

ETSI GR CIM 020 V1.1.1 (2022-12)



**Context Information Management (CIM);
NGSI-LD;
Guidelines for the deployment of Smart City
and Communities data platforms**

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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

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Executive summary

The present document presents ideas and state-of-the-art solutions, based on the NGSi-LD eco-system (specifically the NGSi-LD API in ETSI GS CIM 009 [i.2], information model in ETSI GS CIM 006 [i.3] and security and privacy in ETSI GR CIM 007 [i.4]), in the area of smart cities, i.e. the area of software platforms which, based on real-time data flows, make it possible to better manage cities and communities.

Introduction

A smart city platform helps to systematically manage and utilize various data generated in the city. It may improve the quality of life of citizens by creating new businesses and services and continuously developing the city.

Concepts like "federation", "interoperability", and "security" should be considered for smart city services. Through an NGSI-LD based smart city platform, the various data generated in the city are systematically managed, and through this, the digital industry ecosystem can be activated by creating new services and business models, or by creating added value to the existing ones.

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<https://standards.iteh.ai/catalog/standards/sist/21490fe4-4f8e-4c1c-bc24-e910a83c08c2/etsi-gr-cim-020-v1-1-1-2022-12>

1 Scope

The present document presents ideas and state-of-the-art solutions in the area of smart cities, that is in the area of software platforms which, based on (near) real-time data flows, make it possible to better manage cities and communities.

Specifically, the solutions are centred on the NGSI-LD API [i.2] and information model [i.3], as a means to achieve cross-domain interoperability among data coming from different sectors and the different (possibly pre-existing) data sources installed in public spaces, utilities and infrastructures.

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.

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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:

3D	Three Dimensional
AI	Artificial Intelligence
API	Application Programming Interface
ArcGIS	Graphical Information Software

NOTE From the organization ESRI, see <https://www.esri.com>. (2022-12)

CBAC	Context-Based Access Control
CSV	Comma Separated Value
DCAT	Data CATalogue vocabulary
DTD	Digital Twins Definition Language
EDM	Europeana Data Model

NOTE: An initiative funded since 2005 by the EU.

FTP	File Transfer Protocol
GIS	Graphical Information System
GML	Geography Markup Language
HTTP	HyperText Transfer Protocol
ICT	Information and Communications Technology
ID	IDentifier
IoT	Internet of Things
IUDX	Indian Urban Data Exchange
JSON	Java Script Notation Object
LD	Linked Data
LOD	Linked Open Data
MIM	Minimal Interoperability Mechanism(s)
MQTT	Message Queue Telemetry Transport
NGSI	Next Generation Service Interface
OASC	Open and Agile Smart Cities
OGC	Open Geospatial Consortium
OKG	Open Knowledge Graph
OWL	W3C Web Ontology Language
PDP	Policy Decision Point
PEP	Policy Enforcement Point
RBAC	Role-Based Access Control

RDBMS	Relational DataBase Management System
RDF	Resource Description Format
REST	REpresentational State Transfer
senML	Sensor Measurement Lists
SKOS	Simple Knowledge Organization System
SMS	Short Message Service
SPARQL	SPARQL Protocol and RDF Query Language
SQL	Structured Query Language,
SWS	Semantic Web Standards
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
W3C	World Wide Web Consortium
WCS	OGC Web Coverage Service
WFS	OGC Web Feature Service
WMS	OGC Web Map Service
WPS	OGC Web Processing Service

4 Basics for building a smart city platform

4.0 Introduction

To implement a data-based smart city, a software platform that can systematically manage and utilize the various kinds of data generated in the city is required. Smart city platforms process, store, and convert data collected by the city, and provide it to city services that extract useful information out of data, for example by carrying out predictive analysis based on AI. In this way, the city can provide the building blocks for various types of applications according to the emergence of information out of real-time data such as car/motor traffic volume or other data collected by new technologies. For this purpose, it is necessary to ensure a continuous data flow to the platform, and therefore data collected from various systems and domains would benefit from inter-linking.

Towards this goal, a smart city platform based on the NGSI-LD ecosystem would ensure data interoperability by using and exploiting the NGSI-LD [i.2] API and its associated, cross-domain data model [i.3] to store and deliver data.

4.1 Objectives of implementing a smart city platform

The purpose of the smart city platform is to manage urban data that provides a data-based collaboration, analysis, and decision-making environment, by establishing a real-time linkage of vast amounts of information generated by infrastructure, administration, and civil communities that make up the urban environment through the horizontal/vertical convergence of smart city technologies.

High-level objectives are summarized as follows:

- Establish an urban management model that supports the collective acquisition and sharing of information about various smart city infrastructures and urban conditions required by industry-specific services.
- Create an urban data industry ecosystem for integrated storage, analysis, and utilization of large amounts of data in collaboration with cloud infrastructures.
- Support the interoperability between different domains so that added value emerges.
- Collect city data from heterogeneous data sources such as legacy systems, IoT platforms, and GIS, in order to process, analyse, and distribute data to city services and other external systems.
- Link the data via semantic web technologies for better data usage, cost minimization for the services, and improved usability of data from various domains.

The expected features of a smart city platform are:

- Data ingestion & integration from various domains
- Cloud-based document and multimedia storages
- Assets management
- Data analysis and monitoring
- Security & Access control for users

4.2 NGSI-LD-based smart city platform architecture

The smart city platform needs to implement technologies to collect data from a variety of external platforms and convert and adapt it to already existing data models for smart cities, e.g. Smart Data Models [i.13].

Using data models which are compatible with the NGSI-LD cross-domain information model allows a high degree of data inter-linking when an NGSI-LD broker is used as the central piece of this architecture.

Various external IoT data sources (e.g. based on oneM2M), Geographical Information Systems, legacy systems, as well as other smart city platforms can be considered as input to the smart city platform, which is then implemented as a cloud-based system that collects, processes, and stores information about the various smart city infrastructures and urban situations.

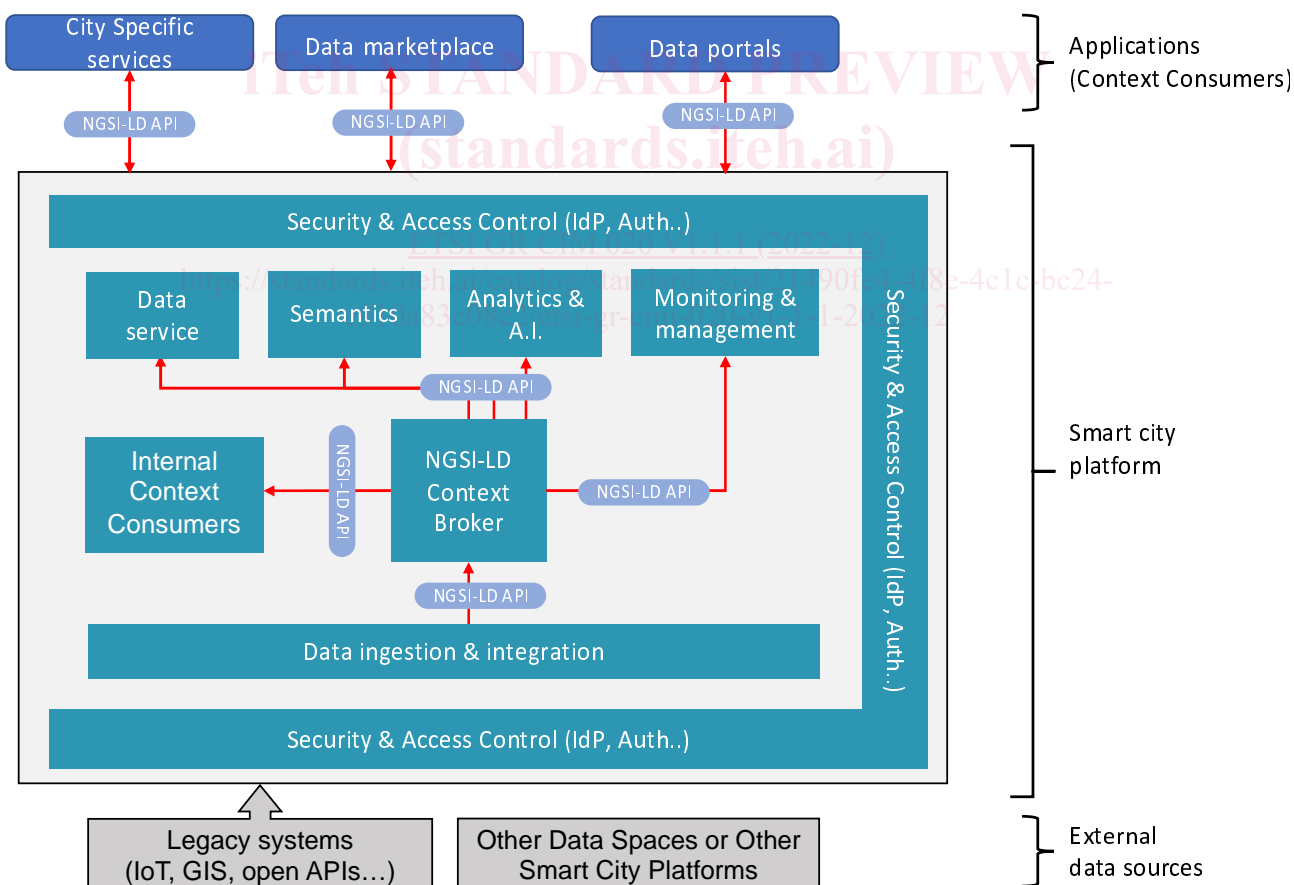


Figure 4.2-1: The structure of an NGSI-LD-based smart city platform

In Figure 4.2-1 the overall architecture of a typical smart city platform is depicted. The platform itself is represented by the middle box, which collects data from external sources and peer platforms (at the bottom, grey boxes), and feeds information to external applications on top (blue boxes).

Logical functions, the green boxes, which are part of the structure of the smart city platform are:

- **Data ingestion & integration:** collects, transform, and load heterogeneous data from several types of systems such as IoT platforms, RDBMS, and open APIs. When data needs to be transformed to fit the NGSI-LD information model used by the smart city platform, this function could be used as an adapter to load the data.
- **NGSI-LD Context Broker:** ensuring data interoperability by applying NGSI-LD API and information model to data storage and provision.
- **Semantics:** supports the construction and utilization of semantic data of the smart city platform. This function converts city data to semantic (RDF triples) data, based on smart city ontologies, to support application services such as Linked Open Data (LOD). Since new knowledge could be extracted through semantic technologies such as semantic mashup and semantic reasoning, it has a bidirectional connection with the NGSI-LD context broker. See LOD, described in clause 11.
- **Analytics & Artificial Intelligence (AI):** supports the development of a convergence analysis/prediction service of city data. This function analyses the data stored in the smart city platform and creates a machine learning model, and execution of the generated model enables the generation of prediction information. See Digital Twins for smart cities, described in clause 6.
- **Monitoring & management:** provides real-time integrated monitoring and system operation management such as public/private data and cloud management, devices and database management in the smart city platform. See clause 5.
- **Security & Access Control:** provides authentication for smart city platform users and applications, access control policy management, and access control token management functions. See Data Sovereignty, Trust and Privacy, described in clause 10.

4.3 Smart city and communities

Collaboration is the key component in a smart city with technology and citizen involvement. Because each smart city platform is different in many ways, exchanging knowledge or data and experience is necessary for smart and sustainable cities and communities. Smart cities could be smarter together and build on their strengths through sharing and reuse of resources and knowledge with communities. The city context broker could have a federated/distributed structure that is shared with other brokers, allowing distributed collection according to domains or data types such as IoT, infrastructure, and document, which it then provides the smart city services.

Figure 4.3-1 presents an example of federated context brokers. It is based on one city context broker that is federated with a set of community context brokers. The community context brokers may share (some or) all their data with the city context broker. This is according to the hierarchical relation between cities and communities. When communities are physically sharing some resources, such as a river or roads, it is possible to create a secure channel between community context brokers to partially share common data. A community context broker can, in turn, be built on a federated architecture where the sub-context broker is defined according to the dedicated domain. The federated and distributed architecture of the NGSI-LD context brokers fully supports this desired hierarchy relation between cities and communities.

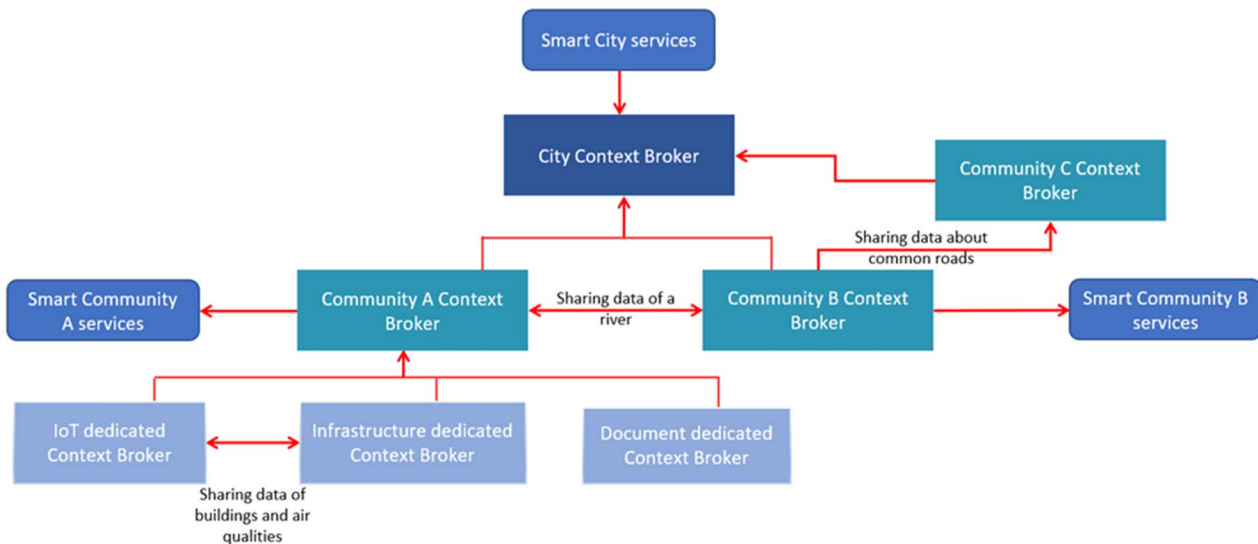


Figure 4.3-1: The distributed/federated structure of smart city and communities

A more complex approach to federation is gaining traction in the past few years, implemented in practice using the concept of a Data Space composed of many building blocks. The concept of federation needs to be augmented with Trust and Identity Providers, in order to form an effective, shared Data Space, as explained in clause 7.

4.4 Public lights in smart city example use case

This clause describes an example of the lifecycle of a public tender implemented and managed through an NGSI-LD context broker in a smart city. It details the main actions requested for a public lighting tender. Figure 4.4-1 presents an overview of how it would be possible to manage a public tender in an NGSI-LD-based city platform. The tender's life cycle progress, steps, and its projection on NGSI-LD are detailed in the following.

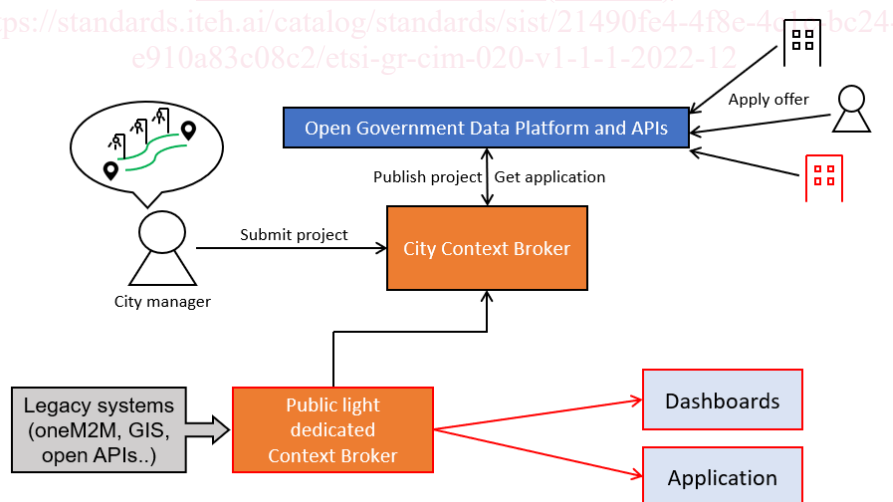


Figure 4.4-1: Scenario overview for managing a public tender in a NGSI-LD-based city platform

- Submitting the public tender on the city platform:

After agreeing on the public tender internally, the city will start by publishing it on its platform. A public tender is usually detailed by documents, objects (videos, images, etc.) and limited by deadlines. For multimedia and object storage using context brokers refer to clause 5.3. Tender metadata (short description, budget, deadline, requirement, etc.) and relations (responsible, related cities, etc.) may be modelled as NGSI-LD Properties and Relationships.