ETSI TR 103 508 V1.1.1 (2019-10)

SmartM2M;
SAREF extension investigation;
Requirements for Automotive

Reference

DTR/SmartM2M-103508

Keywords

automotive, IoT; oneM2M, ontology, SAREF, semantic

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Sous-Préfecture de Grasse (06) N° 7803/88

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Foreword

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

Modal verbs terminology

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Introduction

The present document was drafted by ETSI Technical Committee SmartM2M as a starting point for the development of an extension of the SAREF ontology for the automotive domain (SAREF4AUTO). The present document includes the first outcomes of a Specialist Task Force (STF) requested by ETSI SmartM2M; it gives insights into the current landscape of initiatives in the automotive domain, including standardization and research projects. It identifies a set of relevant use cases for this domain, and extracts from those use cases the requirements answering the competency questions that should be satisfied by the SAREF4AUTO extension.

1 Scope

The present document provides the requirements for an initial semantic model in the smart automotive domain based on a limited set of use cases and from available existing data models. The present document is developed in close collaboration with AIOTI, the H2020 Large Scale Pilots, with ETSI activities in the automotive domain and with oneM2M. Further extensions are envisaged in the future to cover entirely the smart automotive domain. The associated technical specification will define the extension (i.e. the semantic model) for the smart automotive domain (SAREF4AUTO) based on the requirements and use cases described 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: "D-S4 Final Report - SMART 2013-0077 - Study on Semantic Assets for Smart Appliances Interoperability", March 2015.

[i.2] ETSI TS 103 264 (V2.1.1): "SmartM2M; Smart Appliances; Reference Ontology and oneM2M Mapping".

[i.3] ETSI TR 103 411 (V1.1.1): "SmartM2M; Smart Appliances; SAREF extension investigation".

[i.4] ETSI TS 102 894-2: "Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary".

[i.5] oneM2M-TR-0026-V-4.5.0: "oneM2M; Vehicular Domain Enablement".

[i.6] CEN EN 16157-2:2019: "Intelligent transport systems - DATEX II data exchange specifications for traffic management and information - Part 2: Location referencing".

[i.7] ETSI TR 103 545: "SmartM2M; Pilot test definition and guidelines for testing cooperation between oneM2M and Ag equipment standards".

[i.8] HD Live Map Data Specification, HERE, 2019.

NOTE: Available online at https://developer.here.com/olp/documentation/hd-live-map/topics/hdlm2-logical-road-link.html.

[i.9] "The Benefits of a Common Map Data Standard for Autonomous Driving, White Paper", June 2019.

NOTE: Available online at https://www.nds-association.org/.

[i.10] ISO 11783: "Tractors and machinery for agriculture and forestry -- Serial control and communications data network".

[i.11] ETSI EN 302 637-3: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service".

[i.12] C-ITS Platform, Final report Phase I, January 2016.

[i.13] ETSI TS 103 301: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services".

[i.14] Autopilot: "The Autopilot H2020 Large Scale Pilot".

NOTE: Available at http://autopilot-project.eu.

[i.15] Schema.org markup model for automobiles.

NOTE: Available at https://schema.org/docs/automotive.html.

[i.16] "The DATEX II Parking Publications Extension".

NOTE: Available at https://datex2.eu/implementations/extension_directory/parking-publications-extension-v10a.

[i.17] SENSORIS: "Sensor Interface Specification".

NOTE: Available at https://sensor-is.org/.

[i.18] The SynchroniCity Project.

NOTE: Available at https://synchronicity-iot.eu/.

[i.19] ENSEMBLE project: "Platooning together".

NOTE: Available at https://platooningensemble.eu.

[i.20] The TransAID project: "Transition Areas for Infrastructure-Assisted Driving".

NOTE: Available at https://www.transaid.eu/.

[i.21] ETSI EN 302 665: "Intelligent Transport Systems (ITS); Communications Architecture".

[i.22] ETSI TR 103 300-1 "Intelligent Transport System (ITS); Vulnerable Road Users (VRU) awareness; Part 1: Use Cases definition; Release 2".

[i.23] W3C Automotive Ontology Working Group.

NOTE: Available at https://www.w3.org/community/gao/.

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

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

3.2 Symbols

Void.

3.3 Abbreviations

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

AEF	Agricultural industry Electronics Foundation
AIOTI	Alliance for Internet of Things Innovation
AVP	Automated (Autonomous) Valet Parking
CAM	Cooperative Awareness Message
CCTV	Closed-Circuit TeleVision
C-ITS	Cooperative ITS
CPS	Cooperative Perception Service
DATEX	Data Exchange
DENM	Decentralized Environmental Notification Message
IBM	International Business Machines (corporation)
IoT	Internet of Things
ISO	International Organization for Standardization
ITS	Intelligent Transport Systems
M2M	Machine to Machine
MAP	Map Data
NDS	Navigation Data Specification
OWL	Web Ontology Language
PMD	Photonic Mixer Device
SAE	Society of Automotive Engineers
SAREF	Smart Applications REFerence ontology
SPAT	Signal Phase And Time
UML	Unified Modeling Language
UTC	Universal Time Coordinated
UUID	Universally Unique IDentifier
V2V	Vehicle to Vehicle
VMS	Variable Message Signs
VRU	Vulnerable Road user
WGS	World Geodetic System 1984

4 SAREF extension for the automotive domain

SAREF is a reference ontology for the IoT created in close interaction with the industry during a study requested by the European Commission in 2015 [i.1] and subsequently transferred into an ETSI Technical Specification [i.2]. 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.3] 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 automotive domain. This initial SAREF extension will be based on a limited set of use cases and existing data models identified within available initiatives that will be summarized in dedicated clauses of the present document. The work conducted in the present document has been developed in the context of the STF 566 (https://portal.etsi.org/STF/STFs/STFHomePages/STF566.aspx), which was established with the goal of creating SAREF extensions for the following domains: Automotive, eHealth/Ageing-well, Wearables and Water. This work is expected to be developed in close collaboration with ETSI, oneM2M, AIOTI, automotive-related H2020 Large Scale Pilots and EU projects. However, other initiatives coming from the industrial world and alliances will also be investigated.

STF 566 consists of the following two main tasks:

1) to gather requirements, collect use cases and identify existing sources (e.g. standards, data models, ontologies, etc.) from the domains of interest (Automotive, eHealth/Ageing-well, Wearables and Water) in order to determine the requirements for an initial semantic model for each of the aforementioned domains, based on at least 2 use cases and existing data models; and

2) to specify and produce the extensions of SAREF for each of the aforementioned domain based on these requirements.

The present document focuses on analysing sources, collecting use cases and gathering requirements for an extension of SAREF for the Automotive domain. The present document sets the requirements of an initial semantic model that will result in a new SAREF ontology extension for Automotive, called SAREF4AUTO, that will be published as part of the SAREF extensions technical specifications.

5 Related initiatives

5.1 Introduction

Clause 5 reviews relevant initiatives in the Automotive domain, including initiatives in the standardization bodies and alliances, European research projects, available partial data models and ontologies that can be found in this domain as well as other initiatives such as a technical report for an ETSI pilot test involving agriculture equipment. Each of the selected initiatives is described and how it brings relevant information to this study is described.

5.2 Standardization initiatives and associations

5.2.1 oneM2M

In the automotive domain, oneM2M develops oneM2M-TR-0026 [i.5] which examines how the current oneM2M System can be used in the Vehicular Domain and includes a study of advanced features that the future oneM2M release(s) could support for this vertical domain.

5.2.2 AIOTI

The Alliance for Internet of Things Innovation (AIOTI) was initiated by the European Commission (then moved to a full-fledged association) in order to develop and support the dialogue and interaction among the Internet of Things (IoT) various players in Europe. The overall goal of the AIOTI is the creation of a dynamic European IoT ecosystem to unleash the potentials of the IoT. The work in AIOTI is performed in dedicated working groups. Two of them are relevant to the present document:

- WG03 on IoT standardization, which includes a sub-group on semantic interoperability; and
- WG09 on Smart Mobility.

5.2.3 ETSI TC ITS

The TC ITS of ETSI is in charge of developing and maintaining standards, specifications and other reports related to the implementation of V2V communication and interaction in C-ITS. Its scope goes from wireless access (apart from radiofrequency issues) to generic services and related applications. The security and implementation of tests are also tackled. Its WG1 develops a data dictionary [i.4] to handle all the data elements used in ITS messages such as CAM, DENM and CPS which are relevant for the present document.

5.2.4 DATEX-II

In the road sector, the DATEX standard was developed for information exchange between traffic management centres, traffic information centres and service providers. The second generation DATEX II specification (CEN EN 16157-2:2019 [i.6]) enables applications requiring access to dynamic traffic and travel related information in Europe.

5.2.5 SENSORIS

SENSORIS [i.17] (https://sensor-is.org/) is a result of the cooperation of a number of parties from the automotive domain that proposed data models for exchanging data between vehicles and cloud services. Currently, vehicle sensor data exists in different formats across automakers and it is typically carmaker specific. When connecting vehicles to IoT platforms standardization is needed, as pooling analogous vehicle data from millions of vehicles will be a key enabler for bringing vehicle-to-vehicle and vehicle-to-infrastructure communication to the next level. SENSORIS was initiated by HERE [i.8] in June 2015 when the company published the first open specification for how vehicle sensor data gathered by connected cars will be sent to the cloud (as well as between clouds) for processing and analysis.

5.2.6 W3C - Automotive Ontology Working Group

The Automotive Ontology Community Group in W3C [i.23] (https://www.w3.org/community/gao/) is an informal group aiming to advance the use of shared conceptual structures in the form of web ontologies for better data interoperability in the automotive industry. This group has published an automotive extension of the data markup schema at schema.org [i.15] (referred as auto.schema.org). It is available on the schema.org site at: https://schema.org/docs/automotive.html (see also clause 5.4.1).

5.3 European Projects

5.3.1 SynchroniCity

The SynchroniCity H2020 Large Scale Pilot [i.18] (https://synchronicity-iot.eu/) is working to establish a reference architecture for the envisioned IoT-enabled city market place with identified interoperability points and interfaces and data models for different verticals. This includes tools for co-creation and integration of legacy platforms and IoT devices for urban services and enablers for data discovery, access and licensing lowering the barriers for participation on the market. SynchroniCity pilots these foundations in the reference zones together with a set of citizen-centred services in three high-impact areas, showing the value to cities, businesses and citizens involved, linked directly to the global market.

5.3.2 AUTOPILOT

The Autopilot H2020 Large Scale Pilot (http://autopilot-project.eu) [i.14] focuses on the use of IoT for improving autonomous driving. "Automated driving Progressed by Internet of Things" (AUTOPILOT) will bring IoT into the automotive world to transform connected vehicles - moving "things" in the IoT ecosystem - into highly automated vehicles (towards levels 4 and 5 of driving automation). AUTOPILOT will also make data from autonomous cars available to Internet-of-Things platforms such as oneM2M and IBM Watson. Various use cases are implemented at the six pilot sites (Finland, France, Italy, the Netherlands, Spain and South Korea) in large scale demonstrations in order to evaluate the potential and calculate the related impacts of using Internet of Things for Automated Driving. Examples of use cases are: platooning where vehicles are automatically following each other at a relatively close distance to improve traffic throughput and reduce fuel consumption; and Automated Valet Parking (AVP) where the autonomous vehicle will park itself after the driver has left the car at a drop-off point.

5.3.3 ENSEMBLE

ENSEMBLE [i.19] (https://platooningensemble.eu) is a European project that will lay the foundation for multi-brand truck platooning across Europe, by speeding up the implementation of multi-brand platooning, bringing its real-world deployment within reach. Its final outcome will be a demonstration of a six-truck platoon, each one of a different brand, driving in real-world traffic conditions across national borders in 2021. To allow the transition from single-brand to multi-brand platooning, platoon operation levels need to be defined to harmonize the design of different platooning functionalities and strategies, reflecting the full diversity of trucks with platooning functionality. Thanks to cooperative automated dynamic control between the trucks, truck operations will be safer and less stressful. At highway entries, exits and junctions, platoons will automatically increase vehicle gaps to give way to other road users. Interoperability is a leading design principle. Existing standardized C-ITS message sets will be used to coordinate the trucks, and new message sets will be developed.

5.3.4 TransAID

The TransAID European project [i.20] (https://www.transaid.eu/) develops and demonstrates traffic management procedures and protocols to enable smooth coexistence of automated, connected, and conventional vehicles, especially at Transition Areas, i.e. at areas where it is not allowed or not possible to use a high level of automation due to missing sensor inputs or high complexity situations. A hierarchical approach is followed where control actions are implemented at different layers including centralized traffic management, infrastructure, and vehicles.

5.4 Ontologies and data models

5.4.1 W3C Automotive Ontology Working Group

The Automotive Ontology Community Group [i.23] (https://www.w3.org/community/gao/) is an informal group of individuals and corporations whose objective is to develop web ontologies for better data interoperability in the automotive industry, and this at Web scale. In particular,

- extension proposals for schema.org so that automotive information can be better understood by search engines; and
- OWL Web ontologies for the automotive industry.

So far, the group has mainly published an automotive extension in the schema.org community (https://schema.org/). This schema refers to real-world objects related to popular vehicles like cars, buses (coaches) and motorcycles. However, its main target is on passenger automobiles to enable the elaboration of retail market web sites.

Figure 1 shows an extract of the vehicle properties in this model. The markup model for automobiles is available online at https://schema.org/docs/automotive.html [i.15].

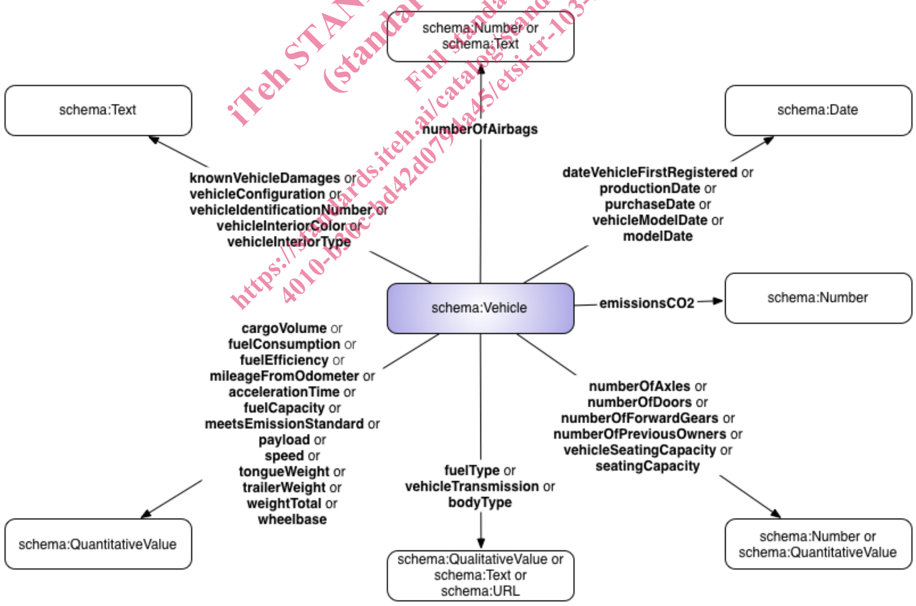

Figure 1: The Vehicle type and its properties in the schema.org extension (from https://schema.org/docs/automotive.html) [i.15]

5.4.2 DATEX II Parking Publications Extension

The DATEX II Parking Publications [i.16] (available at https://datex2.eu/implementations/extension_directory/parking-publications-extension-v10a) is a set of three UML models, extending the DATEX II standard, which allow to specify static and dynamic information about parking sites as well as information on individual parking vehicles:

- ParkingTablePublication