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Context Information Management (CIM); NGSI-LD/oneM2M interworking proxy proposal

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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 [i.2], information model [i.3] and security and privacy [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

The present document aims to find candidate interworking solutions between oneM2M and NGSI-LD technologies.

oneM2M is one of the most widely used middleware platform standard for IoT/M2M devices/gateways and servers. oneM2M, as the name stands for, is the standards for communicating IoT data among IoT things and IoT applications so oneM2M provides IoT data and things related functions such as collecting IoT data, to actuating IoT things, managing IoT things. NGSI-LD is the standard focusing on exchanging data from data providers and consumers. Therefore, in NGSI-LD stand point, what kind of data to be exchanged is out of scope and it does not provide any IoT specific functions.

As stated above, two technologies have its own speciality so the present document investigates the complementary use of the two technologies as follows:

1) NGSI-LD context broker can make use of oneM2M for actuating IoT things.

2) NGSI-LD context broker can make use of oneM2M for collecting IoT data.

3) oneM2M can make use of NGSI-LD for collecting data from external systems so oneM2M applications can access that with oneM2M protocols.

4) oneM2M can make use of NGSI-LD for collecting linked data which can be leveraged with its semantic features.

In the end of 2022, there are 4 versions of oneM2M standards and compliant products in the deployments. In the case of NGSI-LD, there are release 1 compatible deployments. One important requirement for the candidate solutions in the present document is the version compatibility of any of the oneM2M and NGSI-LD standards. Therefore, the solutions do not propose any changes of features or APIs of both NGSI-LD and oneM2M specifications and use as-is features.

The scope of the present document is limited to data synchronization between oneM2M and NGSI-LD. Other interworking for example querying information of NGSI-LD context broker from oneM2M system or querying information of oneM2M system from NGSI-LD context broker is out-of-scope of the present document.

To be able to synchronize data between NGSI-LD and oneM2M, the interworking solutions relies on the oneM2M Subscription/Notification and NGSI-LD Subscription/Notification.

1 Scope

The present document provides several NGSI-LD/oneM2M interworking proxy solutions using existing oneM2M features and analyses those to find which one is suitable for a certain condition.

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 TS 118 101: "oneM2M; Functional Architecture (oneM2M TS-0001)".

[i.2] ETSI GS CIM 009 (V1.6.1): "cross-cutting Context Information Management (CIM); NGSI-LD API".

NOTE 1: The interworking scheme uses the NGSI-LD ontology (e.g. ngsi-ld:Entity) in ETSI GS CIM 009.

NOTE 2: Available at https://www.etsi.org/deliver/etsi_gs/CIM/001_099/009/01.06.01_60/gs_CIM009v010601p.pdf.

[i.3] FED4IoT project.

NOTE 2: Available at https://fed4iot.org/.

[i.4] ETSI TS 118 123 (V3.7.3): "oneM2M; Home Appliances Information Model and Mapping (oneM2M TS-0023 version 3.7.3 Release 3)".

[i.5] ETSI TS 118 104: "oneM2M; Service Layer Core Protocol Specification (oneM2M TS-0004)".

[i.6] oneM2M TR-0007 (V2.11.1): "Study of Abstraction and Semantics Enablements".

[i.7] Smart Data Models About Web Page.

NOTE: Available at: https://smartdatamodels.org/index.php/about/.

[i.8] JSONPath: Query expressions for JSON.

NOTE: Available at https://datatracker.ietf.org/doc/draft-ietf-jsonpath-base/.

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:

AE	Application Entity
API	Application Programming Interface
ASN	Application Service Node
CSE	Common Services Entity
ID	Identifier
IN	Infrastructure Node
IoT	Internet of things
IPE	Interworking Proxy Entity
JSON	JavaScript Object Notation
M2M	Machine to machine
MN	Middle Node
NGSI-LD	Next Generation Service Interface Linked Data
OWL	Web Ontology Language
RDF	Resource Description Framework
RDFS	Resource Description Framework Schema
SAREF	Smart Applications REFerence ontology
SDT	Smart Device Template
TS	Technical Specifications
URI	Uniform Resource Identifier
URL	Uniform Resource Locator

4 Architecture Model

4.1 Information Model

The notion of data synchronization between oneM2M and NGSI-LD systems can be realized by data mapping as well as interface interworking. The two standards have a different view on information and data modelling and it is important to understand this difference.

oneM2M takes two approaches regarding information models. One is the modelling and corresponding models' standardization with Smart Device Template (SDT) (ETSI TS 118 123 [i.4]). Figure 4.1-1 shows the hierarchy of SDT in oneM2M standard. It is a template to represent device and functional modules. It is a good fit for oneM2M as a model for M2M/IoT device management and data collection from devices. On the other hand, any service-specific or user-defined data can be exchanged by oneM2M platforms with <*container*> and <*contentInstance*> resources, for example. It allows flexibility to use any preferred data models for IoT services, but the downside of this is lack of data interoperability to 3rd party application providers, because there is no common, cross-domain data model.

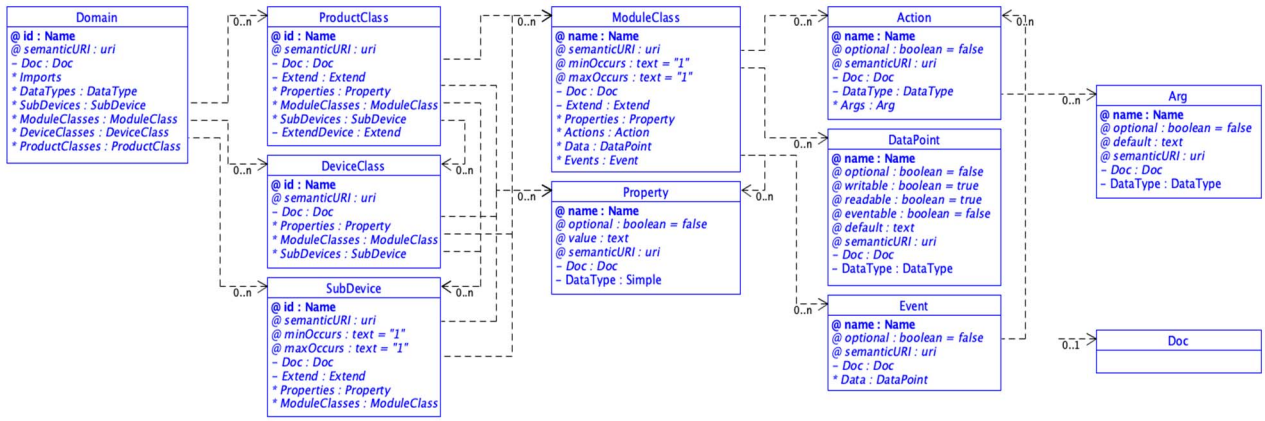

Figure 4.1-1: oneM2M Smart Device Template (SDT) [i.4]

In NGSI-LD systems, it is up to service or data providers to define their domain-specific information models. Indeed, NGSI-LD standard does not define any domain-specific information models but, instead, defines a common, cross-domain data model based on the Entity, Property and Relationship concepts that form a Property Graph. Even though there is no schemas for service implementations, by means of the Linked Data concept, each NGSI-LD Entity instance and its attributes (Properties and Relationships) can be identified uniquely, so that 3rd party application providers, willing to conform to the underlying cross-domain model, can use data from other data providers.

On top of the cross-domain model, NGSI-LD advocates for higher level models that are domain-specific, to be constructed and adopted on top of the cross-domain one, to enable full interoperability (oneM2M TR-0007 [i.6]).

4.2 Reference Model

To be able to interwork between two technologies, the application called IPE (Interworking Proxy Entity) which understands the technologies need existing.

IPE on oneM2M side, acts as Application Entity (AE) and interacts with a Common Services Entity (CSE). The CSE can be IN (Infrastructure), Middle Node (MN), or Application Service Node (ASN). Even though IPE interact with the CSE, depending on address of oneM2M resource, IPE can get or manipulate resources in other CSEs via Mcc or Mcc'.

IPE on NGSI-LD side, acts as NGSI-LD application and interacts with a NGSI-LD context broker. Even though IPE interacts with the NGSI-LD context broker, IPE can get or manipulate entities in other NGSI-LD context brokers using CSourceRegistration information.

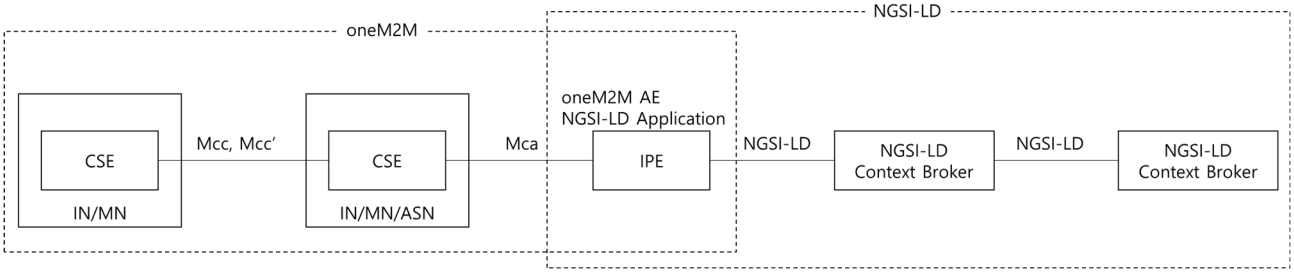

Figure 4.2-1: NGSI-LD - oneM2M Interworking Reference Model

4.3 Types of Interworking Proxy Entity

Depending on the use case, oneM2M data needs synchronizing to NGSI-LD context broker or NGSI-LD data needs synchronizing to oneM2M. Therefore, in the present document, each solution specifies direction of data synchronization.

- oneM2M to NGSI-LD: This can be used when services are already implemented and data are already being stored in oneM2M platform. The goal is for users to get data of oneM2M services using the NGSI-LD API.

- NGSI-LD to oneM2M: This can be used when device management or actuation is required from NGSI-LD enabled system (e.g. city operation centre) as well as when oneM2M applications make use of NGSI-LD data.

5 Solution 1 - labels based dynamic interworking

5.1 Introduction

Interworking between oneM2M and NGSI-LD systems requires interfaces and data mapping between the two. It is realized by the Interworking Proxy Entity (IPE) which understand two standard interfaces and application logics including data models.

The proposed interworking solution retrieves information on the interworking via labels attribute, which is the oneM2M resource universal attribute, because all oneM2M resource can have labels. This means that any of the oneM2M resource in any resource type, can be mapped with NGSI-LD Entity instances. Since NGSI-LD Entity represents a logical entity, while oneM2M resource can represent a measurement of a device, which is a small portion of a device model, NGSI-LD Entity can be mapped with one or more oneM2M resource instances.

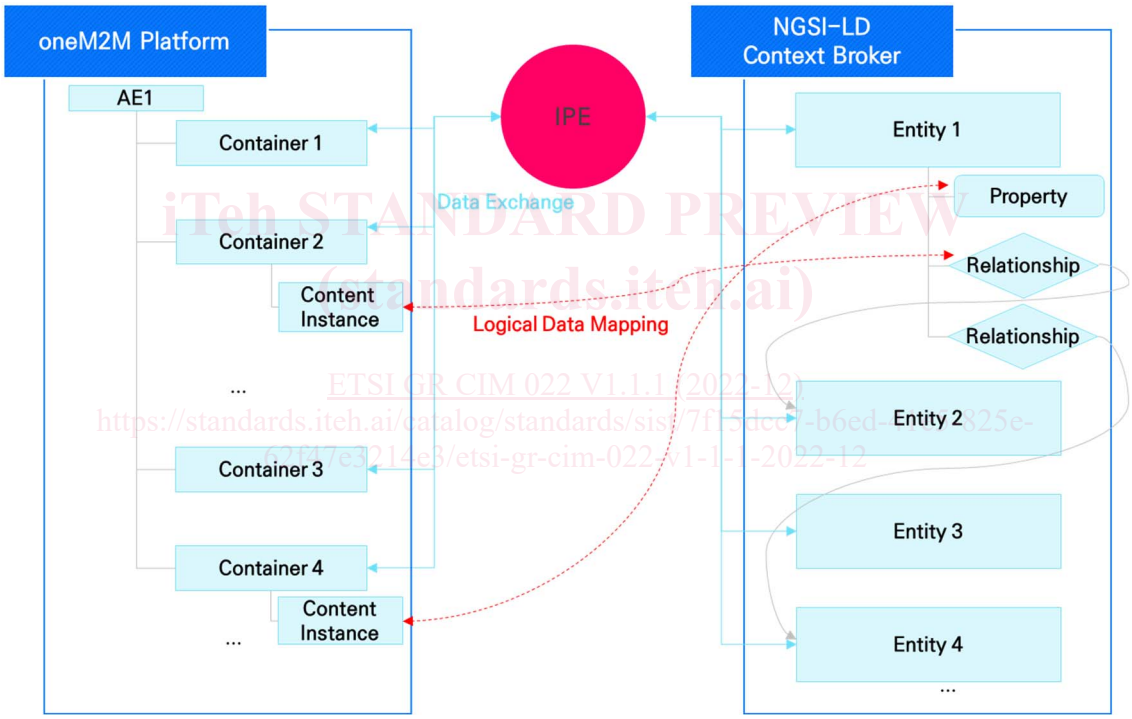

Figure 5.1-1: Example of Resource mapping between oneM2M and NGSI-LD systems

The given examples in the clause 5.1 only use <*container*> resource type from the oneM2M standard, but <*flexContainer*> or <*timeSeries*> resource types can also be applied for this label-based interworking mechanism.

5.2 oneM2M features

This solution uses labels attribute, one of the common attributes in all resource types. Normally in oneM2M labels attribute is used for discovery purposes like hash tag, but this solution uses for storing mapping rules.

Labels attribute is a list of individual labels and each of them is either a standalone label-key, used as a simple "tag", that can be used for example for discovery purposes when looking for particular resources that one can "tag" using that label-key or a composite element made of a label-key and a label-value, separated by a special character defined in ETSI TS 118 101 [i.1].

5.3 Resource mapping

In this interworking scheme, the labels attribute contains mapping information between oneM2M resources and NGSI-LD Entities. The labels attribute has string array data type in ETSI TS 118 104 [i.5], so it is proposed to use key-value pair in a single token string and there are one or more pairs in the labels attribute on the oneM2M resource instance. The keys that represent interworking information are defined in the Table 5.3-1.

Table 5.3-1: Interworking mapping labels keys

Label Key Name	Data Type	Limitation	Multiplicity	Description
Iwked-Technology	String	"NGSI-LD"	1	"NGSI-LD"
Iwked-Entity-Type	String	NGSI-LD Entity Type	0..1	Type of the NGSI-LD Entity
Iwked-mapping-rule	List of MappingRule	Mapping Rule	0..1	Data mapping rules for oneM2M resource and NGSI-LD Entities
Iwked-Entity-ID	String	n/a	0..1	The id attribute of NGSI-LD Entity instance. If not exists, it is decided by "oneM2M platform ID" + ":" + "ri of oneM2M resource"
Iwked-Related-Resources	List of String	n/a	0..1	Other oneM2M resources instances to be combined for the NGSI-LD Entity instance
NGSI-LD-Context	List of String	n/a	1	@context attribute of NGSI-LD Entity instance

Table 5.3-2 defines the Mapping Rule data type that is used by Iwked-mapping-rule.

Table 5.3-2: Data type of Mapping Rule

Name	Data Type	Limitation	Multiplicity	Description
oneM2MResourceId	String	n/a	0..1	Identifier of a oneM2M resource instance
oneM2MAttribute Name	String	n/a	1	Attribute name of the instance
oneM2MJsonPath	String	n/a	0..1	JSONPath [i.8], this is valid when the resource is serialized in JSON
oneM2MDataType	String	n/a	0..1	Data type for the attribute or the element referred by JSONPath. Allowed values are: "String", "Integer", "Double", "Boolean", "Date", "ArrayString", "ArrayInteger", "ArrayDouble", or "ArrayBoolean"
ngsi-ldQueryTermAttributePath	String	n/a	0..1	Attribute or element of Attribute referred by QueryTerm in Query Language [i.2]
ngsi-ldAttributeType	List of String	"Property" or "Relationship"	1	Type of NGSI-LD attribute
ngsi-ldAttribute DataType	List of String	n/a	1	Data type of ngsi-ldQueryTermAttributePath. Allowed values are: "String", "Integer", "Double", "Boolean", "Date", "ArrayString", "ArrayInteger", "ArrayDouble", or "ArrayBoolean"
ngsi-ldAttribute ParentInformation	Array of ParentInformation	n/a	0..1	Since there is no schema information of the NGSI-LD Entity, information on parent attributes is required

Name	Data Type	Limitation	Multiplicity	Description
oneM2MArrayIndex	Integer	n/a	0..1	Indicates an index of an array item. This is valid when oneM2MDataType is in array
ngsi-ldArrayIndex	Integer	n/a	0..1	Indicates an index of an array item. This is valid when Ngsi-ldAttributeDataType is in array

Table 5.3-3 defines the ParentInformation data type introduced in Table 5.3-2.

Table 5.3-3: Data type of ParentInformation

Name	Data Type	Limitation	Multiplicity	Description
ngsi-ldQueryTermAttributePath	String	n/a	1	Attribute of QueryTerm in Query Language
ngsi-ldAttributeType	String	"Property" or "Relationship"	1	Type of NGSI-LD attribute

5.4 Procedures

5.4.1 Pre-configuration

An NGSI-LD system user updates the labels attribute with mapping information as specified in clause 5.3. It is iterated for all the oneM2M resources for NGSI-LD Entity mapping.

5.4.2 IPE initialization

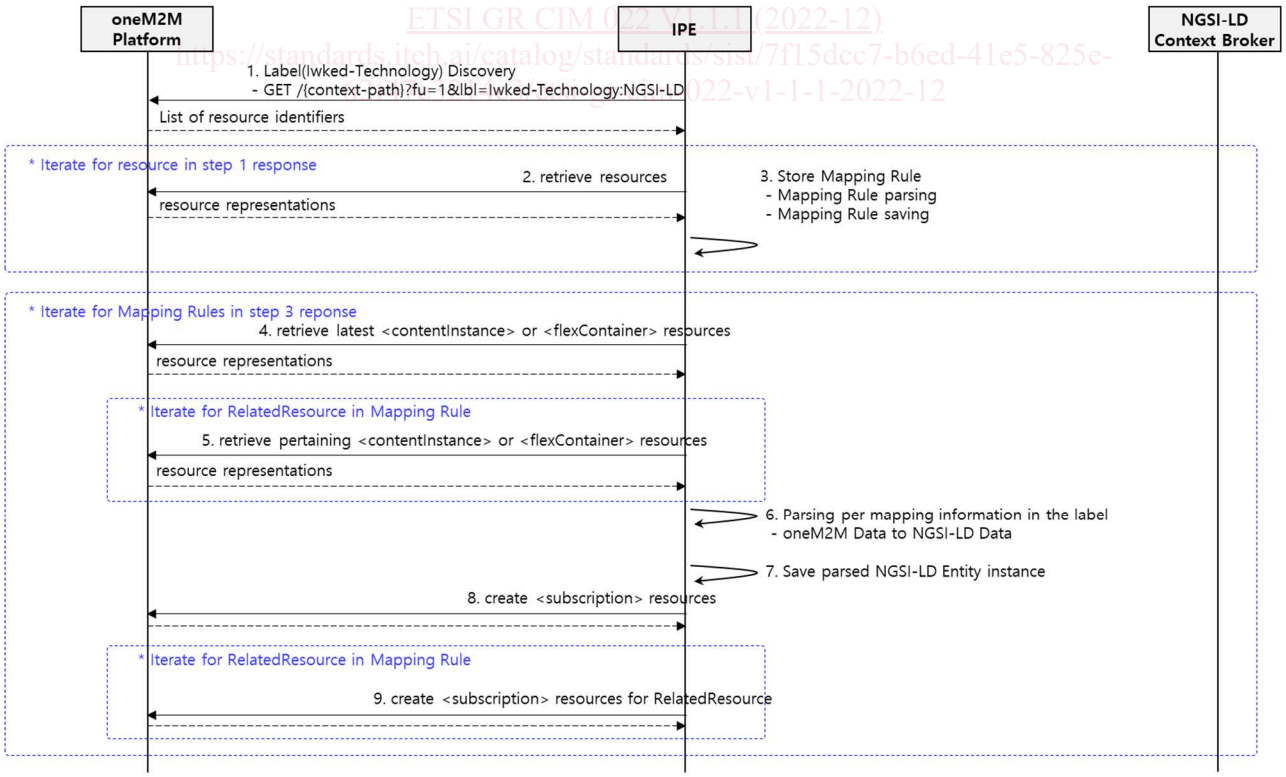

Figure 5.4.2-1: Procedures for IPE initialization

Step 1. IPE discovers <*container*> and <*flexContainer*> resource identifiers which contains the interworking information in the labels attribute.