



Status of NSGI-LD API V.1.6.1 (2022-08): Context Information Management (CIM) NGSI-LD Status, Errata, Comments, Questions, + Answers, and how to join ISG CIM

NGSI-LD Status update September 2022

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Foreword

The present document is referenced in the introduction of the published ETSI GS CIM 009 specification [5] as an informative reference

“The ongoing status of the NGSI-LD API can be found in [i.17].”

whereby in section 2.2 the reference is listed as

[i.17] ETSI ISG CIM: "NGSI-LD Status".

NOTE: Available at <https://docbox.etsi.org/ISG/CIM/Open/NGSI-LD Status.pdf>

Introduction to Using this Document

You may provide the ETSI ISG CIM team with a new comment or question regarding NGSI-LD API and protocol, by please sending an email to ngsi-ld@etsi.org referencing the page and/or section number from the latest copy of the NGSI-LD API Specification (ETSI GS CIM 009) [5], as well as a snippet from the text, with your proposed changes or comment.

You may of course provide proposals for future text for the specification however direct replication of your proposal cannot be made for reasons of copyright. If you want your name or organization listed as the author of the comment then please clearly write attribution=<your-text-here> in your email.

Here is a simple example which would be easy for the NGSI-LD team to include in this “NGSI-LD Status.pdf” file for other developers to consider. The next Table 2 contains real errata.

Table 1: Template for emailing a comment/erratum to ngsi-ld@etsi.org mailing list.

Page#/ Section#	(C) Comment or (E) Erratum or (Q) Question	Who / Org.	Date
page XX, Section YY	(Q) Why don't you allow a query like "give me the sub-graph of entity ABC". See figure X.Y.Z	Mr. Fred Flintstone, CTO, Cartoon Cie	2022.09.28
790 / 4.2.2	(E) Text and figure use "MetaModel" or "Meta-Model" for same concept. See "Figure 4.2.2-1 provides a graphical representation of the NGSI-LD Meta-Model in terms of classes and their"	Mr. U.R. Wrong (Acme Inc).	2022.09.28

ETSI ISG CIM team thanks you in advance for any comments and insights!

List of Comments or Errata in NGS-LD Specification ETSI GS CIM 009

This section lists typographical corrections which have been identified in the current specification ETSI GS CIM 009 [5], without however adding or subtracting functionality. At a later time, the corrections will be applied in a minor update of the specification. You can submit errata comments by emailing information as described in the previous section. The table below will be updated as we receive input.

Table 2: List of errata and comments for latest published v1.6.1 NGS-LD API Specification [5]

Page#/Section#	(E)rratum or (C)omment	Who / Org.	Date	ISG CIM Response

Why should you use NGS-LD API?

The RESTful API and protocol NGS-LD API is designed to allow exchange of information together with the related metadata defining the meaning of the attributes and relationships involved, in both centralized and federated systems. This is very important for use cases like the ones below (see also [2]):

- Smart Cities:** Cities are systems of systems (e.g. power or water utility systems, parking notification systems, traffic control systems, waste collection and recycling systems, citizen complaints-about-services portals, etc). All these systems have some established data sources and definitions which are known to the current main users, but combining of information can be a challenge e.g. the water department may "know" there is a major leak at "pipe-join-A33742" but this may not be linked to the information "north-side of Street ABC, between D and E intersections" which might be needed by a traffic control system. NGS-LD allows publishing and linking of information across domain and administrative boundaries.
- Smart Water:** NGS-LD allows integration with existing modelling platforms like EPANET (modelling of distribution networks) with other tools for the waste water treatment or to provide the standardized data for the AI systems which provide further insights on the water management performance/planning.
- Digital Twins:** Encapsulated software models, which provide digital representations of real-world entities or systems. They are often implemented by aggregating data, forming a composite view across a number of real-world entities. Just like for Smart Cities, combining information can be challenging, and NGS-LD is often used to bring standardised access to context entities which can also act as entry points (one-stop-shop) to digital twins. It allows the traceability of the source of information and the correlation of complementary origins, to provide a more complete and robust encapsulated model.

Relationship to other SDOs (oneM2M, SAREF in TC SmartM2M, etc)

The work related to NGS-LD is by definition cutting across many technology areas and hence SDOs. Some external groups already reference NGS-LD concepts or specifications for cross-domain information exchange: e.g. Bureau of Indian Standards in June 2021.

The focus of ETSI ISG CIM is to enable exchange of information and metadata. The scope of work is "to develop for cross-domain context information management an interchange protocol between diverse systems from the IoT, Mobile Applications, Open Data Portal and proprietary database worlds". This includes municipal databases, open data portals and IoT platforms, including oneM2M. ETSI ISG CIM makes no attempt to use NGSI-LD to manage devices, gateways and networks: oneM2M has extensive specifications for doing so.

NGSI-LD is expanding potential usage of oneM2M and supporting use of ETSI SmartM2M (SAREF) work to align ontologies across many domains. Discussions are underway on how to achieve aspects of NGSI-LD functionality via the oneM2M interfaces.

Relationship to Trials and Research Projects

Real-world deployments (not RnD projects) using NGSI-LD principles and/or open-source code based on ISG CIM specifications are known to be in use at these locations (company or organisational names are redacted according to ETSI rules):

Location	Country	Topic
Bordeaux City	FR	smart-heating
India (national)	IN	IUDX National Platform for SmartCities
South Korea	KR	Smart City Data Hub
Saint Quentin	FR	Smart Irrigation
Saint Quentin	FR	Connected canteens/restaurants
Paderborn	DE	Smart City

Open-Source Implementations

Open-source code to implement (or partially implement, with intent to complete) the ISG CIM NGSI-LD specifications is provided in the following projects:

Project	Country	Website	Type
Cassiopeia	DE	https://github.com/geonet-mrn/cassiopeia-ngsi-ld-broker	light-weight NGSI-LD Broker
Cosmos	EU	https://github.com/ging/fiware-cosmos https://github.com/telefonicaid/fiware-cosmos	Big Data
Cygnus	EU	https://github.com/telefonicaid/fiware-cygnus	NGSI-LD agent
City Data Hub	KR	https://github.com/loTKETI/citydatahub_data_core_module	Broker
Draco	EU	https://github.com/ging/fiware-draco	

FIWARE IoT Agents	EU	https://github.com/FIWARE/catalogue/tree/master/iot-agents	Agents
FogFlow	EU	https://github.com/smartfog/fogflow	Orchestrates
Orion-LD	EU	https://github.com/FIWARE/context.Orion-LD	Broker
Quantum Leap	EU	https://github.com/smartsdk/ngsi-timeseries-api	Time Series
Scorpio	EU	https://github.com/ScorpioBroker/ScorpioBroker	Broker
Stellio	EU	https://github.com/stellio-hub/stellio-context-broker	Broker
Thing'In	EU	https://thinginthefuture.com/	NGSI-LD information model
VirIoT	EU	https://github.com/fed4iot/VirIoT	NGSI-LD information model and API

Data Models (based on NGSI-LD information model)

- GSMA Harmonized Entities <https://github.com/GSMADeveloper/NGSI-LD-Entities>
- Smart Data Models (FIWARE / tmforum / IUDX / OASC) <https://smartdatamodels.org/>
- SynchroniCity Data Models <https://gitlab.com/synchronicity-iot/synchronicity-data-models/>

Projects

The following table is included so that developers may locate interesting projects with the associated documentation, source codes, use cases, etc. Readers are warned that each project may implement NGSI-LD differently (or partially) and interoperability can only be tested, not assumed.

Table 4: Partial list of research projects and trials involving NGSI-LD

Project Title	Project Nr.	Zone	Website	Short description
ADEPTNESS	871319	EU	https://cordis.europa.eu/project/id/871319	Running until December 2022, systems comprise interacting digital, analog, physical, and human components engineered for function through integrated physics and logic will be investigated for a streamlined and automatic workflow. The project will explore the creation and reuse of test cases and oracles from initial phases of development. It will also detect unforeseen situations in operation to enhance development models for increasing resilience.
AutoPilot	731993	EU	http://autopilot-project.eu	AUTOPILOT was one of the European Large-Scale Pilots (LSPs), specifically Pilot 5: autonomous vehicle in a connected environment, closing in early 2020.
CEF-SALTED	2020-EU-IA-0274	EU	https://salted-project.eu/	CEF SALTED researches, develops, and provides an AI-based Data Enrichment Pipeline, creates needed AI components for Knowledge Extraction and Data Enrichment, provides the Service Infrastructure and provides enriched data as open data and publish it in the European Data Portal.

Project Title	Project Nr.	Zone	Website	Short description
City Catalyst	046119	PT	http://citycatalyst.efacec.com	City Catalyst (Catalyst for Sustainable Cities Project) runs until June 2023 to support research, development and validation, in a real context, of technological solutions and innovative services that enhance an integrated, more efficient and effective urban management, and catalyst for innovation and development. The solutions will be trialed in the cities of Porto, Aveiro, Guimarães, Famalicão and Cascais.
Smart City Data Hub		KR, EU	https://smartcity.go.kr/en	This Smart City Information System project is an online platform that is under trial in several South Korean cities. It provides a communication window for sharing knowledge and sharing various policies promoted by the public, such as smart city-related plans, smart city projects, R&D, and governance. It also aims to be an archive of past, present and future policies beyond simple policy information services.
Context-as-a-Service (CoaaS)		AUS		CoaaS allows smart connected objects providing real-time information about entities and their environment through internet-based services, to contextualize such data in order to use it effectively. Inaccurate, incomplete and difficult to interpret data is classified, annotated and semantically enriched to be fit-for-purpose.
CPaaS.io	723076	EU	https://cpaas.bfh.ch	CPaaS.io "City Platform as a Service. Integrated and Open" developed a City Platform as a Service (CPaaS) that can be federated to support regional or even global applications, and that forms the basis for a smart city data infrastructure. Technical challenges included data provenance, data quality, adaptive privacy levels, policies and adaptive processes for distributing and deploying processing intelligence to the cloud or to the edge. Other important aspects include data governance, data management and the empowerment of the citizen to control access and sharing of data about her using a MyData approach.
Cybersec4Europe	830929	EU	https://cybersec4europe.eu	Cyber security competence centres for Europe ends in July 2022. CyberSec4Europe aims to boost defences within the vertical sectors of digital infrastructure, finance, government, transport, health and smart cities. The project will utilise practical experience gained during the work to develop a specialised roadmap and recommendations for the implementation of network competence centres.
DEMETER	857202	EU	https://h2020-demeter.eu	IoT-based data analysis to improve farming: the H2020 DEMETER project runs until February 2023 and is a large-scale deployment of farmer-driven, interoperable smart farming-IoT based platforms, delivered through a series of 20 pilots across 18 countries (15 EU countries).
DIGITAL-WATER.city	820954	EU	https://www.digit-al-water.city	The DWC project ends in November 2022 and aims to promote integrated water management in urban and peri-urban areas of five big EU cities with the support of data and smart digital solutions. It will develop digital solutions to face gaps related to ICT governance, system ability and cybersecurity topics.
DomusSapiens	F/050207/01-03/X32	IT	https://www.iogr.oup.eu/en/projects/domus-sapiens/	DOMUS SAPIENS project runs until August 2021 and involves the construction of an advanced home automation system, based on innovative technologies, which allowed health monitoring and habits of users in domestic environments. The system collects and processes data through a sensors network placed inside the building and worn by people.

Project Title	Project Nr.	Zone	Website	Short description
Fed4IoT	814918	EU, JP	https://fed4iot.org	The Fed4IoT project, that ends in September 2021, addresses the interoperability issue, focusing on large scale environments by introducing novel IoT virtualization technologies at device, platform and information levels. The goal of the project is to federate IoT and Cloud Infrastructures to provide scalable and interoperable Smart Cities applications by introducing novel IoT virtualization technologies.
iFishENCI	818036	EU	http://ifishienci.eu/	iFishENCI ends in October 2022 and will deliver breakthrough innovations supporting sustainable aquaculture, based on enabling technologies and circular principles, revolutionizing global efficiency in fish production.
IoF2020	731884	EU	https://www.iof2020.eu/	Internet of Food and Farms 2020
IoTcrawler	779852	EU	https://iotcrawler.eu	IoTcrawler projects ends in April 2021, providing a search engine for IoT in an open IoT ecosystem of systems and platforms. The project spans both industry, universities and cities. Several key enablers are created: adaptive and scalable crawling, indexing, semantic data/service search and integration, privacy and security, combined with real world and large-scale enablers. This will assist us in building a new internet paradigm where not just websites are discoverable through search, but also dynamic data sources and IoT devices.
Phoenix	893079	EU	https://eu-phoenix.eu	The project PHOENIX (Adapt-&-Play Holistic cOst-Effective and user-frieNdly Innovations with high replicability to upgrade smartness of eXisting buildings with legacy equipment) runs until August 2023. The aspiration of PHOENIX project is to change the role of buildings from unorganized energy consumers to active agents orchestrating and optimizing their energy consumption, production and storage, with the goal of increasing energy performance, maximizing occupants' benefit, and facilitating grid operation.
SynchroniCity	732240	EU	https://synchronicity-iot.eu/	This was a major Large Scale Pilot across multiple cities, developing the Minimal Interoperability Mechanisms for smart cities.

Relationship to Research

The NGSI-LD API information model and specification has been discussed in over 260 research publications ([see Google Scholar](#), increased from 200 in 02/2022). Some recent examples are:

- Haghgoo, Maliheh, Ilya Sychev, Antonello Monti, and Frank HP Fitzek. "ENTIRETY—sEmanNTic pRovisioning and govErning IoT devices in smart energY domain." *SoftwareX* 18 (2022): 101081. <http://publications.rwth-aachen.de/record/844925/files/844925.pdf>
- Anam, Mamoona, D. Harikrishnan, A. Prithiviraj, R. Regin, M. Kalyan Chakravarthi, and K. Praghash. "Automation of Internet of things Using Deep Learning on the Basis of Extraction of Data." *Webology* 19, no. 1 (2022). <https://www.webology.org/data-cms/articles/20220122034057pmWEB19093.pdf>
- Palma, Raul, Ioanna Roussaki, Till Döhmen, Rob Atkinson, Soumya Brahma, Christoph Lange, George Routis, Marcin Plociennik, and Szymon Mueller. "Agricultural Information Model." In *Information and Communication Technologies for Agriculture—Theme III: Decision*, pp. 3-36. Springer, Cham, 2022. Abstract: https://link.springer.com/chapter/10.1007/978-3-030-84152-2_1
- Jeong, Seungmyeong, Seongyun Kim, and Jaeho Kim. "City Data Hub: Implementation of Standard-Based Smart City Data Platform for Interoperability." *Sensors* 20, no. 23 (2020): 7000. <https://www.mdpi.com/1424-8220/20/23/7000/pdf>
- IoF2020 - Position Paper on a Common European Data Space (8. September 2020). <https://www.iof2020.eu/press/iof2020-positionpaper-commondataspace-v04.pdf>
- Gonzalez-Gil P, Martinez JA, Skarmeta AF. Lightweight Data-Security Ontology for IoT. *Sensors (Basel)*. 2020 Feb;20(3). doi:10.3390/s20030801. PMID: 32024127; PMCID: PMC7038771. <https://europepmc.org/backend/ptpmcrender.fcgi?accid=PMC7038771&blobtype=pdf>
- J. Hernandez-Ramos, et al., "Security and Privacy in Internet of Things-Enabled Smart Cities: Challenges and Future Directions" in *IEEE Security & Privacy*, vol. no. 01, pp. 0-0, 5555. doi: 10.1109/MSEC.2020.3012353. <https://www.computer.org/csdl/api/v1/periodical/mags/sp/5555/01/09165889/1mevXDqn9ra/download-article/pdf>
- Kalatzis N, Routis G, Marinellis Y, Avgeris M, Roussaki I, Papavassiliou S, Anagnostou M. Semantic Interoperability for IoT Platforms in Support of Decision Making: An Experiment on Early Wildfire Detection. *Sensors (Basel)*. 2019 Jan 27;19(3):528. doi: 10.3390/s19030528. PMID: 30691223; PMCID: PMC6387244. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6387244/pdf/sensors-19-00528.pdf> (39MB)
- Abid, Ahmed, Charlotte Dupont, Franck Le Gall, Allan Third, and Frank Kane. "Modelling Data For A Sustainable Aquaculture." In *2019 Global IoT Summit (GloTS)*, pp. 1-6. IEEE, 2019. <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8766376>
- Cirillo F, Wu FJ, Solmaz G, Kovacs E. Embracing the Future Internet of Things. *Sensors (Basel)*. 2019 Jan;19(2) . doi:10.3390/s19020351. PMID: 30654571; PMCID: PMC6359451. <https://europepmc.org/backend/ptpmcrender.fcgi?accid=PMC6359451&blobtype=pdf>
- Andrea Detti, Giuseppe Tropea, Giulio Rossi, Juan A. Martinez, Antonio F. Skarmeta, and Hidenori Nakazato, "Virtual IoT Systems: Boosting IoT Innovation by Decoupling Things Providers and Applications Developers", *Proceedings of IEEE Global IoT Summit 2019, Aarhus, Denmark*. <https://ieeexplore.ieee.org/document/8766422>. DOI: 10.1109/GIOTS.2019.8766422.

Ongoing Work and Getting Involved

The first phase of the ETSI ISG CIM specification work was completed mid-2018. The initial cornerstone documents describing the NGSI-LD API in ETSI GS CIM 009 [1] as well as an accompanying Use Case Analysis ETSI GR CIM 002 V1.1.2 [2] and ETSI GS CIM 006 V1.1.1 Information Model [6] were published respectively in Q1 and Q2 of 2019. The latest NGSI-LD V1.6.1 is now published [5], which added several

new features such as distributed operations, concise representation, advanced notification and recording of deletions, advanced update operations, workflow for actuation and digital twins.

You can join the team by asking your organization to sign the ETSI ISG CIM Member Agreement [3] (for ETSI Members) or ETSI ISG CIM Participant Agreement [4] (for non ETSI Members) which describes copyright and IPR rules.

Additional changes are expected by end of 2022 to add extra functionality. Interworking with oneM2M platforms is being explored and practical demonstrations are under development..

All public documents are available via the “[CIM Published Deliverables](#)” link at the CIM Home page of the ETSI Portal, here: <https://portal.etsi.org/tb.aspx?tbid=854>

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[1] ETSI GS CIM 009 V1.1.1 (2019-01) “Context Information Management (CIM); NGSI-LD API” published at https://www.etsi.org/deliver/etsi_gs/CIM/001_099/009/01.01.01_60/gs_CIM009v010101p.pdf

[2] ETSI GR CIM 002 V1.1.1 (2018-09) “Context Information Management (CIM); Use Cases (UC)”. See https://www.etsi.org/deliver/etsi_gr/CIM/001_099/002/01.01.01_60/gr_CIM002v010101p.pdf

A new version of ETSI GR CIM 002 is planned to be published in December 2022. See https://portal.etsi.org/webapp/WorkProgram/Report_WorkItem.asp?WKI_ID=56428

[3] ETSI ISG CIM Member Agreement to join ETSI ISG CIM (for ETSI Members) https://etsisign.eu1.echosign.com/public/esignWidget?wid=CBFCIBAA3AAABLbqZhCITUOGMDm2GKr_Jv1oSqv9FchK0OFswaTnY3gTuzwVtk6cOBQTOv752kfuNFOwZI* available from <https://portal.etsi.org/CIM>

[4] ETSI ISG CIM Participant Agreement to join ETSI ISG CIM (for non ETSI members) https://etsisign.eu1.echosign.com/public/esignWidget?wid=CBFCIBAA3AAABLbqZhDGdnnkiv_5tj9HOSdZ0xiO_lbaDa0qOiXFoKamADRWeq4oYQAc1mfV5fNsxfIJRc* available from <https://portal.etsi.org/CIM>

[5] ETSI GS CIM 009 V1.6.1 (2022-08) “Context Information Management (CIM); NGSI-LD API” published at https://www.etsi.org/deliver/etsi_gs/CIM/001_099/009/01.06.01_60/gs_CIM009v010601p.pdf

[6] ETSI GS CIM 006 V1.1.1 (2019-07) “Context Information Management (CIM); Information Model (MOD0)” published as pdf at https://www.etsi.org/deliver/etsi_gs/CIM/001_099/006/01.01.01_60/gs_CIM006v010101p.pdf