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STN	**Smart M2M SAREF pokyny pre sémantickú interoperabilitu IoT Rozvíjanie, aplikácia a vyvíjanie ontológie inteligentných aplikácií**	**STN EN 303 760 V1.1.1** 87 3760

SmartM2M; SAREF Guidelines for IoT Semantic Interoperability; Develop, apply and evolve Smart Applications ontologies

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Foreword

This European Standard (EN) has been produced by ETSI Technical Committee Smart Machine-to-Machine communications (SmartM2M).

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Modal verbs terminology

In the present document "**shall**", "**shall not**", "**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).

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Introduction

Fragmentation of the IoT ecosystem in terms of standardization, architectures and available technologies and IoT service platforms targeting specific applications or application domains impede the sharing of information between the resulting silos. An increasing number of IoT devices located in different IoT networks generate greater quantities of data to be shared across the IoT. Therefore, more and more devices and applications need to interoperate. Manufacturers of IoT devices are faced with many standards and protocols to choose from. Consumers invest in smart IoT products. In order to combine products from different vendors according to their needs, consumers want to make sure that these products are interoperable with each other.

All of this underscores the need for open and standardized interfaces for products of different brands to interoperate and to avoid vendor-lock in. Interoperability offers the business benefit, to unlock new added value services for consumers from data integration, while manufacturers and other commercial parties can still maintain their competitive advantage in offering their solutions (not everything needs to become open and interoperable).

In the past, interoperability used to be addressed at the technical communication level.

EXAMPLES:

- by using one agreed single data model, but nowadays there is too big fragmentation in existing data models/protocols to choose from;
- by implementing ad-hoc translations between different data models/protocols, which turns to be very expensive when there are so many standards/protocols that can be translated into each other.

In recent years, the interoperability challenge has been raised to the information level, where the common concepts for all existing data models/protocols can be incorporated in an ontology (i.e. a common vocabulary). This captures the meaning of a concept (i.e. semantics) rather than the specific data format in which the concept is encoded for data exchange at the underlying communication layer.

The Smart Applications REFerence ontology (SAREF) developed and maintained by ETSI since 2015 provides a mature, sustainable and standardized framework of ontologies for IoT that enables different parties to interoperate with each other at the semantic level.

The present document brings together widely considered good practices in semantic interoperability for IoT smart applications in a set of high-level outcome-focused provisions. The objective of the present document is to support all parties involved in the development and manufacturing of IoT smart applications and products with guidance on making them interoperable in compliance to the SAREF framework. The provisions give organizations and companies the flexibility to innovate and implement SAREF-compliant semantic interoperability solutions appropriate for their products and applications.

The present document is not intended to specify the technical details of SAREF, which are evolving further dynamically in the respective ETSI Standards, and which it refers to. Rather, it describes a methodology to apply SAREF in products/solutions and how to show SAREF compliance according to the present SAREF EN and optionally how to contribute to a new SAREF extension (if what Users need is not yet in the SAREF framework).

The provisions in the present document have been developed following a review of published standards, recommendations and guidance on semantic interoperability and SAREF, including:

- "SAREF: the Smart Applications REFerence ontology" [i.7]
- ETSI TS 103 673 [1]
- ETSI TS 103 264 [2]
- ETSI TS 103 548 [3]
- ETSI TS 103 410-1 [4]
- ETSI TS 103 410-2 [5]
- ETSI TS 103 410-3 [6]
- ETSI TS 103 410-4 [7]

- ETSI TS 103 410-5 [8]
- ETSI TS 103 410-6 [9]
- ETSI TS 103 410-7 [10]
- ETSI TS 103 410-8 [11]
- ETSI TS 103 410-9 [12]
- ETSI TS 103 410-10 [13]
- ETSI TS 103 410-11 [14]
- ETSI TS 103 410-12 [16]

As IoT applications and products become increasingly interoperable, it is envisioned that future revisions of the present document will mandate provisions that are currently recommendations in the present document.

1 Scope

The present document gives guidance and provisions for making IoT smart applications and products interoperable at the semantic level in compliance to the SAREF framework. It contains provisions about how to use SAREF, points to the relevant existing Technical Reports and Technical Specifications and specifies a methodology to follow for showing SAREF compliance according to the present SAREF EN. Further on, it describes how to contribute optionally to a new SAREF extension (if what Users need is not yet in the SAREF framework).

The present document addresses parties involved in the development and manufacturing of IoT smart applications and products, who might take different roles in their organization like:

- executives and product owners, who decide on to invest in a SAREF-compliant product;
- developers, who will implement a SAREF-compliant product as non-ontology experts or even ontology experts.

Different roles imply different intentions and expectations when reading the present document according to their tasks in the organization. The present document considers this by its implemented structure. Clause 4 provides guidance about how to go throughout the present document in order to judge, which clauses might be essential for the special role of the reader and which ones might be skipped.

The present document is structured as follows:

- **Clauses 1 to 3** set the scene and provide references as well as definitions of terms, symbols and abbreviations, which are used in the present document.
- **Clause 4** defines the motivation and principles shared by those who are reading the present document also serving as a checkpoint whether the reader is in the right place or not. It includes a brief reading guide as not everyone needs to read every part of the present document, depending on the reader's role and expertise.
- **Clause 5.1** provides guidance about the best practice of specifying use cases as the important basis for deriving requirements from them.
- **Clause 5.2** provides guidance/provisions about identifying core elements from the use cases defined in clause 5.1.
- **Clause 5.3** describes, how to get acquainted with SAREF.
- **Clause 5.4** provides guidance /provisions about ensuring that the correct (latest) versions of the relevant SAREF modules/patterns/extensions are selected. It illustrates, how to document the version of those SAREF modules, which the product, application, or possible ontology extension is compliant to.
- **Clause 6.1** provides guidance/provisions about the translation of data into SAREF.
- **Clause 6.2** gives guidance about testing "SAREF-compliant data" in one example application of interoperability exchange with another organization/manufacturer/brand.
- **Clause 7.1** provides guidance/provisions about creating a new SAREF extension (or pattern).
- **Clause 7.2** provides guidance/provisions about checking SAREF compliance of a new created SAREF extension without going (yet) to an official standardization contribution to ETSI.
- **Clause 8** describes the process of incorporating a new created SAREF extension according to clause 7 in the official standardization process in ETSI, which will then result in a new official extension/pattern (SAREF4abcd) under the ETSI SAREF namespace.
- **Annex A** contains an example of a possible use case to provide context to clause 5.1.
- **Annex B** contains examples of relevant core elements from use cases to provide context to clause 5.2.
- **Annex C** contains examples of translating data into SAREF-compliant data to provide context to clause 6.1.
- **Annex D** contains examples of testing SAREF data to provide context to clause 6.2.

- **Annex E** provides a short summary of SAREF ontology development methodology with figures and different phases.
- **Annex F** provides a mechanism for the User of the present document (who is expected to be an entity involved in the development and manufacturing of IoT smart applications and products) to give information about the implementation of the provisions within the present document.
- **Annex G** provides an example of how to enhance the SAREF core with its extensions to give context to clause 7.

2 References

2.1 Normative 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.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

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 necessary for the application of the present document.

[1] ETSI TS 103 673: "SmartM2M; SAREF Development Framework and Workflow, Streamlining the Development of SAREF and its Extensions".

[2] ETSI TS 103 264: "SmartM2M; Smart Applications; Reference Ontology and oneM2M Mapping".

[3] ETSI TS 103 548: "SmartM2M; SAREF reference ontology patterns".

[4] ETSI TS 103 410-1: "SmartM2M; Extension to SAREF; Part 1: Energy Domain".

[5] ETSI TS 103 410-2: "SmartM2M; Extension to SAREF; Part 2: Environment Domain".

[6] ETSI TS 103 410-3: "SmartM2M; Extension to SAREF; Part 3: Building Domain".

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

[8] ETSI TS 103 410-5: "SmartM2M; Extension to SAREF; Part 5: Industry and Manufacturing domains".

[9] ETSI TS 103 410-6: "SmartM2M; Extension to SAREF; Part 6: Smart Agriculture and Food Chain Domain".

[10] ETSI TS 103 410-7: "SmartM2M; Extension to SAREF; Part 7: Automotive Domain".

[11] ETSI TS 103 410-8: "SmartM2M; Extension to SAREF; Part 8: eHealth/Ageing-well Domain".

[12] ETSI TS 103 410-9: "SmartM2M; Extension to SAREF; Part 9: Wearables Domain".

[13] ETSI TS 103 410-10: "SmartM2M; Extension to SAREF; Part 10: Water Domain".

[14] ETSI TS 103 410-11: "SmartM2M; Extension to SAREF; Part 11: Lift Domain".

[15] ETSI Labs: SAREF extensions online.

[16] ETSI TS 103 410-12: "SmartM2M; Extension to SAREF; Part 12: Smart Grid Domain".

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 Labs: SAREF pipeline SW.

[i.2] Poveda-Villalón, M., Fernández-Izquierdo, A., Fernández-López, M., & García-Castro, R. (2022). LOT: An industrial oriented ontology engineering framework. Engineering Applications of Artificial Intelligence, 111, 104755.

[i.3] Linked Open Terms (LOT) methodology website.

[i.4] ETSI TR 103 411: "SmartM2M; Smart Appliances; SAREF extension investigation".

[i.5] IEC 62559: "Use case methodology".

[i.6] EN 50631-1: "Household appliances network and grid connectivity - Part 1: General Requirements, Generic Data Modelling and Neutral Messages" (produced by CENELEC).

[i.7] ETSI SAREF portal.

[i.8] EN 50491-12-2: "General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) - Part 12-2: Smart grid - Application specification - Interface and framework for customer - Interface between the Home / Building CEM and Resource manager(s) - Data model and messaging" (produced by CENELEC).

[i.9] ETSI Labs: Sources of the SAREF Extensions.

[i.10] ETSI Labs: SAREF-portal repository.

[i.11] Chávez-Feria, Serge, Raúl García-Castro, and María Poveda-Villalón. "Chowlk: from UML-Based Ontology Conceptualizations to OWL." The Semantic Web: 19th International Conference, ESWC 2022, Hersonissos, Crete, Greece, May 29-June 2, 2022, Proceedings. Cham: Springer International Publishing, 2022.

[i.12] W3C® Recommendation 27 September 2012: "A Direct Mapping of Relational Data to RDF".

[i.13] W3C® Recommendation 27 September 2012: "R2RML: RDB to RDF Mapping Language".

[i.14] Declarative RDF graph generation from heterogeneous (semi-)structured data: A systematic literature review, Journal of Web Semantics, Volume 75, January 2023, 100753.

[i.15] Common JUnit XML Format & Examples, JUnit project.

[i.16] W3C® Recommendation 21 March 2013: "SPARQL 1.1 Query Language".

[i.17] ETSI TS 103 735: "SmartM2M; Smart Lifts IoT System".

[i.18] EN 627: "Specification for data logging and monitoring of lifts, escalators and passenger conveyors", 1995 (produced by CEN).