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Context Information Management (CIM); Usage of geo-information

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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).

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1 Scope

The present document contains the key learning gained from 13 interviews with a variety of key city stakeholders.

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 GS CIM 050: "Context Information Management (CIM); Aligning with geo-information".

[i.2] The Smart City Strategy of the City of Brussel.

[i.3] Local Digital Twins: Forging the Cities of Tomorrow.

[i.4] A proof of concept to show the ingestion of data into a FROST-Server using the Orion Context Broker API.

[i.5] Recommendation ITU-T Y.4505: "Minimal Interoperability Mechanisms for smart and sustainable cities and communities".

[i.6] Open Geospatial Consortium (OGC): "Web Feature Service".

[i.7] Open Geospatial Consortium (OGC): "OGC APIs - Features".

[i.8] GeoJSON.

[i.9] Open Geospatial Consortium (OGC): "Geography Markup Language (GML)".

[i.10] OGC GeoPackage.

[i.11] Open Geospatial Consortium (OGC): "CityGML".

[i.12] ISO 16739-1:2024: "Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries - Part 1: Data schema".

[i.13] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

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
API	Application Programming Interface
BIM	Building Information Modeling
CAD	Computer Aided Design
DG	Directorate General
DS4SSCC	Data Space for Smart Communities
GIS	Geographic Information System
GML	Geography Markup Language
GS	Group Specification
IEC	International Electrotechnical Commission
IFC	Industry Foundation Classes
IoT	Internet of Things
IT	Information Technology
JRC	Joint Research Center
JTC	Joint Technical Committee
LD	Linked Data
LDT	Local Digital Twin
MIM	Minimal Interoperability Mechanism
MIM	Minimal Interoperable Mechanism
NGSI	Next Generation Service Interface
NGSI-LD	Next Generation Service Interface Linked Data
OGC	Open Geospatial Consortium
SAREF	Smart Applications REFerence ontology
STA	SensorThings API
SyC	Systems Committee
WFS	Web Feature Service

4 Problem Statement

The present document has been written to provide an accurate picture of how smart cities and territories are using geo-information at the moment, what standards they are using for what purposes and what experiences there are in using NGSI-LD as part of those use cases. The present document also covers the use of geo-information related to environmental issues more generally, as covered by the INSPIRE directive [i.13].

The aim is to be to highlight the key challenges of using NGSI-LD to link to data managed using such standards such as OGC WFS [i.6] and OGC API [i.7] as well as the INSPIRE directive's [i.13] requirements, or encoded using such standards as GeoJSON [i.8], GML [i.9], GeoPackage [i.10], CityGML [i.11] and IFC [i.12]. These challenges would then be addressed by ETSI GS CIM 050 [i.1]. The aim, along with the associated deliverable ETSI GS CIM 050 [i.1], is to enable ETSI to further develop the work on NGSI-LD to:

- specify how to make geodata accessible as Linked Data, how to share spatial (and spatio-temporal) data, and how to make them interoperable with, within, and between systems and territories;
- specify how to both establish and maintain the number of connections between NGSI-LD entities and their geographical 2D/3D representations.

The three families of standards considered; NGSI-LD, Geospatial standards developed by the Open Geospatial Consortium, and BIM and IFC standards developed by BuildingSmart International (see https://www.buildingsmart.org), are all used by cities although often by different departments within those cities.

All three sets of standards need to handle the same set of issues:

- Data about locations and movements.
- Data about urban infrastructure - buildings, roads, bridges.
- How to link different data sources together to provide insight.

However, because of their different focus, they each have their own strengths and weaknesses. At a very high-level:

- NGSI-LD is particularly good at enabling IoT data to be linked with valuable context data to show its significance. It can handle geospatial and building data but only to a certain level.
- OGC standards allow geo-spatial data to be handled to a high degree of sophistication, but can only provide a certain degree of context and building related information.
- BIM/IFC standards provide a rich and detailed way of describing buildings and urban infrastructure, but struggle to indicate precise geographic location and wider context.

The interviews highlighted that smart cities and communities are increasingly recognizing that to tackle almost any urban issues, they need to be able access detailed sets of specific information about location, urban infrastructure and context taken from data collected using these different sets of standards.

They do not need all possible information - just the minimal but "good enough" sets of information relevant to guide them in tackling specific challenges. They are therefore trying to identify practical solutions and "work arounds" that will enable them to gather the information they need from data collected using the different standards. The present document identifies a number of these "work arounds" that cities are using. ETSI, along with OGC and BuildingSmart International, need to see how the standards they develop can be enhanced to support the use of these solutions.

There are many ways to improve ease of integration between different data structured according to different data standards. For instance, it is helpful if the different data sets use common data models for all the key entities, or at least ones that can easily be aligned. Similarly, the use of common identifiers will greatly add data integration. The use of these solutions can greatly enhance the ease of integration between the different types of data.

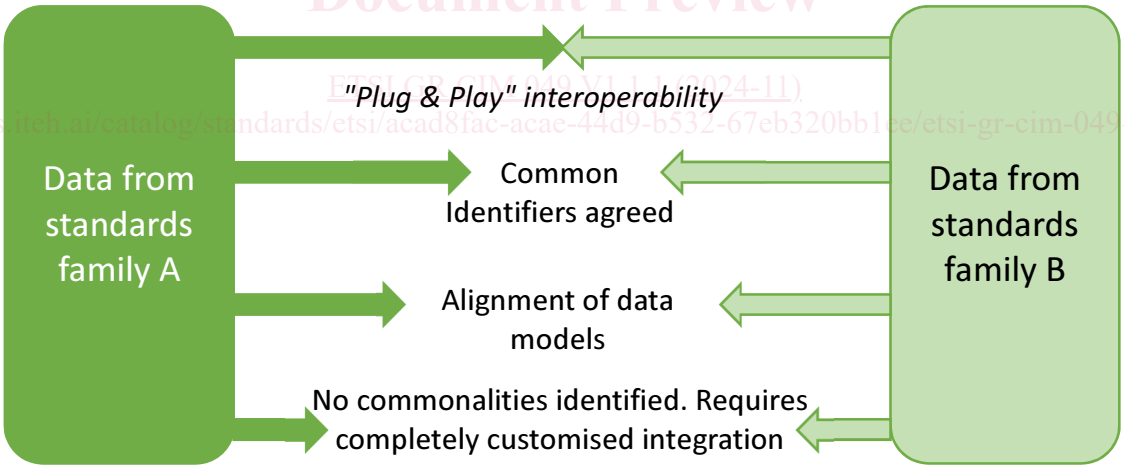

Figure 1: Examples of solutions to improve data integration

It is interesting that OGC have also recognized the need to find alignment with smart data models and linked data and the present document learns from their proof of concept. So, there is an opportunity to work at this from both sides.

The interviews indicated that the key issue is not one or two specific use cases where smart cities and communities are using geospatial standards, but rather that they are increasingly realizing that to tackle almost every challenge they face, they need to be able to bring together information from geospatial data and services and context data from NGSI v2 along with NGSI-LD and other formats using linked data.

5 Methodology

5.1 Information required

The work was aimed at using interviews to identify common use cases where smart cities and territories need to use geospatial data as a key part of the solution and specifically, any information about any role that NGSI might play in helping to link context information to the geospatial data.

In addition, the interviews were used to identify any challenges in linking NGSI with geospatial data and any solutions developed by those interviewed so that this could feed into the work of deliverable D4 within this project.

5.2 Information gathering process

The work commenced with informal interviews with the European Commission DG JRC team managing the INSPIRE initiative, Forum Virium Helsinki, Civitas-Connect and Porto Digital to gain a general overview of the key issues. Using these interviews, and internal discussions, a set of eleven questions was agreed to act as the basis for a further set of interviews, to ensure that all key issues were covered. The questions are provided in Annex A.

The interviews were transcribed using the help of an AI application and many of them were also recorded.

All the participants acknowledged the value of the work that ETSI has originated and are open to further interviews and questions, which will be a useful input to the work on deliverable ETSI GS CIM 050 [i.1].

5.3 Interviews

13 interviews were conducted, each lasting on average around one hour:

- European Commission DG JRC/INSPIRE on the general issues of cities and communities linking their geospatial data with other data.
- Overview of Swedish municipalities use of geospatial data by Tobbe Lahrin - a public sector geospatial expert since the 80 s and who has been working for the last few years on supporting Swedish municipalities around the use of IoT.
- Valencia that uses NGSI extensively and has done a lot of work on a platform that can provide two-way alignment with geospatial data.
- Porto digital (2 x) the innovation agency of the city of Porto, that is actively exploring how to integrate their NGSI-data with their GIS data.
- Civitas-Connect a German not for profit made up of 7 cities and regions and 6 municipal companies, all exclusively in the public sector that is developing a core data sharing platform on behalf of the members, which specifically aims to address aligning NGSI and OGC standards.
- Rennes - a French city that is investigating the potential role of NGSI in its data platform, with the link with geospatial data as one of the key issues.
- Forum Virium Helsinki - a city with a strong geospatial background, that is looking at how to link geospatial with other types of data to provide added insights, specifically around the use of local digital twins.
- Riga.
- Eindhoven.
- City of Brussels.
- Catalonia/Norway consortium preparing proposal for a bid for DS4SSCC pilot focusing on linking different types of data and with a strong FIWARE® and OGC background.

- A Consortium that has won a proposal starting in September 2024 3DXVERSE on developing a platform to link LDTs.

These interviews provided a great deal of information about key use cases related to geospatial data and some helpful information about the challenges that this will involve.

6 Results of interviews - Use cases

6.1 General

Based on recent research commissioned by the European Commission DG JRC, the team interviewed confirmed that all cities heavily use geospatial data for many issues. This is because cities are required to maintain much of this information by government regulations and also because they need it to manage all the assets that they own and tackle key issues such as managing traffic and the environment, for which geospatial data is vital.

However, the research showed that **this city data tends to be siloed off** and not readily available for re-use. The interviews conducted for the present document highlighted the fact that in many cities the Geospatial department **tends to manage its data separately from the data collected by other departments**.

This provides the opportunity for significant gains from leveraging geospatial data more effectively and linking it with other data to help the city tackle the key issues it faces. In this clause 6, some of the main use cases within smart cities and communities are covered for linking geospatial data with other data to gain greater insight.

The interviews made it clear that cities and communities need to use geospatial data alongside other data in order to address a number of different use cases and some of the most important of these are covered in this clause.

In looking at these use cases, it is important not just to focus on the technical issues of interoperability, but also to look more widely at how data can support the procurement of solutions and the wider business case for the investment needed in gathering and using the data. It is not enough to develop solutions that work if they cannot be implemented because of the lack of a clear business case.

So, when looking for solutions, it is useful to look at each use case, not only from the perspective of what data is needed to make it work, but also to identify what data is needed to demonstrate value for money. Most of the data needed will be common, but there is likely to be some additional requirements, the fulfilment of which would help to enrich the business case for using geospatial and other data to tackle that use case.

For instance, it is important to show that the solution is described in a way that demonstrates how it opens up the data to be used in other ways by providing some hooks that will allow solutions to other use cases to be built on more easily in the future.

6.2 Real Estate and urban infrastructure

6.2.1 Overview

In looking at use cases, the obvious place to start is real estate within the city - the buildings and their inhabitants, the roads, along with all of the urban infrastructure - as this is the first reason why cities needed to collect geospatial data.

The city needs to be able to identify where all the buildings in the city are, who owns them and who uses them. It needs to be able to identify the boundaries of parcels of land and who has rights over the use of that land.

There are many specific use cases. For instance, when procuring work to resurface a road, it is important to know the surface area of that road so as to quantify how much tarmac will be needed to cover it, and to be able to define exactly the precise length of road that needs to be resurfaced. Defining the surface area of a road is also important when it comes to putting salt on the roads during icy weather, or using snow ploughs to clear the roads, or even cleaning up roads after a major storm from mud and debris.

Then there are all the requirements of city planning to make long term plans for the city and decide where new housing can be built, where industry should be located, and where there should be commercial offices.