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Building information modelling (BIM) - Semantic modelling and linking (SML) - Part 1: Generic modelling patterns

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Semantischer Modellierungs- und Verknüpfungsstandard (SMLS) für die Datenintegration in der gebauten Umwelt

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European foreword

This document (EN 17632-1:2022) has been prepared by Technical Committee CEN/TC 422 “Building information modelling (BIM)”, the secretariat of which is held by SN - Norway.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2023, and conflicting national standards shall be withdrawn at the latest by June 2023.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

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Introduction

This document is about the built environment. In the built environment, assets relating to buildings and infrastructures need to be managed across their entire life cycle, involving programming, design, construction, operation, modification and demolition or disassembly. Vast amounts of valuable information about them are created or captured, stored and communicated according to a diverse range of forms and structures - and often lost again.

To manage these projects and their resulting assets more efficiently and effectively, information needs to be findable, accessible, interoperable and reusable (FAIR). The world wide web consortium (W3C) provides open and generic linked data (LD) and semantic web (SW) technologies [1] which are capable of providing this 'FAIRness' giving information a common form ('syntax') and structure ('semantics').

Using the 'new European Interoperability Framework' (EIF) [9] terminology, this document focuses on syntactic and semantic interoperability.

This document specifies how organizations in the built environment can apply this W3C technology to best suit their needs. For example, it can be used within organizations to communicate information internally between various business departments and software, or it can be used externally to publish information across the multitude of databases and organizations in the sector.

Application of this document will in particular help to align and integrate relevant 'modelling worlds' for the built environment, typically involving already existing complex information models, like in Building Information Modelling (BIM), Geographical Information Systems (GIS), Systems Engineering (SE), Monitoring & Control (M&C) and Electronic Document Management (EDM).

Regarding to BIM Building Information Modelling, this document has been prepared with the EN ISO 16739-1 [11] Industry Foundation Classes (IFC) information model in mind, and it has been aligned with the revision work of EN ISO 12006-3 [17] (used to extend IFC via a buildingSmart data dictionary (bSDD)). More specifically, this document offers a 'linked data' view on the 'data templates' related to CEN TC442/WG4. It provides a way to represent the 'attributes' for 'properties' of EN ISO 23386:2020 [15] implemented according to EN ISO 23387:2020 [16], again involving EN ISO 12006-3.

As any other technical specification, this document requires expertise and experience in specifying, procuring and delivering work results. As semantic modelling and linking is in the domain of computer science, the content is aimed at those professionals. This document however, provides a standardized approach for the built environment, and thus this introduction addresses the sector and its decision makers.

Wherever the sector could benefit from better ways of searching, finding and (re)using information, this document specifies how to store, model, publish and link this information, with the aim of modelling information once in a standardized way, instead of adapting and transforming information on an ad hoc basis. In other words, it is not a matter of shifting information structures already in place, but a matter of modelling them for publishing on the Web/internet in more cloud-native ways.

The key principle of this document is to keep semantic modelling as simple and standardized as possible. The objectives for capability range from machine-readable information (interpreted by humans) via (as far as possible) machine-interpretable information to fully integrated and interlinked information sources.

This document is complementary to other ISO standards. In the Annex D, related ISO standards are listed and the exact relationships are described.

The standardized modelling patterns introduced in this document may be applicable to other industry sectors as well.

1 Scope

This document addresses *syntactic and semantic interoperability* for information describing assets going through their life cycle in the built environment. It assumes the underlying *technical interoperability* provided already by the Internet/World Wide Web (WWW) technology-stack. The syntactic aspects relate to the Linked Data (LD)/Semantic Web (SW) formats and the SPARQL direct access method provided. The semantic aspects relate to the LD/SW-based information models in the form of thesauri and ontologies giving meaning to the information.

The following information architecture (Figure 1) applies.

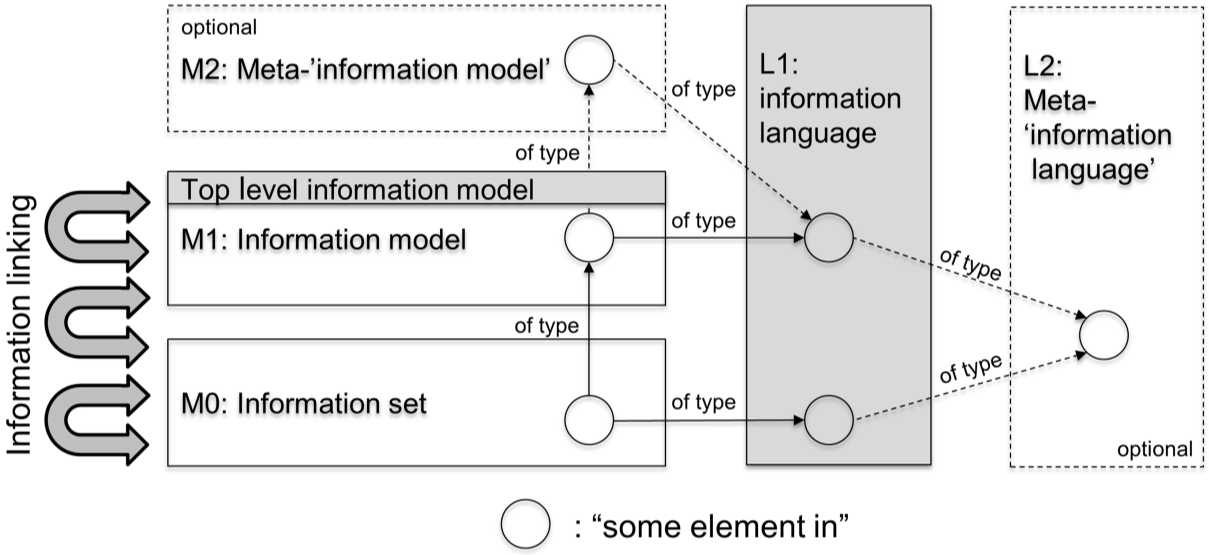

Figure 1 — Information architecture with (grey areas indicating the scope of this document)

This document specifies:

— a conceptual "L1: Information language" with four RDF-based language bindings being SKOS, RDFS, OWL and SHACL, including:

  — a choice of 'linked data'/RDF-based formats (to be used for all modelling and language levels); and

— a generic Top Level Information Model of a total "M1: Information model", here "an upper ontology", including:

  — a set of generic information modelling patterns for identification, annotation, enumeration datatypes, complex quality/quantity modelling, decomposition and grouping.

This modelling approach for information models and information sets is relevant within the built environment from multiple perspectives such as:

— Building information modelling (BIM);

— Geographical information systems (GIS);

— Systems engineering (SE);

— Monitoring & control (M&C); and

— Electronic document management (EDM).

Annex E discusses in an informative way how the information models and sets relevant for these different worlds can be linked together using LD/SW technology.

This document does not specify a full meta-'information model', sometimes referred to as a 'Knowledge Model (KM)'. EN ISO 12006-3 provides such an often used model for the built environment. In Annex D, Subclause D.3 it is shown how this existing model can be made compliant to this document. The only direct support for this meta level comes in the form of the possibility to define 'types' (enumeration types or concept types) and 'objectifications' as metaconcepts.

This document does not specify a meta-'information language' since this is already provided by the concrete RDF-based language bindings (being RDFS).

The scope of this document in general excludes the following:

— Business process modelling;

— Software implementation aspects;

— Information packaging and transportation/transaction aspects already handled by ISO TC59/SC13 Information container for linked document delivery (ICDD) ([13]) respectively various information delivery manual (IDM) / information exchange requirements (EIR)-related initiatives; and

— Domain-specific (here: 'built environment'-specific) content modelling in the form of concepts, attributes and relations at end-user level (the actual ontologies themselves) beyond a generic top level information model ('upper ontology') and modelling and linking patterns.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements for this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

JSON-LD 1.1, A JSON-based Serialization for Linked Data, W3C Recommendation, 16 July 2020, https://www.w3.org/TR/json-ld11/

OWL 2[1] Web Ontology Language, Document Overview (Second Edition), W3C Recommendation, 11 December 2012, https://www.w3.org/TR/2012/REC-owl2-overview-20121211/

RDF 1.1 Concepts and Abstract Syntax, W3C Recommendation, 25 February 2014, https://www.w3.org/TR/rdf11-concepts/

RDF 1.1 Turtle,W3C Recommendation, 25 February 2014, https://www.w3.org/TR/turtle/

RDF 1.1 XML Syntax, W3C Recommendation 25 February 2014, https://www.w3.org/TR/rdf-syntax-grammar/

RDF Schema 1.1, W3c Recommendation, 25 February 2014, https://www.w3.org/TR/rdf-schema/

SHACL (Shapes Constraint Language). W3C Recommendation, 20 July 2017, https://www.w3.org/TR/shacl/

SKOS Simple Knowledge Organization System Reference. W3C Recommendation, 18 August 2009, https://www.w3.org/TR/skos-reference/

[1] Hereafter referred to as just "OWL".

SPARQL 1.1 Overview, 21 March 2013, W3C Recommendation, https://www.w3.org/TR/sparql11-overview/ (referencing, among others, the next two, more specific, references)

SPARQL 1.1 Query Language, W3C Recommendation, 21 March 2013, https://www.w3.org/TR/2013/REC-sparql11-query-20130321/

SPARQL 1.1 Protocol, W3C Recommendation, 21 March 2013, https://www.w3.org/TR/sparql11-protocol/

XML Schema Part 2: Datatypes, Second Edition, W3C Recommendation, 28 October 2004, https://www.w3.org/TR/xmlschema-2/

assumption, in a formal system of logic used for knowledge representation that a statement that is true is also known to be true; therefore, conversely, what is not currently known to be true is false

Note 1 to entry: Typically combined with the Unique Name Assumption (UNA).