ETSI TR 103 506 V1.1.1 (2018-09)

SmartM2M;
SAREF extension investigation;
Requirements for Smart Cities

Reference

DTR/SmartM2M-103506

Keywords

IoT, oneM2M, ontology, SAREF, semantic, smart city

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:
http://www.etsi.org/standards-search

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the only prevailing document is the print of the Portable Document Format (PDF) version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx

If you find errors in the present document, please send your comment to one of the following services:
https://portal.etsi.org/People/CommiteeSupportStaff.aspx

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Smart Machine-to-Machine communications (SmartM2M).

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).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document specifies the requirements for an initial semantic model for the smart cities domain based on a limited set of use cases and from available existing data models. The present document has been developed in close collaboration with AIOTI, the H2020 Large Scale Pilots and with ETSI activities in the smart cities domain. Further extensions are envisaged in the future to cover different aspects in the smart cities domain, for example focusing in public equipment. The associated ETSI TS 103 410-4 [i.9] will define the ontology extension (i.e. the semantic model) for the smart cities domain based on the requirements and use cases specified in the present document.

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] European Commission and TNO: "Smart Appliances REFerence ontology (SAREF)", April 2015.

NOTE: Available at http://ontology.tno.nl/saref.

[i.2] European Commission and TNO: "D-S4 Final Report - SMART 2013-0077 - Study on Semantic Assets for Smart Appliances Interoperability", March 2015.

NOTE: Available at https://sites.google.com/site/smartappliancesproject/documents.

[i.3] ETSI TS 103 264 (V2.1.1) (03-2017): "SmartM2M; Smart Appliances; Reference Ontology and oneM2M Mapping".

[i.4] ETSI TR 103 411 V1.1.1 (2017-02): "SmartM2M; Smart Appliances; SAREF extension investigation".

[i.5] ETSI TS 103 410-1: "SmartM2M; Smart Appliances Extension to SAREF; Part 1: Energy Domain".

[i.6] ETSI TS 103 410-2: "SmartM2M; Smart Appliances Extension to SAREF; Part 2: Environment Domain".

[i.7] ETSI TS 103 410-3: "SmartM2M; Smart Appliances Extension to SAREF; Part 3: Building Domain".

[i.8] AIOTI WG08 - Smart Cities: "Smart City Replication Guidelines. Part 1: Cross-Domain/Application Use Cases". Version 1.0. June 2018.

NOTE: Available at https://aioti.eu/aioti-wg08-report-on-smart-cities/.

[i.9] ETSI TS 103 410-4: "SmartM2M; Extension to SAREF; Part 4: Smart Cities Domain".

[i.10] oneM2M TS-0012 (V3.7.1): "Base Ontology".

[i.11] OGC City Geography Markup Language (CityGML) Encoding Standard V2.0.

NOTE 1: CityGML is available at http://www.opengeospatial.org/standards/citygml.

NOTE 2: OGC CityGML open standardized data model for digital 3D models of cities and landscapes is available at https://www.citygml.org/about/.

[i.12] AENOR UNE 178301:2015: "Smart Cities. Open Data".

NOTE: Available at https://www.aenor.com/normas-y-libros/buscador-de-normas/une?c=N0054318.

[i.13] ISO 37120:2018: "Sustainable cities and communities -- Indicators for city services and quality of life".

NOTE: Available at https://www.iso.org/standard/68498.html.

[i.14] ISO/IEC 30182:2017: "Smart city concept model -- Guidance for establishing a model for data interoperability".

NOTE: Available at https://www.iso.org/standard/53302.html.

[i.15] ETSI GR CIM 002: "Context information Management (CIM); Use Cases (UC)".

NOTE: Draft and further publication status to be checked at https://portal.etsi.org/webapp/workProgram/Report_WorkItem.asp?wki_id=51347.

[i.16] Draft GeoSPARQL standard proposed by Open Geospatial Consortium.

NOTE: Available at http://www.opengis.net/ont/geosparql.

[i.17] ITU-T Recommendation Y.4903/L.1603 (10/2016): "Evaluation and assessment Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals".

NOTE: Available at http://handle.itu.int/11.1002/1000/12884.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

ontology: formal specification of a conceptualization, used to explicit capture the semantics of a certain reality

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AENOR	Asociación Española de Normalización (Spanish Association for Standardization)
AIOTI	Alliance for the Internet Of Things Innovation
CIM	Cross-cutting Context Information Management
CTN	Comité Técnico de Normalización
EU	European Union
FEMP	Federación Española de Municipios y Provincias (Spanish Federation of Municipalities and Provinces)
GPS	Global Positioning System
IEC	International Electrotechnical Commission
IoT	Internet of Things
ISA	Interoperability Solutions for European Public Administrations
ISG	Industry Specification Group
ISO	International Organization for Standardization
ITU-T	International Telecommunication Union - sector Telecommunication

KPI	Key Performance Indicator
MDR	Metadata Registry
OGC	Open Geospatial Consortium
PM	Particulate Matter
SAREF	Smart Appliances REFerence ontology
SAREF4CITY	SAREF extension for Smart Cities
SCCM	Smart City Concept Model
SKOS	Simple Knowledge Organization System
STF	ETSI Specialist Task Force
TNO	Netherlands Organization for Applied Scientific Research
TR	Technical Report
TS	Technical Specification
UC	Use Case
UNE	Una Norma Española (Spanish Standardization Association)
WG	Working Group
WGS84	World Geodetic System 1984

4 SAREF extension for the Smart City domain

SAREF [i.1] is a reference ontology for IoT created in close interaction with the industry during a study requested by the European Commission in 2015 [i.2] and subsequently transferred into ETSI TS 103 264 [i.3]. SAREF contains core concepts that are common to several IoT domains and, to be able to handle specific data elements for a certain domain, dedicated extensions of SAREF can be created. Each domain can have one or more extensions, depending on the complexity of the domain. As a reference ontology, SAREF serves as the means to connect the extensions in different domains. The earlier document ETSI TR 103 411 [i.4] specifies the rationale and methodology used to create, publish and maintain the SAREF extensions.

The present document specifies the requirements for an initial SAREF extension for the smart city domain based on a limited set of use cases and from available existing data models. The present document has been developed in the context of the STF 534 (https://portal.etsi.org/STF/STFs/STFHomePages/STF534.aspx), which was established with the goal to create SAREF extensions for the domains of Smart Cities, Smart Industry & Manufacturing, and Smart AgriFood. The STF 534 follows the outcomes of the earlier STF 513, which developed an updated SAREF specification [i.3] and the first extensions of SAREF in the energy [i.5], environment [i.6] and building [i.7] domains. The STF 534 consists of the following two main tasks:

1) gather requirements, collect use cases and identify existing sources (e.g. standards, data models, ontologies, etc.) from the domains of interest (i.e. Smart Cities, Smart Industry & Manufacturing, and Smart AgriFood); and

2) produce extensions of SAREF for each domain based on these requirements.

The present document focuses on the extension of SAREF for the smart cities domain, which will result in a new ontology, called SAREF4CITY, to be published in the companion ETSI TS 103 410-4 [i.9] as part of the SAREF extensions series ETSI TS 103 410 [i.5], [i.6] and [i.7].

5 Related initiatives

In this clause, some of the main related initiatives in terms of modelling and standardization in the smart cities domain are reviewed. Existing efforts range from national or international norms to rather specific models used in certain software solutions. Therefore, the potential stakeholders identified for this SAREF extension might be classified as: public administrations, associations related to the Internet of Things and Smart Cities, European projects, platforms for IoT data processing, and standardization bodies. For each type of stakeholder, the initiatives that have been taken into account are described next.

- **Standardization bodies:**
  - **oneM2M:** oneM2M is devoted to the development of technical specifications for M2M solutions related to the service layer which can be combined with existing hardware and software solutions. The main goal of the organization is to attract and involve organizations in domains such as telematics and intelligent transportation, healthcare, utilities, industrial automation, or smart homes, among others. oneM2M prepares, approves and maintains technical specifications and reports for use cases, service layer aspects, protocols, APIs, interoperability, data collection, and many other aspects of the M2M domain. The **oneM2M base ontology** [i.10] is the minimal ontology that enables achieving interoperability among organizations.
  - **OGC (Open Geospatial Consortium):** The OGC is an international organization devoted to the development of quality open standards for the global geospatial community. It includes different member types such as governments, commercial organizations, NGOs, or academic and research organizations. One of the standards developed by the OGC is **CityGML** [i.11], which consists of a model and SML-based format for the exchange and storage of virtual 3D models. In addition, OGC provides a standard model, **GeoSPARQL**, which supports the representation and querying of geospatial data based on semantic web technologies.
  - **AENOR CTN 178:** The Spanish Association for Standardization and Certification (AENOR, or UNE since 2017), is a private non-profit organization founded in 1986. AENOR published in 2015 the **UNE 178301:2015** [i.12]. The norm is intended to measure the maturity level of open data projects for smart cites, easing its development and deployment. The city-related domains considered in the norm are: business catalogue; cultural agenda; population; air quality; contracts, public procurement, and service providers; municipal budget and budget execution; public park loads; bus timetable, line, stops and fares; traffic; touristic places; and city street guide.
  - **ISO (International Organization for Standardization):** The ISO is a worldwide federation of national standardization bodies dedicated to develop international standards through technical committees specialized in a particular field. In 2014, ISO published the standard **ISO 37120:2018** [i.13], which establishes definitions and methodologies for indicators for city services and quality of life. This standard allows measuring the performance of any city, municipality or local government in a comparable and verifiable manner. In 2017, ISO in liaison with **IEC** (the International Electrotechnical Commission) published the standard **ISO/IEC 30182:2017** [i.14]. The Smart City Concept Model (SCCM) defines concepts and relationships that can be used to describe data from a smart city in order to facilitate interoperability.

- **Associations:**
  - **AIOTI:** The Alliance for Internet of Things Innovation, founded by the European Commission in 2015, consists of thirteen working groups; one of them is dedicated to Smart Cities, namely the WG08. This group focuses on IoT solutions to enhance city performance, safety and wellbeing, cost reduction and increase citizen engagement and active participation. The group has an interest in city-related sectors like transport, energy, healthcare, lighting, water, and waste, among others.
  - **FEMP (Federación Española de Municipios y Provincias):** The Spanish Federation of Municipalities and Provinces has recently published a guide for smart city open data publication that included the participation of around 40 representatives, from 8 different municipalities, as well as researchers and other bodies like organizations for open data, open participation and transparency in cities. In addition, the list of local entities supporting transparency and citizen participation includes 222 local entities from all the Spanish geography. The city-related domains for which the FEMP proposes datasets or vocabularies, and which extend the AENOR CTN 178 ones, are: municipal agenda; activities and events; public park loads; warnings, suggestions and complaints; public bikes; air quality; city street guide; census of premises, activities, terraces, restaurants and opening licenses; acoustic pollution; contracts, public procurement, and service providers; agreements; public debt; municipal equipment; traffic; sport equipment; touristic places; population; municipal budget and budget execution; public WiFi points and public transport.

- **IoT Platforms:**
    - **FIWARE:** FIWARE is software platform for smart cities to develop smart applications in multiple vertical sectors. FIWARE provides data models for the following domains: alarm; environment; civic issue tracking; device; indicator (KPI); parking; park and garden; point of interest; street lighting; transportation; waste management; and weather.

- **European projects and initiatives:**
    - **ISA^2:** ISA^2 is a European programme for supporting the development of digital solutions that benefit from interoperable cross-border and cross-sector public services. This programme started the 1st of January 2016 and is planned to run until the 31st of December 2020. One of the solutions provided by this programme is a set of core vocabularies which are simplified, re-usable and extensible data models for capturing fundamental characteristics of entities. The core vocabularies developed by the time of writing this document are: Core Person, Registered Organization, Core Location, Core Public Service, Core Criterion and Core Evidence, Core Public Organization, and Core Public Event Vocabulary. Such vocabularies are published under the **Joinup** initiative that is part of the ISA^2 programme (https://joinup.ec.europa.eu/collection/semantic-interoperability-community-semic/core-vocabularies). The Joinup action is, more precisely, a European collaborative platform and catalogue where the core vocabularies are hosted.
    - **ESPRESSO:** The ESPRESSO H2020 project analysed different sectorial systems in order to develop a conceptual Smart City Information Framework based on open standards. The project analysed the core vocabularies for smart cities, which enable cities and stakeholders to share data in an interoperability way in different smart city sectors.
    - **VICINITY:** The VICINITY H2020 project will build and demonstrate a platform and ecosystem that provides "interoperability as a service" for infrastructures in the Internet of Things. The approach is bottom-up, decentralized, user-centric, and involving standardization without relying on a single standard. Different smart city domains are involved in the VICINITY pilots, such as buildings, energy, transport, and health.

6 Use cases

6.1 Use case 1: eHealth and Smart Parking

Caring of an aging population is one of the major challenges of the future of healthcare. An important step is the need to move from institutional care to assisted-living at home, in particular for elderly people living alone and for people with long-term needs and chronical illness (such as people with hypertension, dementia, or obesity). Electronic medical care services enable these people to obtain a better quality and independent life.

By making use of different IoT data coming from monitoring equipment, wearables and building sensors, the goal of the use case is, on the one hand, to provide assisted living to elderly people and people with long-term needs and, on the other hand, to support middle-aged municipal citizens to change their everyday way of living and habits to obtain a better quality and independent life. Actors in this use case include not only the monitored people and their close circle (relatives, neighbours), but also health service providers (ambulances, doctors, pathologists, dietitians), assistance services (call centres), and the same municipality.

For the case of assisted living to elderly people, the data would be collected from sensors from the building and smart home domains, for example motion sensors, occupancy sensors, or pressure mats, among others. The collected data would be used by added-value services to detect abnormal conditions in elderly people's daily life environment and to trigger alarms to the municipal 24-hour call centre where specialists can provide assistance. In addition, the use case is complemented with smart allocation of parking space when needed for municipality health services in case their actuation is needed in a particular location, for example when a user presses the panic button.

For the middle-aged people use case, the data would be collected from wearables (for example smart bands, pedometers, etc.) and IoT proximity sensors that track everyday activities. The role of the municipality in this case is to collect and process such data to create award and goal-oriented services based on individuals' needs that promote healthy life-styles among users. In addition, specialist knowledge provided by professionals like pathologists or dieticians could be incorporated in the use case by means of recommendations or by defining municipal-scale campaigns to promote fitness activities to citizens.

This use case has been adapted from the Pilea-Hortiatis (Greece) pilot scenario from the H2020 VICINITY project which deals with prevention, health promotion, mobilization and orientation in health facilities. The "Smart Parking and Assisted Living" use case defined in AIOTI WG08 [i.8] has also been taken into account in combination with the use case "Sharing information between parking management systems and traffic management applications" being defined in ETSI GR CIM 002 [i.15].

6.2 Use case 2: Air Quality Monitoring and Mobility

Air pollution is a well-known problem nowadays being especially critical in larger cities such as London, Rome or Barcelona, due to the presence of PM10 and PM25 particles. Consequently, reducing air pollution is becoming one of the main action points in local administrations in order to meet EU directives.

Even though cities have already deployed air quality sensors, the quantity of such sensors is usually limited. In addition, the location of such sensors might interfere in obtaining accurate air quality measurements; for example, when sensors are located in parks that are quite distant from road traffic. In this sense, a dense network of air quality sensors would increase the actual data from air quality allowing real-time route generation based on pollution levels. These new air pollution sensors could be integrated in the smartphones that users are already carrying and moving over the city, sending such data to a central monitoring and processing point. Taking this into account, one possible application is to divert traffic over less polluted routes, therefore reducing pollution level peaks by including such an option in GPS devices. Another possible application is avoiding high polluted roads for users exercising outside, for example running. This could be done by integrating the real-time pollution information within mobile running applications.

This use case has been adapted from the "Air Quality Monitoring, Traffic Routing and Road Pricing" use case defined in AIOTI WG08 [i.8] in combination with the use case "Traffic Management/Pricing based on Air Quality, Congestion, and other KPIs" being defined in ETSI GR CIM 002 [i.15]. The use case, together with road pricing depending on vehicle pollution levels is being investigated in on-going pilots in London and Barcelona.

6.3 Use case 3: Street Lighting, Air Quality Monitoring and Mobility

Street lighting is a key city infrastructure for citizens as it is directly associated to the sense of security at night by them. However, this idea of security in addition to the sense of wealth and modernity risen by lighting systems, is increasing the light pollution levels mostly in highly populated cities like Madrid. On the one hand, both the awareness about the light pollution consequences over citizens' health and the need for reducing costs in energy are pushing local administrations to find solutions for a more efficient street lighting system. On the other hand, city administrations should handle the well-known problem of air pollution suffered also by big cities due to the high concentration of vehicles emitting CO_2. Finally, there is also a need for reducing pedestrian accidents due to maintenance works and issues on the roads. Taking all this into account, city administrations should find a way to:

a) balance the energy spent on street lighting while keeping roads safe for pedestrians;

b) re-route traffic in order to reduce high concentrations of air pollution in specific points; and

c) provide alternative routes for pedestrians in order to avoid areas with air pollution and potential hazards due to road works or issues.

In this use case, local administrations need to provide and deploy the infrastructure to monitor traffic and manage the street lighting configuration. For example, there is a need for sensors to detect presence in order to reduce the intensity of lighting when there is no traffic or pedestrians and increase it otherwise. Citizens could register road incidences by means of mobile or web applications as well as city reporting services. Such information could be used for suggesting safer routes to pedestrians. Final users could be both drivers, who could be re-directed to different routes according to the air pollution concentration in specific points, or pedestrians and cyclers who could be re-directed according to the safety and pollution conditions of the roads.