. Only RoofSurface, WallSurface, GroundSurface, OuterCeilingSurface, OuterFloor-Surface and ClosureSurface as subclasses of _BoundarySurface are allowed. The boundedBy property (not to be confused with the gml:boundedBy property) shall not be used if the building is only repre-sented in LOD1. If the exterior shell is represented by _BoundarySurface elements, an additional geometric representa-tion as volume or surface model using the lodXSolid and lodXMultiSurface, X [2..4], properties shall not explicitly define the geometry, but has to reference the according components of the gml:MultiSurface element of _BoundarySurface within each LOD using the XLink concept of GML 3.1.1.
D	Starting from LOD2, curve parts of the building shell may be represented using the lodXMultiCurve, X [2..4], property of _AbstractBuilding. This property shall not be used if the building is only repre-sented in LOD1.

E	Starting from LOD2, the outerBuildingInstallation property (type: BuildingInstallationPropertyType) of _AbstractBuilding may be used to model BuildingInstallation elements. BuildingInstallation elements shall only be used to represent outer characteristics of a building which do not have the significance of building parts. The outerBuildingInstallation property shall not be used if the building is only repre-sented in LOD1.
F	Starting from LOD2, the geometry of BuildingInstallation elements may be semantically classified by _BoundarySurface elements using the boundedBy property (type: BoundarySurfacePropertyType) of BuildingInstallation. Only RoofSurface, WallSurface, GroundSurface, OuterCeilingSurface, Outer-FloorSurface and ClosureSurface as subclasses of _BoundarySurface are allowed.
G	Starting from LOD3, openings of _BoundarySurface elements may be modelled using the opening property (type: OpeningPropertyType) of _BoundarySurface. This property shall not be used for _BoundarySurface elements only represented in LOD2. Accordingly, the surface geometry representing a _BoundarySurface in LOD2 must be simply connected. The opening property of _BoundarySurface may contain or reference _Opening elements. If the geo-metric location of an _Opening element topologically lies within a surface component of the _BoundarySurface, the opening must also be represented as inner hole of that surface. The embrasure surface of an _Opening element shall belong to the relevant adjacent _BoundarySurface.
G	Starting from LOD4, the interiorRoom property (type: InteriorRoomPropertyType) of _AbstractBuilding may be used to semantically model the free space inside the building by Room ele-ments. This property shall not be used if the building is only represented in LOD 1 – 3. The Room ele-ment may be geometrically represented as a surface or volume model, using its lod4Solid or lod4MultiSurface property (gml:SolidPropertyType resp. gml:MultiSurfacePropertyType). In addition, different parts of the visible surface of a room may be modelled by thematic _BoundarySurface elements. Only FloorSurface, CeilingSurface, InteriorWallSurface, and ClosureSur-face as subclasses of _BoundarySurface are allowed. If the visible surface of a room is represented by _BoundarySurface elements, an additional geometric representation as volume or surface model using the lod4Solid and lod4MultiSurface property shall not explicitly define the geometry, but has to refer-ence the according components of the gml:MultiSurface element of _BoundarySurface using the XLink concept of GML 3.1.1.

H	Starting from LOD4, the interiorBuildingInstallation property (type: IntBuildingInstallationProperty-Type) of _AbstractBuilding may be used to represent immovable objects inside the building that are permamently attached to the building structure. The interiorBuildingInstallation property shall not be used if the building is only represented in LOD 1 – 3. Furthermore, the interiorBuildingInstallation property shall only be used if the object cannot be associated with a Room element. In the latter case, the roomInstallation property (type: IntBuildingInstallationPropertyType) of the corresponding Room element shall be used to represent the object.
I	Starting from LOD4, the geometry of IntBuildingInstallation elements may be semantically classified by _BoundarySurface elements using the boundedBy property (type: BoundarySurfacePropertyType) of IntBuildingInstallation. Only FloorSurface, CeilingSurface, InteriorWallSurface, and ClosureSurface as subclasses of _BoundarySurface are allowed.

Requirement 7	**/req/building/refIntegrity**
A	The boundedBy property (type: BoundarySurfacePropertyType) of the element _AbstractBuilding may contain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface ele-ment using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the boundedBy property may only point to a remote _BoundarySurface element (where remote _BoundarySurface ele-ments are located in another document or elsewhere in the same document). Either the contained ele-ment or the reference must be given, but neither both nor none. Only RoofSurface, WallSurface, GroundSurface, OuterCeilingSurface, OuterFloorSurface and Clo-sureSurface elements are allowed to be encapsulated or referenced by the boundedBy property of _AbstractBuilding.
B	The outerBuildingInstallation property (type: BuildingInstallationPropertyType) of the element _AbstractBuilding may contain a BuildingInstallation element inline or an XLink reference to a remote BuildingInstallation element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href at-tribute of the outerBuildingInstallation property may only point to a remote BuildingInstallation ele-ment (where remote BuildingInstallation elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

C	The interiorBuildingInstallation property (type: IntBuildingInstallationPropertyType) of the element _AbstractBuilding may contain an IntBuildingInstallation element inline or an XLink reference to a re-mote IntBuildingInstallation element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the interiorBuildingInstallation property may only point to a remote IntBuildingInstallation element (where remote IntBuildingInstallation elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
D	The interiorRoom property (type: InteriorRoomPropertyType) of the element _AbstractBuilding may contain a Room element inline or an XLink reference to a remote Room element using the XLink con-cept of GML 3.1.1. In the latter case, the xlink:href attribute of the interiorRoom property may only point to a remote Room element (where remote Room elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but nei-ther both nor none.
E	The consistsOfBuildingPart property (type: BuildingPartPropertyType) of the element _AbstractBuilding may contain a BuildingPart element inline or an XLink reference to a remote Build-ingPart element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the consistsOfBuildingPart property may only point to a remote BuildingPart element (where remote BuildingPart elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
F	The address property (type: core:AddressPropertyType) of the element _AbstractBuilding may contain an core:Address element inline or an XLink reference to a remote core:Address element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the address property may on-ly point to a remote core:Address element (where remote core:Address elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

G	The opening property (type: OpeningPropertyType) of the element _BoundarySurface may contain an _Opening element inline or an XLink reference to a remote _Opening element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the opening property may only point to a re-mote _Opening element (where remote _Opening elements are located in another document or else-where in the same document). Either the contained element or the reference must be given, but neither both nor none.
H	The address property (type: core:AddressPropertyType) of the element Door may contain an core:Address element inline or an XLink reference to a remote core:Address element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the address property may only point to a remote core:Address element (where remote core:Address elements are located in another docu-ment or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
I	The boundedBy property (type: BoundarySurfacePropertyType) of the element BuildingInstallation may contain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the bound-edBy property may only point to a remote _BoundarySurface element (where remote _BoundarySurface elements are located in another document or elsewhere in the same document). Either the contained el-ement or the reference must be given, but neither both nor none. Only RoofSurface, WallSurface, GroundSurface, OuterCeilingSurface, OuterFloorSurface and Clo-sureSurface elements are allowed to be encapsulated or referenced by the boundedBy property of Build-ingInstallation.

J	The boundedBy property (type: BoundarySurfacePropertyType) of the element IntBuildingInstallation may contain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the boundedBy property may only point to a remote _BoundarySurface element (where remote _BoundarySurface elements are located in another document or elsewhere in the same document). Either the contained el-ement or the reference must be given, but neither both nor none. Only FloorSurface, CeilingSurface, InteriorWallSurface, and ClosureSurface elements are allowed to be encapsulated or referenced by the boundedBy property of IntBuildingInstallation.
K	The boundedBy property (type: BoundarySurfacePropertyType) of the element Room may contain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the boundedBy property may only point to a remote _BoundarySurface element (where remote _BoundarySurface elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none. Only FloorSurface, CeilingSurface, InteriorWallSurface, and ClosureSurface elements are allowed to be encapsulated or referenced by the boundedBy property of Room.
L	The interiorFurniture property (type: InteriorFurniturePropertyType) of the element Room may contain an BuildingFurniture element inline or an XLink reference to a remote BuildingFurniture element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the interiorFurni-ture property may only point to a remote BuildingFurniture element (where remote BuildingFurniture elements are located in another document or elsewhere in the same document). Either the contained el-ement or the reference must be given, but neither both nor none.

M	The roomInstallation property (type: IntBuildingInstallationPropertyType) of the element Room may contain an IntBuildingInstallation element inline or an XLink reference to a remote IntBuildingInstalla-tion element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the roomInstallation property may only point to a remote IntBuildingInstallation element (where remote IntBuildingInstallation elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
N	The lodXImplicitRepresentation, X □ [2..4], property (type: core:ImplicitRepresentationPropertyType) of the element BuildingInstallation may contain a core:ImplicitGeometry element inline or an XLink reference to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the lat-ter case, the xlink:href attribute of the lodXImplicitRepresentation, X □ [2..4], property may only point to a remote core:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
O	The lod4ImplicitRepresentation property (type: core:ImplicitRepresentationPropertyType) of the ele-ment IntBuildingInstallation may contain a core:ImplicitGeometry element inline or an XLink reference to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the lod4ImplicitRepresentation property may only point to a remote core:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
P	The lodXImplicitRepresentation, X □ [3..4], property (type: core:ImplicitRepresentationPropertyType) of the element _Opening may contain a core:ImplicitGeometry element inline or an XLink reference to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the lodXImplicitRepresentation, X □ [3..4], property may only point to a remote core:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

Q	The lod4ImplicitRepresentation property (type: core:ImplicitRepresentationPropertyType) of the ele-ment BuildingFurniture may contain a core:ImplicitGeometry element inline or an XLink reference to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the lod4ImplicitRepresentation property may only point to a remote core:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

7.3. Requirement Class Tunnel

Brief intro to the core class

UML models as needed with description of key classes (should be taked from the class description)

For more information, see the CityGML Concetual Model Best Practices.

Requirements Class	
http://www.opengis.net/spec/CityGML/3.1/req/req-class-tunnel	
Target type	Instance Document
Dependency	TBD
Dependency	TBD

Requirement 8	**/req/tunnel/base**
A	If a tunnel only consists of one (homogeneous) part, it shall be represented by the element Tunnel. However, if a tunnel is composed of individual structural segments, it shall be modelled as a Tunnel el-ement having one or more additional TunnelPart elements. Only the geometry and non-spatial proper-ties of the main part of the tunnel should be represented within the aggregating Tunnel element.

Requirement 9	**/req/tunnel/refIntegrity**

A	The boundedBy property (type: BoundarySurfacePropertyType) of the element _AbstractTunnel may contain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface ele-ment using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the boundedBy property may only point to a remote _BoundarySurface element (where remote _BoundarySurface ele-ments are located in another document or elsewhere in the same document). Either the contained ele-ment or the reference must be given, but neither both nor none. Only RoofSurface, WallSurface, GroundSurface, OuterCeilingSurface, OuterFloorSurface and Clo-sureSurface elements are allowed to be encapsulated or referenced by the boundedBy property of _AbstractTunnel.
B	The outerTunnelInstallation property (type: TunnelInstallationPropertyType) of the element _AbstractTunnel may contain a TunnelInstallation element inline or an XLink reference to a remote TunnelInstallation element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href at-tribute of the outerTunnelInstallation property may only point to a remote TunnelInstallation element (where remote TunnelInstallation elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
C	The interiorTunnelInstallation property (type: IntTunnelInstallationPropertyType) of the element _AbstractTunnel may contain an IntTunnelInstallation element inline or an XLink reference to a remote IntTunnelInstallation element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the interiorTunnelInstallation property may only point to a remote IntTunnelInstallation el-ement (where remote IntTunnelInstallation elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
D	The interiorHollowSpace property (type: InteriorHollowSpacePropertyType) of the element _AbstractTunnel may contain a HollowSpace element inline or an XLink reference to a remote Hol-lowSpace element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the interiorHollowSpace property may only point to a remote HollowSpace element (where remote Hol-lowSpace elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

E	The consistsOfTunnelPart property (type: TunnelPartPropertyType) of the element _AbstractTunnel may contain a TunnelPart element inline or an XLink reference to a remote TunnelPart element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the consistsOfTunnelPart property may only point to a remote TunnelPart element (where remote TunnelPart elements are locat-ed in another document or elsewhere in the same document). Either the contained element or the refer-ence must be given, but neither both nor none.
F	The opening property (type: OpeningPropertyType) of the element _BoundarySurface may contain an _Opening element inline or an XLink reference to a remote _Opening element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the opening property may only point to a remote _Opening element (where remote _Opening elements are located in another document or else-where in the same document). Either the contained element or the reference must be given, but neither both nor none.
G	The boundedBy property (type: BoundarySurfacePropertyType) of the element TunnelInstallation may contain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface ele-ment using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the boundedBy property may only point to a remote _BoundarySurface element (where remote _BoundarySurface ele-ments are located in another document or elsewhere in the same document). Either the contained ele-ment or the reference must be given, but neither both nor none. Only RoofSurface, WallSurface, GroundSurface, OuterCeilingSurface, OuterFloorSurface and Clo-sureSurface elements are allowed to be encapsulated or referenced by the boundedBy property of Tun-nelInstallation.

H	The boundedBy property (type: BoundarySurfacePropertyType) of the element IntTunnelInstallation may contain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the bound-edBy property may only point to a remote _BoundarySurface element (where remote _BoundarySurface elements are located in another document or elsewhere in the same document). Either the contained el-ement or the reference must be given, but neither both nor none. Only FloorSurface, CeilingSurface, InteriorWallSurface, and ClosureSurface elements are allowed to be encapsulated or referenced by the boundedBy property of IntTunnelInstallation.
I	The boundedBy property (type: BoundarySurfacePropertyType) of the element HollowSpace may con-tain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the boundedBy property may only point to a remote _BoundarySurface element (where remote _BoundarySurface ele-ments are located in another document or elsewhere in the same document). Either the contained ele-ment or the reference must be given, but neither both nor none. Only FloorSurface, CeilingSurface, InteriorWallSurface, and ClosureSurface elements are allowed to be encapsulated or referenced by the boundedBy property of HollowSpace.
J	The interiorFurniture property (type: InteriorFurniturePropertyType) of the element HollowSpace may contain an TunnelFurniture element inline or an XLink reference to a remote TunnelFurniture element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the interiorFurni-ture property may only point to a remote TunnelFurniture element (where remote TunnelFurniture el-ements are located in another document or elsewhere in the same document). Either the contained ele-ment or the reference must be given, but neither both nor none.

K	The hollowSpaceInstallation property (type: IntTunnelInstallationPropertyType) of the element Hol-lowSpace may contain an IntTunnelInstallation element inline or an XLink reference to a remote IntTunnelInstallation element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the hollowSpaceInstallation property may only point to a remote IntTunnelInstallation ele-ment (where remote IntTunnelInstallation elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
L	The lodXImplicitRepresentation, X □ [2..4], property (type: core:ImplicitRepresentationPropertyType) of the element TunnelInstallation may contain a core:ImplicitGeometry element inline or an XLink ref-erence to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the lodXImplicitRepresentation, X □ [2..4], property may only point to a remote core:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
M	The lod4ImplicitRepresentation property (type: core:ImplicitRepresentationPropertyType) of the ele-ment IntTunnelInstallation may contain a core:ImplicitGeometry element inline or an XLink reference to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the lod4ImplicitRepresentation property may only point to a remotecore:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
N	The lodXImplicitRepresentation, X □ [3..4], property (type: core:ImplicitRepresentationPropertyType) of the element _Opening may contain a core:ImplicitGeometry element inline or an XLink reference to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the lodXImplicitRepresentation, X □ [3..4], property may only point to a remote core:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

O	The lod4ImplicitRepresentation property (type: core:ImplicitRepresentationPropertyType) of the ele-ment TunnelFurniture may contain a core:ImplicitGeometry element inline or an XLink reference to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the lod4ImplicitRepresentation property may only point to a remote core:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

7.4. Requirement Class Bridge

Brief intro to the core class

UML models as needed with description of key classes (should be taked from the class description)

For more information, see the CityGML Concetual Model Best Practices.

Requirements Class	
http://www.opengis.net/spec/CityGML/3.0/req/req-class-bridge	
Target type	Instance Document
Dependency	TBD
Dependency	TBD

Requirement 10	**/req/bridge/base**
A	If a bridge only consists of one (homogeneous) part, it shall be represented by the element Bridge. However, if a bridge is composed of individual structural segments, it shall be modelled as a Bridge el-ement having one or more additional BridgePart elements. Only the geometry and non-spatial proper-ties of the main part of the bridge should be represented within the aggregating Bridge element.

Requirement 11	**/req/bridge/restrictions**
A	The lodXSolid and lodXMultiSurface, X X E [1..4], properties (gml:SolidPropertyType resp. gml:MultiSurfacePropertyType) of _AbstractBridge may be used to geometrically represent the exte-rior shell of a bridge (as volume or surface model) within each LOD. For LOD1, either lod1Solid or lod1MultiSurface must be used, but not both. Starting from LOD2, both properties may be modelled in-dividually and complementary.

B	Starting from LOD2, the exterior shell of an _AbstractBridge may be semantically decomposed into _BoundarySurface elements using the boundedBy property (type: BoundarySurfacePropertyType) of _AbstractBridge. Only RoofSurface, WallSurface, GroundSurface, OuterCeilingSurface, OuterFloor-Surface and ClosureSurface as subclasses of _BoundarySurface are allowed. The boundedBy property (not to be confused with the gml:boundedBy property) shall not be used if the bridge is only represented in LOD1. If the exterior shell is represented by _BoundarySurface elements, an additional geometric representa-tion as volume or surface model using the lodXSolid and lodXMultiSurface, X [2..4], properties shall not explicitly define the geometry, but has to reference the according components of the gml:MultiSurface element of _BoundarySurface within each LOD using the XLink concept of GML 3.1.1.
C	Starting from LOD2, curve parts of the bridge shell may be represented using the lodXMultiCurve, X [2..4], property of _AbstractBridge. This property shall not be used if the bridge is only represented in LOD1.
D	Starting from LOD1, the outerBridgeConstruction property (type: BridgeConstructionElementProper-tyType) of _AbstractBridge may be used to model BridgeConstructionElement elements. BridgeCon-structionElement elements shall only be used to represent outer characteristics of a bridge which do not have the significance of bridge parts and are essential from a structural point of view.
E	Starting from LOD2, the geometry of BridgeConstructionElement elements may be semantically classi-fied by _BoundarySurface elements using the boundedBy property (type: BoundarySurfaceProperty-Type) of BridgeConstructionElement. The boundedBy property (not to be confused with the gml:boundedBy property) shall not be used if the bridge construction element is only represented in LOD1.
F	Starting from LOD2, the outerBridgeInstallation property (type: BridgeInstallationPropertyType) of _AbstractBridge may be used to model BridgeInstallation elements. BridgeInstallation elements shall only be used to represent outer characteristics of a bridge which do not have the significance of bridge parts and are not essential from a structural point of view.

G	Starting from LOD2, the geometry of BridgeInstallation elements may be semantically classified by _BoundarySurface elements using the boundedBy property (type: BoundarySurfacePropertyType) of BridgeInstallation. Only RoofSurface, WallSurface, GroundSurface, OuterCeilingSurface, OuterFloor-Surface and ClosureSurface as subclasses of _BoundarySurface are allowed.
H	Starting from LOD3, openings of _BoundarySurface elements may be modelled using the opening property (type: OpeningPropertyType) of _BoundarySurface. This property shall not be used for _BoundarySurface elements only represented in LOD2. Accordingly, the surface geometry representing a _BoundarySurface in LOD2 must be simply connected. The opening property of _BoundarySurface may contain or reference _Opening elements. If the geo-metric location of an _Opening element topologically lies within a surface component of the _BoundarySurface, the opening must also be represented as inner hole of that surface. The embrasure surface of an _Opening element shall belong to the relevant adjacent _BoundarySurface.
I	Starting from LOD4, the interiorBridgeRoom property (type: InteriorBridgeRoomPropertyType) of _AbstractBridge may be used to semantically model the free space inside the bridge by BridgeRoom el-ements. This property shall not be used if the bridge is only represented in LOD 1 – 3. The BridgeRoom element may be geometrically represented as a surface or volume model, using its lod4Solid or lod4MultiSurface property (gml:SolidPropertyType resp. gml:MultiSurfacePropertyType). In addition, different parts of the visible surface of a bridge room may be modelled by thematic _BoundarySurface elements. Only FloorSurface, CeilingSurface, InteriorWallSurface, and ClosureSur-face as subclasses of _BoundarySurface are allowed. If the visible surface of a room is represented by _BoundarySurface elements, an additional geometric representation as volume or surface model using the lod4Solid and lod4MultiSurface property shall not explicitly define the geometry, but has to refer-ence the according components of the gml:MultiSurface element of _BoundarySurface using the XLink concept of GML 3.1.1.

J	Starting from LOD4, the interiorBridgeInstallation property (type: IntBridgeInstallationPropertyType) of _AbstractBridge may be used to represent immovable objects inside the bridge that are permamently attached to the bridge structure. The interiorBridgeInstallation property shall not be used if the bridge is only represented in LOD 1 – 3. Furthermore, the interiorBridgeInstallation property shall only be used if the object cannot be associated with a BridgeRoom element. In the latter case, the bridgeRoomInstal-lation property (type: IntBridgeInstallationPropertyType) of the corresponding BridgeRoom element shall be used to represent the object.
K	Starting from LOD4, the geometry of IntBridgeInstallation elements may be semantically classified by _BoundarySurface elements using the boundedBy property (type: BoundarySurfacePropertyType) of IntBridgeInstallation. Only FloorSurface, CeilingSurface, InteriorWallSurface, and ClosureSurface as subclasses of _BoundarySurface are allowed.

Requirement 12	**/req/bridge/refIntegrity**
A	The boundedBy property (type: BoundarySurfacePropertyType) of the element _AbstractBridge may contain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface ele-ment using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the boundedBy property may only point to a remote _BoundarySurface element (where remote _BoundarySurface ele-ments are located in another document or elsewhere in the same document). Either the contained ele-ment or the reference must be given, but neither both nor none. Only RoofSurface, WallSurface, GroundSurface, OuterCeilingSurface, OuterFloorSurface and Clo-sureSurface elements are allowed to be encapsulated or referenced by the boundedBy property of _AbstractBridge.
B	he outerBridgeConstruction property (type: BridgeConstructionElementPropertyType) of the element _AbstractBridge may contain a BridgeConstructionElement element inline or an XLink reference to a remote BridgeConstructionElement element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the outerBridgeConstruction property may only point to a remote BridgeCon-structionElement element (where remote BridgeConstructionElement elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

C	The outerBridgeInstallation property (type: BridgeInstallationPropertyType) of the element _AbstractBridge may contain a BridgeInstallation element inline or an XLink reference to a remote BridgeInstallation element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href at-tribute of the outerBridgeInstallation property may only point to a remote BridgeInstallation element (where remote BridgeInstallation elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
D	The interiorBridgeInstallation property (type: IntBridgeInstallationPropertyType) of the element _AbstractBridge may contain an IntBridgeInstallation element inline or an XLink reference to a remote IntBridgeInstallation element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the interiorBridgeInstallation property may only point to a remote IntBridgeInstallation el-ement (where remote IntBridgeInstallation elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
E	The interiorBridgeRoom property (type: InteriorBridgeRoomPropertyType) of the element _AbstractBridge may contain a BridgeRoom element inline or an XLink reference to a remote BridgeRoom element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the interiorBridgeRoom property may only point to a remote BridgeRoom element (where remote BridgeRoom elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
F	The consistsOfBridgePart property (type: BridgePartPropertyType) of the element _AbstractBridge may contain a BridgePart element inline or an XLink reference to a remote BridgePart element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the consistsOfBridgePart property may only point to a remote BridgePart element (where remote BridgePart elements are locat-ed in another document or elsewhere in the same document). Either the contained element or the refer-ence must be given, but neither both nor none.

G	The address property (type: core:AddressPropertyType) of the element _AbstractBridge may contain an core:Address element inline or an XLink reference to a remote core:Address element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the address property may only point to a remote core:Address element (where remote core:Address elements are located in another docu-ment or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
H	The opening property (type: OpeningPropertyType) of the element _BoundarySurface may contain an _Opening element inline or an XLink reference to a remote _Opening element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the opening property may only point to a re-mote _Opening element (where remote _Opening elements are located in another document or else-where in the same document). Either the contained element or the reference must be given, but neither both nor none.
I	The address property (type: core:AddressPropertyType) of the element Door may contain an core:Address element inline or an XLink reference to a remote core:Address element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the address property may only point to a remote core:Address element (where remote core:Address elements are located in another docu-ment or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
J	The boundedBy property (type: BoundarySurfacePropertyType) of the element BridgeConstruc-tionElement may contain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href at-tribute of the boundedBy property may only point to a remote _BoundarySurface element (where re-mote _BoundarySurface elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

K	The boundedBy property (type: BoundarySurfacePropertyType) of the element BridgeInstallation may contain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface ele-ment using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the boundedBy property may only point to a remote _BoundarySurface element (where remote _BoundarySurface ele-ments are located in another document or elsewhere in the same document). Either the contained ele-ment or the reference must be given, but neither both nor none. Only RoofSurface, WallSurface, GroundSurface, OuterCeilingSurface, OuterFloorSurface and Clo-sureSurface elements are allowed to be encapsulated or referenced by the boundedBy property of BridgeInstallation.
L	The boundedBy property (type: BoundarySurfacePropertyType) of the element IntBridgeInstallation may contain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the bound-edBy property may only point to a remote _BoundarySurface element (where remote _BoundarySurface elements are located in another document or elsewhere in the same document). Either the contained el-ement or the reference must be given, but neither both nor none. Only FloorSurface, CeilingSurface, InteriorWallSurface, and ClosureSurface elements are allowed to be encapsulated or referenced by the boundedBy property of IntBridgeInstallation.
M	The boundedBy property (type: BoundarySurfacePropertyType) of the element BridgeRoom may con-tain a _BoundarySurface element inline or an XLink reference to a remote _BoundarySurface element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the boundedBy property may only point to a remote _BoundarySurface element (where remote _BoundarySurface ele-ments are located in another document or elsewhere in the same document). Either the contained ele-ment or the reference must be given, but neither both nor none. Only FloorSurface, CeilingSurface, InteriorWallSurface, and ClosureSurface elements are allowed to be encapsulated or referenced by the boundedBy property of BridgeRoom.

N	The interiorFurniture property (type: InteriorFurniturePropertyType) of the element BridgeRoom may contain an BridgeFurniture element inline or an XLink reference to a remote BridgeFurniture element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the interiorFurni-ture property may only point to a remote BridgeFurniture element (where remote BridgeFurniture ele-ments are located in another document or elsewhere in the same document). Either the contained ele-ment or the reference must be given, but neither both nor none.
O	The bridgeRoomInstallation property (type: IntBridgeInstallationPropertyType) of the element BridgeRoom may contain an IntBridgeInstallation element inline or an XLink reference to a remote IntBridgeInstallation element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the bridgeRoomInstallation property may only point to a remote IntBridgeInstallation ele-ment (where remote IntBridgeInstallation elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
P	The lodXImplicitRepresentation, X □ [1..4], property (type: core:ImplicitRepresentationPropertyType) of the element BridgeConstructionElement may contain a core:ImplicitGeometry element inline or an XLink reference to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the lodXImplicitRepresentation, X □ [1..4], property may only point to a remote core:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
Q	The lodXImplicitRepresentation, X □ [2..4], property (type: core:ImplicitRepresentationPropertyType) of the element BridgeInstallation may contain a core:ImplicitGeometry element inline or an XLink ref-erence to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the lodXImplicitRepresentation, X □ [2..4], property may only point to a remote core:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

R	The lodXImplicitRepresentation, X □ [3..4], property (type: core:ImplicitRepresentationPropertyType) of the element _Opening may contain a core:ImplicitGeometry element inline or an XLink reference to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the lodXImplicitRepresentation, X □ [3..4], property may only point to a remote core:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
S	The lod4ImplicitRepresentation property (type: core:ImplicitRepresentationPropertyType) of the ele-ment IntBridgeInstallation may contain a core:ImplicitGeometry element inline or an XLink reference to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the lod4ImplicitRepresentation property may only point to a remote core:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.
T	The lod4ImplicitRepresentation property (type: core:ImplicitRepresentationPropertyType) of the ele-ment BridgeFurniture may contain a core:ImplicitGeometry element inline or an XLink reference to a remote core:ImplicitGeometry element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the lod4ImplicitRepresentation property may only point to a remote core:ImplicitGeometry element (where remote core:ImplicitGeometry elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

7.5. Requirement Class Water Body

Brief intro to the core class

UML models as needed with description of key classes (should be taked from the class description)

For more information, see the CityGML Concetual Model Best Practices.

Requirements Class	
http://www.opengis.net/spec/CityGML/3.1/req/req-class-waterbody	
Target type	Instance Document

Dependency	TBD
Dependency	TBD

Requirement 13	**/req/waterbody/base**
A	For LOD0 and LOD1, the geometry of a WaterBody may be modelled as a linear network using gml:MultiCurve geometry elements. In that case, each gml:MultiCurve shall be composed of straight line segements, where the line orientation denotes the flow direction. The flow direction is from the first point of a line segment to its last point.
B	Starting from LOD2, the exterior shell of a WaterBody may be semantically decomposed into _WaterBoundarySurface elements using the boundedBy property (type: BoundedByWaterSurfaceProp-ertyType) of WaterBody. The boundedBy property shall not be used if the water body is only represented in lower LODs. If the exterior shell is represented by _WaterBoundarySurface elements, an additional geometric repre-sentation as volume model using the lodXSolid, X [2..4], property of WaterBody shall not explicitly define the geometry, but has to reference the according gml:_Surface elements of the _WaterBoundarySurface objects within each LOD using the XLink concept of GML 3.1.1.
C	Each _WaterBoundarySurface element must have at least one associated surface geometry given by the lodXSurface, X [2..4], properties of _WaterBoundarySurface.
D	_WaterBoundarySurface elements shall only be included as parts of corresponding WaterBody ele-ments. They may not be given as stand-alone city objects within a CityGML model.

Requirement 14	**/req/waterbody/refintegrity**
A	The boundedBy property (type: BoundedByWaterSurfacePropertyType) of the element WaterBody may contain a _WaterBoundarySurface element inline or an XLink reference to a remote _WaterBoundarySurface element using the XLink concept of GML 3.1.1. In the latter case, the xlink:href attribute of the boundedBy property may only point to a remote _WaterBoundarySurface el-ement (where remote _WaterBoundarySurface elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

7.6. Requirements Class Transportation

Brief intro to the core class

UML models as needed with description of key classes (should be taked from the class description)

For more information, see the CityGML Concetual Model Best Practices.

Requirements Class	
http://www.opengis.net/spec/CityGML/3.0/req/req-class-transportation	
Target type	Instance Document
Dependency	TBD
Dependency	TBD

Requirement 15	/req/transportation/base
A	For LOD0, the geometry of a TransportationComplex shall be modelled using GML line objects repre-senting the centerline of the transportation complex. The line objects shall establish a linear network. Thus, the lod0Network property (type: gml:GeometricComplexPropertyType) of the element Transpor-tationComplex may only contain or reference an appropriate curve geometry element.
B	Starting from LOD2, the trafficArea property (type: TrafficAreaPropertyType) as well as the auxilia-ryTrafficArea property (type: AuxiliaryTrafficAreaPropertyType) of the element TransportationCom-plex may be used. These properties shall not be used if the transportation complex is only represented in lower LODs.

Requirement 16	/req/transportation/refInteg
A	The trafficArea property (type: TrafficAreaPropertyType) of the element TransportationComplex may contain a TrafficArea element inline or an XLink reference to a remote TrafficArea element using the XLink concept of GML 3.1.1. In the latter case, the `xlink:href` attribute of the trafficArea property may only point to a remote TrafficArea element (where remote TrafficArea elements are located in another document or elsewhere in the same document). Either the contained element or the reference must be given, but neither both nor none.

B	The auxiliaryTrafficArea property (type: TrafficAreaPropertyType) of the element TransportationCom-plex may contain an AuxiliaryTrafficArea element inline or an XLink reference to a remote Auxilia-ryTrafficArea element using the XLink concept of GML 3.1.1. In the latter case, the `xlink:href` attribute of the auxiliaryTrafficArea property may only point to a remote AuxiliaryTrafficArea element (where remote AuxiliaryTrafficArea elements are located in another document or elsewhere in the same docu-ment). Either the contained element or the reference must be given, but neither both nor none.

Chapter 8. Clause containing normative material

Paragraph

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)

NOTE	Ensure that there is a conformance class for each requirements class and a test for each requirement (identified by requirement name and number)

A.1. Conformance Class A

A.1.1. Requirement 1

Test id:	/conf/conf-class-a/req-name-1
Requirement:	/req/req-class-a/req-name-1
Test purpose:	Verify that…
Test method:	Inspect…

A.1.2. Requirement 2

Annex B: Title ({Normative/Informative})

NOTE	Place other Annex material in sequential annexes beginning with "B" and leave final two annexes for the Revision History and Bibliography

Annex C: Revision History

Date	Release	Editor	Primary clauses modified	Description
2016-04-28	0.1	G. Editor	all	initial version

Chapter 10. 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

NOTE

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

- 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).