

# ETSI GS CIM 050 V1.1.1 (2024-11)



## Context Information Management (CIM); Aligning with geo-information

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# Foreword

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

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# Modal verbs terminology

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# Executive summary

The present document specifies how to make geodata accessible as Linked Data. It proposes changes and enhancements to ETSI GS CIM 006 [5] and ETSI GS CIM 009 [1].

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# Introduction

The present document is complementary to ETSI GR CIM 049 [i.21]. The use cases that ETSI GR CIM 049 [i.21] has documented show that many cities and communities use both geographical systems and NGSI-based systems and will continue in the future.

By further analysing the results and ideas of ETSI GR CIM 049 [i.21], which are derived from interviews with a large number of smart cities representatives, the present document recommends changes to ETSI GS CIM 006 [5] and ETSI GS CIM 009 [1].

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# 1 Scope

The present document specifies how to make geodata accessible as Linked Data. It specifies how to share spatial (and spatio-temporal) data, and how to make them interoperable with, within, and between systems and territories. It also specifies how to both establish and maintain the number of connections between NGSI-LD Entities (see ETSI GS CIM 009 [1]) and their geographical 2D/3D representations.

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## 2 References

### 2.1 Normative references

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

Referenced documents which are not found to be publicly available in the expected location might be found in the [ETSI docbox](#).

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The following referenced documents are necessary for the application of the present document.

- [1] [ETSI GS CIM 009 \(V1.8.1\)](#): "Context Information Management (CIM); NGSI-LD API".
- [2] [IETF RFC 7946](#): "The GeoJSON Format".
- [3] OGC® GeoSPARQL: "[A Geographic Query Language for RDF Data](#)".
- [4] [ISO/IEC 12113:2022](#): "Information technology — Runtime 3D asset delivery format — Khronos glTF™ 2.0".
- [5] [ETSI GS CIM 006](#): "Context Information Management (CIM); NGSI-LD Information Model".
- [6] OGC®: "[OGC Name Type Specification - Definitions - part 1 - basic name](#)".
- [7] OGC® RAINBOW: "[Collections](#)".

### 2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or nonspecific. 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] W3C®: "[Universal Resource Identifier \(URI\)](#)".
- [i.2] Eric Evans, Addison-Wesley Professional, 2003: "Domain-Driven Design (DDD): Tackling Complexity in the Heart of Software".
- [i.3] Open Agile Architecture™, Part 2: The O-AA Building Blocks: "[Domain-Driven Design: Strategic Patterns](#)".

- [i.4] [Open Geospatial Consortium Inc. OGC® 06-103r4](#): "OpenGIS® Implementation Standard for Geographic information - Simple feature access - Part 1: Common architecture".
- [i.5] FIWARE, IUDX, TM Forum, OASC and others: "[Parking Smart Data Model](#)".
- [i.6] Digital Twin® Consortium: "[Digital Twin definition](#)".
- [i.7] OGC®: "[Geography Markup Language \(GML\)](#)".
- [i.8] OGC®: "[CityGML](#)".
- [i.9] OGC®: "[CityJSON](#)".
- [i.10] OGC®: "[IndoorGML](#)".
- [i.11] OGC®: "[API - Features - Part 1: Core](#)".
- [i.12] OGC®: "[API - Features - Part 2: Coordinate Reference Systems by Reference](#)".
- [i.13] OGC®: "[Coordinate Transformation Service](#)".
- [i.14] W3C®: "[Time Ontology in OWL](#)".
- [i.15] Building Smart: "[IFC Industry Foundation Classes 4.0.2.1: Version 4.0 - Addendum 2 - Technical Corrigendum 1](#)".

NOTE: Published also as ISO 16739-1:2018.

- [i.16] Interoperable Europe Programme: "[GeoDCAT-AP](#)".
- [i.17] EC DG JRC Unofficial Draft 31 May 2024: "[DCAT-AP-JRC - Version 2](#)".
- [i.18] [ETSI GR CIM 048 \(V1.1.1\)](#): "Context Information Management (CIM); Handling of data catalogues and data services with NGSI-LD".
- [i.19] [ETSI DGR/CIM-0055](#): "Context Information Management (CIM); Handling of services execution in NGSI-LD based systems".
- [i.20] ArcGIS - ESRI. [ETSI GS CIM 050 V1.1.1 \(2024-11\)](#)
- [i.21] ETSI GR CIM 049: "Context Information Management (CIM); Usage of geo-information".
- [i.22] Filip Biljecki, Hugo Ledoux, and Jantien Stoter: "[An improved LOD specification for 3D building models](#)". Computers, Environment and Urban Systems, 59: 25–37, 2016.
- [i.23] [ISO 7817-1:2024](#): "Building information modelling — Level of information need, Part 1: Concepts and principles".
- [i.24] [ISO 19650-1:2018](#): "Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling, Part 1: Concepts and principles".
- [i.25] W3C®: "[Building Topology Ontology](#)", Draft Community Group Report 28 June 2021.

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## 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:

AI                    Artificial Intelligence  
AP                    Application Profile

NOTE: Part of DCAT-AP.

API                    Application Programming Interface  
AP-JRC                Application Profile – Join Research Center

NOTE: Part of DCAT-AP-JRC.

AR                    Augmented Reality  
BIM                    Building Information Modelling  
CAD                    Computer Aided Design  
CityGML                City Geography Markup Language  
CRS                    Coordinate Reference System  
DCAT                    Data Catalog vocabulary  
DDD                    Domain Driven Design  
EU                    European Union  
GIS                    Geographic Information System  
glTF                    gl Transmission Format  
GML                    Geography Markup Language  
GNSS                    Global Navigation Satellite System  
GPS                    Global Positioning System  
GPU                    Graphic Processing Unit  
HTML                    HyperText Markup Language  
HTTP                    HyperText Transfer Protocol  
HVAC                    Heating Ventilation Air Conditioning  
ID                    Identifier  
JSON                    JavaScript Object Notation  
KML                    Keyhole Markup Language  
LD                    Linked Data  
LOD                    Level Of Details  
LOIN                    Level Of Information Need  
NGSI                    Next Generation Service Interfaces  
NGSI-LD                Next Generation Service Interface - Linked Data.  
OGC                    Open Geospatial Consortium  
OWL                    Web Ontology Language  
QGIS                    Quantum Geographic Information System  
RDF                    Resource Description Format  
SPARQL                SPARQL Protocol And RDF Query Language  
SQL                    Standard Query Language  
TTL                    Terse RDF Triple Language

NOTE: Pronounced "turtle".

URI                    Uniform Resource Identifier  
URL                    Unified Resource Locator  
VR                    Virtual Reality  
WGS                    World Geodetic System  
WKT                    Well-Known Text  
XML                    eXtensible Markup Language  
XSD                    eXtensible markup language Schema Definition

## 4 Recommendations derived from ETSI GR CIM 049

### 4.1 Lessons learned from the analysis of use cases documented in ETSI GR CIM 049

The use cases that ETSI GR CIM 049 [i.21] has documented show that many cities and communities use both geographical systems and NGSI-based systems and will continue in the future. Several of those use cases require some level of interoperability between geographical software components and NGSI ones.

The interoperability needs can be illustrated by two simple examples:

- A city would like to provide a service enabling a citizen or tourist to indicate a geographical location and obtain a list of events (e.g. a concert, an exhibition, etc.) to which he or she could join. The list of events and their description is managed by a Context Broker that implements a Cultural Events Smart Data Model.
- The team that manages the gardens using an application that implements a Garden Smart Data Model needs to access garden information contained in the geographical system and keep that information consistent in both systems. For example, the geographical system using some AI capabilities identifies that a tree has died. The garden team needs to be informed to take care of the dead tree.

For practical reasons as well as economical ones, it would not make sense to (re)-develop cultural events management use cases in the geographical system or (re)-develop geographical mapping features in the garden management system.

The OGC/NGSI interoperability initiatives that were analysed such as the OGC incubator or the Civitas Connect initiative are developing NGSI-LD domain models that mirror the corresponding OGC models (i.e. a Battery model for Civitas Connect and an airport facility model for the OGC incubator). This type of approach does not meet all the needs of the use cases have been analysed. It is not only needed to specify how to translate from one domain model to another (static view), but it is also needed to specify how to model the behaviour of a composite system (e.g. a city digital twin [i.6]) made of heterogenous subsystems (dynamic view).

On the static side, OGC models can be represented as Domain-Specific Ontologies. The potential loss of semantic information results from the fact that NGSI-LD API does not support sub-typing of Entity Types.

On the dynamic side, providing that both OGC and NGSI-LD support a subscription functionality, it is possible to implement the type of interactions that Local Digital Twin need to model. However, additional features need to be added to the NGSI-LD specifications and new modelling practices need to be adopted.

Some cities are using the transition to digital twins as a way of breaking out from the siloed way they operate. They are creating cross-functional working groups dedicated to the development and operation of digital twins. This organizational evolution is necessary to effectively manage the new types of interactions demanded by digital twins.

### 4.2 Topics from ETSI GR CIM 049 and associated standards or technologies

#### 4.2.1 The 10-minute city

The key issues highlighted in ETSI GR CIM 049 [i.21] focus on data quality and the pathfinding algorithms within the applications. While NGSI-LD doesn't directly address the algorithms used in routing apps, it plays a crucial role in ensuring the data behind those routes is timely and accurate. By leveraging the `observedAt`, `createdAt`, or `modifiedAt` properties in an NGSI-LD response, people can deliver the real-time, reliable data that great routing depends on. Implementors are reminded to refer to ETSI GS CIM 009 [1], clause 6.3.11.

Recommendation: add the following note in a future revision of ETSI GS CIM 009 [1], clause 4.8, to help the implementors meet the objectives on the data quality timeliness of the system generated Temporal Attributes:

NOTE: Implementors are recommended to request the `TemporalProperty` values when the timeliness of the data is an important data quality criteria for their use cases. For example, in case of HTTP binding, see ETSI GS CIM 009 [1], clause 6.3.11.

## 4.2.2 Underground Utilities Networks

Simple graph network representations with 2D or 3D polylines, using OGC Features for the components, are usually enough to represent and share context information for utilities networks.

When dealing with underground artefacts, the elevation (depth) of the artefact can be specified using a GeoJSON geometric object that includes altitude as specified in IETF RFC 7946 [2] and quoted in the present document in italics as follows:

*"A position is an array of numbers. There MUST be two or more elements. The first two elements are longitude and latitude, or easting and northing, precisely in that order and using decimal numbers. Altitude or elevation MAY be included as an optional third element".*

EXAMPLE: { "type": "Feature", "geometry": { "type": "Point", "coordinates": [12.4924, 41.8902, 50] } }

Again in GeoJSON [2], *"An OPTIONAL third-position element SHALL be the height in meters above or below the WGS 84 reference ellipsoid. In the absence of elevation values, applications sensitive to height or depth SHOULD interpret positions as being at local ground or sea level".*

For the components of the utilities' networks, the ETSI SAREF ontology (<https://saref.etsi.org>) provides the necessary complement to the NGSI-LD API and could be extended when needed.

Due to the large scale of these networks and the needed precision, geo-localized coordinates are normally used, and the NGSI-LD Cross Domain Information Model [5], as well as the NGSI-LD API [1], answer the need, **provided that a CRS is added to them, as specified in clause 6.2.**

Recommendation: add a CRS property to the Cross Domain Information Model [5] and API [1].

## 4.3 Disaster and emergency

### 4.3.0 Foreword

The ability to share data with precise geospatial references in 2D and 3D with higher refresh intervals is important. Because disasters and emergencies always trigger a "crisis mode", it may be useful that the requirements on subscriptions related to crisis events can be defined and tested in advance and be ready to be instantiated in the context broker when an alert is raised.

The "isActive" member of a subscription enables this capability, as described in Table 1, which is extracted from Table 5.2.12-1 of ETSI GS CIM 009 [1].

**Table 1: isActive member description**

isActive	Boolean	true by default	0..1	Allows clients to temporarily pause the subscription by making it inactive. <i>true</i> indicates that the Subscription is under operation. <i>false</i> indicates that the subscription is paused, and notifications shall not be delivered.
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The description in Table 1 might be clearer to the users of the NGSI-LD API if the fact that a *paused* subscription does not execute any queries is added in the description, for example by changing it as follows:

*Allows clients to temporarily pause the subscription by making it inactive. true indicates that the Subscription is under operation. false indicates that the subscription is paused, **associated queries shall not be executed**, and notifications shall not be delivered.*

More importantly, in Table 5.2.14.1-1 of ETSI GS CIM 009 [1], NotificationParams.endpoint cardinality is "1", indicating that the notification is sent to only one endpoint. The proposal is to change it to "1..\*" to dispatch the same information to various endpoints, instead.

Recommendation: further study the opportunity to modify the NotificationParams.endpoint cardinality from "1" to "1..\*" in Table 5.2.14.1-1 of the NGSI-LD API [1].

### 4.3.1 Challenge of defining regions of interest

In order to define a location, cities are using both geometries with precisely defined geospatial coordinates and/or geographical names. The OGC standards, allow Locations to be defined by a geometry object like a point, a polygon, a polyline, a set geometry, but also with a name and a URI [i.1] which identify the Location, as shown in Table 2, extracted from section 7.12 of release 3.0.0 of GeoDCAT-AP [i.16].

In ETSI GS CIM 009 [1] and ETSI GS CIM 006 [5] the geographic location (GeoProperty) is defined as a coordinate-based location. It is useful, to meet the requirements of the smart cities, to add support to "named locations", similarly to what is specified by the GeoDCAT.

**Table 2: Location entity of GeoDCAT  
(source [i.16] version 2.0.0)**

+gazetteer	skos:inScheme	skos:ConceptScheme	This property <i>MAY</i> be used to specify the gazetteer to which the Location belongs.	0..1
+geographic identifier	dct:identifier	rdfs:Literal	This property contains the geographic identifier for the Location, e.g. the URI or other unique identifier in the context of the relevant gazetteer.	0..n
+geographic name	skos:prefLabel	rdfs:Literal	This property contains a preferred label of the Location. This property can be repeated for parallel language versions of the label - see <a href="#">§ 9. Accessibility and Multilingual Aspects</a> .	0..n
geometry	locn:geometry	rdfs:Literal typed as gsp:wktLiteral or gsp:gmlLiteral	This property associates any resource with the corresponding geometry.	0..1

The GeoDCAT-AP [i.16] does not say anything about the simultaneous usage of geometry, bbox, centroid or names to define the location, whereas the DCAT-AP-JRC [i.17] specifies that the Location has to be defined either by a name or by a geometry, but not both.

For NGSI-LD the choice of following the DCAT-AP-JRC [i.17] recommendation of using either names or geometry is to be evaluated with the NGSI-LD philosophy. Allowing simultaneous usage of the names and the geometries will simplify the processing of data as there is no need for an extra query to a geoname server to get the geometry associated with the identifier.

It can be noted that, as proposed in ETSI GR CIM 048 [i.18], attaching an identifier to the location may let infer that Location becomes an Entity. However, this identifier being "optional", it makes sense to keep location as a Property in NGSI-LD and call this identifier "geographic-identifier".

There are 4 options to implement named locations:

- Domains are free to define Location as an entity and include named location members in addition to NGSI-LD location GeoProperty in the entity. This was the initial proposal from the DCAT mapping:
  - PRO: no impact on NGSI-LD API.
  - CONS: different domains will end up having different ways to specify named locations.