Web Services and Ontologies for Building Data

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ABSTRACT

Building Information Modeling (BIM) needs to be placed in a larger architectural context with data modeling, geography, web infrastructures, public safety, and real estate. A common reference system is needed to ensure fundamental characteristics of building interiors are understood in affiliated software and services. Only a few pieces of data need hooks, for example footprints, entrances, floors, circulation, occupancy, spaces and specified contents. Implementation of successful BIM web services will be a symphony of the following: a Data Model (isolate certain International Foundation Classes); a Dictionary (APIs with the buildingSMART Data Dictionary); classification and taxonomies (OmniClass); and Process Descriptions (Information Delivery Manuals and Model View Definitions). A kit of parts, including metadata organization and rules for what is discoverable in registries and repositories, needs to conform to Simple Object Access Protocol (SOAP), Representational State Transfer (REST), Web Services Description Language (WSDL), and new Internet technologies as they are invented. The whole system could benefit from a collection of Tiny Ontologies All Stitched Together (TOAST) branching out from a common core. The US National Information Exchange Model (NIEM) is an ideal home for elements related to justice, emergency management, health and family services - many people could benefit from this work.

Keywords
BIM, GIS, NIEM, OmniClass, Data Structures

INTRODUCTION

As timely and practical as Building Information Modeling (BIM) is, the greatest use may be via web services. For example, to achieve President Obama's 2011 goal for "...a firefighter to download the design of a burning building onto a handheld device" several applications, networks, policies, and Internet layers need to work together [Figure 1]. While this might be possible in a closed environment today, for any firefighter to access up-to-date information, BIMs need to be placed in a larger architectural context with data modeling, geography, web infrastructures, public safety, and real estate.

Current BIMs are not scalable to thousands of simultaneous users focused on specific buildings during an emergency, or to seamlessly navigate indoor and outdoor locations. A common reference system is needed to ensure fundamental characteristics of building interiors are understood in affiliated software and services. Only a few pieces of data need hooks, for example footprints, entrances, floors, circulation, occupancy, spaces and specified contents.
OPEN ARCHITECTURE

Standards Development Organizations (SDOs) and vendors should have a summit to understand what everyone else is doing relative to themselves. Significant results could be achieved quickly. Everyone is in a better position to do this now, most Memorandums of Understanding (MOUs) are already in place. Shared concepts, software interfaces, service interfaces, and data structures can be extended in more detail by each stakeholder to understand interrelationships of shared building information through their own data, systems, and viewpoints.

Different parts of an open architecture for BIM and related technologies will originate, and need to be maintained, by diverse professional organizations. Senders and receivers need to agree on exactly which information to exchange and what it should look like. The whole system needs to be dynamic and cyclical, updating with continuous improvements and strict version control. Defining where each part belongs in the whole world's digital infrastructure will ensure each part is worth doing, will be sustainable, published openly, and owned by people that care about what the information means. The results will not be duplication - but harmonization and increased customer satisfaction.

WEB SERVICES

Web Services are automated machine-to-machine exchanges and data integration processes using open standards over the Internet to simplify complex data into messages.

Successful web services for BIM requires the following: a Data Model (isolate certain International Foundation Classes); a Dictionary (APIs with the International Framework for Dictionaries); classification and taxonomies (OmniClass); and Process Descriptions (Information Delivery Manuals and Model View Definitions). A kit of parts, including metadata organization and rules for what is discoverable in registries and repositories, needs to conform to Simple Object Access Protocol (SOAP), Representational State Transfer (REST), Web Services Description Language (WSDL) and new Internet technologies as they are invented.

Leveraging existing work by others will require specified sets of building data to stay bound together in messages. Message types will define the order data are presented, beginning with the most important sets first, then compiling more detail depending on the contracted web service.

ONTOLOGIES

Ontologies are often used for search, decision support, and software design. Matthew West defines ontologies simply as "The things there are and the rules that govern them." BIM ontologies need to be web-based to support workflow functions, provide overviews, relationship structures, necessary attributes, reminders about information to include, and consistency across integration models used with master and reference data. Ronald Reck suggests a collection of Tiny Ontologies All Stitched Together (TOAST) branching out from a common core. The US National Information Exchange Model (NIEM), a data model for data exchanges using a common core, is an ideal home for facility data elements related to emergencies, justice, health, and family services - many people could benefit from a focused collaborative effort.

Large complex models like NIEM and the Open Geospatial Consortium (OGC)'s CityGML are made for different reasons. Ontologies drawing from them can be leaner and fit for purpose. Maintaining linkages between and among data assets, keeping specific data types bound together, and resolving multiple records describing the same assets needs ontologies to tell machines how to interpret the information, what to do with it, and what level of detail to store in each environment without restating the same instructions for each web service or affecting other data models internal structures.

LINKED DATA

Changing a published building layout or occupancy should be able to tap back into open floor plans, linked databases, and public records. Exporting heavy files like typical BIMs are today sends more information than needed and too many copies are generated. Using a Service Oriented Architecture (SOA) approach instead, data remains with one application for reference or modification in other applications by maintaining links and mutually supportive artifacts. Shared elements and a messaging structure created for BIM going outwards could also benefit BIM going deeper into the design process at Architecture/Engineering firms. Some typical software such as BIM and specification writing programs can maintain rolling associations, but they are only two of many. If web services and ontologies could be used to establish semantic connections rather than just software connections, archival flows could extend to knowledge management systems so a critical mass can be reached within firms and across the industry. The number of known answers to repeated questions
and combinatorial complexity of geometric objects can be reduced using thematic and logical restrictions. When an OmniClass type usually has a limited range of typically associated components, it will get easier to link back and forth between applications and resources. Repeated instances of OmniClass types, and formulaic buildings like dormitories, will be especially adaptable.

**BENEFITS**

Live data could be automatically captured in compliance with policy constraints to flow through to first responders, maintenance contractors, real estate agents, energy auditors, financial agents, and other authorized users without duplication and potential human error. Real-time information compared to historical trends will let machines keep track of minutiae and fastest routes to improve scheduling, perform analysis, and assess scenarios.

Several initiatives need to converge so the results will begin showing up in software. Defining a core set of elements with relationships between them and the outside world will let users, or machines on their behalf, periodically submit questions such as "have the regulations for chlorine storage changed in Arlington County?" and get an answer from the local jurisdiction or other authoritative data source.

Each user and their machine would only receive the information they need, or are allowed to access, rather than an unwieldy batch of data to extract an answer. The extraction is performed via web services. Invasion of privacy and terrorist planning can be prevented by limiting distribution to public information or authorized web services with elemental traceability. Some web services and ontologies will be free for the general public, some will cost a lot of money. The first and most collaborative versions should be for public safety in public buildings such as schools, hospitals, courthouses, stadiums, airports, hotels, and shopping malls. These are also buildings where anyone may want to look up their current location on a handheld device so consumer demand and Internet service providers can help speed development.

**CONCLUSION**

Web services and ontologies are progressive; there will never be a final version, finite set of questions and answers, or set of dots to connect. A shared reference architecture needs to celebrate complexity in the world, not dull it down, or the results will not be realistic and effective.

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