Demo Abstract: Interactive Metadata Integration with Brick

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ABSTRACT

Many different digital representations of a building are produced over the course of its lifecycle. While these representations individually contain metadata required to support different stages of the building's lifecycle, they are largely not interoperable due to differences in structure, syntax and semantics. This impedes the development and deployment of data-driven applications providing fault detection and diagnosis, virtual metering or optimal control. [4] introduces a new platform for the continuous curation of a unified, Brick [1]-based metadata model that can be maintained throughout the building lifecycle. In this demonstration, we present a live proof-of-concept implementation of the platform with support for several metadata representations in the context of a simulated building lifecycle.

CCS CONCEPTS

• **Information systems → Ontologies**; *Data encoding and canonicalization*; *Information extraction.*

KEYWORDS

Smart Buildings, Data Integration, Metadata, Ontologies, OWL, RDF, Brick

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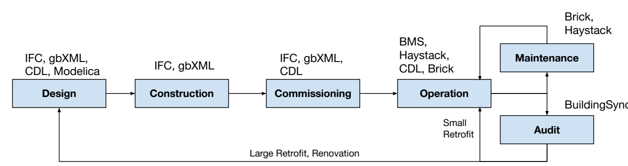

Figure 1: Illustration of the different sources of metadata produced over the course of a building's lifecycle

1 INTRODUCTION

Many different digital representations of a building are produced over the course of its lifecycle. These representations — sources of *metadata* — each support workflows within a given stage of a building's lifecycle (Figure 1) but largely lack the semantic content required to support many common data driven applications [2]. Recent building metadata efforts such as Brick [1] define models that can express the metadata required for such applications, but the challenge of how to bootstrap the creation of these models remains.

Current lines of research explore the use of human-in-the-loop machine learning techniques to derive Brick metadata from unstructured sources such as the labels found in building management systems [3, 5], or address one-off translations of existing sources of metadata to Brick [6]. In contrast, the work presented in [4] and demonstrated here explores the synthesis of a Brick metadata model from multiple existing sources of metadata.

While existing metadata representations like IFC, gbXML, Project Haystack, Modelica/CDL and BuildingSync are governed by a mix of standards, formats, and industry conventions, they are sufficiently different in their structure, syntax, and semantics that they are not interoperable. The lack of interoperability means that the different representations cannot be easily combined without significant manual effort. To complicate matters, because these representations are typically produced at different times and by different teams or individuals, the metadata they contain can often be incomplete, out of date or even change at a later date in response to retrofits or repairs.

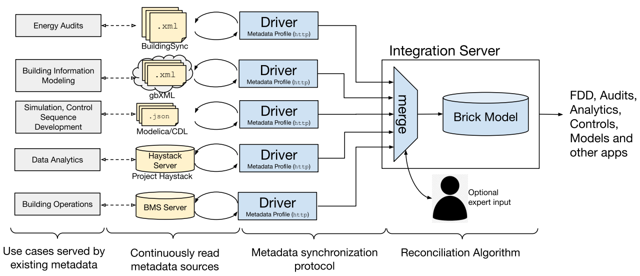

Figure 2: Architecture of the reconciliation platform

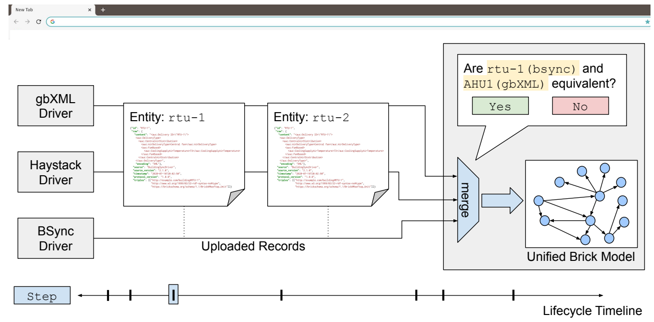

Figure 3: Mockup of interactive web interface showing timeline, transmitted records from drivers, integration server, and merged Brick model.

2 A METADATA INTEGRATION PLATFORM

The metadata integration platform introduced in [4] enables the creation and maintenance of a Brick metadata model for a building. In order to address the challenges outlined above, the platform divides its responsibilities into two components: *drivers* and the *integration server* (Figure 2).

Drivers interact directly with a source of metadata — e.g. gbXML files hosted on a file share or a Project Haystack model stored in a database — and produce a stream of *records* describing a set of *entities*. An entity is any virtual, logical or physical thing or data source in the building. Each record contains the Brick metadata for an entity that has been inferred or derived from the underlying metadata source, a pointer to the definition of the entity from the source and some supplementary metadata. A driver produces a set of records for each version of the original metadata source. As metadata sources change or become available, drivers transmit these metadata-containing records to the integration server.

The *integration server* catalogs the records received from the set of deployed drivers and merges the contained Brick metadata into a unified Brick model. The integration server *reconciles* the differences between the Brick metadata reported by each driver so that the unified Brick model is consistent with respect to the entities common to multiple metadata sources. The reconciliation process employed by the server consists of two phases. The first phase produces clusters of equivalent entities using a combination of properties for each entity, including their original labels, Brick relationships and other ontology-derived characteristics. Each cluster consists of one or more entities from one or more different metadata sources.

The second phase merges the Brick metadata for each entity in a cluster and validates the result using the formal axioms and rules defined by Brick. When validation fails or the clustering algorithm is unable to find equivalent entities, the integration server consults a human expert for additional metadata and reinitiates the reconciliation process. After validation succeeds, the integration server unifies the Brick metadata for all clusters into a model that can be made available to applications.

3 DEMONSTRATION OVERVIEW

In the demonstration, we plan to give participants the opportunity to interact with a live, proof-of-concept implementation of the metadata integration platform in the context of a simulated building lifecycle. A web interface (Figure 3) will illustrate a timeline of a simulated building's lifecycle and provide access to historical versions of a Project Haystack model, Modelica model and BuildingSync model for the simulated building. Users can advance through the timeline, inspect the produced records of inferred Brick metadata at each stage, and participate in the reconciliation algorithm resulting in a unified Brick model. The implementation of the metadata integration platform is open-source and available online at https://github.com/gtfierro/shepherding-metadata/.

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