BIM – Building Information Modelling/Management
Outline

- What is the Industry Foundation Classes?
  - Background
  - Schema
  - Domains

- What is the Information Delivery Manual?
Managing Data Requirements

• The Information Delivery Manual (IDM) was developed as a direct response to the challenge of defining data requirements to meet BLC processes.

• It has been developed by buildingSMART

• Together with Model View Definitions (MVDs), they provide a methodology for different domain experts to model the specific data requirements that are needed to meet their own use cases.
The IDM/MVD methodology defines how to specify business use cases and how to coordinate involved stakeholders with their tools and data requirements.

A prerequisite for this is to be clear about processes, actors, shared or exchanged data and used interfaces or data structures.

It provides a framework for the specification of collaborative design scenarios, in particular for Building Information Modelling (BIM)
IDM Methodology

- IDM focuses on knowledge defined by domain experts.
- It defines processes and exchange requirements, which will answer:
  - what kind of tasks (processes) must be carried out?
  - who is responsible?
  - when they have to carry out (order, dependencies?)
  - what data needs to be exchanged?
IDM Methodology

• Two kinds of specifications are used
  1. Process Maps based on the Business Process Modelling Notation (BPMN)
  2. Exchange Requirements typically collected in a table format
IDM/MVD Methodology

- Information Delivery Manual (IDM, orange parts)
- Model View Definition (MVD, blue parts)
IDM Methodology

• Process Maps define the various tasks to be carried out throughout the life-cycle of a building.
  • Each task is placed within a swim lane, which is assigned to an actor role
  • Arrows between tasks define data dependencies and are typically linked with data exchange requirements.
IDM Methodology

- For making data exchanges more explicit IDM introduces swim lanes which carry additional information about the kind of data exchange
  - E.g. BIM, drawings, regulations or other kinds of data.
- The horizontal axis is tailored according to the life-cycle phases so that it is visible what BLC stage the task is to be carried out
IDM Methodology

- Exchange Requirements specify the data that needs to be exchanged.
  - As mentioned above it typically starts with identifying main data sources in terms of high-level data structures or domains

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Data Type</th>
<th>Actor supplying</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object Type</td>
<td>String</td>
<td>BPM</td>
<td>The type of building product</td>
</tr>
<tr>
<td>Manufacturer Name</td>
<td>String</td>
<td>BPM</td>
<td>Name of the manufacturing company</td>
</tr>
<tr>
<td>Model Number</td>
<td>String</td>
<td>BPM</td>
<td>Manufacturer’s name/number of the product</td>
</tr>
<tr>
<td>Weight</td>
<td>Number</td>
<td>BPM</td>
<td>The lifting weight of the product (in kg)</td>
</tr>
<tr>
<td>U-Value</td>
<td>Number</td>
<td>BPM</td>
<td>Heat transfer coefficient of building element.</td>
</tr>
<tr>
<td>Links</td>
<td>hyperlink</td>
<td>BPM</td>
<td>Link to installation documentation</td>
</tr>
<tr>
<td>Material</td>
<td>Object</td>
<td>BPM</td>
<td>Name, quality, strength</td>
</tr>
<tr>
<td>Geometry</td>
<td>Numbers</td>
<td>BPM</td>
<td>Geometry that allows measures to be taken</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Numbers</td>
<td>BPM</td>
<td>Dimensions that allows measures to be taken</td>
</tr>
</tbody>
</table>
IDM Methodology (Process Map)
# IDM Methodology (Exchange Requirement)

<table>
<thead>
<tr>
<th>Type of Information</th>
<th>Information Needed</th>
<th>Descriptions and Comments</th>
<th>Req’d</th>
<th>Data Type</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project/Building</strong> Information</td>
<td>The following properties should be included</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td></td>
<td></td>
<td>X</td>
<td>string</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>o Project ID</td>
<td>Unique identifier for the project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Project Name</td>
<td>Name assigned to the project by the client or designers</td>
<td></td>
<td>string</td>
<td>n/a</td>
</tr>
<tr>
<td>Building</td>
<td>The following properties should be included</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Building ID</td>
<td>Unique identifier for the building</td>
<td>X</td>
<td>string</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>o Building Name</td>
<td>Name assigned to the building by the client or designers</td>
<td></td>
<td>string</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>o Geographic Location</td>
<td>Geographic location, expressed in degrees, minutes, and seconds of rotation.</td>
<td></td>
<td>latitude, longitude</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Elevation</td>
<td>Base (datum) elevation for the building – relative to sea level</td>
<td>X</td>
<td>real number</td>
<td>feet or meters</td>
</tr>
<tr>
<td>Building Stories</td>
<td>The following properties should be included</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Building Story ID</td>
<td>Unique identifier for the building story</td>
<td>X</td>
<td>string</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>o Building Story Name</td>
<td>Name assigned to the building story by the client or designers</td>
<td></td>
<td>string</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>o Story height</td>
<td>Vertical length measure from top of slab to top of slab for the building story above</td>
<td>X</td>
<td>real number</td>
<td>feet or meters</td>
</tr>
<tr>
<td></td>
<td>o Base elevation</td>
<td>Base (datum) elevation for the building story – relative to building elevation.</td>
<td>X</td>
<td>real number</td>
<td>feet or meters</td>
</tr>
<tr>
<td></td>
<td>o Design Gross Area</td>
<td>Area for the building story, using measurement rules defined for “Design Gross” in the owner’s requirements documentation.</td>
<td>X</td>
<td>real number</td>
<td>sq feet or sq meters</td>
</tr>
<tr>
<td><strong>Spatial Information</strong></td>
<td>The following properties should be included</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space</td>
<td></td>
<td></td>
<td>X</td>
<td>string</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>o Identification</td>
<td>Unique identifier for space</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Description</td>
<td>Description assigned to the space by the designers</td>
<td></td>
<td>string</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>o Classification values</td>
<td>Support for multiple classifications is required. Examples include GSA STAR space type, BOMA Space Category, and GSA STAR space category.</td>
<td></td>
<td>faceted strings</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>o Inside or Outside space</td>
<td></td>
<td>X</td>
<td>Boolean</td>
<td>n/a</td>
</tr>
</tbody>
</table>
IFC in Use – Establish Exchange Requirements

1. IFC defines universe of requirements
2. IDM to document work flows and exchanges
3. MVD for Exchange Specification using IFC.DOC
4. bSDD repository for Entities/Types/Properties with GUID and Context for specific use
5. Requirements expressed openly in applications
IDM Conclusion

- IDM provides a method for collaborative capture of use cases and data requirements, supporting mapping of conceptual models to existing standards.
- The flexible nature of the process modelling and conceptual modelling of exchanges, can often lead to several representations of data requirements.
- Tools like IFC.DOC are also difficult to use for non-experts to identify the appropriate way to support a data exchange in IFC.
Guidelines for Publishing BIM Data
Related Ontologies and Linking
Network Management of Devices

• Brief introduction to the drive for standardisation of device models and its relevance to Network Management

• Introduction to a current standard for smart appliances
  • Smart Appliances Reference Ontology (SAREF)

• Links between the SAREF and another BIM standard (IFC).
Network Management of Devices

- Network management of devices is fundamental to network management.
  - Most devices are housed in buildings.
- Standardization in IoT has largely focused at the technical communication level, leading to a large number of different solutions based on various standards and protocols
  - Widespread fragmentation in current market and technology
  - Existing IoT solutions are characterized by non-interoperable concepts, and cannot integrate with one another as wished
- Little attention has been given to the common semantics contained in the data structures exchanged at the technical level
  - Need to abstract from specific details of individual standards and create an abstraction layer based on a commonly agreed semantics (interoperable concepts)
SAREF: Smart Appliances Reference Ontology

- In 2013, the European Commission (EC) launched a standardization initiative and issued a tender to create a reference ontology for the smart appliances domain
  - TNO (the Netherlands Organisation for applied scientific research) was invited by the EC to perform the work and created SAREF – the Smart Appliances REFerence ontology (January 2014 - April 2015)
  - Project website https://sites.google.com/site/smartappliancesproject

- In November 2015, SAREF was standardized by ETSI (the European Telecommunications Standard Institute) as a Technical Specification, TS 103 264 V1.1.1 (2015-11)

- The first extension of SAREF, called SAREF4EE, was created for the energy domain and published in December 2015

- TNO currently involved in a Special Task Force (STF 513) funded by ETSI for the maintenance and evolution of SAREF and its extensions (March 2016 - December 2016)
SAREF: Smart Appliances Reference Ontology

- Reference ontology for smart appliances that focuses on the smart home environment.

- Makes an important contribution to enable semantic interoperability in the IoT.

- Developed in close interaction with the industry, supported by the European Commission (EC).

- First ontology standard in the Internet of Things (IoT) ecosystem.
SAREF: Smart Appliances Reference Ontology

- SAREF is an OWL-DL ontology
  - 110 classes, 31 object properties and 11 datatype properties
  - available at http://w3id.org/saref
  - registered in LOV at http://lov.okfn.org/dataset/lov/vocabs/saref

- SAREF is standardized by ETSI in “ETSI TS 103 264 V1.1.1 (2015-11)”
  - http://www.etsi.org/deliver/etsi_ts/103200_103299/103264/01.01.01_60/ts_103264v010101p.pdf
SAREF: General Overview
SAREF: Device
SAREF: Types of Devices
SAREF: Device Functions
SAREF: Device Commands
SAREF: Device State
SAREF: Measurements
SAREF: Extensions
SAREF: OneM2M Alignment
SAREF4BLDG: SAREF for Buildings

- Links IfcBuilding to BuildingSpace
SAREF4BLDG: IFC Relations
SAREF Conclusions

- SAREF provides detailed descriptions of Building Devices
  - Supports a wide range of additional modelling which can be utilised for monitoring and control.
- Takes a modular approach, allowing different areas of concern to be included or ignored
- SAREF has also been extended with IFC concepts
SAREF Conclusions

- Currently, the danger for SAREF is that it may overreach its original scope.
- Linking between ontologies can potentially reduce the size of the ontology
  - Links to other ontologies, IFC, SSN, etc.
Network Management of Sensors

- Brief introduction to the drive for standardisation of sensor models and its relevance to Network Management

- Introduction to a current standard for sensors
  - Semantic Sensor Network Ontology (SSN)

- Links between the SSN and another BIM standard (IFC).
Integrating BIM and Sensor Data

- Existing BIM standards (e.g. IFC) do not provide good support for modelling sensors or sensor readings.

- Sensor models are central to many Smart Building applications (see SAREF), which make use of the contextual data they provide.

- These sensors need to be integrated into Network Management to support their monitoring and control
  - A method is needed to make use of BIM alongside available sensor models.
W3C Semantic Sensor Network

- Goal of Ontology: To define the capabilities of sensors and sensor networks.
- But - Sensor Data are not just about the measurements
  - Event-based nature of sensors and sensor networks
  - Temporal and spatial relationships
  - Physical constraints (e.g. limited power availability, limited memory, variable data quality, loose connectivity)
W3C Semantic Sensor Network

- SSN reflects existing Open Geospatial Consortium standards
  - Sensor Model Language (SensorML)
  - Observations and Measurement (O&M)
- OWL-2 DL ontology for describing sensors and the observations
Overview: Sensor configuration and management

Configure and manage sensor networks and services

1. Data discovery and Linkage
2. Device selection
3. Provenance and diagnostic

Manipulate results/data

Sensor Networks

Sensor Web

Semantic Web
## SSN: Diagram Legend

<table>
<thead>
<tr>
<th></th>
<th>Module</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ontology module</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Class</strong></td>
<td>Class</td>
</tr>
<tr>
<td><strong>Individual</strong></td>
<td>Individual</td>
</tr>
<tr>
<td><strong>Subclass-of property</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Type property</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Object or datatype property</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Equivalent to a restriction in an object property</strong></td>
<td>Class</td>
</tr>
<tr>
<td><strong>Subclass of a restriction in an object property</strong></td>
<td>Class</td>
</tr>
</tbody>
</table>
Ontology Modularisation

• Ontology modularization
  • is a common method used in ontology engineering to segment an ontology into smaller parts
  • aims at providing users of ontologies with the knowledge they require, reducing the scope as much as possible to what is strictly necessary in a given use case.

• SSN make extensive use of modules, each of which can be though of as its own ontology (similar to an IFC MVD)
SSN Modules

- Deployment
- PlatformSite
- Data
- System
- Device
- Process
- OperatingRestriction
- MeasuringCapability
- ConstraintBlock

* Stimulus Sensor Observation

* SSO Pattern
Overview of SSN Ontologies
Sensor and environmental properties
DOCLE UltraLite Ontology

Descriptive Ontology for Linguistic and Cognitive Engineering* (DOLCE)

*http://www.loa.istc.cnr.it/old/Papers/DOLCE2.1-FOL.pdf
Main Conclusions on SSN

- The SSN ontology:
  - Is compatible with the Open Geospatial Consortium (OGC) standards
  - Is aligned with an upper ontology
    - Dolce Ultra Light (DUL)
  - Only includes core concepts; needs to be extended
    - Time, location, units of measurement, domain specific (feature/property/sensor) hierarchies, etc.
  - Does not need to be wholly reused
    - Only observations
    - Only sensors
    - ...
  - Unfortunately, SSN has suffered due to the complexity of the layering underneath with the DOLCE UltraLite upper level ontology!
Sensor, Observation, Sample and Actuator (SOSA)

- The Sensor, Observation, Sample and Actuator (SOSA) ontology is now one of the modules provided by the SSN.
  - It acts as the core building block of SSN around which all other classes and relationships evolve.
- Support standalone usage of the ontology
  - for applications that merely require light-weight specifications such as many Linked Datasets, the Internet Of Things, citizen science, Schema.org-style semantic enrichment of data repositories etc.
SOSA: Integrating Dolce-UltraLite, SSN and O&M

- Vertical segmentation:
  - Vertical modules build upon each other.
  - Without importing, may lead to different answers when reasoning over a module
  - Lower level modules are independent of higher, and logical consistent

- SOSA is independent of the other ontologies
SOSA: Main Classes

- Classes:
  - Actuation
  - Actuator
  - FeatureOfInterest
  - ObservableProperty
  - Observation
  - Platform
  - Procedure
  - Result
  - Sample
  - Sensor
Aligning SSN/SOSA with IFC
Aligning SOSA with IFC
Aligning SSN/SOSA with IFC
SOSA: Conclusions

- SOSA provides detailed descriptions of sensors, beyond IFC and SAREF
- Supports additional modelling which can be utilised for monitoring and control, e.g. related to measurement capabilities
- SOSA can be aligned with IFC through the IfcSensor and SOSA:Sensor concept concepts
Related Ontologies and Linking
Network Management of Sensors

• Brief introduction to the drive for standardisation of district/city models and its relevance to Network Management

• Introduction to a current standard for district/city modelling
  • CityGML

• Links between the CityGML and another BIM standard (IFC).
Network Management Across Districts and Cities

- Network managers may have networks of interest distributed across different geological scales: campuses, cities, countries, even globally.

- How to move between different scales to configure systems, identify and locate faults, security breaches, improve performance, etc.?

- District/City models provide a means to present information at larger scales, supporting different types of network management applications.
DAREED: Demo

http://demo.dareed.eu/
Integrating BIM and GIS (Geolocation) Data

- Existing standards for supporting BIM do not currently provide good support for geolocation.

- Need to identify and define requirements where convergence between geospatial and building information across the building lifecycle.

- Spatial awareness across AEC lifecycle is defined to be a critical requirement
  - Inside and outside of a building
BuildingSMART: Integrating BIM and GIS Data

GIS/BIM ifc Based Information Exchange

ORGANIZATION: buildingSMART Alliance

Chair
John Przybyla
john.przybyla@woolpert.com
(937) 631-1130

Today the BIM and GIS worlds are operating in seemingly separate spheres but each has value to the other if they could exchange data effectively. This project is intended to provide the basis for an information relationship between the two environments and their underlying databases.

1. This project will help ensure convergence of all spatial information so that it can be usable by any stakeholder in the facility environment. This will eliminate significant amounts of non-value added effort and keep information normalized by storing it in only one location so that it can be sustained, yet accessible to all authorized users.
2. Spatial awareness is of absolute importance whether you are outside or inside a facility. This project will work with all parties involved to craft a spatial approach which minimized non-value added effort.
3. Potential workflows that define the roles of BIM and GIS tools within the lifecycle of a facility (or campus) will be developed, and resulting information needs will be described.

Meetings
The kickoff meeting for this Project was held by tele and webconference on March 29, 2010. The meeting presentation and minutes are below.

Kickoff Meeting Presentation
Kickoff Meeting Minutes
BIM-GIS Focus

• How can Network Management applications and information seamlessly interact with BIM and geospatial information across the lifecycle process?

• How can BIM and geospatial applications be used to communicate building and district/city information requirements for Network Management operations?
BIM-GIS Interaction Issues

• What open standard tool sets (IFC-BIM, GIS, OWL/RDF, etc.) should be used to perform what functions?

• Are there requirements for convergence that can only be supplied by file exchange?
  • What message format(s) should be used for data exchange?

• What data standards and protocols exist or need to be developed?
Elements in BIM are Created at a High Level of Detail

- This data is required to convey the information needed to construct the facility, but is not essential for other services, such as those relevant to network management and related to location.
Can We Use BIM As a Spatial Data Repository?

- File-based
- Proprietary data formats
  - Exports to IFC not uniform
- Not easily query-able across multiple buildings
- Not scalable to large number of users
  - BIM Server technology limited to design stage of buildings

Not a Viable Solution –
Look at standards-based geospatial tools
Traditional Scalability Using GIS

Traditional CAD/BIM Space

Natural Asset
- Air / Space
- Underground
- Water / Sea

Real Property Asset
- Land / Parcel

Facility / Built

System
- Sub-Systems
  - Components

Space
- Level
  - Room

Overlay
- Sub-Systems
  - Components

Country
- State / Province

Region
- County

City
- Site

World

Traditional GIS Space

Building
- System
- Space
- Overlay
- Sub-Systems
  - Components
- Level
  - Room
Traditional Scalability Using GIS
BIM to GIS Integration Issues

- BIM is MUCH richer in detail than a GIS database
- GIS has only recently become fully 3-D
- Design BIM contains all the information needed to construct a building, but not to manage it
  - Space polygons
  - Asset details (make, model, etc.)
  - Device maintenance data
- Some of the missing data can be supplied by other related standards, e.g. COBie
- GIS database and BIM will require network capabilities to share information
Fundamental Differences Between Traditional BIM and GIS

BIM (IFC)
- Highly standardized structure
- Parametric – highly structured
- File based
- File based exchange
- Inferior data exchange between commercial products
- Not yet widely used outside AEC
- Thick client

GIS
- User defined structures
- Parametric – loosely structured
- Server based - relational database
- File and web services for exchange
- Large numbers of users
- Thick and thin clients
CityGML for Integrating BIM and GIS

- CityGML is an application independent Geospatial Information Model for virtual 3D city and landscape models
  - Comprises different thematic areas (buildings, vegetation, water, terrain, traffic etc.)
  - Data model (UML) according to ISO 19100 standards family
  - Exchange format results from mapping of the UML diagrams to a Geography Markup Language (GML3) application schema
  - Adopted OGC standard since 08/2008
CityGML represents 3D geometry, 3D topology, semantics, and appearance in 5 discrete scales (Levels of Detail, LOD).

- **LOD 0 – Regional, landscape model**: 2.5D Digital terrain model, 3D landmarks
- **LOD 1 – City / Site model**: Prismatic buildings without roof structures
- **LOD 2 – City / Site model**: Simple buildings with detailed roof structures
- **LOD 3 – City / Site model**: Detailed architectural models, landmarks
- **LOD 4 – Interior Model**: “Walkable” architectural models

The same object may be represented in different LODs simultaneously.
CityGML Modules

CityGML 2.0
CityGML Core: Geometry
CityGML Building

- Different LODs for buildings are still only small subsets of what IFC supports.
- Very basic information, has more in common with VR models, e.g. VRML, X3D, COLLADA and geo-visualiziation standards like KML.
CityGML Limitations

- CityGML is focused on visualization and building representation
  - Useful for selecting buildings as part of wider district/city views thus supporting network management applications at larger scales
- Active research is taking place to understand how IFC and CityGML can work together.
Linking CityGML to IFC

CityGML OWL - http://cui.unige.ch/isi/onto/citygml2.0.owl
GeoSPARQL

- GeoSPARQL is an OGC standard, which provides a minimal RDF/OWL/SPARQL vocabulary for storage and query of geospatial information
  - Should be able to be easily attached to ontologies with a need for spatial information
  - Represents *only* geometries and the concept of a Feature (a thing with Geometry) and the geospatial relationships between them
- Result: Triple store implementation can spatially index the information in the vocabulary and perform spatial reasoning
  - GeoSPARQL intends to be:
    - Robust enough to be used for ‘serious” geospatial data
    - Simple enough for Linked Open Data
GeoSPARQL

- Three main components for encoding geographic information:
  1. The definition of vocabularies for representing features, geometries and their relationships
  2. A set of domain-specific, spatial functions for use in SPARQL queries
  3. A set of query transformation rules
GeoSPARQL Vocabulary: Basic Classes and Relations
Topological Relations between geo:SpatialObject

- geo:sfEquals
- geo:sfTouches
- geo:sfOverlaps
- geo:sfContains
- geo:sfWithin
- geo:sfIntersects
- geo:sfCrosses
GeoSPARQL Components

- Vocabulary for Query Patterns
  - Classes
  - Spatial Object, Feature, Geometry
  - Properties
    - Topological relations
    - Links between features and geometries
  - Datatypes for geometry literals
    - Geo:wktLiteral, geo:gmlLiteral
- Query Functions
  - Topological relations, distance, buffer, intersection
## Some GeoSPARQL Examples

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>:City rdfs:subClassOf</td>
<td>geo:Feature</td>
</tr>
<tr>
<td>:School rdfs:subClassOf</td>
<td>geo:Feature</td>
</tr>
<tr>
<td>:Taipei rdf:Type</td>
<td>:City</td>
</tr>
<tr>
<td>:NTU rdf:type</td>
<td>:School</td>
</tr>
<tr>
<td>:NTU :isDeveloped</td>
<td>“1928-3-16”^^xsd:date</td>
</tr>
<tr>
<td>:Taipei geo:hasGeometry</td>
<td>:geo_001</td>
</tr>
<tr>
<td>:geo_001 geo:asWKT</td>
<td>“Polygon((...))”^^geo:wktLiteral</td>
</tr>
<tr>
<td>:NTU geo:hasGeometry</td>
<td>:geo_002</td>
</tr>
<tr>
<td>:geo_002 geo:asWKT</td>
<td>“Polygon((...))”^^geo:wktLiteral</td>
</tr>
<tr>
<td>:NTU geo:sfWithin</td>
<td>:Taipei</td>
</tr>
</tbody>
</table>
Linking GeoSPARQL with IFC?

See slides on IFC for more information on possible linking!
Future Directions: Building Topology Ontology

- The IFC schema is complex for new developers

- Currently there are moves to create a W3C Standard for Building Data on the Web

- Should it be based on ifcOWL? GeoSPARQL? Building Topology Ontology?
Building Topology Ontology

- Focus only on the topology of buildings
- Developed by Pieter Pauwels and Mads Holten
  - Being further explored within the auspices of the W3C Linked Building Data on the Web Group Community group
- The topology ontology is intended as a references ontology to support linking with other ontologies
- Provides basic concepts to model a building
  - For web developers
BOT Ontology: Overview

Bot:hasStorey

bot:Building

bot:Storey

Bot:hasSpace

bot:Space

Bot:adjacentElement
Bot:hasElement

bot:Element
Linking BOT to GeoSPARQL

Bot:hasStorey  Bot:hasSpace  Bot:adjacentElement

bot:Building  bot:Storey  bot:Space  bot:Element

geo:Feature  geo:Geometry  geo:SpatialObject

gos:hasGeometry

wkt/gml

Point  Surface  Polygon

Level of detail of wkt to support more complex building geometries?
Linked Building Data on the Web

- Get involved!

https://www.w3.org/community/lbd/
The Analytic Power of GIS

- Spatial analysis and modeling
  - Overlay analysis (union, intersect)
  - Proximity analysis (buffer, near)
  - Surface analysis (hill shade, slope)
  - Linear analysis (connectivity, tracing)
  - Raster analysis
- Geoprocessing tools
- Relational Database structure
- Enterprise-ready
- Web services