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**GROUP REPORT**

## Context Information Management (CIM); NGSI-LD Primer

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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 (this "Primer") is intended to give developers an introduction on how the NGSI-LD API is used. The aim is to give developers, especially to those building applications and services on top of the NGSI-LD API, an easy start by explaining the NGSI-LD API based on typical examples. For illustration purposes a scenario is introduced, for which the information is modelled according to the NGSI-LD information model. Examples for providing information, i.e. creating, updating and deleting information, and for requesting information, i.e. synchronous queries as well as asynchronous subscribe/notify interactions, are given. The focus is on typical usage rather than on completeness of all features.

# Introduction

While ETSI GS CIM 009 [i.1] provides the complete specification of the NGSI-LD API, the present document, called "Primer", is intended to give users an introduction to the use of the NGSI-LD API. The idea is to take a simple scenario, i.e. a store that sells products to customers, for illustration purposes and show typical NGSI-LD API operation examples. The examples for information provision show how entities, properties and relationships can be created, updated, appended and deleted. The examples for information consumption show how entities can be synchronously queried, filtered according to property values or filtered according to geographical location using geographic queries. Finally change-based and time-based subscriptions are introduced and how these create asynchronous subscriptions depending on a change-based or time-based trigger.

# 1 Scope

The present document provides an introduction, in particular for developers, on how the NGSI-LD API, defined in ETSI GS CIM 009 [i.1], is used. The focus is on typical use and is based on a small NGSI-LD information model example. More information about the NGSI-LD information model can be found in ETSI GR CIM 002 [i.2].

# 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 009: "Context Information Management (CIM); NGSI-LD API".

[i.2] ETSI GR CIM 002: "Context Information Management (CIM); Use Cases (UC)".

[i.3] IETF RFC 3986: "Uniform Resource Identifier (URI): Generic Syntax".

NOTE: Available at https://tools.ietf.org/html/rfc3986.

[i.4] IEEE POSIX 1003.2™-1992: "IEEE Standard for Information Technology - Portable Operating System Interfaces (POSIX®) - Part 2: Shell and Utilities".

[i.5] IETF RFC 7946: "The GeoJSON Format".

NOTE: Available at https://tools.ietf.org/html/rfc7946.

# 3 Definition of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in ETSI GS CIM 009 [i.1] and the following apply:

NOTE: The letters "NGSI-LD" were added to most terms to confirm that they are distinct from other terms of similar/same name in use in other organizations, however, in the present document the letters "NGSI-LD" are generally omitted for brevity.

**NGSI-LD Attribute:** reference to either the name of an NGSI-LD Property or to the name of an NGSI-LD Relationship

**NGSI-LD Central Broker:** NGSI-LD Context Broker that only uses a local storage when serving NGSI-LD requests, without involving any external Context Sources

**NGSI-LD Context Broker:** architectural component that implements all the NGSI-LD interfaces

**NGSI-LD Context Consumer:** agent that uses the query and subscription functionality of NGSI-LD to retrieve context information

**NGSI-LD Context Producer:** agent that uses the NGSI-LD context provision and/or registration functionality to provide or announce the availability of its context information to an NGSI-LD Context Broker

**NGSI-LD Entity:** informational representative of something that is supposed to exist in the real world, physically or conceptually

> NOTE: In the NGSI-LD API, any instance of such an entity is **uniquely identified by a URI**, and characterized by reference to one or more **NGSI-LD Entity Type(s)**. The API defined by the present document only allows associating one NGSI-LD Entity Type per NGSI-LD Entity. This restriction will be removed in future versions.

**NGSI-LD Entity Type:** categorization of an NGSI-LD Entity as belonging to a class of similar entities, or sharing a set of characteristic properties

> NOTE: In the NGSI-LD API, an NGSI-LD Entity Type is **uniquely identified by a URI**.

> EXAMPLE 1: "Vehicle" is an NGSI-LD Entity Type and is identified with a proper URI.

> EXAMPLE 2: Bob's private car whose plate number is "ABCD1234" is an NGSI-LD Entity whose NGSI-LD Entity Type Name is "Vehicle".

**NGSI-LD Linked Entity:** NGSI-LD Entity referenced from another NGSI-LD Entity (the linking NGSI-LD Entity) via an NGSI-LD Relationship

**NGSI-LD Linking Entity:** NGSI-LD Entity which is the subject of a Relationship to another NGSI-LD Entity (the linked NGSI-LD Entity) or an external resource (identified by a URI)

**NGSI-LD Name:** short-hand string (term) that locally identifies an NGSI-LD Entity Type, Property Type or Relationship Type and which can be mapped to a URI which serves as a fully qualified identifier

> EXAMPLE: The sentence "Bob's vehicle's speed is 40 km/h" can be represented by an NGSI-LD Property, whose Name is "speed", and which characterizes an NGSI-LD Entity, which NGSI-LD Type Name is "Vehicle". Such a name can be expanded to a fully qualified name in the form of a URI, for instance "http://example.org/Vehicle" or "http://example.org/speed".

**NGSI-LD Property:** description instance which associates a main characteristic, i.e. an **NGSI-LD Value**, to either an NGSI-LD Entity, an NGSI-LD Relationship or another NGSI-LD Property and that uses the special *hasValue* property to define its target value

**NGSI-LD Relationship:** description of a directed link between a subject which is either an NGSI-LD Entity, an NGSI-LD Property, or another NGSI-LD Relationship on one hand, and an object, which is an NGSI-LD Entity, on the other hand, and which uses the special *hasObject* property to define its target object

> EXAMPLE: An NGSI-LD Entity of type (Type Name) "Vehicle" (when parked) can be the subject of an NGSI-LD Relationship which object is an NGSI-LD Entity of type "Parking".

**NGSI-LD Value:** JSON value (i.e. a string, a number, true or false, an object, an array), or a JSON-LD typed value (i.e. a string as the lexical form of the value together with a type, defined by an XSD base type or more generally an IRI), or a JSON-LD structured value (i.e. a set, a list, a language-tagged string)

> EXAMPLE: Bob's private car 'speed' NGSI-LD Value is the number 100 (kilometres per hour).

## 3.2     Symbols

Void.

## 3.3      Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS CIM 009 [i.1] and the following apply:

| | |
|---|---|
| API | Application Programming Interface |
| HTTP | Hypertext Transfer Protocol |
| IETF | Internet Engineering Task Force |
| IoT | Internet of Things |
| IRI | Internationalized Resource Identifier |
| ISG | Industry Specification Group |
| JSON | JavaScript Object Notation |
| JSON-LD | JSON Linked Data |
| NGSI | Next Generation Service Interfaces |
| NGSI-LD | NGSI Linked Data |
| POSIX | Portable Operating System Interface |
| RFC | Request For Comments |
| URI | Uniform Resource Identifier |
| URL | Universal Resource Locator |

# 4        Motivation and an Example Use Case

The concept of entity is at the core of the NGSI-LD model. Entities represent physical or conceptual objects existing in the real world. Entities can have properties describing aspects of the object the entity stands for and relationships to other entities. What kind of properties entities and relationships have is determined by the entity type?

As example use case, the present document is using a system for managing context information related to grocery stores as depicted in Figure 4.1. It shows two instances of grocery store "6-Stars" and "Checker Market" with its location depicted on a map, a product "Wine" and a customer "Paul".
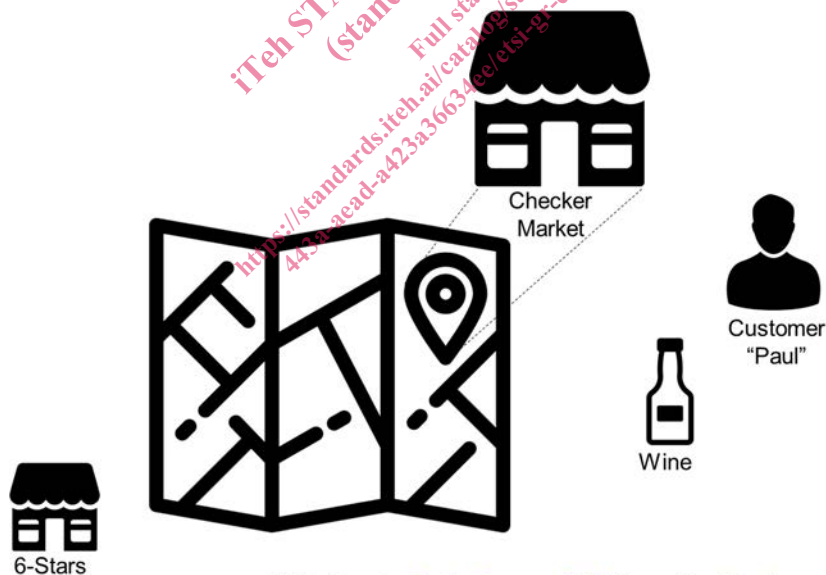


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**Figure 4.1: Grocery store use case example**

The entity types used in the example are Store, Customer, Shelf, Inventory item and Product. Figure 4.2 shows the entity types together with the properties and relationships that instances of the respective entity type can have. As a convention for this example, properties are defined as nouns, whereas relationships are defined as verbs. (The use of this convention is not a requirement of NGSI-LD).

**Store**
- Name
- Postal Address
- Geographic Location
- contains (Shelf)

**Customer**
- Name
- Postal Address
- has Visited (Store)
- has Purchased (Product, at Store)

**Shelf**
- Location
- Max Capacity
- is Contained In (Store)
- holds (Inventory Item)

**Inventory item**
- Stock Count
- Shelf Count
- relates To (Product)
- is Held In (Shelf)
- is Inventory Of (Store)

**Product**
- Name
- Price
- Size

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**Figure 4.2: Entity types, relationships and properties of use case**

# 5      NGSI-LD Getting Started

## 5.1     Introduction

The purpose of clause 5 is to give a first introduction to the NGSI-LD representation and API operations using the HTTP binding. The examples can be used in an HTTP client (e.g. Postman or curl), targeting an NGSI-LD implementation, i.e. an NGSI-LD Context Broker.

## 5.2     Architectural Assumptions

NGSI-LD defines an API together with an underlying information model. It does not define a specific system architecture, but instead it is envisioned that the NGSI-LD API can be used in different architectural settings and the architectural assumptions of the API are kept to a minimum. For the following examples, the present document is using the simplest architectural setup, i.e. a centralized NGSI-LD Context Broker that stores all information. The resulting architecture is depicted in Figure 5.1 and requires a certain subset of NGSI-LD operations that are introduced in clauses 5, 6, 7, 8, 9 and 10.
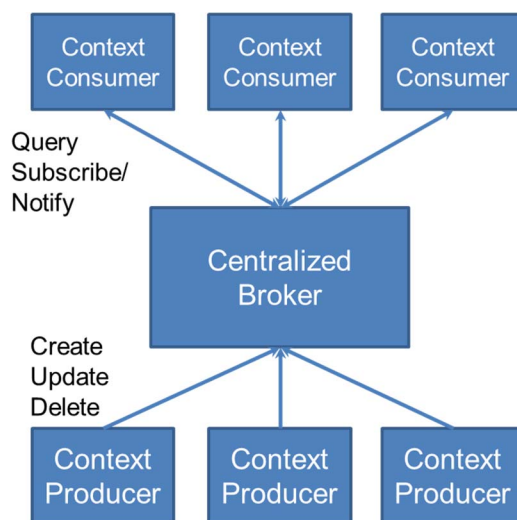
**Figure 5.1: Basic architectural assumptions**

The roles in this setup are Context Producers, Context Consumers and a Centralized Broker. The assumption is that the Centralized Broker stores all information. Context Producers manage information, i.e. create, update and delete it, whereas Context Consumers synchronously query information or subscribe to information to be asynchronously notified. In the following, the assumption is that the Centralized Broker exposes the NGSI-LD API on `localhost:9090`. Context Producers and Context Consumers are roles. The same software program can have both roles at the same time, i.e. manage and request information.

It is planned to introduce more advanced architectural options in a future version of this Primer.

## 5.3      Creating NGSI-LD Entities and Properties

As entities are at the core of NGSI-LD, the following HTTP request creates a store entity with the id `urn:ngsi-ld:Store:001` of type `Store` (mapped to `https://uri.etsi.org/ngsi-ld/primer/Store`) in `@context`, the properties `address` and `storeName` and the GeoProperty `location` (all mapped to the respective URI concepts in `@context`).

```
POST /ngsi-ld/v1/entities/ HTTP/1.1
Host: localhost:9090
Content-Type: application/ld+json

{
    "@context": [
        {
            "Store": "https://uri.etsi.org/ngsi-ld/primer/Store",
            "address": "https://uri.etsi.org/ngsi-ld/primer/address",
            "storeName": "https://uri.etsi.org/ngsi-ld/primer/storeName",
            "streetAddress": "https://uri.etsi.org/ngsi-ld/primer/streetAddress",
            "addressRegion": "https://uri.etsi.org/ngsi-ld/primer/addressRegion",
            "addressLocality": "https://uri.etsi.org/ngsi-ld/primer/addressLocality",
            "postalCode": "https://uri.etsi.org/ngsi-ld/primer/postalCode"
        },
            "https://uri.etsi.org/ngsi-ld/v1/ngsi-ld-core-context.jsonld"
    ],
    "id": "urn:ngsi-ld:Store:001",
    "type": "Store",
    "address": {
        "type": "Property",
        "value": {
            "streetAddress": "Main Street 65",
            "addressRegion": "Metropolis",
            "addressLocality": "Duckburg",
            "postalCode": "42000"
        }
    },
    "location": {
        "type": "GeoProperty",
        "value": {
            "type": "Point",
```

```
            "coordinates": [57.4874121, -20.2845607]
        }
    },
    "storeName": {
        "type": "Property",
        "value": "Checker Market"
    }
}
```

**Figure 5.2: NGSI-LD entity creation**

If the creation was successful, the response in Figure 5.3 with HTTP return code 201 Created is returned.

```
HTTP/1.1 201 Created
Date: Wed, 03 Apr 2019 15:08:33 GMT
location: /ngsi-ld/v1/entities/urn:ngsi-ld:Store:001
```

**Figure 5.3: NGSI-LD entity creation result**

NGSI-LD defines the three special properties `location`, `observationSpace` and `operationSpace` as `GeoProperty`. A GeoProperty encodes a geographical location in GeoJSON format. A GeoProperty can be used for the scope of geographic queries, whereby the API specification requires that such queries will only return results based on that scope.

# 5.4 Retrieving NGSI-LD Entities and Properties

Now that the store entity with the id `urn:ngsi-ld:Store:001` has been created, it can be retrieved. The request is shown in Figure 5.4 and the successful result in Figure 5.5. Note that since no @context was provided in the request, only the core context is returned, whereas all user-defined aspects are returned with fully qualified names. How to provide the @context in requests without body is presented in clause 8.

```
GET /ngsi-ld/v1/entities/urn:ngsi-ld:Store:001 HTTP/1.1
Host: localhost:9090
Accept: application/ld+json
```

**Figure 5.4: NGSI-LD entity retrieval**

```
HTTP/1.1 200 OK
Date: Wed, 03 Apr 2019 15:50:09 GMTContent-Type: application/ld+json

{
  "id" : "urn:ngsi-ld:Store:001",
  "type" : "https://uri.etsi.org/ngsi-ld/primer/Store",
  "location" : {
    "type" : "GeoProperty",
    "value" : {
      "type" : "Point",
      "coordinates" : [ 57.4874121, -20.2845607 ]
    }
  },
  "https://uri.etsi.org/ngsi-ld/primer/address" : {
    "type" : "Property",
    "value" : {
      "https://uri.etsi.org/ngsi-ld/primer/addressLocality" : "Duck Village",
      "https://uri.etsi.org/ngsi-ld/primer/addressRegion" : "Metropolis",
      "https://uri.etsi.org/ngsi-ld/primer" : "42000",
      "https://uri.etsi.org/ngsi-ld/primer" : "Main Street 65"
    }
  },
  "https://uri.etsi.org/ngsi-ld/primer/storeName" : {
    "type" : "Property",
    "value" : "Checker Market"
  },
  "@context" : [ "https://uri.etsi.org/ngsi-ld/v1/ngsi-ld-core-context.jsonld" ]
}
```

**Figure 5.5: NGSI-LD entity retrieval result**