
interconnect
interoperable solutions
connecting smart homes,
buildings and grids

Roundtable session on reference models: Panelist Introduction

Laura Daniele, TNO

Panelist @Reference architecture for cross-border and cross-sector energy data exchange

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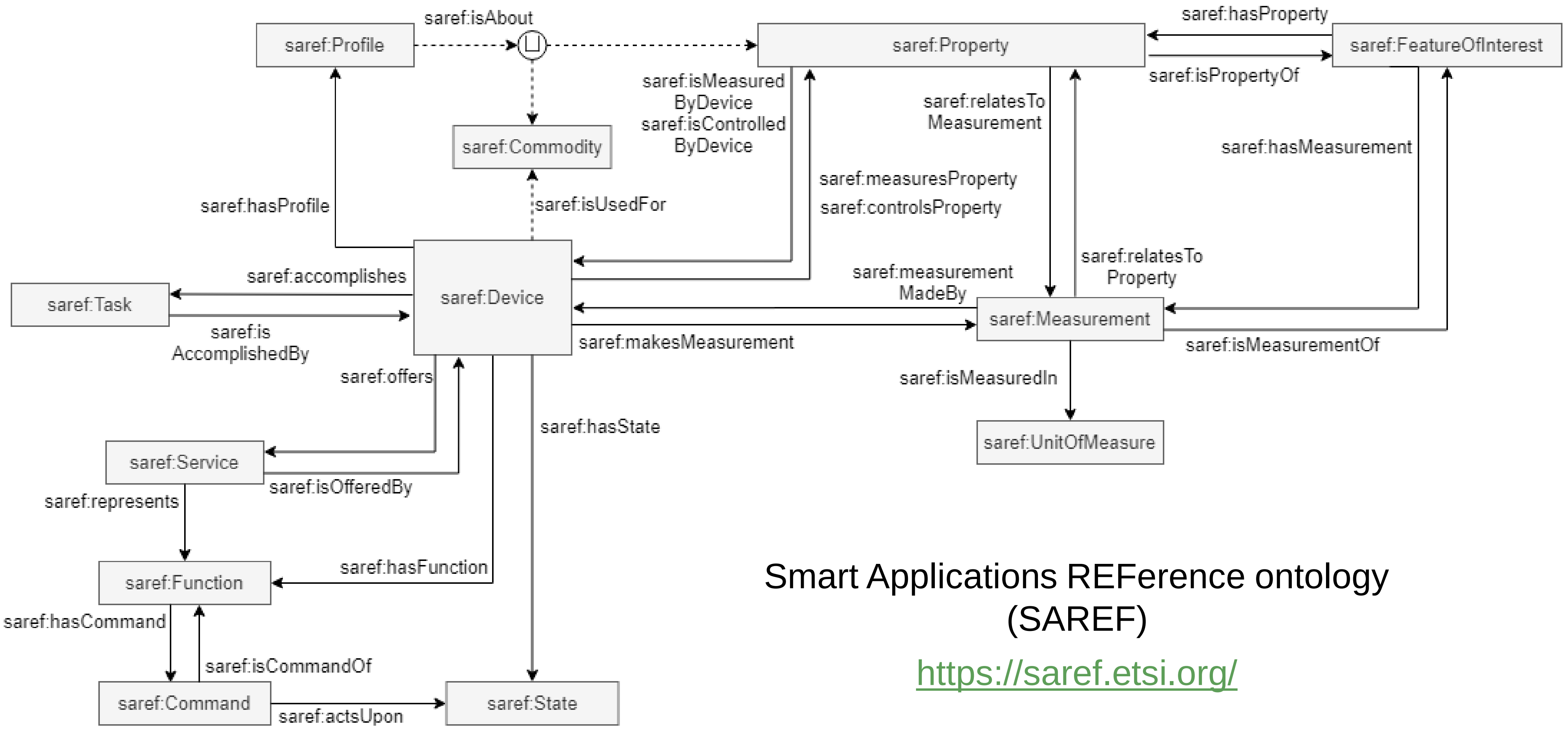
About me

laura.daniele@tno.nl

https://nl.linkedin.com/in/lauradaniele

- MSc in Electronic Engineering (University of Cagliari, Italy) and PhD in Computer Science (University of Twente, NL)
- Senior Scientist at TNO, Data Science department, Unit ICT. Tno is the largest Dutch independent research organization. Intermediary between basic research organisations and industry
- Data Science department combines expertise in AI and data analytics with expertise in semantics, standards, interoperability architectures and data governance
- Leading semantic interoperability research and standardization activities in IoT at TNO
- Expert in ETSI SmartM2M TC
- Co-leader of the semantic interoperability group in WG3 of AIOTI together with Martin Bauer (NEC)
- Leading scientist in H2020 Interconnect large scale pilot for smart and interoperable homes, buildings and grids

What is SAREF?



Smart Applications REFerence ontology (SAREF)

https://saref.etsi.org/

Source: ETSI TS 103 264 V3.1.1

SAREF is a reference (core) ontology wit… extensions in different domains

List of SAREF ontologies

Below is the list of published SAREF ontologies, and SAREF ontologies under development

- SAREF: the core Smart Applications REFerence ontology
- Ontology patterns:
  - SAREF4SYST: ontology pattern for Systems, Connections, and Connection Points
- Extensions for domains:
  - SAREF4ENER: SAREF extension for the Energy domain
  - SAREF4ENVI: SAREF extension for the Environment domain
  - SAREF4BLDG: SAREF extension for the Building domain
  - SAREF4CITY: SAREF extension for the Smart Cities domain
  - SAREF4INMA: SAREF extension for the Industry and Manufacturing domains
  - SAREF4AGRI: SAREF extension for the Smart Agriculture and Food Chain domains
  - SAREF4AUTO: SAREF extension for the Automotive domain *(under development)*
  - SAREF4EHAW: SAREF extension for the eHealth/Ageing-well domain *(under development)*
  - SAREF4WEAR: SAREF extension for the Wearables domain *(under development)*
  - SAREF4WATR: SAREF extension for the Water domain *(under development)*

https://saref.etsi.org/extensions.html

The SAREF public portal, the SAREF sources with continuous integration and deployment, the SAREF Pipeline software, and ETSI Technical Specification TS 103 673 v1.1.1 "SAREF Development Framework and Workflow, Streamlining the Development of SAREF and its Extensions", have been developed in the context of the ETSI STF 578, which followed the ETSI STF 556

SAREF is also a (series of) Technical Specification(s)

ETSI TS 103 264 V3.1.1 (2020–02)

SmartM2M;

Smart Applications;

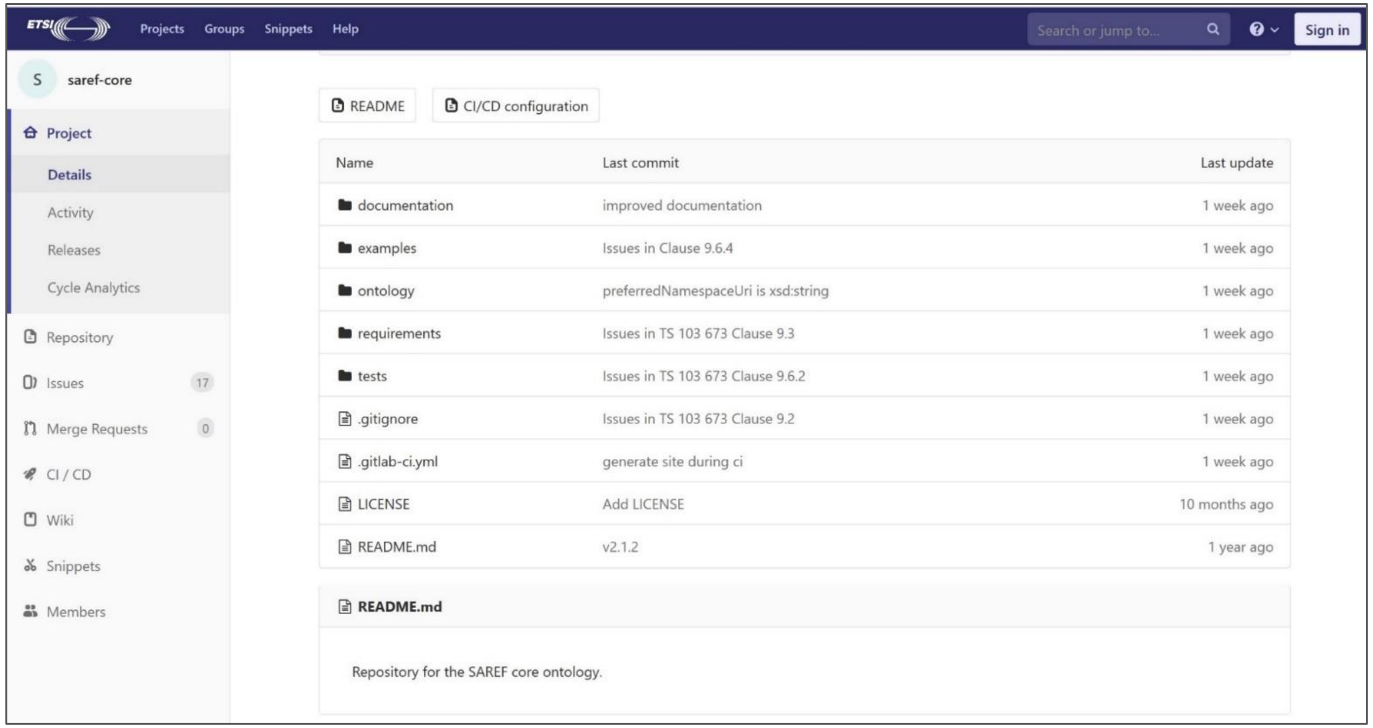
Reference Ontology and oneM2M Mapping

SAREF version 3 Technical Specification (February 2020): TS 103 264 V3.1.1

Previous versions

- SAREF version 2 Technical Specification (March 2017): TS 103 264 V2.1.1
- SAREF version 1 Technical Specification (November 2015): TS 103 264 V1.1.1

… with a repository for developers



https://forge.etsi.org/rep/SAREF

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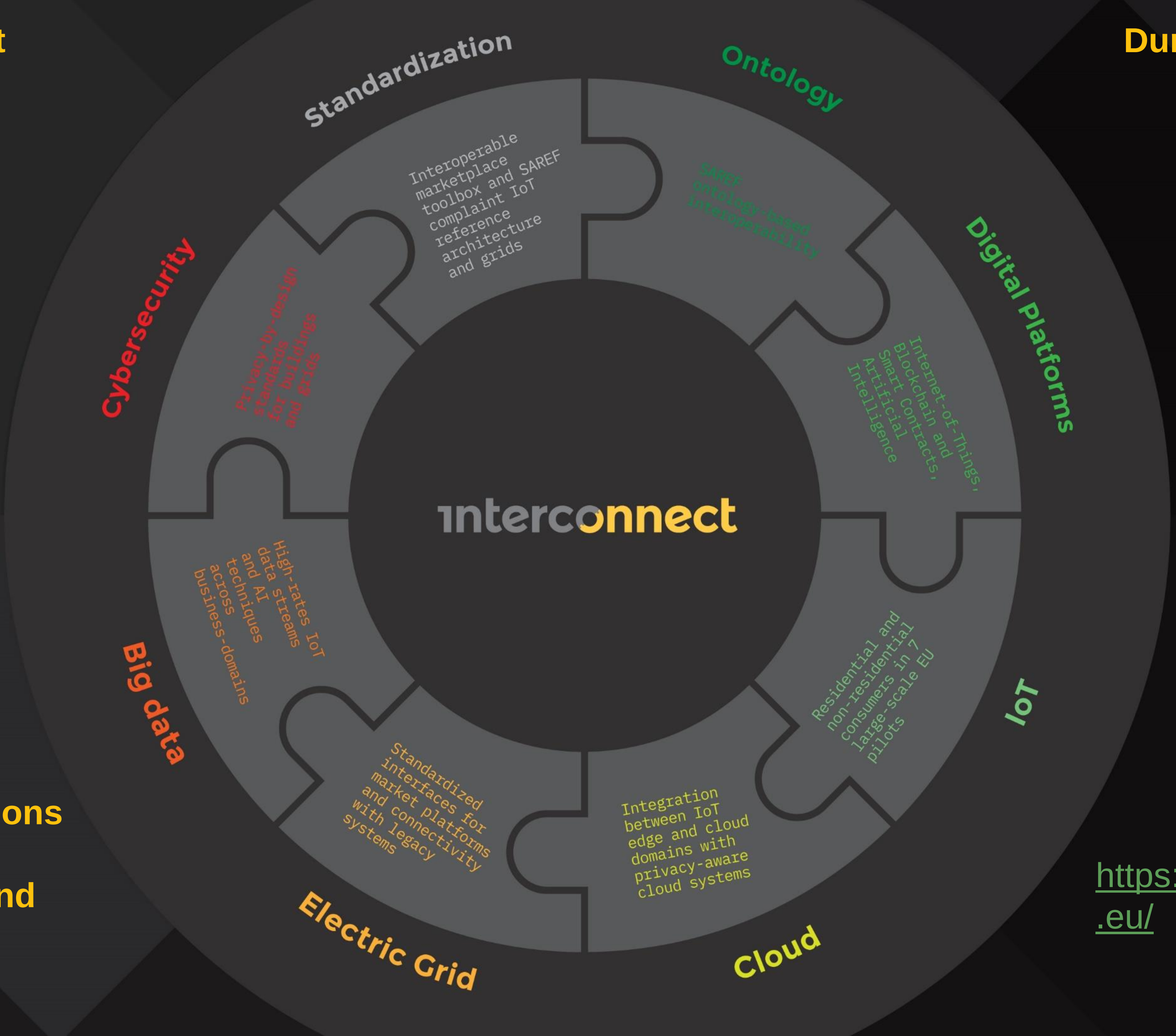
Main contact SAREF portal:
Maxime Lefrançois, IMT - MINES Saint-Étienne, maxime.lefrancois@emse.fr (STF 578 leader)

H2020 InterConnect
Large Scale Pilot

Duration 2019-2023



interoperable solutions connecting smart homes, buildings and grids

https://interconnectproject.eu/

What impacts Interconnect expects to achieve?

Deployment and adoption of IoT standards and platforms

Accelerate a wider deployment and adoption of IoT standards and platforms in smart homes and buildings in Europe and development of secure, cost-effective and sustainable IoT ecosystems and related business models

Energy apps, services and connected devices and appliances

Increasing number of energy apps, services - energy (ex: building energy efficiency, electrical mobility, renewable integration) and non-energy (comfort, convenience, security, privacy) - and connected devices and appliances

User acceptance and demonstration of concepts

Validation of end user acceptance, as well as demonstration of viable concepts that ensure privacy, liability and trust in connected data spaces

Marketplace for news services in EU

Demonstrate that IoT platforms lead to a marketplace for new services in EU homes and buildings with opportunities for SMEs and start-ups

Increase the use of renewables & energy efficiency

Contribute to increase the use of renewables and energy efficiency, offering access to cheaper and sustainable energy for consumers and maximising social welfare

Seven large scale pilots leading to market driven deployments

The future of smart energy management solutions will start by testing seven connected large-scale pilots across Europe:

- **Greece**
  - Large residential community with smart appliances and EV integration
- **France**
  - Residential & non-residential, with tertiary buildings and apartments
- **Portugal**
  - Residential & geographically widespread tertiary buildings
- **Netherlands**
  - Residential & non-residential buildings
- **Germany**
  - Groups of residential buildings and hotels
- **Belgium**
  - Residential and tertiary buildings in communities of multi-energy vectors
- **Italy**
  - Residential social housing

The consortium is composed by 50 members covering full IoT & energy value chain

R&D

Consultancy

Manufacturers

Associations

IoT/ICT Providers

DSOs

Retailers

End-User

Challenges ahead (I)

- Ontologies are perceived by stakeholders as a useful tool for interoperability, but still stakeholders do not understand them in practice

- What are the questions and challenges when concretely using (the SAREF framework of) ontologies to develop large scale applications? Especially when going across-domain, like the Interconnect project aims to do, by combining the different domains of smart homes, buildings and grids?
  - Each domain (smart homes, buildings and grids) is an already mature domain that evolved in parallel, from different requirements, different communities, creating different standards, based on different architectures, etc. Combining is a huge challenge!
    - See, for example, the challenge of defining a reference architecture that harmonizes existing IoT reference architectures with Energy architectures, while also incorporating semantic components to allow full exploitation of the reasoning capabilities associated with the ontologies

Challenges ahead (II)

- Aim of Interconnect is to develop a new, improved version of SAREF4ENER covering flexibility (and contributions to other extensions, if needed), involving more stakeholders in the energy/ building ecosystem compared to the first version
  - Consensus and agreement among many more stakeholders is therefore needed (challenging), but this effort will result into a better ontology and a broader adoption
  - How to integrate, complement and strengthen with each other important existing reference models such as, for example, ETSI SAREF family of ontologies (formalized in RDF/OWL) and IEC CIM (defined in UML), which have been developed with different purposes by different communities, but present an overlap in certain concepts?

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FINANCING

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant agreement No 857237

PROJECT CONTACT

interconnect_project@inesctec.pt

DURATION

01.10.2019 / 30.09.2023

Backup slides: SAREF4ENER

SAREF4ENER - General information

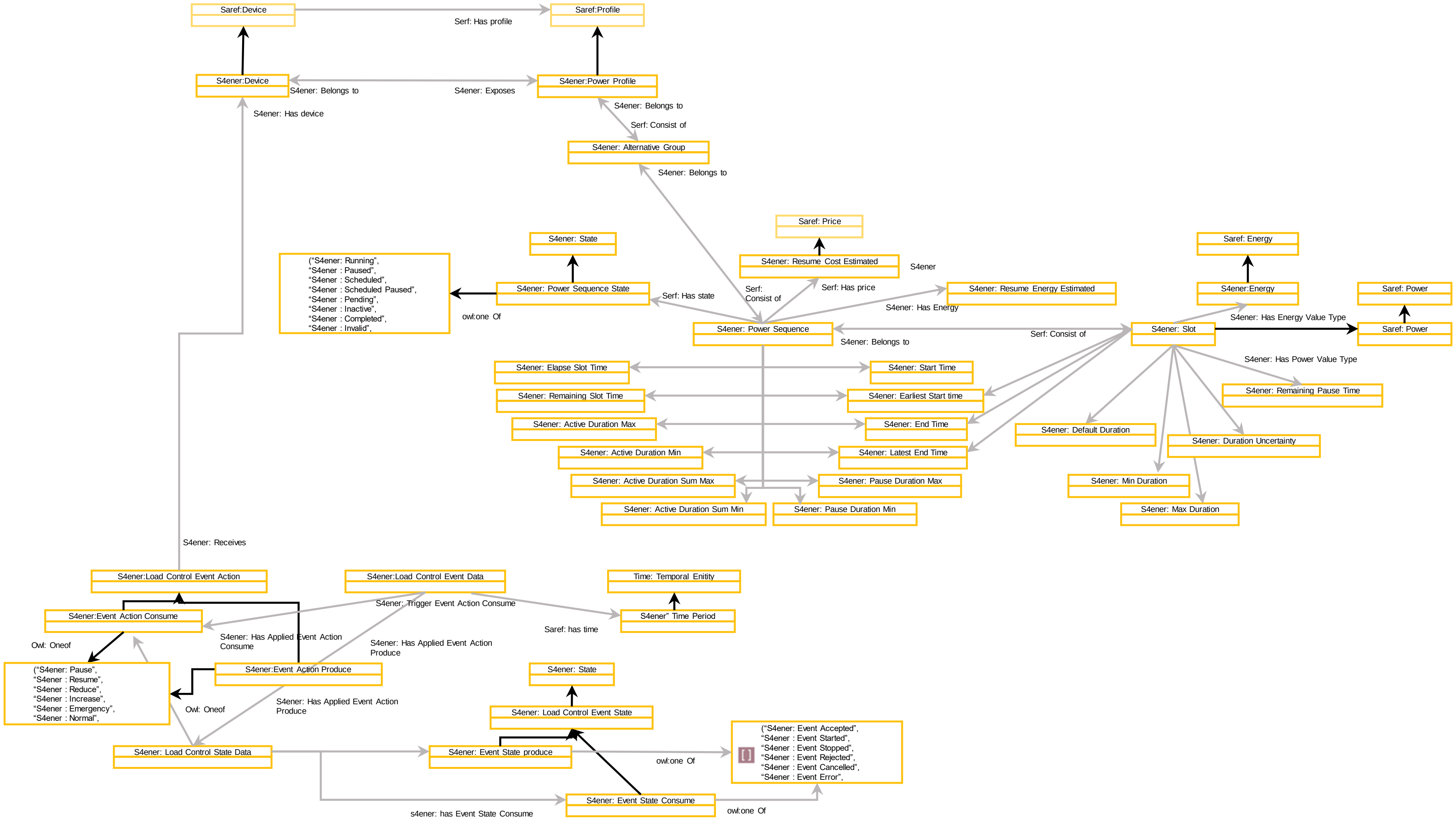
SAREF4ENER has been developed based on the data models of the Energy@Home and EEBUS associations.

More info on the current specification of SAREF4ENER can be found at https://saref.etsi.org/extensions.html#SAREF4ENER

SAREF4ENER: Extension for the Energy domain

- IRI: https://saref.etsi.org/saref4ener/
- ETSI Technical Specification: ETSI TS 103 410-1 V1.1.2 (2020-05): “SmartM2M; Extension to SAREF; Part 1: Energy Domain”
- Sources: https://saref.etsi.org/sources/saref4ener/
- All versions
  - V1.1.2
    - Version IRI: https://saref.etsi.org/saref4bldg/V1.1.2/
    - ETSI Technical Specification: ETSI TS 103 410-1 V1.1.2 (2020-05): “SmartM2M; Extension to SAREF; Part 1: Energy Domain”
  - V1.1.1
    - ETSI Technical Specification: ETSI TS 103 410-1 V1.1.1 (2017-01): “SmartM2M; Extension to SAREF; Part 1: Energy Domain”

SAREF4ENER: Overview



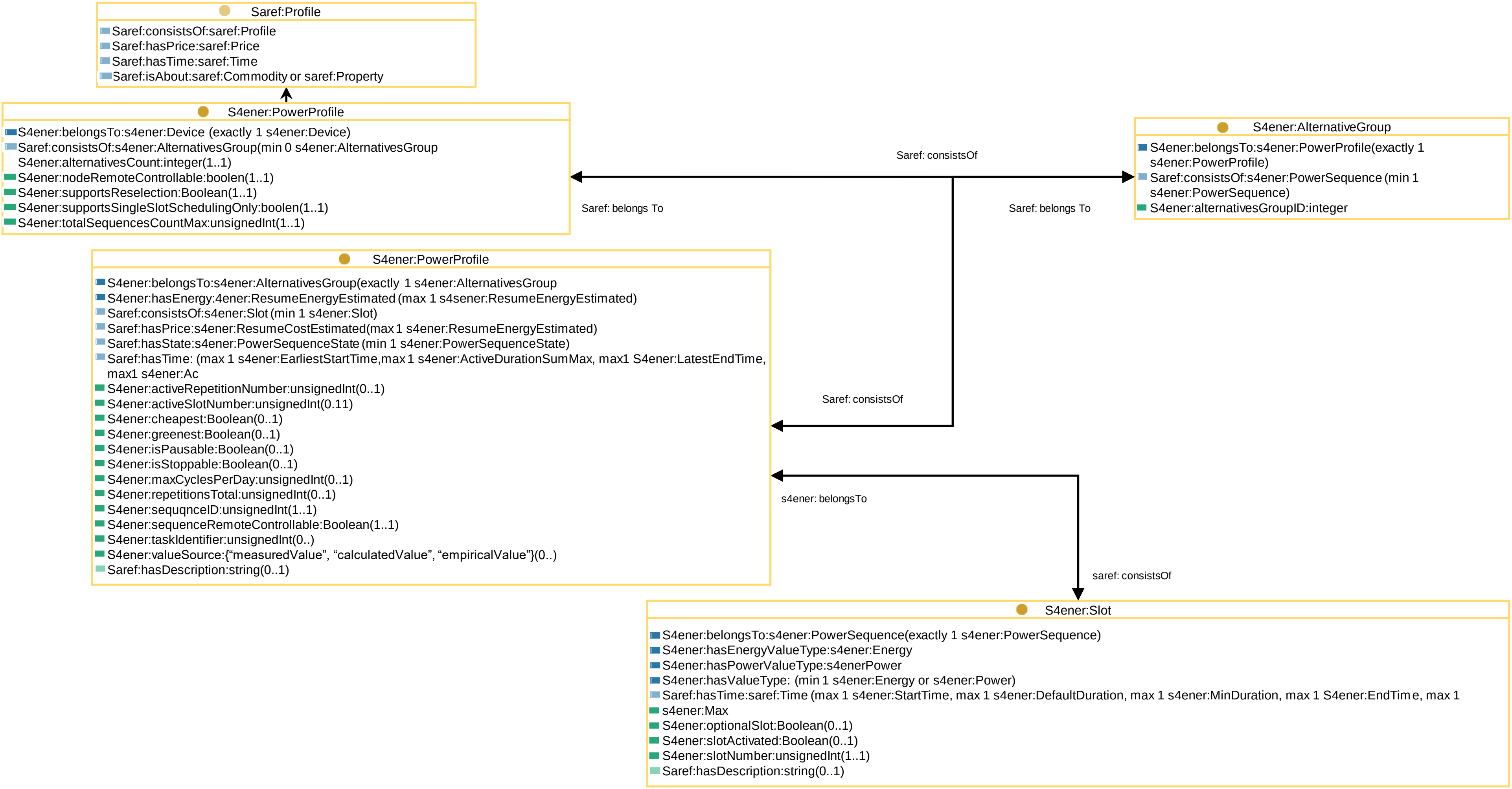
Source: ETSI TS 103 410-1 V1.1.1
Figure by Laura Daniele (TNO)

Power Profile, Alternatives Group, Power Sequence and Slot

- A power profile is a way to model curves of power and energy over time, which also provides definitions for the modelling of power scheduling including alternative plans. With a power profile, a device (or power sequences server) exposes the power sequences that are potentially relevant for the CEM (or power sequences client)
- An alternatives group is a collection of power sequences for a certain power profile
- A power sequence is the specification of a task, such as wash or tumble dry, according to user preferences and/or manufacturer's settings for a certain device. It is the most 'coarse' view; a power sequence can represent all single steps of a whole task, where the single steps are represented by slots
- A slot is a single step of a power sequence. A slot is associated with a slot number (while a power sequence is associated with a power sequence identifier). The slot numbers of two power sequences should be considered independent from each other, i.e. slot number 7 of sequence 1 describes a different slot than slot number 7 of sequence 2. Therefore, a slot is only uniquely identified in combination with a sequence ID

Source: ETSI TR 103 411 V1.1.1

SAREF4ENER: Power Profile



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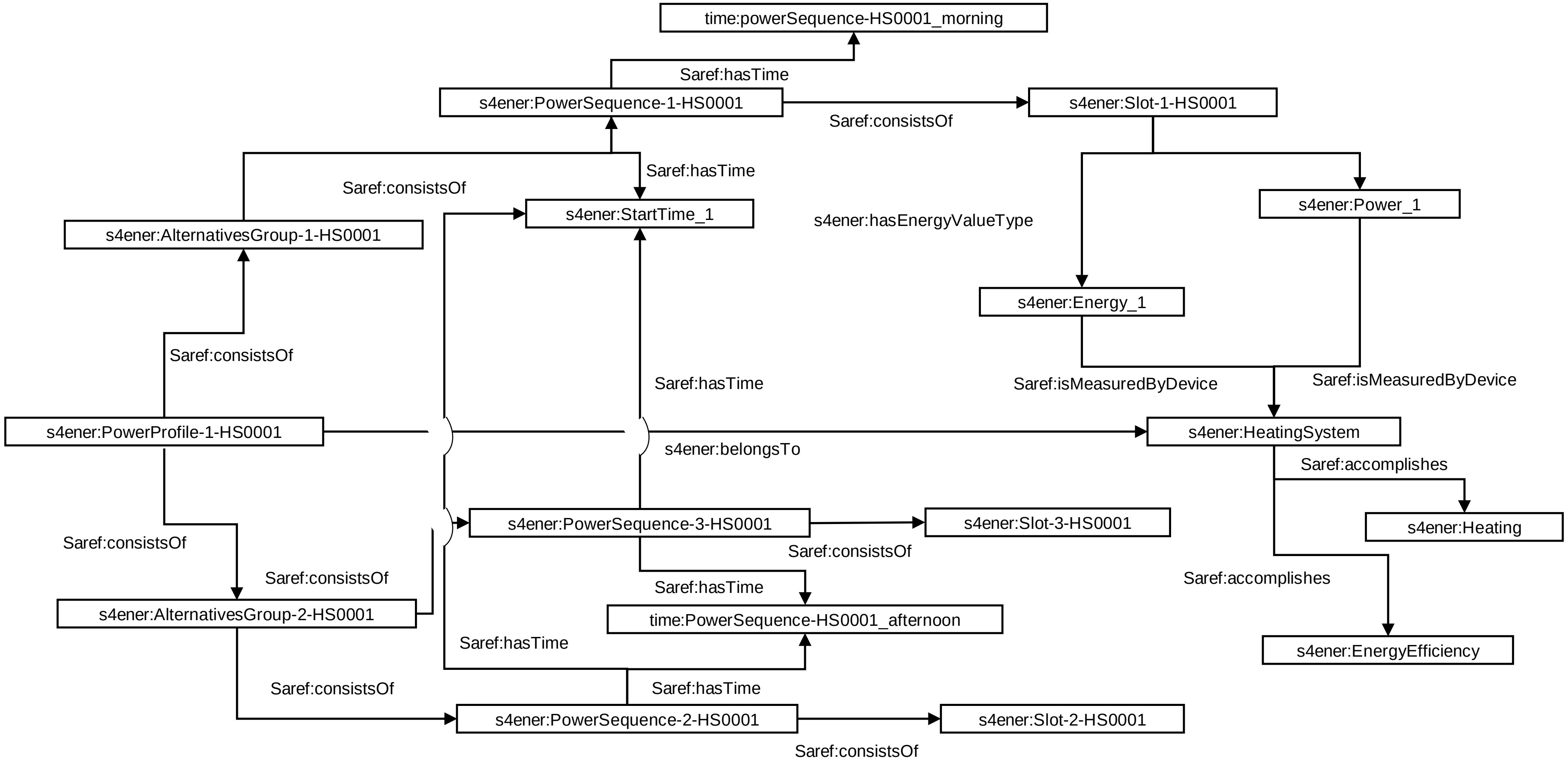
Source: ETSI TS 103 410-1 V1.1.1
Figure by Laura Daniele (TNO)

SAREF4ENER: Example (I)



Source: ETSI TS 103 410-1 V1.1.1
Figure by Laura Daniele (TNO)

SAREF4ENER: Example (II)

The s4ener:PowerProfile is used by a s4ener:Device to expose potentially relevant power sequences, for example, a heating system with hot water tank that wants to communicate its expected energy consumption for a certain day. The s4ener:HeatingSystem exposes a s4ener:PowerProfile (s4ener:PowerProfile-1-HS0001 instance), which consists of two groups with alternative plans (each group is modelled as a s4ener:AlternativesGroup class). These groups do not overlap in time and allow to model consecutive (and also rather independent) periods of action. For example, the s4ener:PowerProfile-1-HS0001 contains one group of alternatives for a task in the morning, and another group of alternatives for another (additional) task in the afternoon. Within one group, there can be one or more plans represented by s4ener:PowerSequence classes (i.e. s4ener:AlternativesGroup-1-HS0001 and s4ener:AlternativesGroup-2-HS0001) which are alternatives to each other (i.e. at most one of these plans can be finally executed). For example, to charge the hot water tank, the heating system can offer within the "afternoon alternative group" two alternative plans, represented as power sequences: (a) a "cheapest" plan in which the CEM should try to minimize the user's energy bill, and (b) a "greenest" plan in which the CEM should try to optimize the configuration towards the maximum availability of renewable energy

 Source: ETSI TR 103 411 V1.1.1

SAREF4ENER: Example (III)

In the afternoon group (s4ener:AlternativesGroup-2-HS0001) the heating system offers two different power sequences: (a) s4ener:PowerSequence-3-HS0001 that aims to run "as cheap as possible" and permits the CEM to shift the start between 8:45 and 12:00, and (b) s4ener:PowerSequence-2-HS0001 that aims to reduce energy (it can even announce the user's preference for "green energy"). This means for the afternoon the CEM can take a choice for the "cheap" or the "green" plan. The plans may have further options with regards to their flexibility. For example one of the plans may offer that the CEM can pause a sequence (as long as the sequence completes before the latest time set by the user). Finally, a s4ener:PowerSequence consists of one or more slots (s4ener:Slot class) that represent different phases of consumption (or production) and their values. The power sequences of the heating system example have a single slot each. However, for other devices such as washing machines, a power sequence may have various slots for the different phases of washing, such as heating the water, washing and rinsing

Source: ETSI TR 103 411 V1.1.1