ETSI GR CIM 051 V1.1.1 (2025-02)

GROUP REPORT

Context Information Management (CIM); Using NGSI-LD in the context of Building Information Management (BIM)

Disclaimer

The present document has been produced and approved by the cross-cutting Context Information Management (CIM) ETSI Industry Specification Group (ISG) and represents the views of those members who participated in this ISG.
It does not necessarily represent the views of the entire ETSI membership.

Reference
DGR/CIM-0051

Keywords
API, IoT, NGSI-LD

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Important notice

The present document can be downloaded from the ETSI Search & Browse Standards application.

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format on ETSI deliver repository.

Users should be aware that the present document may be revised or have its status changed, this information is available in the Milestones listing.

If you find errors in the present document, please send your comments to the relevant service listed under Committee Support Staff.

If you find a security vulnerability in the present document, please report it through our Coordinated Vulnerability Disclosure (CVD) program.

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ETSI GR CIM 051 V1.1.1 (2025-02)
https://standards.iteh.ai/catalog/standards/etsi/937f2081-9673-475c-b916-b0a68e58e933/etsi-gr-cim-051-v1-1-1-2025-02

Notice of disclaimer & limitation of liability

The information provided in the present deliverable is directed solely to professionals who have the appropriate degree of experience to understand and interpret its content in accordance with generally accepted engineering or other professional standard and applicable regulations.
No recommendation as to products and services or vendors is made or should be implied.
No representation or warranty is made that this deliverable is technically accurate or sufficient or conforms to any law and/or governmental rule and/or regulation and further, no representation or warranty is made of merchantability or fitness for any particular purpose or against infringement of intellectual property rights.
In no event shall ETSI be held liable for loss of profits or any other incidental or consequential damages.

Any software contained in this deliverable is provided "AS IS" with no warranties, express or implied, including but not limited to, the warranties of merchantability, fitness for a particular purpose and non-infringement of intellectual property rights and ETSI shall not be held liable in any event for any damages whatsoever (including, without limitation, damages for loss of profits, business interruption, loss of information, or any other pecuniary loss) arising out of or related to the use of or inability to use the software.

Copyright Notification

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.
The content of the PDF version shall not be modified without the written authorization of ETSI.
The copyright and the foregoing restriction extend to reproduction in all media.

© ETSI 2025.
All rights reserved.

Contents

List of figures

List of tables

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI IPR online database.

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™**, **LTE™** and **5G™** logo are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**® and the GSM logo are trademarks registered and owned by the GSM Association.

Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) cross-cutting Context Information Management (CIM).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document encompasses BIM from the city scale down to building components but is mainly focused on the buildings scale and related data. This approach remains inside the domain of application of BIM: Building close environment, Building envelop and indoor components. Infrastructures are not considered here, as they are not covered by actual BIM standards and overlap with geospatial standards at upper scales. The approach is illustrated through a few use cases that cover the main multi-scale aspects of BIM. It also gives some guidelines and recommendations to use NGSI-LD in Buildings context.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI White Paper No. 42: "Guidelines for Modelling with NGSI-LD", March 2021.

[i.2] Marco Pritoni, Drew Paine: "Metadata Schemas and Ontologies for Building Energy Applications: A Critical Review and Use Case Analysis".

[i.3] Martin Bauer, Sonia Bilbao et al.: "Semantic IoT Solutions - A Developer Perspective".

[i.4] ETSI GS CIM 006 (V1.2.1): "Context Information Management (CIM); NGSI-LD Information Model".

[i.5] Jimmy Abualdenien, M.Sc. et al.: "Levels of Detail, Development, Definition, and Information Need: A Critical Literature Review", 2022.

[i.6] Chi Zhang, Jakob Beetz: "BimSPARQL: Domain-specific functional SPARQL extensions for querying RDF building data".

[i.7] Pieter Pauwels, Davy Van Deursen: "IFC-to-RDF: Adaptation, Aggregation and Enrichment".

[i.8] Andrew Malcolm, Jeroen Werbrouck, Pieter Pauwels: "LBD server: Visualising Building Graphs in web-based environments using semantic graphs and glTF-models".

[i.9] W3C® Recommendation: "SPARQL 1.1 Protocol", 21 March 2013.

[i.10] Iker Esnaola-Gonzalez, Jesús Bermúdez, Izaskun Fernandez, and Aitor Arnaiz: "Ontologies for Observations and Actuations in Buildings: A Survey".

[i.11] Diego Vinasco-Alvarez, John Samuel Samuel, Sylvie Servigne, Gilles Gesquière: "From CityGML to OWL". [Technical Report] LIRIS UMR 5205. 2020. hal-02948955.

[i.12] Alper Tunga Akın, Ç. Cömert: "'CITYJSON2RDF' A converter for producing 3D city knowledge graphs".

[i.13] Anna Wagner, Pieter Pauwels et al.:"Representing construction-related geometry in a semantic web context: A review of approaches".

[i.14] Robert Amor and Johannes Dimyadi: "An open repository of IFC data models and analyses to support interoperability deployment", pp. 16-18, 2010.

[i.15] Andre Borrmann, Jakob Beetz, Christian Koch, T. Liebich and Sergej Muhic: "Industry Foundation Classes: A Standardized Data Model for the Vendor-Neutral Exchange of Digital Building Models", pp. 81-126, 2018.

[i.16] Georgios Bouloukakis, Chrysostomos Zeginis, Nikolaos Papadakis, Panagiotis Zervakis, Dimitris Plexousakis, and Kostas Magoutis: "Enabling IoT enhanced Transportation Systems using the NGSI Protocol", In Proceedings of the 12th ACM International Conference on the Internet of Things (Delft, Netherlands), 2022.

[i.17] Manu Sporny, Gregg Kellogg, and Markus Lanthaler. 2014. JSON-LD 1.0 - A JSON-based Serialization for Linked Data. W3C® Recommendation (01/2014).

[i.18] Roberto Yus, Georgios Bouloukakis, Sharad Mehrotra and Nalini Venkatasubramanian: "Abstracting Interactions with IoT Devices Towards a Semantic Vision of Smart Spaces". In Proceedings of the 6th ACM International Conference on Systems for Energy-Efficient Buildings, Cities, and Transportation (New York, NY, USA) (BuildSys '19). Association for Computing Machinery, New York, NY, USA, pp. 91-100, 2019.

[i.19] Roberto Yus, Georgios Bouloukakis, Sharad Mehrotra and Nalini Venkatasubramanian: "The SemIoTic Ecosystem: A Semantic Bridge between IoT Devices and Smart Spaces", ACM Transactions on Internet Technology - TOIT (2022).

[i.20] FAIR in Practice Task Force of the European Open Science Cloud FAIR Working Group: "Six Recommendations for Implementation of FAIR Practice".

[i.21] buildingSMART Australia: "User Guide for Geo-referencing in IFC 'How to Setup Geo-referencing in a Building or Linear Infrastructure Model'", January 2020.

[i.22] ETSI: "SAREF extension for building", 2021.

[i.23] buildingSMART: "Industry Foundation Classes", 2013.

[i.24] OGC: "GeoSPARQL", 2012.

[i.25] Pieter Pauwels: "Building Element Ontology (BEO)", 2018.

[i.26] Maxime Lefrançois: "Props", 2019.

[i.27] Digital Construction Ontology Group: "Digital Construction Ontologies", 2020.

[i.28] W3C® Linked Building Data Community Group: "Building Topology Ontology (BOT)", 2019.

[i.29] Khronos Group: "glTF™ 2.0 Specification", 2017.

[i.30] FOG Ontology Group: "FOG: File Ontology for Geometry formats", 2020.

[i.31] FIWARE: "Revolutionary AI Air Pollution System powered by FIWARE", November 25, 2021.

[i.32] Inspection générale des affaires sociales (IGAS): "L'Observatoire de la qualité de l'air intérieur : bilan et perspectives".

[i.33] Atmo Nouvelle-Aquitaine: "Qualité de L"air en Nouvelle Aquitaine", 2023.

[i.34] Chi Zhang: "Requirement checking in the building industry: enabling modularized and extensible requirement checking systems based on semantic web technologies", March 11, 2019.

[i.35] Chi Zhang: "IFC-to-WKT_Converter", 2021.

[i.36] Matthias Wagner, Pieter Pauwels: "Representing construction-related geometry in a semantic web context", 2019.

[i.37] Pieter Pauwels, Anna Wagner, Maxime Kriss McGlinn: "Interlinking geospatial and building geometry with existing and developing standards on the web", 2019.

[i.38] Nikolaos Papadakis, Georgios Bouloukakis, Kostas Magoutis: "Enabling dynamic smart spaces using IoT-enhanced NGSI-LD data models", November 7, 2022.

[i.39] Interoperable Europe: "Rolling Plan for ICT standardisation: Water Management Digitalisation (RP2024)", 2024.

[i.40] Geonovum: "Use cases for 3D GeoSPARQL", Geonovum General Working Version, September 25, 2024.

[i.41] Fiware4Water: "Demo case #1: Water supply system real time operational management (Greece)".

[i.42] Cinzia Slongo, Giada Malacarne, Dominik T. Matt: "The IFC File Format as a Means of Integrating BIM and GIS: The Case of the Management and Maintenance of Underground Networks", 2022.

[i.43] C. Ellul, J. Stoter, L. Harrie: "Investigating the state of play of GEOBIM across Europe", 2018.

[i.44] BuildingSmart, IFC 4.3.2.20241204 (IFC4X3_ADD2): "IfcBuildingControlsDomain".

[i.45] BuildingSmart, IFC 4.3.2.20241204 (IFC4X3_ADD2): "IfcHvacDomain".

[i.46] BuildingSmart, IFC 4.3.2.20241204 (IFC4X3_ADD2): "IfcPlumbingFireProtectionDomain".

[i.47] ETSI TR 103 547 (V1.1.1): "SmartM2M; SAREF extension investigation; Requirements for the Water domain".

[i.48] ETSI: "SAREF4WATR ontology".

[i.49] FIWARE: "Smart data models repository".

[i.50] ISO 16739-1:2024: "Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries- Part 1: Data schema".

NOTE: ISO 16739-1:2024 supersedes ISO/PAS 16739:2005 and ISO 16739-1:2018.

[i.51] IETF RFC 7946: "The GeoJSON Format".

[i.52] CEN/TC 442: "Building Information Modelling (BIM)".

[i.53] ISO/TC 59/SC 13: "Organisation et numérisation des informations relatives aux bâtiments et ouvrages de génie civil, y compris modélisation des informations de la construction (BIM)".

[i.54] ISO/IEC 12113:2022: "Information technology — Runtime 3D asset delivery format — Khronos glTF™ 2.0".

3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AECO	Architecture, Engineering, Construction, and Operations
API	Application Programming Interface
BBS	Building Block System
BIM	Building Information Modelling
BMS	Building Management System
BOT	Building Operation and Technology
CIM	Context Information Management
CRS	Coordinate Reference System
ECM	Energy Concervation Measures
EPA	Environmental Protection Agency
FAIR	Findable, Accessible, Interoperable, and Reusable
FOG	File Ontology for Geometry formats
GLTF	GL Transmission Format (a file format for 3D models and scenes)
GML	Geography Markup Language
GUID	Global Unique Identifier
HVAC	Heating, Ventilation, and Air Conditioning
ICT	Information Technology
IFC	Industry Foundation Classes
IoT	Internet of Things
JSON	JavaScript Object Notation
JSON-LD	JavaScript Object Notation for Linked Data
LBD	Linked Building Data
LD	Linked Data
LOD	Level Of Details
NGSI	Next Generation Service Interfaces
NGSI-LD	Next Generation Service Interface - Linked Data
NIBS	National Institute of Building Sciences
OGC	Open Geospatial Consortium
OMG	Object Management Group
OWL	Web Ontology Language
RDF	Resource Description Framework
RDFS	Resource Description Framework Schema
SAREF	Smart Applications REFerence ontology
SOSA	Sensor, Observation, Sample, and Actuator (ontology)
SPARQL	SPARQL Protocol and RDF Query Language
SRS	Spatial Reference System
SSN	Semantic Sensor Network
SVG	Scalable Vector Graphics
TIN	Triangulated Irregular Network
UID	Universal Identifier
URI	Uniform Resource Identifier
UUID	Universal Unique Identifier
W3C®	World Wide Web Consortium
WNS	Web Notification Standard

4 Background information

Next Generation Service Interface - Linked Data (**NGSI-LD**) is an open standard for context information management, which defines a common data model and interface for exchanging context information between different systems and applications [i.1]. It is an extension of the NGSI standard, which was developed by the FIWARE Foundation, and is designed to support the integration of Internet of Things (IoT) devices and data sources. NGSI-LD uses Linked Data principles to represent context information as a graph of interconnected entities, where each entity has a unique Uniform Resource Identifier (URI) and can be described using a set of attributes and relationships. This allows for greater flexibility and interoperability in the exchange of context information, as it enables data to be shared and reused across different domains and applications. NGSI-LD is used in a variety of domains, including smart cities, industry 4.0, and transportation. It provides a common framework for managing context information in these domains, enabling the development of new services and applications that can leverage data from multiple sources. By using NGSI-LD, organizations can improve data sharing and collaboration, reduce integration costs, and accelerate the development of innovative solutions.

The NGSI-LD information model (Figure 1) is derived from PGs. Entities, relationships, and properties are the key components of the NGSI-LD information model, as shown in Figure 2. A real-world item, such as a building or a person, is represented by an entity. A relationship connects two or more entities, such as a person who works in a building. A property connects values to elements, such that it can identify that an entity corresponds to a real person. Due to its extensive data structure, it may be utilized for practically any data exchange situation throughout the life cycle of a building.

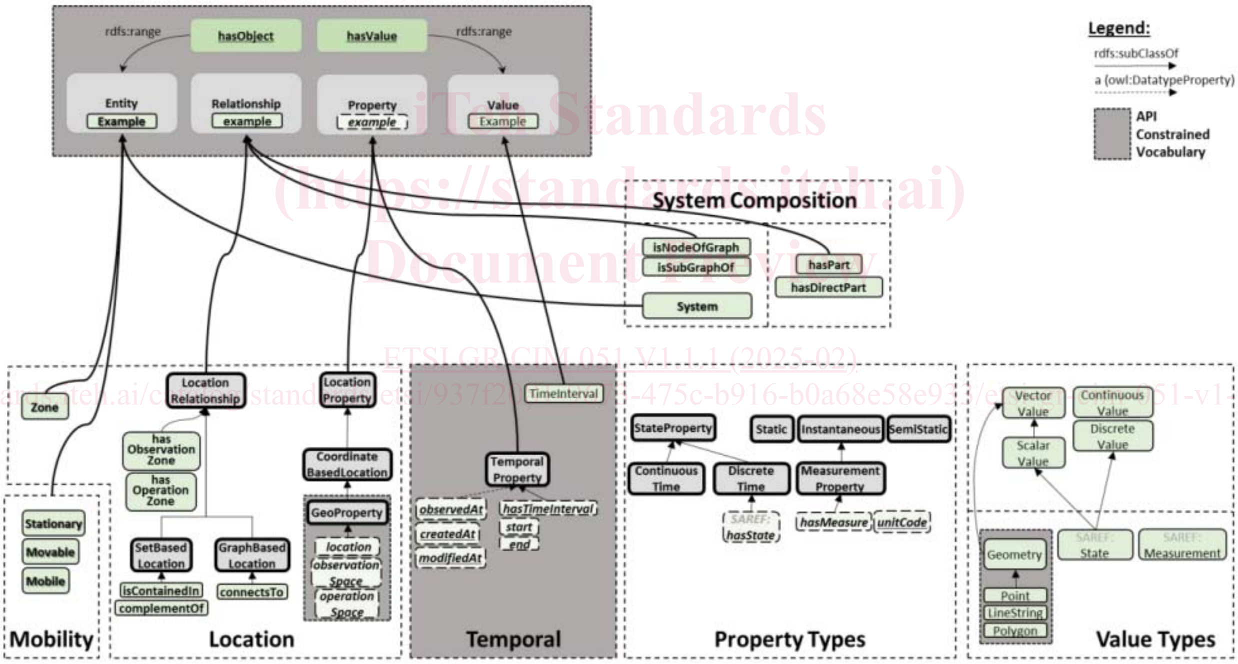

Figure 1: NGSI-LD Information Model

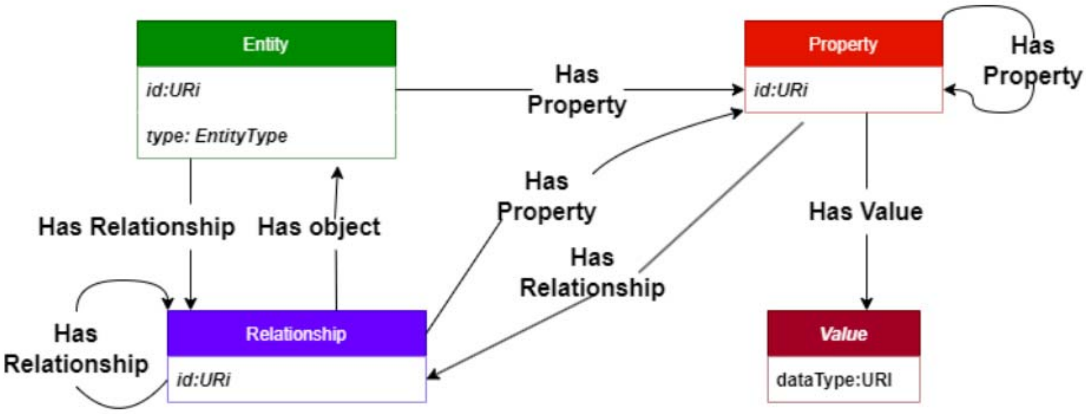

Figure 2: Key components of the NGSI-LD ontology

BIM stands for Building Information Modelling. It is a digital representation of the physical and functional characteristics of a building, including both geometric and non-geometric information. BIM is a process that involves creating and managing digital models of a project, which can be used for planning, design, construction, and management of buildings and infrastructure. The BIM process allows architects, engineers, and construction professionals to collaborate more effectively, as it provides a shared view of the project and enables better communication and coordination. It can also help to improve the accuracy of cost estimates and construction schedules, reduce waste, and enhance the overall quality and sustainability of buildings. BIM is typically used throughout the entire lifecycle of a building, from the initial design phase through to construction, operation, and maintenance. By using BIM, stakeholders can make more informed decisions, improve the efficiency of their workflows, and ultimately deliver better outcomes for their clients and end-users.

Data spaces are a concept used in data management and integration to describe a virtual environment where data from different sources can be stored, managed, and shared in a secure and controlled manner. Data spaces are typically designed to support specific use cases or domains, such as healthcare, finance, or manufacturing. Data spaces provide a common framework for data integration and sharing, enabling organizations to break down data silos and leverage data from multiple sources to gain new insights and create new value. Data spaces typically include a set of tools and services for data discovery, access control, data quality management, and data governance. Data spaces can be implemented using a variety of technologies and architectures, such as data lakes, data warehouses, or federated data platforms. They can also be implemented using decentralized architectures, such as blockchain or peer-to-peer networks, to enable secure and distributed data sharing. Data spaces are becoming increasingly important in the era of big data and digital transformation, as organizations seek to leverage data to gain a competitive advantage and create new business models. By providing a secure and controlled environment for data sharing and collaboration, data spaces can help organizations to unlock the value of their data, while ensuring compliance with privacy and security regulations. By using NGSI-LD, data spaces can provide a common data model and interface for representing and sharing data, enabling greater interoperability and integration between different data sources and applications. For example, in a smart city context, different data spaces may be created for different domains, such as transportation, energy, and building management. NGSI-LD can be used as a common data model and API specification for exchanging data between these different data spaces, enabling greater integration and collaboration between different domains and stakeholders.

Domain models are models that represent the concepts, entities, and relationships within a specific domain or area of interest. A domain model is typically developed by domain experts who have a deep understanding of the business or technical requirements of the domain. The purpose of a domain model is to provide a common language and a shared understanding of the domain among stakeholders, such as business analysts, developers, and users. A domain model typically includes entities, attributes, relationships, and constraints that are relevant to the domain.

A **cross-domain** model refers to a common data model that can be used to represent and exchange context information across different domains or applications. A cross-domain model provides a standardized way to describe entities, attributes, and relationships in a way that is interoperable and reusable across different domains. NGSI-LD is designed to support cross-domain data integration and interoperability, and the development of cross-domain models is an important part of this effort. Cross-domain models can be created by mapping and aligning domain-specific data models to a common data model, using Linked Data principles and vocabularies such as RDF, RDFS, and OWL. For example, in a smart city context, a cross-domain model may be developed to represent and exchange data related to buildings, transportation, energy, and environmental conditions. This cross-domain model would provide a common data model and vocabulary for representing entities such as buildings, vehicles, sensors, and weather conditions, as well as their attributes and relationships. By using a cross-domain model, stakeholders can improve data integration and interoperability, enabling greater collaboration and innovation across different domains and applications. Cross-domain models can also help to reduce data silos and enable the development of new services and applications that leverage data from multiple domains. Developing cross-domain models requires collaboration and consensus-building between different stakeholders, including domain experts, data modelers, and software developers. It also requires the use of common vocabularies and standards, such as those provided by the W3C® and other standards organizations.

An **ontology** is a formal representation of a set of concepts and their relationships within a specific domain of knowledge. An ontology provides a shared vocabulary and a set of rules for describing and reasoning about the concepts and relationships within that domain. Ontologies are used to enable interoperability and knowledge sharing between different systems, applications, and stakeholders. By providing a common understanding of the concepts and relationships within a domain, ontologies can help to overcome semantic heterogeneity, which is the difference in meaning and interpretation of data between different systems and stakeholders. An ontology typically includes a set of classes or concepts, which represent the entities or objects within a domain, and a set of properties or attributes, which describe the characteristics of those entities. Ontologies can also include relationships between classes, such as hierarchical or associative relationships, and constraints or rules that govern the use of the ontology. Ontologies are used in a variety of domains, including healthcare, finance, biology, and engineering. They are often used in the development of semantic web applications, which aim to provide a more meaningful and contextual representation of data on the web. Ontologies can also be used in artificial intelligence and machine learning applications, to provide a structured representation of knowledge and enable more sophisticated reasoning and decision-making.

5 FAIR requirements in BIM context

5.1 Introduction

This clause lists Findable, Accessible, Interoperable, Reusable (FAIR) [i.20] requirements specific to BIM context, and how they are currently addressed by architecture and construction communities [i.14] and [i.15]. W3C® interoperability recommendations and OASC Minimal Interoperability Mechanisms are also listed and taken into account.

5.2 Findable: Locating and Identifying instances

The first step in using data is to be able to find them. Metadata and data should be easy to find for both humans and computers. Machine-readable metadata are essential for automatic discovery of datasets and services.

F1. (Meta)data are assigned a globally unique and persistent identifier

F2. Data are described with rich metadata

F3. Metadata clearly and explicitly include the identifier of the data they describe

F4. (Meta)data are registered or indexed in a searchable resource

Unique identifiers, by means of namespaces and registration identifiers, provided by National Registration authorities (e.g. Nation Building Referential in France) or Building Owners, are to be used.

Identifying properties and geospatial references (as, for instance, described in the user guide for geo-referencing in IFC) is extremely important.

Finding a glue between different scales, for instance using NGSI-LD (see [i.16]), is important.