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Part 1: Energy Domain

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Foreword

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

The present document is part 1 of a multi-part deliverable covering SmartM2M; Extension to SAREF, as identified below:

Part 1: "Energy Domain";

Part 2: "Environment Domain";

Part 3: "Building Domain";

Part 4: "Smart Cities Domain";

Part 5: "Industry and Manufacturing Domains";

Part 6: "Smart Agriculture and Food Chain Domain";

Part 7: "Automotive Domain";

Part 8: "eHealth/Ageing-well Domain";

Part 9: "Wearables Domain";

Part 10: "Water Domain".

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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1 Scope

The present document presents SAREF4ENER, the SAREF extension for EEBus and Energy@Home in the energy domain.

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.

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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] EEBus SPINE.

NOTE: Available at https://www.eebus.org/en/specifications/.

[2] ETSI TS 103 264 (V3.1.1): "SmartM2M; Smart Applications; Reference Ontology and oneM2M Mapping".

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] TNO, EEBus, Energy@Home: "SAREF4EE".

NOTE: Available at https://w3id.org/saref4ee.

[i.2] Energy@home Data Model, v2.1, October 2015.

NOTE: Available at http://www.energy-home.it/Documents/Technical%20Specifications/E@h_data_model_v2.1.pdf.

[i.3] IEC TR 62746-2:2015: "Systems interface between customer energy management system and the power management system - Part 2: Use cases and requirements".

NOTE: Available at https://webstore.iec.ch/publication/22279.

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

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.

3.2 Abbreviations

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

CEM	Customer Energy Manager
E@H	Energy@Home association
EEBus	EEBus initiative
OM	Ontology of units of Measure
OWL	Web Ontology Language
SAREF	Smart Applications REFerence ontology
TNO	Netherlands Organization for Applied Scientific Research
TR	Technical Report
TS	Technical Specification
UML	Unified Modeling Language
XSD	W3C XML Schema Definition

4 SAREF4ENER ontology and semantics

4.1 Introduction and overview

The present document is a technical specification of SAREF4ENER, an extension of SAREF [2] that was created in collaboration with Energy@Home (http://www.energy-home.it) and EEBus (http://www.eebus.org/en), the major Italy- and Germany-based industry associations, to enable the interconnection of their (different) data models. The Energy@Home association, abbreviated in the rest of the document as E@H. E@H aims at developing and promoting technologies and services for energy efficiency in smart homes, based upon the interaction between user devices and the energy infrastructure. The E@H data model is described in [i.2]. EEBus is an important initiative in the area of the Internet of Things, which has its roots in the sector of smart and renewable energy. EEBus developed a standardized and consensus-oriented smart grid and smart home networking concept. The EEBus data model is described in [1]. SAREF4ENER is meant to enable the (currently missing) interoperability among various proprietary solutions developed by different consortia in the smart home domain. By using SAREF4ENER, smart appliances from manufacturers that support the EEBus or E@H data models will easily communicate with each other using any energy management system at home or in the cloud.

Towards this aim, SAREF4ENER should be used to annotate (or generate) a neutral (protocol-independent) set of messages to be directly adopted by the various manufacturers, or mapped to their domain specific protocols of choice.

SAREF4ENER is an OWL-DL ontology that extends SAREF with 63 classes, 17 object properties and 40 data type properties. SAREF4ENER focuses on demand response scenarios, in which customers can offer flexibility to the Smart Grid to manage their smart home devices by means of a Customer Energy Manager (CEM). The CEM is a logical function for optimizing energy consumption and/or production that can reside either in the home gateway or in the cloud. Moreover, the Smart Grid can influence the quantity or patterns of use of the energy consumed by customers when energy-supply systems are constrained, e.g. during peak hours. These scenarios involve the following use cases:

- **Use case 1:** configuration of devices that want to connect to each other in the home network, for example, to register a new dishwasher to the list of devices managed by the CEM;
- **Use case 2:** smart energy management/ (re-)scheduling appliances in certain modes and preferred times using power profiles to optimize energy efficiency and accommodate the customer's preferences;
- **Use case 3:** monitoring and control of the start and status of the appliances;
- **Use case 4:** reaction to special requests from the Smart Grid, for example, incentives to consume more or less depending on current energy availability, or emergency situations that require temporary reduction of the power consumption.

These use cases are associated with the user stories described in [i.3], which include, among others, the following examples:

- User wants to do basic settings of his/her devices;
- User wants to know when the washing machine has finished working;
- User wants the washing done by 5:00 p.m. with least electrical power costs;
- User likes to limit his/her own energy consumption up to a defined limit;
- User allows the CEM to reduce the energy consumption of his/her freezer in a defined range for a specific time, if the grid recognizes (severe) stability issues;
- Grid related emergency situations (blackout prevention).

The prefixes and namespaces used in SAREF4ENER and in the present document are listed in Table 1.

Table 1: Prefixes and namespaces used within the SAREF4ENER ontology

Prefix	Namespace
s4ener	https://saref.etsi.org/saref4ener/
saref	https://saref.etsi.org/core/
dcterms	http://purl.org/dc/terms/
owl	http://www.w3.org/2002/07/owl#
rdf	http://www.w3.org/1999/02/22-rdf-syntax-ns#
rdfs	http://www.w3.org/2000/01/rdf-schema#
om	http://www.wurvoc.org/vocabularies/om-1.8/
xsd	http://www.w3.org/2001/XMLSchema#

4.2 SAREF4ENER

4.2.1 General Overview

An overview of the SAREF4ENER ontology is provided in Figure 1, where rectangles containing an orange circle are used to denote classes created in SAREF4ENER, while rectangles containing a faded orange circle denote classes reused from other ontologies, such as SAREF. For all the entities described in the present document, it is indicated whether they are defined in the SAREF4ENER extension or elsewhere by the prefix included before their identifier, i.e. if the element is defined in SAREF4ENER the prefix is `s4ener:`, while if the element is reused from another ontology it is indicated by a prefix according to Table 1.

Arrows with white triangles on top represent the `rdfs:subClassOf` relation between two classes. The origin of the arrow is the class to be declared as subclass of the class at the destination of the arrow.

Directed arrows are used to represent properties between classes.

Rectangles that contain a list of values between square brackets denote an enumeration of individuals.

Note that Figure 1 aims at showing a global overview of the main classes of SAREF4ENER and their mutual relations. More details on the different parts of Figure 1 are provided in clause 4.2.2 to clause 4.2.6.

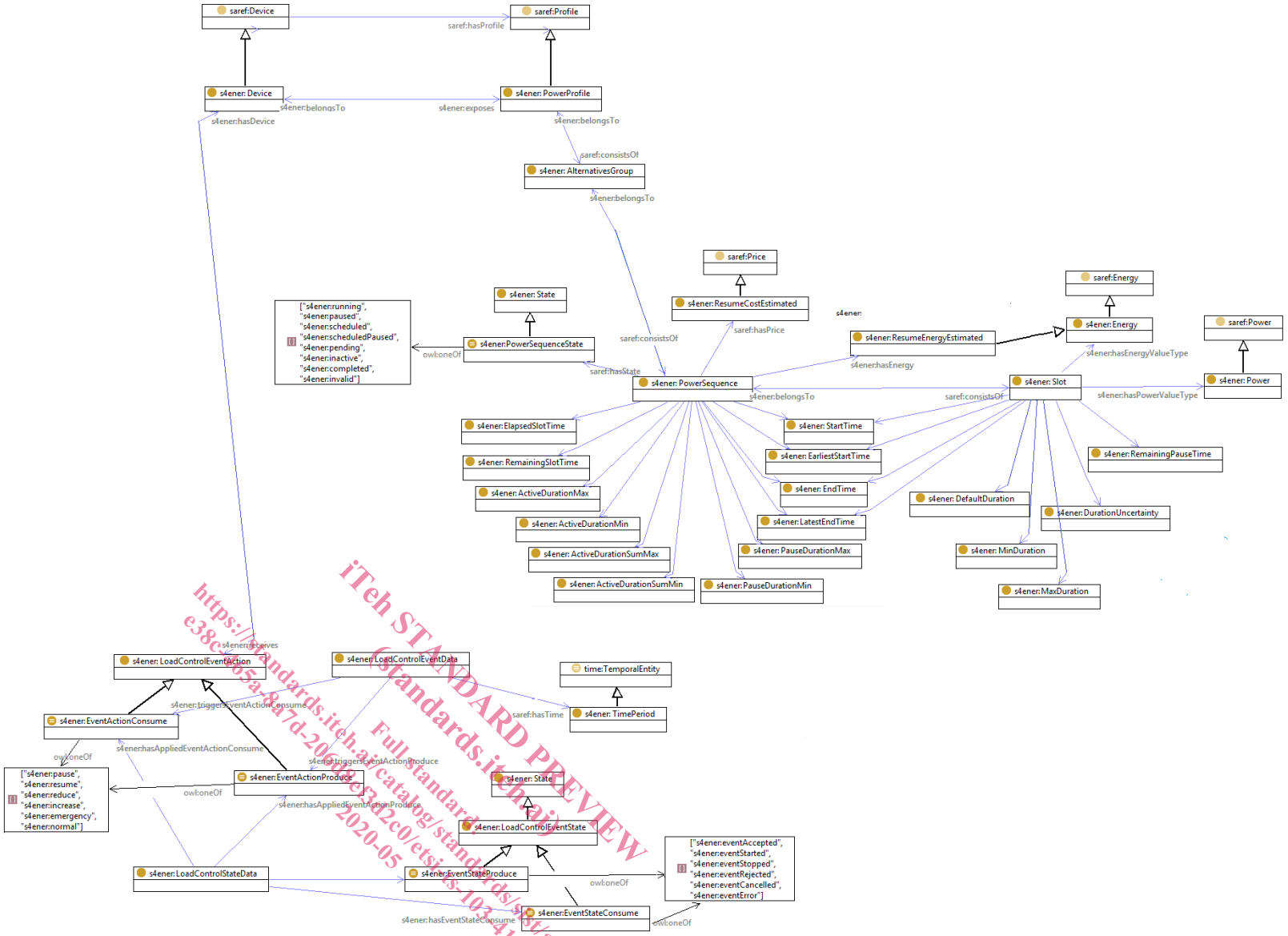

Figure 1: SAREF4ENER overview

Figure 2 shows the hierarchy of classes and properties defined in SAREF4ENER.

Orange circles represent classes of SAREF4ENER, while faded orange circles represent classes that are reused from other ontologies. Object properties - which are properties between two classes - are denoted by blue rectangles, while datatype properties - which are properties between a class and a data type, such as `xsd:string` or `xsd:dateTime` - are denoted by green rectangles. Faded blue and green rectangles denote object properties and datatype properties that are reused from other ontologies.