TOWARDS A UNIFIED REFERENCE ARCHITECTURE IN AECOO INDUSTRY

SPHERE
BIM DIGITAL TWIN PLATFORM

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ACKNOWLEDGEMENT

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Nowadays, discussion across the construction industry about moving away from silos in different phases of the design and construction process has become a hot topic. Utilising key project data through integrated systems and technologies in an effort to eliminate common problems such as re-entry of data or data redundancy is a matter of traceability and trustworthiness, hence controlling the risks. In order to achieve such an integrated information flow across the life cycle of an asset, data interoperability is extremely important in the AECOO (Architecture, Engineering and Construction, Owner and Operator) industry as the industry encounters a lot of complexity like many stakeholders, one-off projects and an ever-changing environment.

THE (SEMANTIC) INTEROPERABILITY ISSUE

The Issue of interoperability is not new within the AECO industry. Already in the nineties, efforts have been made tackling this issue, introducing exchange formats like STEP and IFC. Over the last two decades, the adoption and importance of open semantic standards from W3C[1] has increased significantly, resulting in a well-known set of ontologies/taxonomies developed at different TRL's[2] for different purposes or services across the building lifecycle.

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1 The World Wide Web Consortium is the main international standards organization for the World Wide Web. Founded in 1994 and currently led by Tim Berners-Lee, the consortium is made up of member organizations that maintain full-time staff working together in the development of standards for the World Wide Web.

2 TRL (Technology Readiness Level).

However, when introducing a more holistic approach like a Building Digital Twin, and thus taking in account the entire lifecycle and different domains of an asset, the connection between all the different existing ontologies are not properly unfolded.

Lacking a reference architecture for Building Digital Twins, ad hoc sets of relationships among ontologies are established for specific projects by mixing reference (open) with proprietary ones. This approach is time consuming and not practical since several not mature ontologies (Mid TRL[3]) are still evolving rapidly. A classic example is shown in figure 1[4].
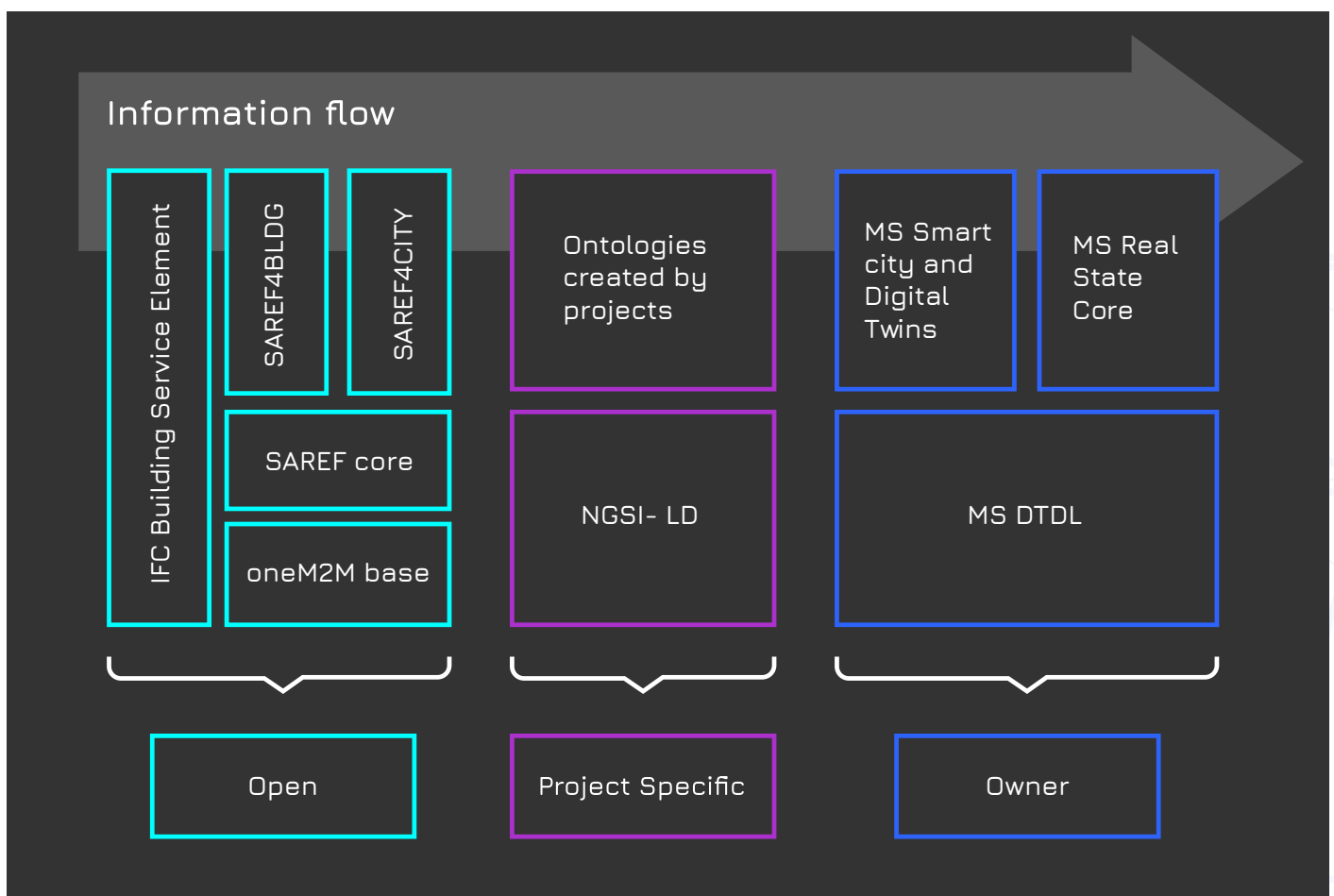

Figure 1. Example of Complexity map for project specific applications

3 It's considered that SAREF4BLDG is TRL6.

4 Adapted from The Digital Twin Hub

BUILDING DIGITAL TWIN AS A KEY CORNERSTONE TO ENABLE INTEROPERABILITY ACROSS THE BUILDING LIFE CYCLE

The SPHERE project conceives a robust framework for testing and implementing transcending data within a semantic interoperable Building Digital Twin ecosystem from both a technical and a business perspective. The cornerstone of the SPHERE BDT ecosystem is the definition of a Network of Ontologies where only OPEN reference ontologies are applied, extended, and empowered in a univocal architecture along the building life cycle.
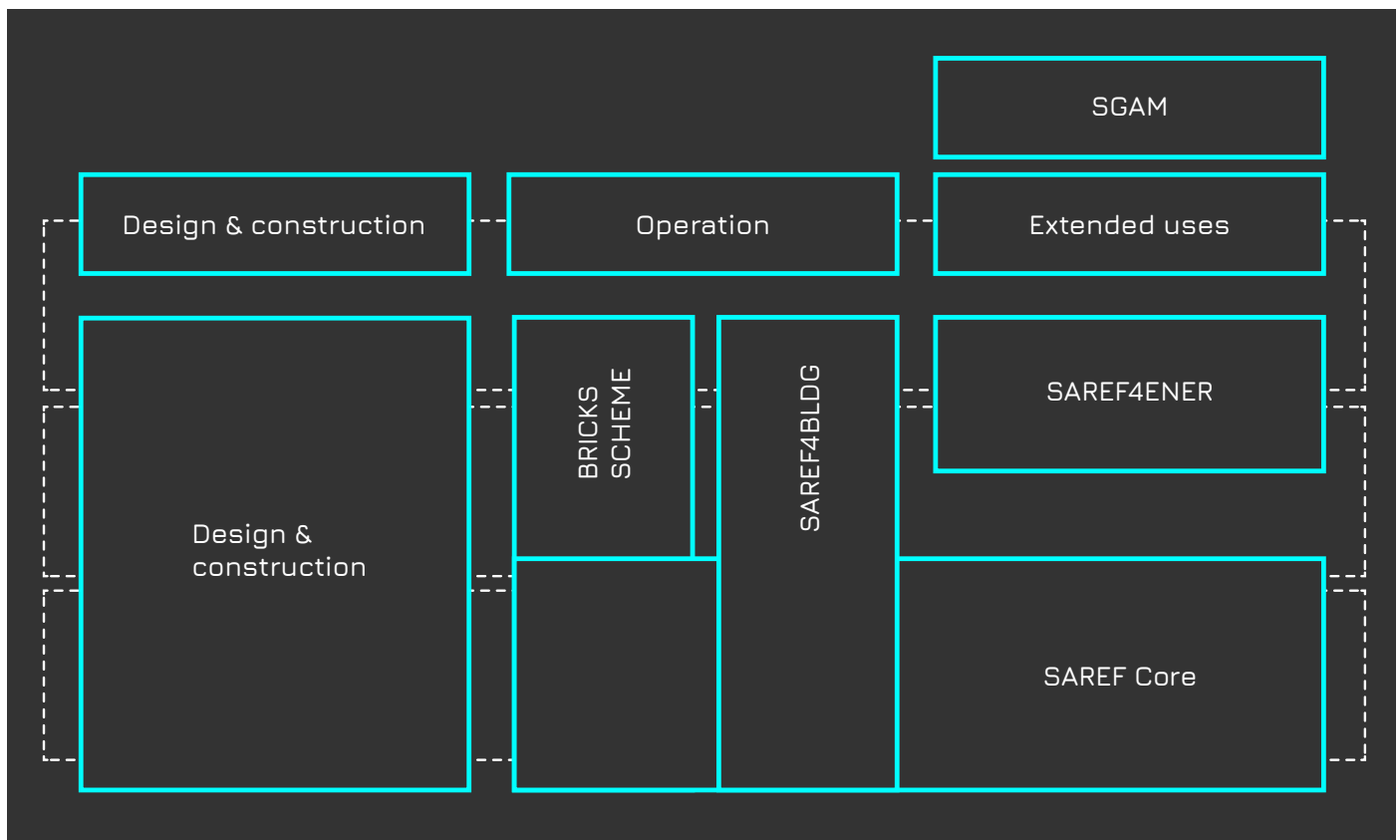

Figure 2. Digital Twin and map of main reference ontologies in AECO and extended sectors

Such a unified OPEN "Network of ontologies" approach enables use case-based extensions like a Distributed Energy Resource (DER) in the context of the smart grid development, or future smart energy networks and smart positive districts, and specifically connecting these emerging technologies to the building life cycle. And on the same hand, this approach allows the introduction of Use Cases within the circular economy like LCA and Material Passports, by extending the applied Network for the purpose of the selected Use Cases and without interfering with each other or having a need of one-size-fits-all ontology that reinvents what is already existing.

FUTURE DIRECTION: TOWARDS A UNIFIED REFERENCE ARCHITECTURE FOR BUILDING LIFE CYCLE MANAGEMENT

The definition of a holistic Ontology Network for a Building Digital Twin is a necessity if the AECO industry wants to fully empower emerging technologies like DER and Circular Economy across Europe and beyond.

A next step is the reflection of such an "Network of Ontologies" approach when applying a Building Digital Twin in a project context: A reference set of tools aimed to manage the entire building lifecycle under a PaaS or ecosystem business model.

Within the SPHERE project the standardisation and definition of a Building Digital Twin Ontology Network will evolve in the development of an Open Digital Twin API. That API is a core part of the SPHERE Digital Twin Architecture enabling the ecosystem approach.