CRC CENTER for RESEARCH COMPUTING
UNIVERSITY of NOTRE DAME

Taking GeoSPARQL to the 3D dimension!

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GeoVocamp DC 2015

Nov 30, 2015

“What’s Chuck Thinking About?”

THE GREEN SCALE

http://www.greenscale.org

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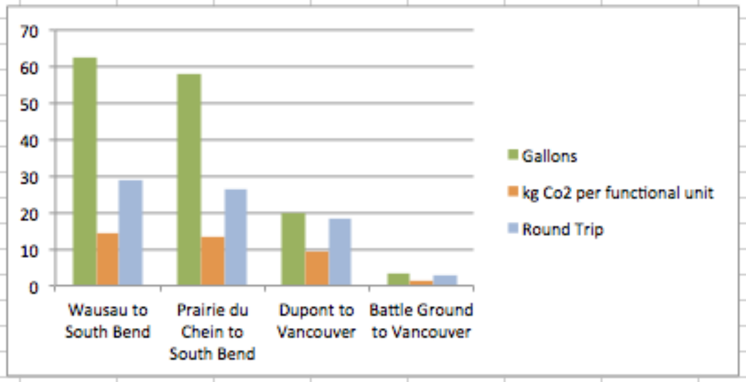
UNIVERSITY of NOTRE DAME

Mass of 1 paver (kg)	Volume of 1 paver (yd^3)	Pavers in 1 cubic yard	mass of 1 yd^3 (kg)	ss of truckload	3 per truckload	of aggregate/polymer in paver (kg)	mass of agg./polymer In functional unit
7.75	0.00588923	169.8014838	1315.961499	28576.32	21.71516	7.61	1292.189
				17000		0.07	11.8861

Aggregate Shipping	Distance	Miles/Gallon	Gallons	Co2 emissions/(	Co2 emissions/(	kg Co2 per functional unit	Round Trip
Wausau to South Bend	375	6	62.5	10.15	634.375	14.34286468	28.6857294
Prairie du Chein to South Bend	348	6	58	10.15	588.7	13.31017843	26.6203569
Dupont to Vancouver	120	6	20	10.15	203	9.179433397	18.3588668
Battle Ground to Vancouver	20	6	3.333333333	10.15	33.83333333	1.529905566	3.05981113

Polyol Shipping	Distance	Miles/Gallon	Gallons	Co2 emissions/(	Co2 emissions/(	kg Co2 per functional unit	Round Trip
Houston, TX to South Bend	1140	6	190	10.15	1928.5	1.348373606	2.69674721
Virginia to South Bend	660	6	110	10.15	1116.5	0.780637351	1.5612747
Houston, TX to Vancouver	2400	6	400	10.15	4060	2.838681276	5.67736255
Virginia to Vancouver	2800	6	466.6666667	10.15	4736.666667	3.311794822	6.62358964

Paver Shipping	Distance	Miles/Gallon	Gallons	Co2 emissions/(	Co2 emissions/(	Co2 per functional unit	Round Trip
Vancouver to South Bend	2200	6	366.6666667	10.15	3721.666667	171.3856104	342.771221



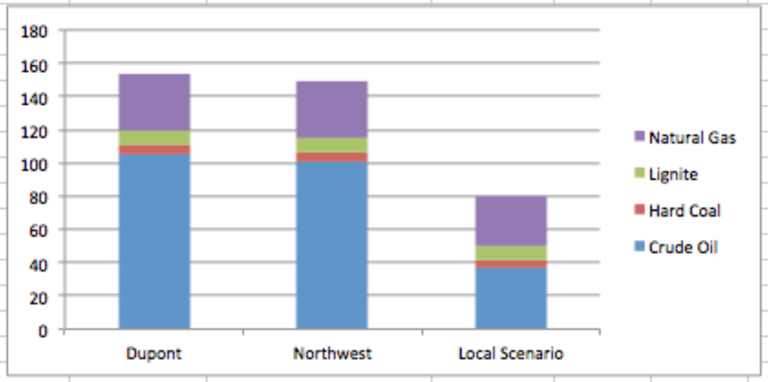
Resource Consumption MJ	Dupont	Northwest	Local Scenario
Crude Oil	105	101	37
Hard Coal	5.23	5.18	4.28
Lignite	8.82	8.81	8.64
Natural Gas	34.3	34.1	30
Total	**153.35**	**149.09**	**79.92**

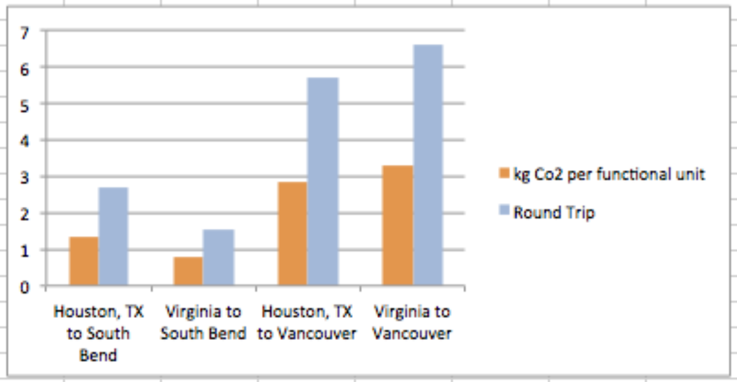
Solid Waste (kg)	Dupont	Northwest	Local Scenario
Overburden	150.9	150.6	143.3
Slag	0.3	0.3	0.3
Spoil	3.9	3.9	3.2
Tailings	14.2	13.6	2.2
Other Waste	1	1	0.9
Total	**170.3**	**169.4**	**149.9**

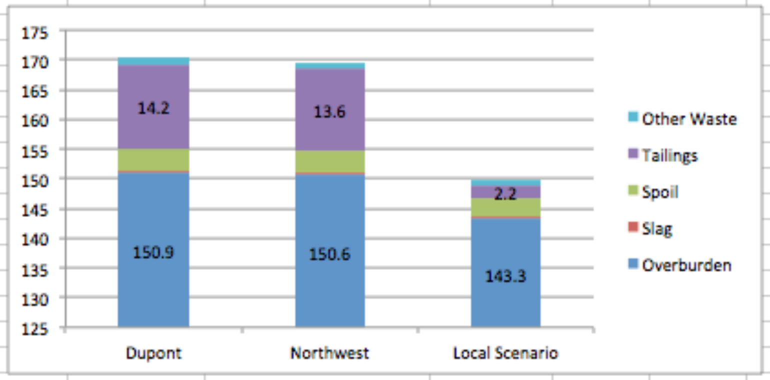
Water Consumption (kg)	Dupont	Northwest	Local Scenario
Waste Ground Water	0.6	0.6	0.5
Cooling Water	1618.7	1605	1342.6
Turbined Water	55625.6	55428.4	51644.3
Waste Sea Water	174	173	111
Waste River Water	677.3	676.3	657.1
Total	**58096.2**	**57883.3**	**53755.5**

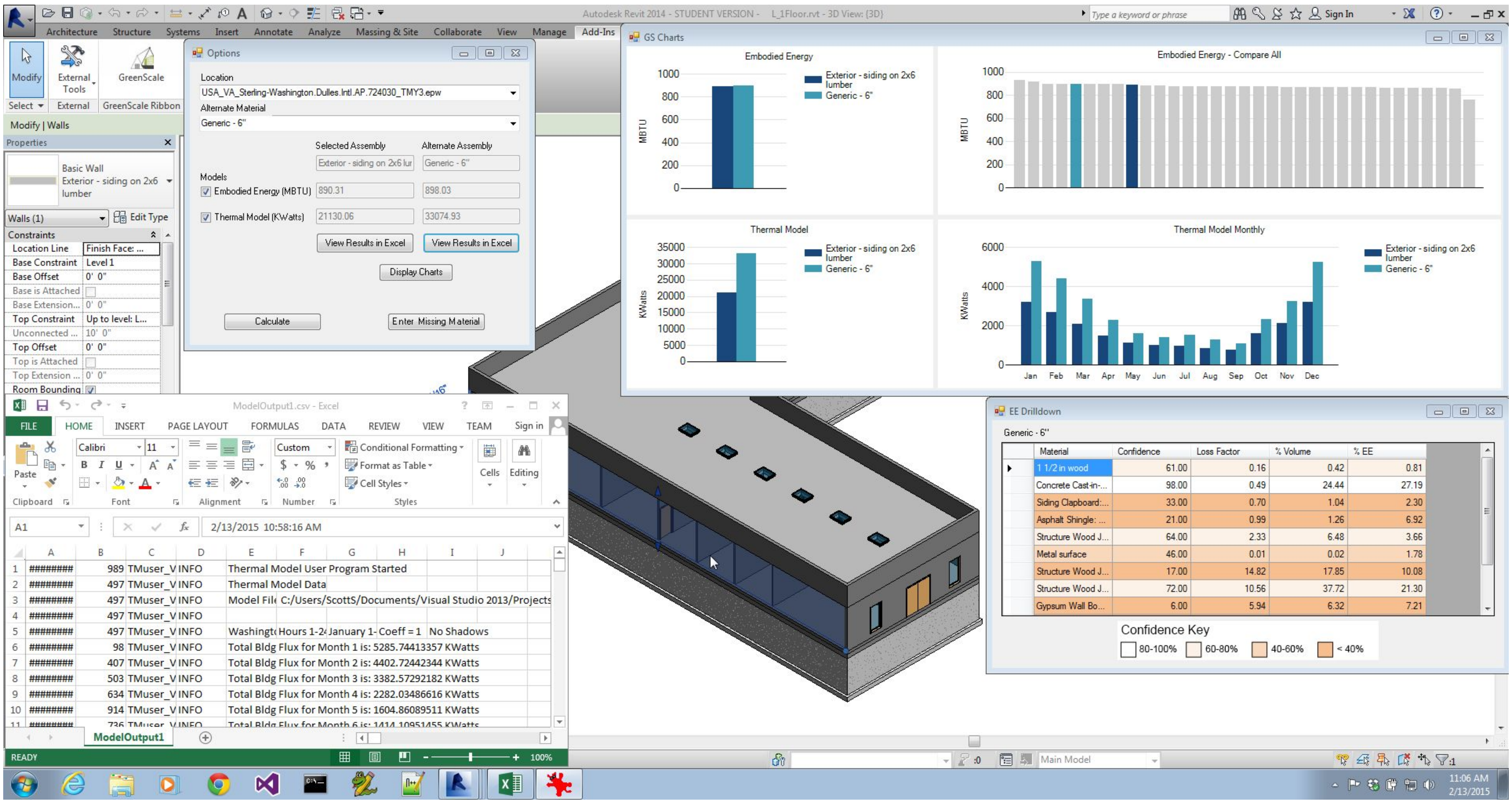
GWP	Dupont	Northwest	Local Scenario
kg CO2 (GaBi)	328	319	147
kg CO2 (manual)	218.9	208.5	62
kg CO2 eq. (GaBi)	348	339	159
kg CO2 eq. (manual)	783.2	752.4	151.9

GWP	Northwest	Northwest w/ crushing data
kg CO2 (GaBi)	319	337.2
kg CO2 eq. (GaBi)	339	358



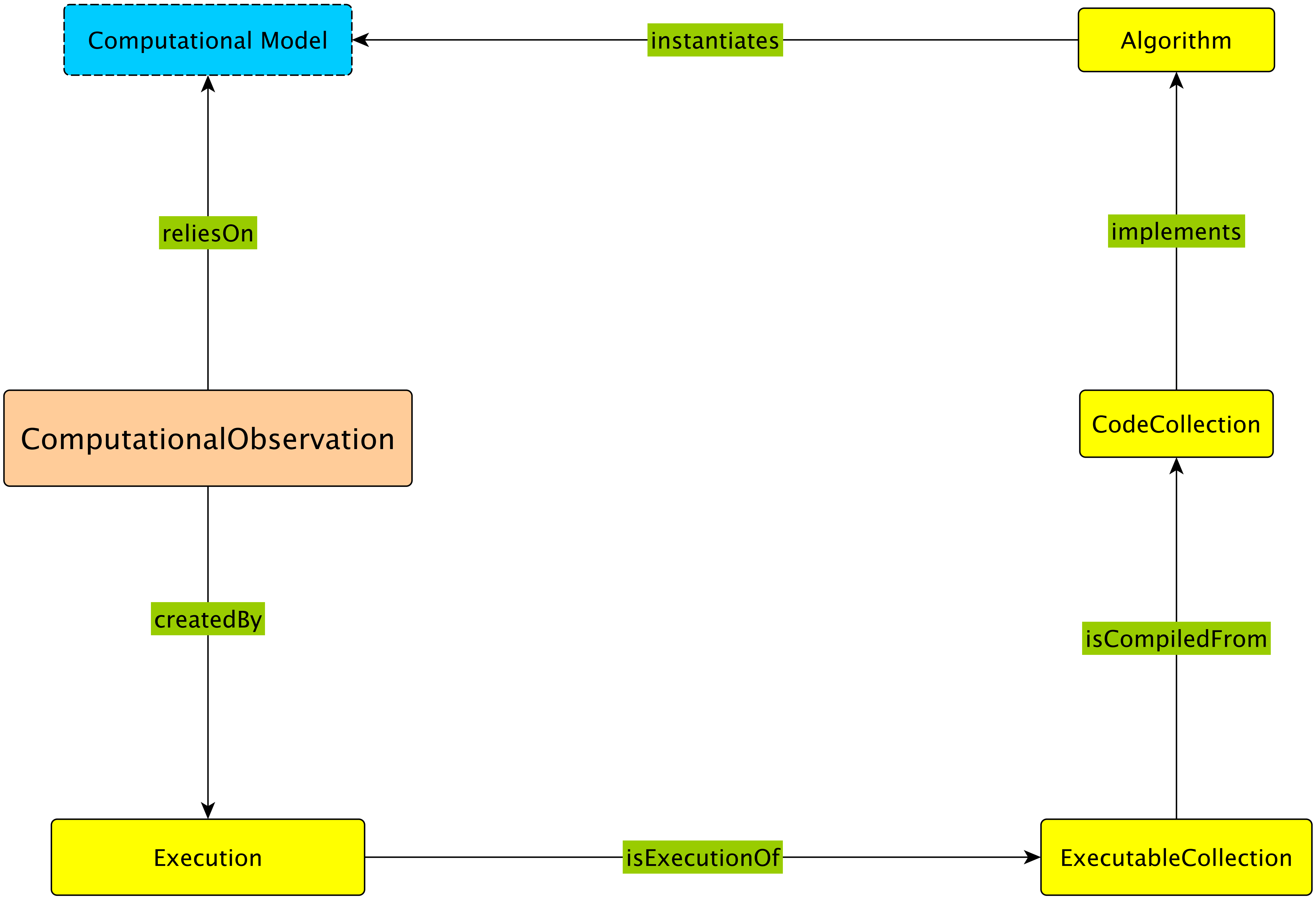





Autodesk Revit 2014 - STUDENT VERSION - L_1Floor.rvt - 3D View: {3D}
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
External Tools
GreenScale
GreenScale Ribbon
Modify | Walls
Properties
Basic Wall
Exterior - siding on 2x6 lumber
Walls (1)
Edit Type
Constraints
Location Line
Finish Face: ...
Base Constraint
Level 1
Base Offset
Base is Attached
Top Constraint
Up to level: L...
Top Offset
Room Bounding
Options
Location
USA_VA_Sterling-Washington.Dulles.Intl.AP.724030_TMY3.epw
Alternate Material
Generic - 6"
Selected Assembly
Alternate Assembly
Exterior - siding on 2x6 lur
Models
Embodied Energy (MBTU)
890.31
898.03
Thermal Model (KWatts)
21130.06
33074.93
View Results in Excel
Display Charts
Calculate
Enter Missing Material
GS Charts
Embodied Energy
Exterior - siding on 2x6 lumber
Generic - 6"
MBTU
Embodied Energy - Compare All
Thermal Model
KWatts
Thermal Model Monthly
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
ModelOutput1.csv - Excel
FILE
HOME
INSERT
PAGE LAYOUT
FORMULAS
DATA
REVIEW
VIEW
TEAM
Conditional Formatting
Format as Table
Cell Styles
2/13/2015 10:58:16 AM
Thermal Model User Program Started
Thermal Model Data
Total Bldg Flux for Month 1 is: 5285.74413357 KWatts
Total Bldg Flux for Month 2 is: 4402.72442344 KWatts
Total Bldg Flux for Month 3 is: 3382.57292182 KWatts
Total Bldg Flux for Month 4 is: 2282.03486616 KWatts
Total Bldg Flux for Month 5 is: 1604.86089511 KWatts
ModelOutput1
READY
EE Drilldown
Generic - 6"
Material
Confidence
Loss Factor
% Volume
% EE
Confidence Key
80-100%
60-80%
40-60%
< 40%
Main Model
11:06 AM
2/13/2015

"A Green Resilience Framework to Support the Design of Sustainable Buildings Under Multiple Hazards"

“ Connect GreenScale (BIM), Computational Resilience Models, Sensor, …, **City Data**”


Computational Model
instantiates
Algorithm
reliesOn
implements
ComputationalObservation
CodeCollection
createdBy
isCompiledFrom
Execution
isExecutionOf
ExecutableCollection

DisConBB - NFIE Workshop, Spring 2015

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EarthCube Building Block on Discrete & Continuous Data (DisConBB)

Spring 2015 Workshop on the National Flood Interoperability Experiment (NFIE): Summer Institute Planning

March 17-19, 2015 at the new

National Water Center on the campus of the

University of Alabama in Tuscaloosa

Project of the NOAA/National Weather Service, US Geological Survey, US Army Corps of Engineers, Federal Emergency Management Agency, and NSF
Led by the University of Texas at Austin, University of Alabama, University of Illinois, University of North Carolina, Brigham Young University, CUAHSI, NCAR

- Venue
- Participants List
- Supporting Files
- Fall 2014 NFIE Kickoff Workshop, Nov 5-7, Tysons Corner, Virginia

http://earthcube.org/workspace/discrete-continuous-data-disconbb/disconbb-nfie-workshop-spring-2015

CityGML

City Geography Markup Language (CityGML)

- Open Geospatial Consortium Standard based on GML3.

- Provides thematic semantics for city objects (buildings, vegetation, **water, terrain,** traffic, tunnels, bridges etc.)

- Data model is **UML** based.

- Provides representations for 3D geometry, topology and appearance in 5 discrete Levels of Detail **(LOD) <urn:Chuck:CityGML:LOD>**

CityGML

LOD **<urn:Chuck:CityGML:LOD>**
Definitions

- LOD 0: Regional Model (2.5D Digital Terrain Model)
- LOD 1: City/Site Model (block model w/o roof structures.
- LOD 2: City/Site Model (textured roofs)
- LOD 3: City /Site Model (detailed architecture model)
- LOD 4: Interior Model (“walkable” interior space)

"Chuck is thinking that the ETL for CityGML looks like a lot of work and that it's a data silo and that the semantics will be difficult to extend since they are not explicit"

"Question: What Would CityGML look like in Linked Open Data (LOD)
<urn:Chuck:LinkedOpenData:LOD>
Approach?"

CityGML using OGC GeoSPARQL?

- Provides geometry descriptions in GML and WKT
- Would need to support 3D descriptions for LOD 1-4
- Would need support for 3D operations
- Would need to borrow “thematic patterns”, a LOD “pattern” (relative relationship as a basis?)
- “Formalization” of CityGML Schema?

Starting Points?

An Ontology Design Pattern for Dynamic Relative Relationships

Holly Ferguson[1], Adila A. Krisnadhi[2,3], and Charles F. Vardeman II[1]

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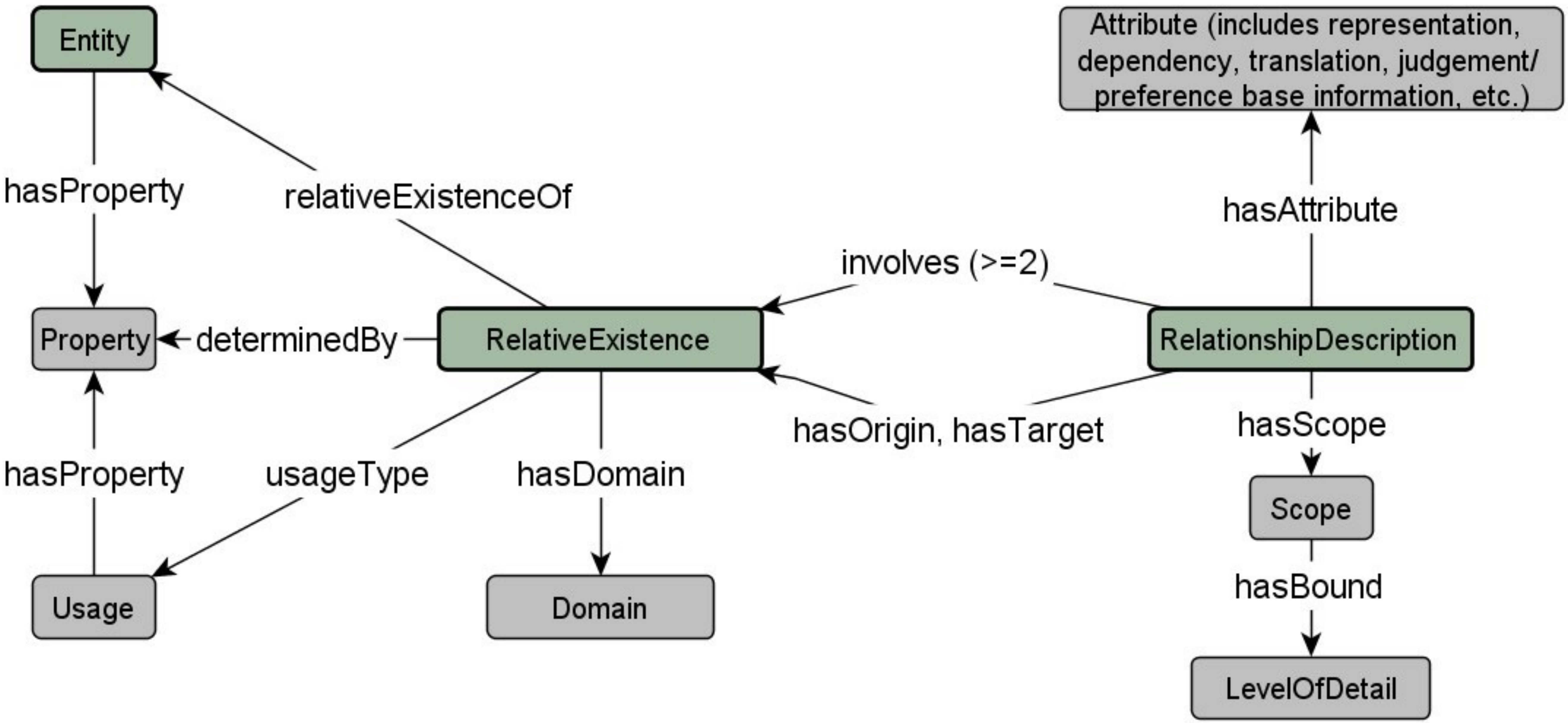
[3] University of Indonesia
{krisnadhi}@gmail.com

Abstract. This research describes an ontology design pattern for dynamically conceptualizing, establishing, tracking, and updating relative relationships and dependencies between entities (real or representational) of a physical, temporal, and/or importance scope. We present a Relative Relationship (RR) Pattern, associated axioms, an implementation of current geometric scale translation research, a detailed example, and suggestions for other potential use cases. It provides data hooks that allow dynamic updating of linked data as changes occur in preference systems, scaling systems, or time expiration parameters; additionally, it separates the false notion that level of detail is always synonymous with scope. Furthermore, we discuss how this design pattern potentially acts as an intermediate step to assist the transition between open linked-data and decision support frameworks that need to readily update changes within the accurate data over modern, distributed data access points.


Entity
hasProperty
relativeExistenceOf
Attribute (includes representation, dependency, translation, judgement/ preference base information, etc.)
hasAttribute
involves (>=2)
Property
determinedBy
RelativeExistence
RelationshipDescription
hasOrigin, hasTarget
hasScope
hasProperty
usageType
hasDomain
Scope
hasBound
Usage
Domain
LevelOfDetail

14.7. PostGIS Functions that support 3D

The functions given below are PostGIS functions that do not throw away the Z-Index.

- AddGeometryColumn - Adds a geometry column to an existing table of attributes. By default uses type modifier to define rather than constraints. Pass in false for use_typmod to get old check constraint based behavior
- Box3D - Returns a BOX3D representing the maximum extents of the geometry.
- DropGeometryColumn - Removes a geometry column from a spatial table.
- GeometryType - Returns the type of the geometry as a string. Eg: 'LINESTRING', 'POLYGON', 'MULTIPOINT', etc.
- ST_3DArea - Computes area of 3D surface geometries. Will return 0 for solids.
- ST_3DClosestPoint - Returns the 3-dimensional point on g1 that is closest to g2. This is the first point of the 3D shortest line.
- ST_3DDFullyWithin - Returns true if all of the 3D geometries are within the specified distance of one another.
- ST_3DDWithin - For 3d (z) geometry type Returns true if two geometries 3d distance is within number of units.
- ST_3DDifference - Perform 3D difference
- ST_3DDistance - For geometry type Returns the 3-dimensional cartesian minimum distance (based on spatial ref) between two geometries in projected units.
- ST_3DExtent - an aggregate function that returns the box3D bounding box that bounds rows of geometries.
- ST_3DIntersection - Perform 3D intersection
- ST_3DIntersects - Returns TRUE if the Geometries "spatially intersect" in 3d - only for points, linestrings, polygons, polyhedral surface (area). With SFCGAL backend enabled also supports TINS
- ST_3DLength - Returns the 3-dimensional or 2-dimensional length of the geometry if it is a linestring or multi-linestring.
- ST_3DLongestLine - Returns the 3-dimensional longest line between two geometries
- ST_3DMakeBox - Creates a BOX3D defined by the given 3d point geometries.
- ST_3DMaxDistance - For geometry type Returns the 3-dimensional cartesian maximum distance (based on spatial ref) between two geometries in projected units.
- ST_3DPerimeter - Returns the 3-dimensional perimeter of the geometry, if it is a polygon or multi-polygon.
- ST_3DShortestLine - Returns the 3-dimensional shortest line between two geometries
- ST_3DUnion - Perform 3D union
- ST_Accum - Aggregate. Constructs an array of geometries.
- ST_AddMeasure - Return a derived geometry with measure elements linearly interpolated between the start and end points.
- ST_AddPoint - Adds a point to a LineString before point <position> (0-based index).
- ST_Affine - Applies a 3d affine transformation to the geometry to do things like translate, rotate, scale in one step.
- ST_ApproximateMedialAxis - Compute the approximate medial axis of an areal geometry.
- ST_AsBinary - Return the Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsEWKB - Return the Well-Known Binary (WKB) representation of the geometry with SRID meta data.
- ST_AsEWKT - Return the Well-Known Text (WKT) representation of the geometry with SRID meta data.
- ST_AsGML - Return the geometry as a GML version 2 or 3 element.
- ST_AsGeoJSON - Return the geometry as a GeoJSON element.
- ST_AsHEXEWKB - Returns a Geometry in HEXEWKB format (as text) using either little-endian (NDR) or big-endian (XDR) encoding.
- ST_AsKML - Return the geometry as a KML element. Several variants. Default version=2, default precision=15
- ST_AsX3D - Returns a Geometry in X3D xml node element format: ISO-IEC-19776-1.2-X3DEncodings-XML
- ST_Boundary - Returns the closure of the combinatorial boundary of this Geometry.
- ST_BoundingDiagonal - Returns the diagonal of the supplied geometry's bounding box.

http://postgis.net/docs/PostGIS_Special_Functions_Index.html

Formalisation of the level of detail in 3D city modelling

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Filip Biljecki, Hugo Ledoux, Jantien Stoter, and Junqiao Zhao. "Formalisation of the Level of Detail in 3D City Modelling." Computers, Environment and Urban Systems 48 (November 2014): 1–15. doi:10.1016/j.compenvurbsys.2014.05.004.

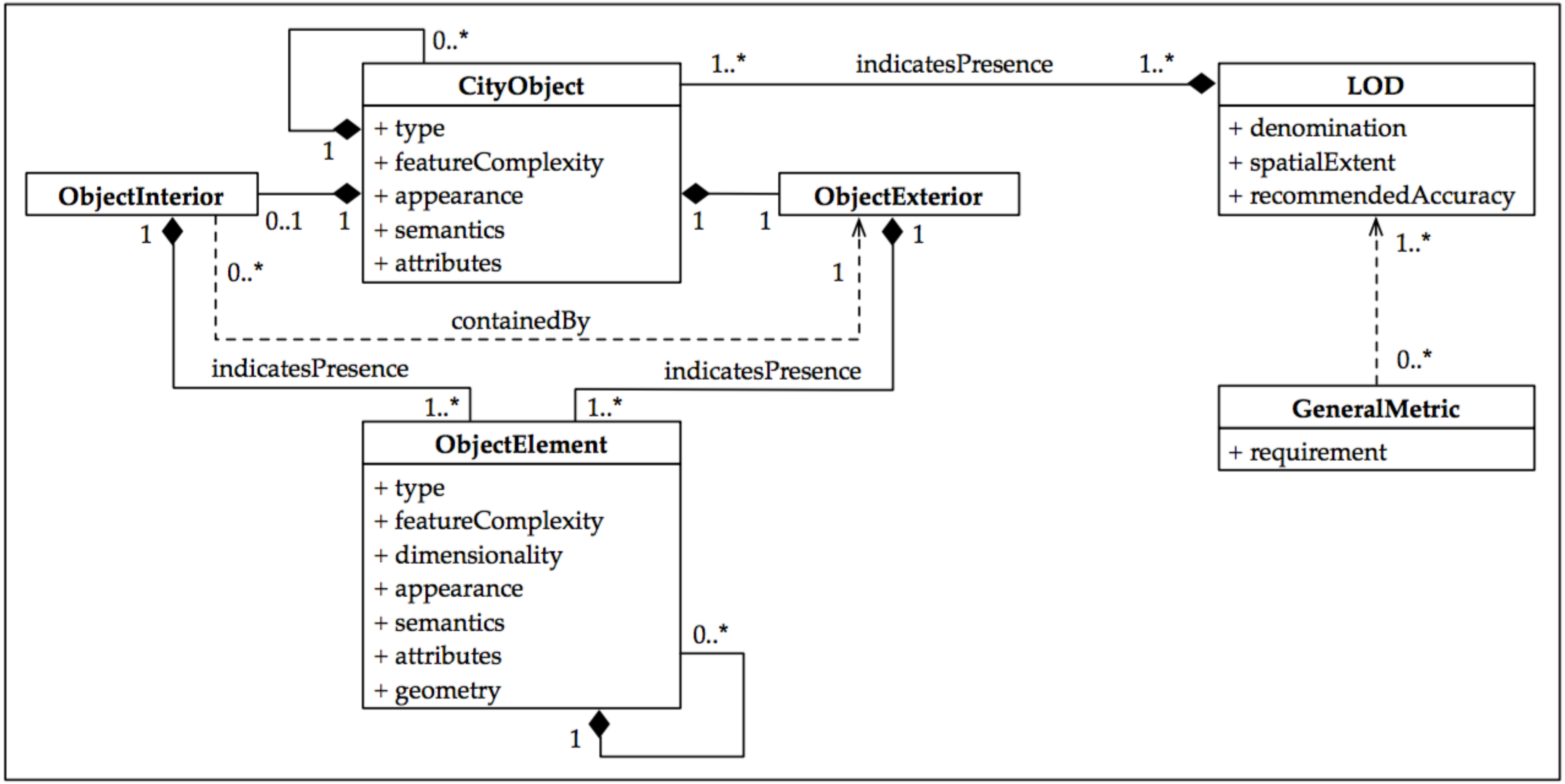

Figure 3: The UML diagram of our LOD specification.

A Naïve Theory of Dimension for Qualitative Spatial Relations

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Torsten Hahmann and Michael Gruninger. “A Naive Theory of Dimension for Qualitative Spatial Relations.” In AAAI Spring Symposium: Logical Formalizations of Commonsense Reasoning, 2011. http://www.cs.utoronto.ca/~torsten/publications/THahmann_Commonsense-2011.pdf.

- CityGML and Linked Data: http://video.esri.com/watch/897/citygml-and-linked-data-technologies-for-geodesign

- PostGIS: http://postgis.net/docs/PostGIS_Special_Functions_Index.html

- http://www.opengeospatial.org/standards/citygml