CEN-CENELEC-ETSI Smart Grid Coordination Group

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SG-CG/ M490/F_ Overview of SG-CG Methodologies

Version 3.0

Foreword

Based on the content of the M/490 EU Mandate in its phase 1 (2011-2012), the general scope of work on standardization of the Smart Grid might be considered as follows:

> CEN, CENELEC, and ETSI are requested to develop a framework to enable European Standardization Organizations to perform continuous standard enhancement and development in the field of Smart Grids, while maintaining transverse consistency and promote continuous innovation.

In the light of the discussions held between the EC Reference Group (EG1) and the Smart Grid Coordination Group (SG-CG), the need to iterate the EC Mandate M/490 was considered and agreed on both sides.

As a main objective of the mandate phase 2, the SG-CG wishes to implement the developed methodology, which set up the foundations for managing the continuous engineering and deployment of standards to ensure a real end-to-end interoperability for all generic use cases, including explicitly security.

A further refinement of the methodology will be used for the set of consistent standards [SG-CG/G] (under item 3.1 and 3.2 of M/490).

The work is based on [SG-CG/C] and [SG-CG/E].

A set of documents is addressing this objective:

- The main report (this document) as a summary of different tools, elements and methodologies developed by the different working groups of the Smart Grid Coordination Group [SG-CG/F],

and additional separate reports detailing specific issues addressed by the working group “Methodology and New Applications”:

- The conceptual model and its relation to market models for Smart Grids [SG-CG/J]
- SGAM User Manual - Applying, testing & refining the Smart Grid Architecture Model (SGAM) [SG-CG/K]
- Overview of the main concepts of flexibility management [SG-CG/L]

Table of Contents

List of figures

List of tables

History of document

V1.0	18/12/2013	For publication and review by the BTs and TCs.
V2.0	29/08/2014	Final for distribution to the SG-CG, commenting phase
V3.0	31/10/2014	Final version after commenting period in SG-CG and integrating of the received comments

Main changes in this version

1. Executive Summary

This document is prepared by the Smart Grid Coordination Group (SG-CG) "Methodology and New Applications" Working Group (SG-CG/Method) and addresses the M/490 mandate's phase 2 deliverable regarding Smart Grid methodology and processes (in this report mainly used for standardization) and its applications to the development of new Smart Grid applications.

In the phase 2 of M/490, SG-CG/Method has taken over work of phase 1 with the intent to complement and harmonize it when necessary. Examples of such work elements are the SGAM or architecture models, or the use case methodology. The report summarizes tools and methods from all working groups (WG) of the Smart Grid Coordination Group (SG-CG).

The overall objective is to provide a methodology that is both complete and coherent. It must be flexible with respect to new applications and the emergence of new or different market models. All the methodology elements developed in SG-CG must be aligned and unambiguous. The report is short and focused on the "how to use"; when details are needed, they can be found in the separate reports [SG-CG/J-L] or in references to the results of M/490 phase 1.

The methodology relies on two pillars. Firstly, concepts and models (and to some extent tools to support them) are the building blocks for the analysis. Secondly, to conduct the work toward completion, processes insert these concepts and models in a specific workflow. These two aspects of the methodology are clearly differentiated and presented sequentially.

The role of the methodology is to support and assist other standardization groups and to provide them with easily applicable methods and architectures and ensure an easy understanding of the approach. The methodology provides tools for the identification and structuring of requirements for new Smart Grid standards and provides a framework for their development and presentation. It considers aspects ranging from markets down to information and communication technology (ICT) and electro-technical components. Though standardization technical committees are the main intended audience of the methodology, other actors like researchers, engineers or legislators can also use it.

The main concepts and models introduced (or refined) in this report are:

- A model of roles and actors including a 'market' view that is needed to ensure that the methodology can support the expected evolution of market structures in Europe.
- A Smart Grid Conceptual Model that is based on the (market) roles and actors model. It is an evolution of the one developed during M/490 phase 1.
- A Smart Grid Use Case model that can support standards development in the definition and design phases. Some support tools complement it.
- The Smart Grid Architecture Model (SGAM) as the reference model in a technology neutral manner which allows one to analyze and visualize different smart grid use cases.
- Methods and tools for Smart Grid Information Security (SGIS), interoperability and system breakdown

Once the main concepts are presented, the methodology describes how they are combined into an integrated and generic pre-standardization process involving new requirements, use cases, use of SGAM, up to the definition of new standards and profiles, and a short overview on conformance.

- [SG-CG/J] provides further details for the developments of market models based on meta models and the harmonized role model. As one result the European conceptual model is introduced. A short overview is provided in Chapter 6.

- [SG-CG/K] describes the usage of SGAM in combination with use cases and possible ways for analysis. Furthermore the report provides several examples of use cases with SGAM to demonstrate the usage and to check the completeness of the proposed methodology. The basic concepts are outlined in chapter 6 of this report.

- [SG-CG/L] analyzes the flexibility management and the traffic light concepts. It identifies and defines the relation between the developments of market models and standards.

Recommendation towards standardization development organizations (SDO):

The aim of this work is to describe new methodologies partly based on known system engineering tools, which can be used for standardization work in the area of new, innovative, and complex system of systems applications. Supported by all working groups of the SG-CG the methods, concepts, tools and processes presented here may also be interesting for real-world projects, but in these reports they are taken from quoted sources and further developed for the use in the standardization process, in order to support interoperability and the management of complex standardization tasks between the different technical committees and stakeholder groups involved.

The aim is to develop a common community view by means of accepted and harmonized use cases and broadly agreed models like the SGAM or the role based conceptual model. The management of standardization tasks is supported by tools like the gap prioritization, the SG-CG work program with dashboards, the V-model, profile development and the organization of accompanying information security. Suggestions of possible implementations in standardization are provided by process descriptions.

SDO's are able to decide where the methodologies suggested and presented can be introduced, adopted and further detailed for their own purpose. These methodologies will certainly be relevant not only for the area of Smart Grid - other 'system of system' areas should benefit as well.

2. Methodology, new applications and Smart Grid standardization

In the first phase of M/490, a large number of elements related to a methodology for Smart Grid standardization have been developed. Examples of such elements are the SGAM or architecture models (by the Reference Architecture WG in [SG-CG/C]), the Use Case Methodology (by the Sustainable Process WG in [SG-CG/E]) or the SGIS Toolbox (by the SGIS WG in [SG-CG/E]). The interaction between these different elements was described in the "Framework for Smart Grids Standardization" (in [SG-CG/A]).

In the second phase of M/490, the "Methodology and New Applications" Working Group has taken over this work with the intent to complement and harmonize it when necessary. The result of the work is a new report (i.e. this document and its additional reports) with a new perspective and largely new content. This report makes reference to the phase 1 documents mentioned above (see references in chapter 3) and, in a few cases, reuses some of their material.

2.1. Objectives

The overall objective is to provide a methodology that is both complete and coherent.

Applicability
On the one hand, the methodology must be applicable to Smart Grid standardization globally. In particular, it must be flexible with respect to new applications and the emergence of new or different market models. On the other hand, all the methodology elements developed in SG-CG must be aligned and unambiguous.

Usability
The second objective is usability. The first application of the methodology has been with the new applications investigated in the working group, thus offering a reality check supported by several examples.

Simplicity

The last objective is simplicity. The report is short and focused on the "how to use". When details are needed, they can be found in the separate reports [SG-CG/J-L] or in references to the results of M/490 phase 1.

2.2. Structure and intended usage of this report

In the definition of the methodology, two kinds of elements are developed. Concepts and models (and to some extent tools to support them) are the building blocks for the analysis. To conduct the work toward completion, processes insert these concepts and models in a specific workflow. These two aspects of the methodology are clearly differentiated and presented in a sequential manner as shown in Figure 1.

The role of the methodology is to support and assist standardization groups and to provide them with easily applicable methods and architectures and ensure an easy understanding of the approach. Though the main intended audience of the methodology is standardization technical committees, it can also be used by other actors like research projects testing new concepts or engineers developing Smart Grids products, or even the legislator in order to check the legislative framework.

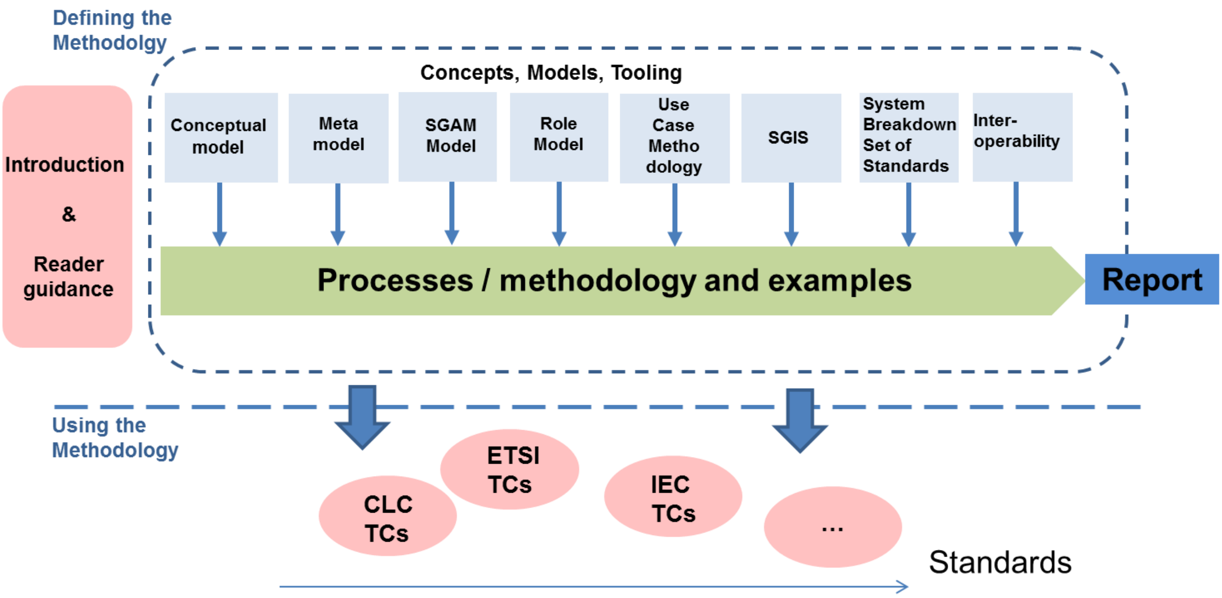

Figure 1: Elements of the Smart Grids Methodology and their usage

2.3. How to read this report

The rest of this document is structured as follows.

Chapters 3, 4 and 5 provide background information (references, etc.). Similar sections may also be present in the additional reports when they are specific.

Chapter 6 provides concepts, elements and tools for the Smart Grid methodology like the European view of the Smart Grid Conceptual Model, an overview of the general elements of a Reference Architecture, or the use case methodology. It introduces the viewpoints chosen as a target of the SG-CG/Methodology Working Group.

Chapter 7 first presents the overall process, how the various elements can be linked and how it is possible to use them across the standardization value chain (from requirements to use cases to SGAM to standards (gaps) to interoperability profiles). Then it discusses how to introduce the suggested methodologies and tools in Smart Grid standardization organizations.

3. References

Smart Grids Coordination Group Phase 1 Documents

[SG-CG/A] SG-CG/M490/A_ Framework for Smart Grid Standardization

[SG-CG/B] SG-CG/M490/B_ Smart Grid First set of standards

[SG-CG/C] SG-CG/M490/C_ Smart Grid Reference Architecture

[SG-CG/D] SG-CG/M490/D_ Smart Grid Information Security

[SG-CG/E] SG-CG/M490/E_ Smart Grid Use Case Management Process

[Gap Prioritization] CEN-CENELEC-ETSI Smart Grid Coordination Group, 'Standardization Gaps Prioritization for the Smart Grid' v.2.1, (SGCG_Sec0028_DC), Brussels, 2011

[Work Program] CEN-CENELEC-ETSI Smart Grid Coordination Group, ' Program of standardization work for the Smart Grid' (SGCG_Sec0032_DC (version 1.6)), Brussels, 2012 […]

Smart Grids Coordination Group Phase 2 Documents

[SG-CG/F] SG-CG/M490/F_ Overview of SG-CG Methodologies (this document)

[SG-CG/G] SG-CG/M490/G_ Smart Grid Set of standards

[SG-CG/H] SG-CG/M490/H_ Smart Grid Information Security

[SG-CG/I] SG-CG/M490/I_ Smart Grid Interoperability

[SG-CG/J] SG-CG/M490/J_ Conceptual model - market models

[SG-CG/K] SG-CG/M490/K_ SGAM usage and examples

[SG-CG/L] SG-CG/M490/L_ Flexibility Management

References made in this document

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[GWAC:2008] GridWise Interoperability Context-Setting Framework (March 2008), GridWise Architecture Council, online: www.gridwiseac.org .

[HEM-RM:2011] The Harmonized Electricity Market Role Model (December 2011), ENTSO-E, online: https://www.entsoe.eu/fileadmin/user_upload/edi/library/role/role-model-v2011-01.pdf.

[IEC 61850] Communication networks and systems for power utility automation, 2010.

[IEC 61850-7] Communication networks and systems for power utility automation - Part 7: Basic communication structure

[IEC 61850-8] Communication networks and systems for power utility automation - Part 8: Specific communication service mapping (SCSM)

[IEC 62264:2003] IEC 62262, Enterprise-control system integration

[IEC 62351] Power systems management and associated information exchange

[IEC 62357:2011] IEC 62357-1, TR Ed.1: Reference architecture for power system information exchange, 2011.

[IEC 62559] IntelliGrid Methodology for Developing Requirements for Energy Systems

[IEC 62559-2] "Use case methodology – Part 2: Definition of the templates for use cases, actor list and requirements list", CDV, 2013

[IEC PAS 62559:2008] IEC PAS 62559:2008-01, IntelliGrid Methodology for Developing Requirements for Energy Systems, 2008

[ISO/IEC 19505-2:2012] Information technology - Object Management Group Unified Modeling Language (OMG UML) - Part 2: Superstructure

[ISO/IEC 27001] Information technology - Security techniques - Information security management systems - Requirements

[ISO/IEC 27002] Information technology - Security techniques - Code of practice for information security controls

[ISO/IEC 42010:2011] ISO/IEC 42010: Systems Engineering – Architecture description, 2011

[ISO/IEC TR 27019] Information technology - Security techniques - Information security management guidelines based on ISO/IEC 27002 for process control systems specific to the energy utility industry

[Jonkers 2010] TOGAF 9 and ArchiMate 1.0 White paper, The Open Group 2010, see also http://pubs.opengroup.org/architecture/togaf9-doc/arch/ and http://pubs.opengroup.org/architecture/archimate2-doc/

[Mapping Tool] SMART GRID STANDARDS MAPPING TOOL, http://smartgridstandardsmap.com/, 2013

[NIST IR-7628] Guidelines for Smart Grid Cyber Security, www.nist.gov/smartgrid/upload/nistir-7628_total.pdf, 2010

[NIST:2009] NIST Framework and Roadmap for Smart Grid Interoperability, Interoperability Standards Release 1.0 (2009), Office of the National Coordinator for Smart Grid Interoperability, National Institute of Standards and Technology, U.S. Department of Commerce. Online:

[NERC CIP] North American Electric Reliability Corporation, Critical Infrastructure Protection www.nerc.com/pa/Stand/Pages/CIPStandards.aspx

[Trefke 2012] "Grundlagen der Referenzarchitekturentwicklung", Jörn Trefke, in „IT-Architekturentwicklung im Smart Grid“, 1 ed., Berlin Heidelberg: Springer, 2012.“

4. Terms and definitions

Terms related to the description of actors and meta-model[1]

Actor
An Actor represents a party that participates in a business transaction. Within a given business transaction an actor performs tasks in a specific role or a set of roles.
EXAMPLE: Employee, Customer, Electrical vehicle, Demand-response system.

Party
Parties are legal entities, i.e. either natural persons (a person) or judicial persons (organizations). Parties can bundle different roles according to their business model.
EXAMPLE: real organisations like Dong Energy, Alliander, APX Group.

Responsibility
Responsibilities define external behavior to be performed by parties.
EXAMPLE: Nominate Energy, Operate a grid, Determine the market energy price after applying technical constraints.

Role
A Role represents the intended external behavior (i.e. responsibility) of a party. Parties cannot share a role. Parties carry out their activities by assuming roles, e.g. system operator, trader. Roles describe external business interactions with other parties in relation to the goal of a given business transaction.
EXAMPLE: Balance Responsible Party, Grid Operator, Market Operator.

[1] Refer also to clause 6.2

Terms related to the description of architectural concepts

Architecture
Fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution [ISO/IEC 42010].

Architecture Framework
Conventions, principles and practices for the description of architectures established within a specific domain of application and/or community of stakeholders [ISO/IEC 42010].

Conceptual Model
A Smart Grid is a complex system of systems for which a common understanding of its major building blocks and how they interrelate must be broadly shared. SG-CG has developed a *conceptual architectural reference model* to facilitate this shared view: the European conceptual model of Smart Grid clusters, (European harmonized) roles and system actors, in line with the European electricity market and electricity system as whole. This model provides a means to analyze use cases, identify interfaces for which interoperability standards are needed, and to facilitate development of a cyber-security strategy (adopted from [NIST 2009]).

Smart Grid Architecture Model
The Smart Grid Architecture Model (SGAM) is a reference model to analyse and visualise smart grid use cases in respect to interoperability, domains and zones.

Domain
In the rest of the document (and its additional reports), this term may refer to two different concepts. In order to avoid ambiguity, the full names 'Conceptual Domain' or 'SGAM Domain' (as defined below) will be used systematically.

Conceptual Domain
A conceptual domain highlights the key areas of the conceptual model from the point of view of responsibility. It groups (market) roles and their associated responsibilities present in the European electricity markets and the electricity system as a whole.

SGAM Domain
One dimension of the *Smart Grid Plane* that covers the complete electrical energy conversion chain, partitioned into 5 domains: Bulk Generation, Transmission, Distribution, DER (Distributed Energy Resources) and Customers' Premises.

Interoperability
Interoperability refers to the ability of two or more networks, systems, devices, applications, components to interwork, to exchange and use information to perform required functions.
[SG-CG/I]

Reference Architecture
A Reference Architecture describes the *structure* of a system with its element types and their structures, as well as their *interaction* types, among each other and with their environment. A Reference Architecture defines restrictions for an instantiation (concrete architecture). Through abstraction from individual details, a Reference Architecture is universally valid within a specific domain. Further architectures with the same functional requirements can be constructed based on the reference architecture. Along with *reference* architectures comes a *recommendation*, based on experiences from existing developments as well as from a wide acceptance and recognition by its users or per definition (following [Trefke 2012]).

SGAM Interoperability Layer
In order to allow a clear presentation and simple handling of the architecture model, the interoperability categories described in the GridWise Architecture model are aggregated in SGAM into five abstract interoperability layers: Business, Function, Information, Communication and Component.

SGAM Smart Grid Plane

The Smart Grid Plane is defined from the application to the Smart Grid Conceptual Model of the principle of separating the Electrical Process viewpoint (partitioning into the physical domains of the electrical energy conversion chain) and the Information Management viewpoint (partitioning into the hierarchical zones (or levels) for the management of the electrical process [IEC 62357:2011, IEC 62264:2003].

SGAM Domain
See above.

SGAM Zone
One dimension of the *Smart Grid Plane* represents the hierarchical levels of power system management, partitioned into 6 zones: Process, Field, Station, Operation, Enterprise and Market [IEC 62357:2011].

Systems
A typical industry arrangement of components and systems, based on a single architecture, serving a specific set of use cases
[SG-CG/B]

<u>Terms related to the description of use cases concepts</u>

Coordinating TC
A technical committee within a standardization organization taking over the responsibility for agreed use cases while involving other interested and concerned technical committees.
NOTE For example the responsibility might include further detailing, analysis, maintenance and harmonization of the use case.

Generic Use Case
A use case that is broadly accepted for standardization, usually collecting and harmonizing different real use cases without being based on a project or technological specific solution.

High Level Use Case
A use case that describes a general requirement, idea or concept independently from a specific technical realization like an architectural solution.

Individual Use Case
A use case that is specifically for a project or within a company / organization.

Involved TC
A technical committee within a standardization organization with an interest in a generic use case.

Primary Use Case
A use case that describes in detail the functionality of (a part of) a business process.
NOTE Primary use cases can be related to a primary goal or function, which can be mapped to one architectural solution.

Repository
A place where information like use cases can be stored (see Use Case Repository).

Scenario
A possible sequence of interactions.
NOTE Scenario is used in the use case template defining one of several possible routes in the detailed description of sequences.

Secondary Use Case
An elementary use case that may be used by several other primary use cases.
EXAMPLE Authentication, Authorization, Accounting

Specialized Use Case
A use case that is using specific technological solutions / implementations.
EXAMPLE Use case with a specific interface protocol

Use Case

Specification of a set of actions performed by a system, which yields an observable result that is, typically, of value for one or more actors or other stakeholders of the system

[ISO/IEC 19505-2:2012, 16.3.6 Information technology – Object Management Group Unified Modeling Language (OMG UML) – Part 2: Superstructure]

NOTE 1 There are two types of Use Cases:

- Business Use Cases describe how Roles of a given system interact to execute a business process. These processes are derived from services, i.e. business transactions, which have previously been identified.
- System Use Cases describe how Actors of a given system interact to perform a Smart Grid Function required to enable / facilitate the business processes described in Business Use Cases. Their purpose is to detail the execution of those processes from an Information System perspective.

NOTE 2 Since a Smart Grid Function can be used to enable / facilitate more than one business process, a System Use Case can be linked to more than one Business Use Case.

[IEC TS 62913-2 CD]

Use Case Cluster

A group of use cases with a similar background or belonging to one system or one conceptual description.

Use Case Repository

A database for edition, maintenance and administration of use cases that are based on a given use cases template.

NOTE The UCR is designed as collaborative platform for standardization committees, inter alia equipped with export functionalities as UML model or text template.

Use Case Template

A form that allows the structured description of a use case in predefined fields.

5. Symbols and abbreviations

AMI	Advanced Metering Infrastructure
ACSI	Abstract communication service interface
BAP	Basic Application Profiles
BAIOP	Basic Application Interoperability Profiles
CC	Coordinating Committee
CD	Committee Draft for Comments
CDV	Committee Draft for Voting
CEN	Comité Européen de Normalisation
CENELEC	Comité Européen de Normalisation Electrotechnique
CIM	Common Information Model
CIS	Customer Information Services
CTC	Coordinating Technical Committee
DER	Distributed Energy Resources
DMS	Distributed Management System
DPIA	Data Protection Impact Assessment
DSO	Distribution System Operator
DUT	Device Under Test
eBIX	(European forum for) energy Business Information Exchange
EC	European Commission
EFET	European Federation of Energy Traders
EMS	Energy Management Systems
EN	European Standard
ENAP	EN Approval Procedure
ENISA	European Union Agency for Network and Information Security

ENTSO-E	European Network of Transmission System Operators for Electricity
ENQ	Enquiry
ESCO	Energy Service Company
ETSI	European Telecommunications Standard Institute
EU	European Union
FDIS	Final Draft International Standard
GUC	Generic Use Cases
GWAC	GridWise Architecture Council
HEM-RM	Harmonized Electricity Market Role Model
HL-UC	High Level Use Case
ICT	Information & Communication Technology
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force
IOP	Interoperability Profiles
IS	International Standard
ISO	International Organization for Standardization
ITU	International Telecommunication Union
MG	Microgrid
MICS	Model Implementation Conformance Statement
MMS	Manufacturing Messaging Specification
MMXU	Measurement logical node
NIST	National Institute of Standards and Technology
NP	New Work Item Proposal (Altern. NWIP New Work Item Proposal)
PAIOP	Project Application Interoperability Profiles
PAP	Project Application Profiles
PICS	Protocol Implementation Conformance Statement
PIXIT	Protocol Implementation eXtra Information for Testing
PWI	Preliminary Work Item
RDF	Resource Description Framework
SCADA	Supervisory Control and Data Acquisition
SDO	Standards Developing Organization
SGAC	SGIP Smart Grid Architecture Committee
SGAM	Smart Grid Architecture Model
SG-CG	Smart Grids Coordination Group
SG-CG/Meth	SG-CG “Methodology and New Applications” Working Group
SGIP	Smart Grid Interoperability Panel
SGIS	Smart Grid Information Security
SGTF EG2	Smart Grid Task Force Expert Group 2
SM-CG	Smart Metering Coordination Group
ST	Support Team
TAP	Two-step Approval Procedure
TB	Technical Body
TC	Technical Committee
TF	Task Force
TOGAF	The Open Group Architecture Framework
TR	Technical Report
TSO	Transmission System Operator
UCR	Use Case Repository (Altern. UCMR Use Case Management Repository)
UML	Unified Modeling Language
WD	Working Draft
WG	Working Groups
WGI	Working Group Interoperability
WG SS	Working Group Set of Standards
XML	Extensible Markup Language

6. Concepts, elements and tools for the Smart Grid methodology[2]

6.1. Introduction

This section provides a high-level view of the concepts, elements and tools for Smart Grid methodology and processes. It is meant to be short, concise and descriptive. This chapter also includes summaries of concepts developed in other working groups of the SG-CG. More details can be found in the additional reports [SG-CG/J-L] (refer to chapter 3 References).

The goal of the Smart Grid methodology is to support international standards development for Smart Grid technologies, products, components, and systems and their interfaces, to support and boost the large-scale deployment of Smart Grids and smart markets in Europe. The methodology provides tools for the identification and structuring of requirements for new Smart Grid standards and provides a framework for their development. It considers aspects ranging from markets down to ICT and electro-technical components. Another added value of these tools is a better overview: e.g. the set of standards document [SG-CG/B] [SG-CG/G] is a selection guide for users of standards.

6.2. Roles and actors in smart grids and smart markets

The applicability of Smart Grid standards in both the current as well as the future European power system must be ensured for large-scale deployment. Therefore it is critical that the design of Smart Grid standards is ‘compatible’ with the evolving market structures in the European Union. In order to guarantee that, the concepts of (market) roles and actors are introduced; these form the basic components, which are used in the European conceptual model, the SGAM model and use cases. The concept of (market) roles and actors allow for the development market structure agnostic standards, as they can be defined in terms of responsibilities that are independent from a certain market structure.

6.2.1. Roles for market models

In Europe, the market models define which activities are regulated and which activities are allowed in the commercial market. In that context, the activities of smart grid parties (e.g. the various DSOs, TSOs, suppliers, Energy Service Companies (ESCOs), traders, customers, etc.) are defined by their roles and responsibilities. This role-allocation to parties may be subject to regulation / legislation.

The energy transition will require an update of existing market models, which differ today, even in different EU member states. For example a DSO in the UK does not have the responsibility for electricity usage administration (this responsibility is assigned to the retailer), while DSOs in other EU member states do. The challenge is to develop standards that are applicable in different European market models and also support the development of more generic European market models. Success will come with the development of standards that support roles.

ENTSO-E, eBIX and EFET have created a harmonized and clear definition of the market roles in the various electricity markets of the EU member states. These roles are modeled in the Harmonized Electricity Market Role Model [HEM-RM 2011].

6.2.2. Actors

The development of system requirements is a key ingredient for the development of Smart Grid and smart market standards. Identifying the actors of and their interactions within Smart Grids and smart markets are an important step therein from the market level to the technology level (see also 6.4 on use cases).

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[2] This report is mainly contributed to the use of concepts elements and tools in standardization but they might be used also for other purposes like engineering or also in other technological areas than smart grid (e.g. Smart Home, Smart City, etc.)

A generic actor list, derived from generic use cases provided by the SG-CG, includes the role-actor relationships. This supports the analysis of the business context when defining requirements of Smart Grid systems from use cases, as the first step towards standards. Moreover, it ensures the required applicability of standards based on these requirements in all market models in the current European electricity market.

6.2.3. Modelling of roles, actors and related concepts

The meta-model in the figure below clarifies the relationship between roles, actors, responsibilities and parties. It only describes the elements required for the meta-model; a more detailed version, with the alignment rationale to SGAM, TOGAF and the Harmonized Electricity Market Role Model can be found in [SG-CG/J] on meta models.

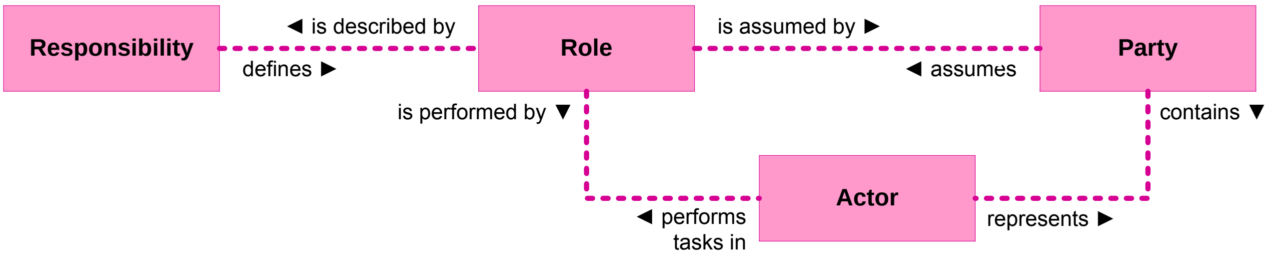

Figure 2: Meta-model of the concepts related to actors and roles

Figure 2 shows elements of the model and their relationships. The relationships can be read in both directions, using the reading direction of the labels, e.g. an Actor performs tasks in a Role.

The elements of the diagram are defined as:

Party Parties are legal entities, i.e. either natural persons (a person) or judicial persons (organizations). Parties can bundle different roles according to their business model.
EXAMPLES: real organisations like Dong Energy, Alliander, APX Group.

Responsibility Responsibilities define external behavior to be performed by parties.
Examples: Nominate Energy, Operate a grid, Determine the market energy price after applying technical constraints.

Role A Role represents the intended external behavior (i.e. responsibility) of a *party*. *Parties* cannot share a *role*. Parties carry out their activities by assuming *roles*, e.g. system operator, trader. *Roles* describe external business interactions with other *parties* in relation to the goal of a given business transaction.
EXAMPLES: Balance Responsible Party, Grid Operator, Market Operator.

Actor An Actor represents a *party* that participates in a (business) transaction. Within a given business transaction an *actor* performs tasks in a specific *role* or a set of *roles*.
EXAMPLES: Employee, Customer, Electrical vehicle, Demand-response system.

The term *Actor* can be used in other contexts within smart grids methodology, particularly discussions around technology. If it helps, in the context of the discussion, the type of actor can be qualified, such as *business actor* in the role model and *system actor* when referring to technological systems.

6.2.4. Generic actor list

Since standards and interoperability are achieved through multiple iterations in the standardization process, it is envisaged to start with a generic set of actors within the Smart Grid Coordination Group. Based on these, technical committees (e.g. of the IEC/TC 8 WG 6) will further refine these actors in the development of actual standards. When these standards are implemented, parties will even further refine them to take into account concerns specific to their implementation.

In this chain of refinement, it is critical that the link between actors and roles is kept intact in order to guarantee robustness to the various market structures. In the context of standardization, for the widest applicability, it should be a goal that, for every actor defined in the generic list, there is only one role to which it relates. This is to ensure that the definition of actors in standards do not force the combination of roles in implementation. However, in specific implementations, actors *may* (e.g. for efficiency) in fact relate to several roles.

When defining use cases as start of the process, it is key that they are built on agreed actor definitions and are reused among different uses cases as much as possible. This creates a commonly used actor list and reduces doubling of actors and misunderstanding regarding the behavior of the actors (Figure 3).

This generic actor list (with only the most abstract actors) is given in [SG-CG/E] including its relationship to roles.

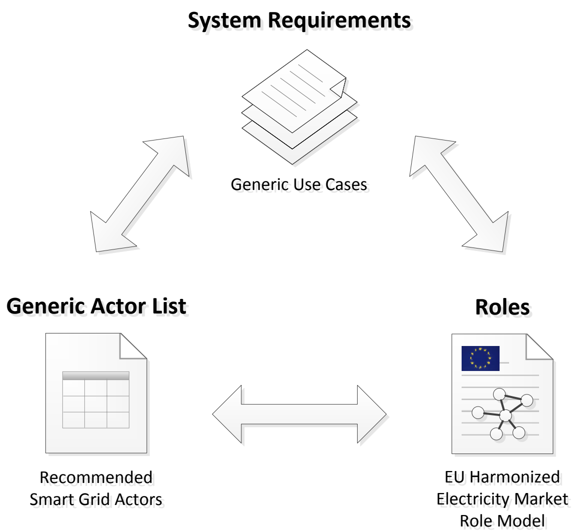

Figure 3: Information flow between roles, actors and use cases

6.3. Smart Grid conceptual model

During the coming years the power system will undergo fundamental changes. In order to define standards that support this transition in a consistent way, applicable in all European markets, a generic European conceptual model is required. This European conceptual model is to be regarded as the starting point for all modeling activities, and for all other models, frameworks, and architectures, which are used to arrive at standards required for Smart Grids and smart markets.

The conceptual model aims to highlight the key areas of attention – conceptual domains and subdomains – from the point of view of responsibility (refer to Figure 4). The model consists of four main conceptual domains: *Operations*, *Grid Users, Markets, and Energy Services*. Each of these conceptual domains contains one or more subdomains which group market roles from the European electricity market. To support its recognition, the *Operations* and *Grid Users* conceptual domains also show some well-known system actors that are present in those domains.

Its main underpinning is the analysis of roles and responsibilities from [HEM-RM 2011]. While this model is based on the electricity market structures of the EU member states, their roles and responsibilities are cleanly defined and provide a solid basis; new parties may enter certain markets, responsibilities may be redistributed, but the fundamental roles and their respective responsibilities are expected to remain constant.

Operations and *Grid Users* are conceptual domains that are directly involved in the physical processes of the power system: electricity generation, transport/distribution and electricity usage. Also, these domains include (embedded) ICT enabled system actors. The *Markets* and *Energy Services* conceptual domains are defined by roles and actors and their activities in trade of electricity products and services (markets), and the participation in the processes of trade and system operations representing grid users (energy services).

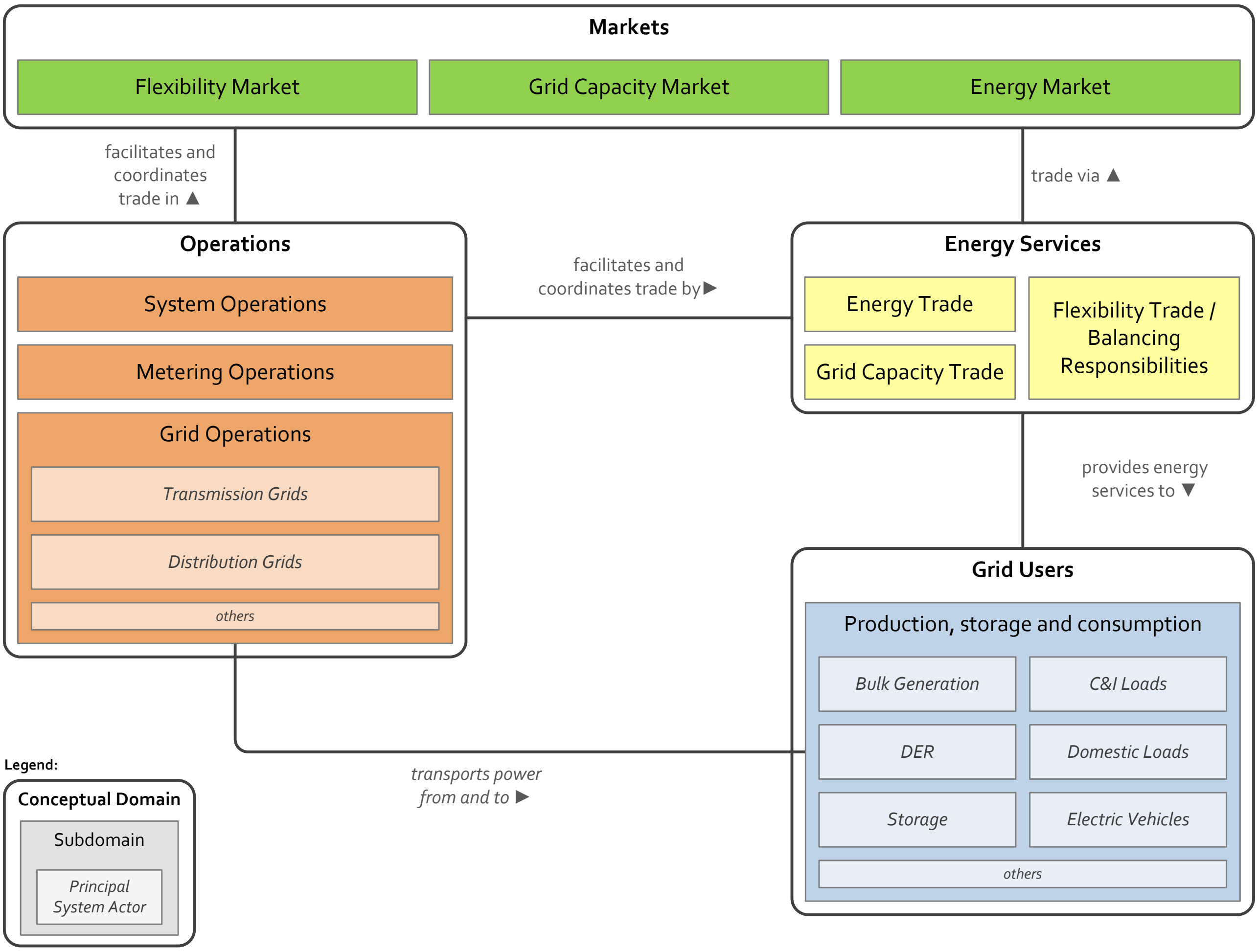

Figure 4: European Conceptual Model for the Smart Grid

In the creation of this conceptual model, input is used from the EU-flexibility concept, [SG-CG/E], NIST, SGIP, SGAC, the Harmonized Electricity Market Role Model (HRM-RM) and European market model developments (e.g. EG3). For more details on how this information is used and which starting principles are the basis for this model, please refer to [SG-CG/J] on the conceptual model.

Furthermore, [SG-CG/J] describes a more detailed mapping of all roles from the Harmonized Electricity Market Role Model and the domains in this conceptual model and a description of each of these roles. Refer also to [SG-CG/J] and [SG-CG/L] on how to define actors in the context of this conceptual model.

6.3.1. Conceptual domains

The sections below provide descriptions for the domains in the conceptual model introduced above.

6.3.1.1. Operations

The *Operations* conceptual domain is defined by roles and actors related to the stable and safe operations of the power system. The domain ensures the usage of the grid is within its operational constraints and facilitates the activities in the market. Actors in this domain may use services from the market to fulfill these responsibilities. *Grid Operations*, *System Operations* and *Metering Operations* are identified as sub-domains in the *Operations* conceptual domain. System actors in this domain include grid assets such as transformers, switchgear, distribution management systems (DMS), energy management systems (EMS), as well as microgrid management systems, metering systems, control center systems, etc. *in transmission and distribution grids*.

Roles in the *Operations* conceptual domain are:

Subdomain	***Harmonized role***
System Operations	System Operator, Control Area Operator, Control Block Operator, Coordination Center Operator, Imbalance Settlement Responsible, Reconciliation Responsible
Metering Operations	Meter Administrator, Meter Operator, Metering Point Administrator, Metered Data Aggregator, Metered Data Collector, Metered Data Responsible
Grid Operations	Grid Operator, Grid Access Provider

6.3.1.2. Grid users

The *Grid Users* conceptual domain is defined by roles and actors involved in the generation, usage and possibly storage of electricity; from bulk generation and commercial and industrial loads down to distributed energy resources, domestic loads, etc. The roles and actors in this domain use the grid to transmit, distribute and receive power from generation to the loads. Apart from roles related to the generation, load and storage assets, the *Grid Users* conceptual domain includes system actors such as (customer) energy management and process control systems. Grid users also provide flexibility, as they become an active participant of the energy system.

Roles in the *Grid Users* conceptual domain are:

Subdomain	***Harmonized role***
Production, storage and consumption	Party Connected to the Grid, Consumer, Producer

6.3.1.3. Energy services

The *Energy Services* conceptual domain is defined by roles and actors involved in providing energy services to the *Grid Users* conceptual domain. These services include balancing & trading of electricity generated, used or stored by the *Grid Users* domain, and ensuring that the activities in the Grid Users domain are coordinated in e.g. the system balancing mechanisms and customer information services (CIS) systems.

Through the *Energy Services* conceptual domain, the *Grid Users* conceptual domain is connected to activities such as trade and system balancing. From the *Grid Users* domain, flexibility in power supply and demand is provided. This flexibility is used for system balancing (through e.g. ancillary services, demand response, etc.) and trading on the market. Additionally, roles related to trade in grid capacity are included.

The roles and actors from the *Energy Services* conceptual domain facilitate participation in the electricity system, by representing the *Grid Users* conceptual domain in operations (e.g. balance responsibility) and markets (trading).

Roles in the *Energy Services* conceptual domain are:

Subdomain	***Harmonized role***
Energy Trade	Balance Supplier, Block Energy Trader, Reconciliation Accountable
Grid Capacity Trade	Capacity Trader, Interconnection Trade Responsible
Flexibility Trade / Balancing Responsibilities	Balance Responsible Party, Consumption Responsible Party, Production Responsible Party, Trade Responsible Party, Scheduling Coordinator, Resource Provider

6.3.1.4. Markets

The *Markets* conceptual domain is defined by the roles and actors that support the trade in electricity (e.g. on day ahead power exchanges) and other electricity products (e.g. grid capacity, ancillary services). It is reflecting the market operations that are possible along the energy conversion chain, e.g. energy trading, mass market, retail market. Sub-domains which are identified in this domain are: *Energy Market* (e.g. commodity market), *Grid Capacity Market* (e.g. Transmission capacity market), and *Flexibility Market* (e.g. Imbalance market). Activities in the *Markets* domain are coordinated by the *Operations* domain to ensure the stable and safe operation of the power system. An example of system actors in this domain is trading platforms.

Roles in the *Markets* conceptual domain are:

Subdomain	***Harmonized role***
Flexibility Market	Reserve Allocator, Merit Order List Responsible
Grid Capacity Market	Capacity Coordinator, Transmission Capacity Allocator, Nomination Validator
Energy Market	Market Information Aggregator, Market Operator

6.4. Smart Grid use cases

6.4.1. Introduction: Use cases and standardization

The idea of use case descriptions was developed originally for software engineering projects. In the following Table 1 some advantages are summarized highlighting the purpose of use cases in standardization:

Table 1 - Advantages of use case descriptions

Use cases gather requirements	Use cases gather requirements, information about functionalities, processes and respective actors in a structured form.
Support standards development	It is the intention that use case descriptions support development of standards in the design and definition phase, e.g. in areas like interoperability, terminology, safety, risk assessment, security and others.
Enable a common understanding between different stakeholder groups and its coordination *Guidance for users of standards*	A discussion of these use cases with its requirements and descriptions should enable a common understanding between different sectors, committees or organizations. Therefore use case descriptions are mainly used for new, complex systems of cross-cutting nature. In this respect they can be seen as a link between new requirements (also from external sources representing e.g. market needs) and standardization. As use cases can be seen as a bracket for a number of standards and standardization activities, they support the management of standardization activities and provide guidance for users of standards.
Management of	Depending on the level of granularity of the description the use cases support the

standards development in complex systems	assignment and management of standards and committees which are related to the respective use case as well as the development of a standardization work program.
Test use cases / Training	Beneath these basic functions validated use cases can be used for testing or training purposes. Therefore use cases will not only have preparatory and administrative functions for standardization organizations and the development of standards. In combination with other tools and models (refer to chapter 7 and the report of the WG Interoperability) they are needed to prove interoperability.
Use Cases - basis for further engineering	Use Cases described in the given template are the basis for further engineering in the technical committees or even for individual projects.
Not only for Smart Grid	The use case methodology is not only used for Smart Grids, as it is general enough to be transferred to other areas in standardization as well.

6.4.2. Use case template

The template as defined in [IEC 62559-2] is a structured format for use case description that helps to describe, compare and administer use cases.

The template mainly contains the following information:

- Administrative information (e.g. version management)
- Description of the function(s)
    - E.g. general narrative description, pictures, detailed description within the scenarios and activities
- The system under discussion (subject) and its design scope
- Actors linked to the function and activities (here activity means: one step of the detailed step-by-step description)
- Extended information for classification of use cases or information to link use cases to other developments (e.g. link use cases to standards or to the SGAM) and to provide information like the maturity of the use case and references like laws, regulation, or grid codes in relation to the use case (depending on the detail of the use case).

The template in its detailed version is designed for an in-depth analysis of processes, information that is exchanged as well as requirements that are linked to this information exchange.

Nevertheless, the author of the use case defines the granularity of his description according to his needs and the task of the respective use case description. In general an iterative approach is recommended: starting with a short description and an easy template (but using fields of the defined template according to [IEC 62559-2]), discussing and extending the description, detailing the use case, if needed, and linking it to other use cases.

The template itself is linked to other databases that contain lists of related information that can be used across different use cases, like lists for actor, information exchanged, terms and definitions, references, requirements.

Use cases and the related information have to be managed in order to maintain an overview. A rough hierarchy is suggested in order to manage different systems and their sub systems (system of system, refer to the report "First set of standards" [SG-CG/B]):

- Area (e.g. Smart Grids, smart home),
    - Domain / zones according to the SGAM, and
        - Systems or groups (e.g. actors related to Smart Metering/AMI, virtual power plants).

6.4.3. Classification of use cases

Because use case descriptions support various tasks, the granularity, type and content of the use case description varies broadly. A use case in general describes functions of a system and related information exchange, mainly in a technology-neutral way (depending on the level of detail). It identifies participating actors that for instance can be other systems or human actors which are linked to this use case.

The various use case types can be classified highlighting different views and tasks of the respective use cases, e.g.:

- Level of detail (see Figure 5 below): for brainstorming / collection (cluster, high level use cases, conceptual description), engineering or testing;
- Nature of the use case: Business (business use case) or technical (system use case)[3];
- Users of the use case: Project (Individual use cases), technology group (specialized use cases), standardization (generic use cases)
- Geographical relation: national, regional or international use cases

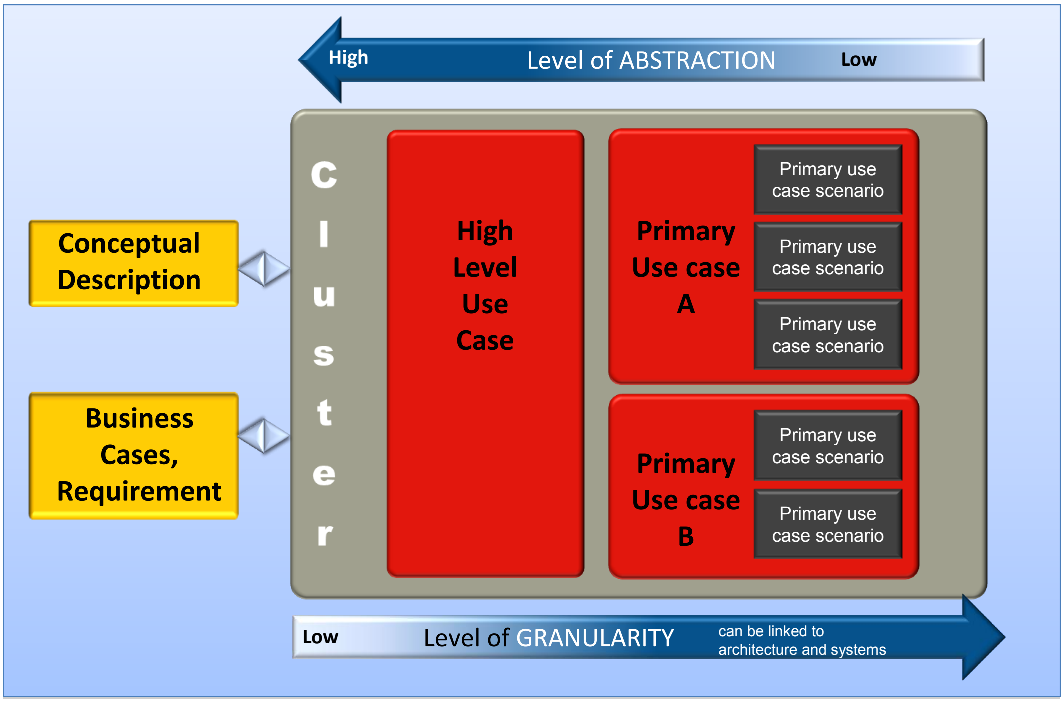

Figure 5: Use case structure[4] (based on SM-CG)

A more detailed overview describing different use cases is provided in [SG-CG/K].

6.4.4. Organization of use cases

Within an area like Smart Grid, a broad variety of different use cases will be established that might be highly interlinked. Some kind of coordination and categorization is required.

Beneath the general grouping into area and the links to domains and zones, clusters of use cases can be established to sort use cases. These clusters can be described in conceptual description.

[3] or even political / legislative use cases might be possible.

[4] Please, note that this is a simplification according to practical experience. In detail use case can be arrange in a network structure.

Examples for clusters of use cases from the Smart Grid Coordination Group reports ([SG-CG/B to E]) are:

- Grid related generic uses cases
- Generic use cases related to electric vehicle charging
- Generic use cases related to the flexibility concept

6.4.5. Use cases repository

Although it is possible to describe use cases in a word processing format, establishing a use case repository will provide a lot of advantages for standardization organizations when the methodology is introduced in a broader scale (refer to [SG-CG/K]).

As example, IEC introduces also a use case repository for the international standardization community.

6.5. Smart Grid Architecture Model (SGAM)

The Smart Grid Architecture Model (SGAM) is a reference model to analyse and visualise Smart Grid use cases in a technology neutral manner. Furthermore, it supports comparison between different approaches to Smart Grid solutions so that differences and commonalities between various paradigms, roadmaps, and viewpoints can be identified. It provides a systematic approach to cope with the complexity of Smart Grids allowing representation of the current state of implementations in the electrical grid as well as the evolution to future Smart Grid scenarios by supporting the principles of universality, localization, consistency, flexibility and interoperability.

SGAM builds on proven approaches from power systems as well as interdisciplinary fields like systems engineering and combines them in a simple but comprehensive model[5].

Power system management distinguishes between electrical process and information management. These viewpoints can be partitioned into the physical domains of the electrical energy conversion chain and the hierarchical zones for the management of the electrical process (refer to [IEC 62357:2011, IEC 62264:2003]). This is the foundation of the *Smart Grid Plane* that spans in one dimension the complete electrical energy conversion chain, partitioned into 5 domains: (bulk) Generation, Transmission, Distribution, DER and Customer Premises. And, in the other dimension the hierarchical levels of power system management, partitioned into 6 zones: Process, Field, Station, Operation, Enterprise and Market. Interoperability, as a key enabler, for smart grids is inherently addressed in SGAM by the 5 superimposed layers: Component, Communication, Information, Function and Business. The complete three-dimensional representation of SGAM is depicted in Figure 6.

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[5] In particular, the work on SGAM is based on significant existing material such as the NIST Conceptual Model [NIST 2009], the GridWise Architecture Council Stack interoperability categories [GWAC 2008], the IntelliGrid Methodology [IEC PAS 62559:2008] and architecture standards like TOGAF and Archimate [Jonkers 2010] or http://pubs.opengroup.org/architecture/togaf9-doc/arch/ and http://pubs.opengroup.org/architecture/archimate2-doc/ .

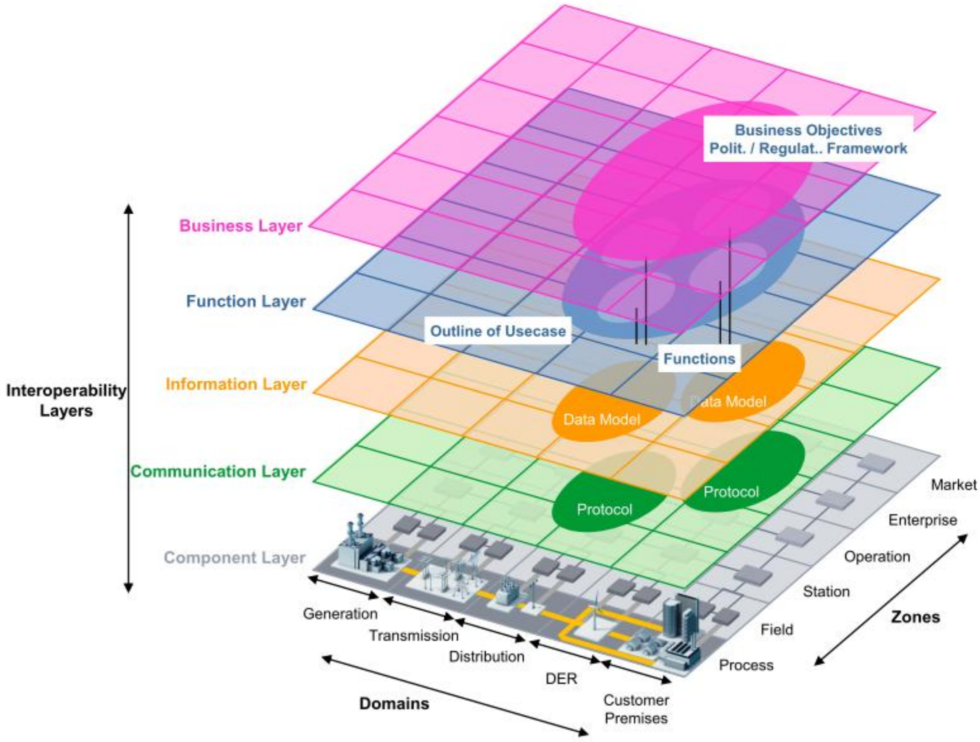

Figure 6: SGAM – Smart Grid Architecture Model

The SGAM Interoperability Layers allow modeling of different views from business as well as technical nature.

- On the business layer SGAM can be used to map regulatory and economic (market) structures and policies, business-related models, business portfolios (products & services) of market parties involved. Also business processes can be represented in this layer. In this way it supports business executives in decision making related to (new) business models and specific business projects (business case) as well as regulators in defining new market models.

The technical views are modeled in SGAM on the four lower layers, in particular:

- The function layer describes functions and services including their relationships following business needs. Functions are represented independent of their physical implementation (represented by elements in the component layer).
- The information layer describes the information that is being used and exchanged between functions. It contains information objects and the underlying canonical data models.
- The emphasis of the communication layer is to describe mechanisms and protocols for the interoperable exchange of information between functions.

Finally, the component layer describes all physical elements that realize a function, logical elements thereof, as well as their relations. Physical elements can, for instance, include power system equipment (typically located at process and field level), protection and tele-control devices, network infrastructure (wired / wireless communication connections, routers, switches), or any kind of computers. Also logical parts, the aforementioned elements, like components or software applications, can be depicted on the component layer. Functions identified for a specific implementation of a use case can be mapped/related to components complementing the relationships between all layers. Smart Grid use cases can be visualized and detailed with SGAM according to their physical distribution and mapped to the layers of the model to test if the use case is supported by existing standards or to identify gaps in standardization. A use case analysis with SGAM is based on the use case description outlined in Section 6.4. The fields in the use case template provide different information for the analysis, e.g. the field *Domain(s)/Zone(s)* specifies directly how the use case maps onto a Smart Grid plane. Furthermore, the actor list in the use case description provides – depending on the type of the actor – information on the involved roles to model the business layer in SGAM or information on involved systems and devices to model the component layer.

Use case descriptions vary in the level of abstraction as well as in design scope as described in detail in [SG-CG/K]. Thus, the analysis with SGAM also varies. Figure 7 provides an overview for each interoperability layer in SGAM on an exemplary level of abstraction on which an SGAM analysis can be applied.

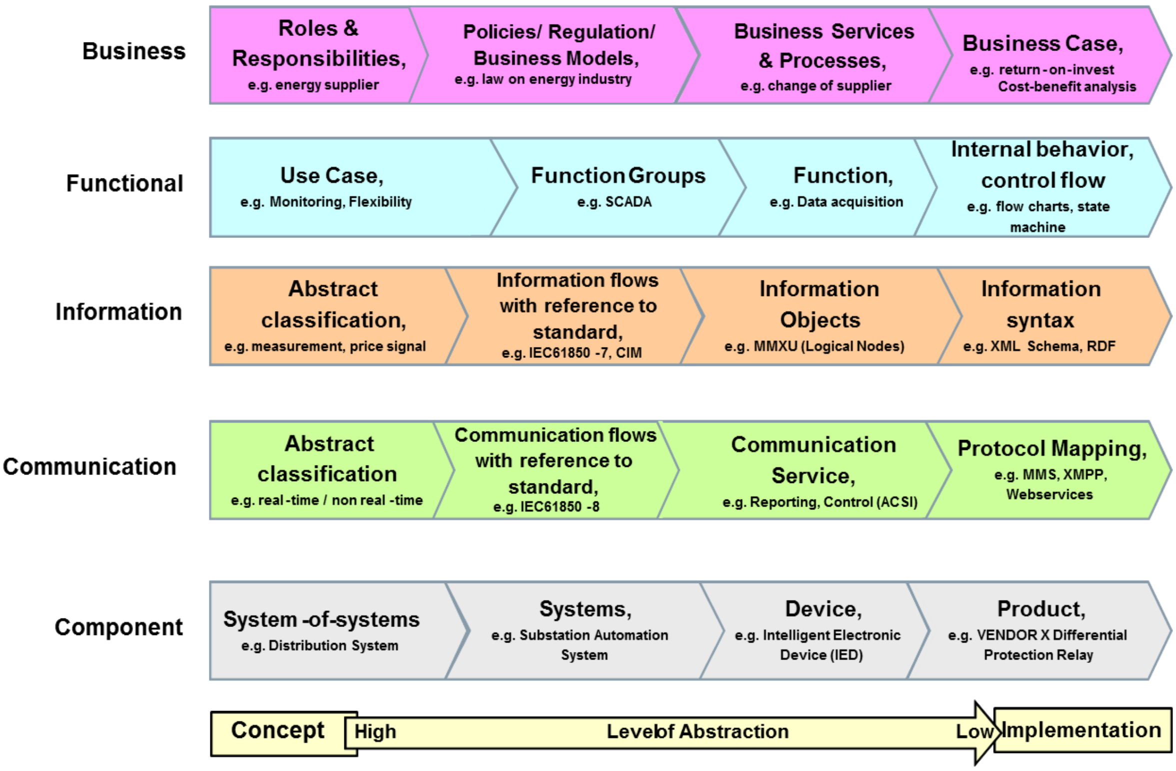

Figure 7: SGAM Analysis Pattern

The SGAM Analysis Patterns are intended to provide guidance on how to model with SGAM on a chosen level of abstraction starting from a concept level up to a detailed level required for implementation. Additionally, they should also support in writing use case descriptions on providing sufficient information needed for a SGAM analysis on the chosen level of detail. For each layer Figure 7 depicts some steps of successive model refinements to define interoperability requirements. Detailed information with examples is provided in [SG-CG/K]. Here are also examples provided showing the usage of the SGAM in other areas: e.g. the classification of systems (refer also to [SG-CG/G]) or usage areas of communication networks.

6.6. Set of standards for the smart grid system

One of the main results of the work of the Smart Grid Coordination Group is the selection guide “Set of standards” ([SG-CG/B] [SG-CG/G] developed by working group Set of Standards).

The set of standards consists of:

- System related standards and
- Cross cutting standards

1. For the analysis and guidance the smart grid system have been broken down in several subsystems (Figure 8).
2. Sub systems are described by relevant use cases for the respective system.

3. Then for each of these subsystems, a (typical) reference architecture (components and interfaces) has been defined in the SGAM as described before.
4. Based on the standards identified in the SGAM a list of standards for each system and its interfaces can be evaluated.
5. Additionally cross-cutting standards are listed (e.g. with reference to SGIS or to communication specific issues).

The report provides an overview for all experts in the field of Smart Grid standardization and a support for users in the selection of relevant standards for their purposes.

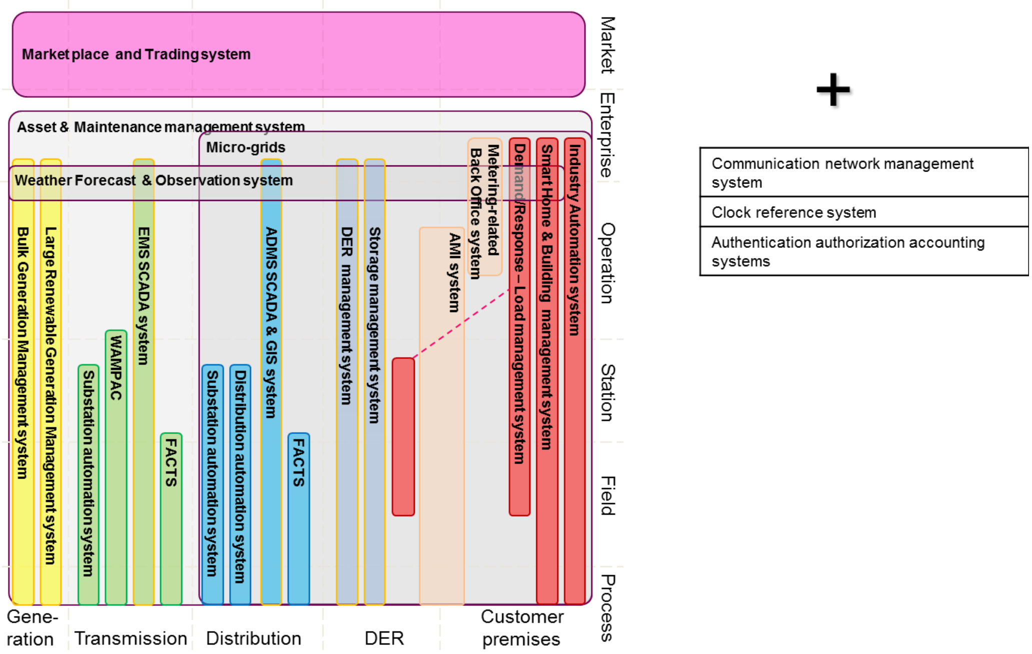

Figure 8: Systems breakdown over the SGAM plane

For more detailed please refer to the relevant documents:

- [SG-CG/B] SG-CG/M490/B_ Smart Grid First set of standards
- [SG-CG/G] SG-CG/M490/G_ Smart Grid Set of standards
- [SG-CG/K] SG-CG/M490/K_ SGAM usage and examples
- [Mapping Tool]

6.7. Standards gaps, prioritization, work program

The following tools provide management support in a broad field of technology in order to focus standardization resources and provide overview and coordination of various activities.

1. Based on a structured analysis (refer to chapter 7) or on input from stakeholders a standardization gap list can be gathered.
2. In the next step the gap list can be prioritized by a voting of the stakeholders represented in the SG-CG on two criteria: “Smart Grid deployment impact” and “Standardization gaps filling-up chance”. Gaps are selected when one criteria is higher than the defined threshold. The prioritization focuses the work of the SG-CG on main topics. Nevertheless, as yet unselected gaps might be subject to a work programme of other technical bodies.
3. The work programme which is based on the gap list and the prioritization serves different needs

a. List, description, status and timetable of selected gaps

b. A dashboard for each selected gap as a management tool providing information like:

   i. The gap to be filled.

   ii. The standardization bodies involved in filling the gap.

   iii. Each gap has a gap leader who follows up the closing of the gap and manages between the different involved groups.

   iv. The standards considered in this work package, with their expected impacts, and associated status.

   v. The plan of actions associated with the work package, including title, initial forecast completion date and updated forecast completion date, in order to monitor the follow-up of the gap filling.

For more detailed please refer to the relevant documents:

- Current version: SG-CG Report Programme of standardisation work for the Smart Grid v2.01 [Work program]. Note: the work programme is updated on regular basis.
- SG-CG Report Standardisation Gaps Prioritisation for the Smart Grid, latest version 2014-12-16 [Gap Prioritization]

6.8. Cyber security & privacy

An important aspect of the work of the Smart Grid Co-ordination Group is to provide Smart Grid information security (SGIS) guidance and standards to Smart Grid stakeholders to support Smart Grid deployment in Europe. Available security standards are increasingly applied to address functional, organizational or procedural requirements. Selecting the right security standards to achieve a dedicated security level on a technical and organizational or procedural level is crucial for the reliability of a European Smart Grid.

Mapping to SGAM

Security has been considered by reference to the Smart Grid Architecture Model (SGAM), the SGIS security levels and selected use cases. The Smart Grid is a system of systems connected and interacting with each other. Their security requirements will vary depending on the SGAM Domain/Zone in which the systems are located. By mapping selected security standards to the SGAM, their applicability in the different Smart Grid zones and domains on different layers can be identified, thus helping system designers and integrators in selecting the proper security standards to protect the Smart Grid system appropriately.

SGIS - Security Levels

SGIS security levels were defined in the 1st phase of Mandate M/490 with the aim of creating a bridge between electrical grid operations and information security. Considering European electrical grid stability and the power loss caused by possible ICT systems failures, a number of scenarios were identified, representing the scale of possible disruptions to the European grid.

From this viewpoint of pan-European electrical grid stability, each SGAM domain/zone cell and the kind of equipment used there to manage power were then considered, and an assessment made of the maximum potential power loss involved. Guidance values could then be defined, to assist identification of the most critical areas, where security matters most from a pan-European grid stability perspective.

This is the basis of the SGIS security levels proposed and illustrates a general approach, which can be applied by stakeholders as desired.

Security standards

In the first phase of the mandate M/490, SGIS focused on the following standards: ISO/IEC 27001, ISO/IEC 27002, IEC 62351, NERC CIP (US Standard), NIST IR-7628 (US Guidelines). Subsequently IEC 62351 has been considered further, together with the energy automation domain specific standard ISO/IEC TR 27019, extending ISO/IEC 27002. The second working period of the SGIS investigated further selected security standards applicable in Smart Grid that also relate to adjacent domains like industrial automation. Additionally, implementation related standards from ISO, IEC and IETF were taken into account. The security standards focused in the second working period are distinguished into requirements standards and solution standards.

These standards have been considered according to their nature, applicability and scope, and mapped to SGAM domains and zones, so as to assist the identification of suitable security standards for a particular use case, and potentially to suggest the need to enhance standards where necessary. Detailed consideration is given to selected security requirements standards, their current status and gaps. Moreover, new standards have been identified for further investigation, which are not covered by the work so far.

European Set of Recommendations

The European set of recommendations objective is to support Smart Grid stakeholders in designing and building a European Smart Grid infrastructure secure by design.

In April 2014, ENISA and European Commission Smart Grid Task Force Expert Group 2 (EG2) ad hoc group, released a “Proposal for a list of security measures for Smart Grids” report. For consistency of work at European level the choice has been made to work with the measures proposed in this report to define the European set of recommendations. Two additional domains have been found which were beneficial to be added during the analysis work: Situational Awareness and Liability.

Recommendations are presented and linked to SGIS-Security Levels, SGAM domains, zones and layers, and standards through a dashboard. Using this dashboard for the SGIS Security Level that has been identified for a given use case, recommended cyber security domains can be prioritized and an action plan proposed. As security measures, domains and security standards are mapped using SGAM, a correspondence can be established between them. Thus for a given domain of measures, available standards to support measures implementation can be identified.

The European Set of Recommendations should be reviewed yearly. This is a continuous process, as both cyber security measures and forms of attack are constantly evolving.

Privacy

Data Privacy and Data protection, particular in the context of smart metering, is crucial for a sustainable business. The forthcoming EU General Data Protection Regulation has been analyzed to understand the potential impact on organizational and functional requirements and its relationship with the current sector-specific regime in four member states examined.

The Smart Grid Task Force Expert Group 2 (SGTF EG2) has developed a Data Protection Impact Assessment (DPIA) template. The main elements of the DPIA template specifically relevant to privacy for the individual have been considered and recommendations developed on how to improve the data protection aspect of the personal information in the SGIS Framework. It is suggested that data protection impact assessment is considered separately in the pre-assessment of the SGIS Framework, since an identical approach to security cannot be applied for data privacy. Additionally, an analysis on emerging Privacy Enhanced Technologies to support privacy by design is presented.

Close liaison and co-operation has been maintained with the parallel work of the Smart Meter Co-ordination Group.

SGIS Framework[6]

During the SGIS Toolbox update discussions an improved approach has been defined which is more focused on the necessity to perform risk analysis than to have a general framework for risk analysis. The

[6] formerly SGIS Toolbox

new approach changes the SGIS Toolbox into a methodology that could be used to create “Awareness” for management and/or decisions makers.

It appeared that the “SGIS Toolbox” name was creating expectations regarding a ready to use tool that would have identified security levels and ad hoc security measures, whereas a process was, and (with the new approach) still has, to be followed. Therefore, the decision was made to rename it “SGIS Framework”.

Conclusion

The standards needed to establish the base of Smart Grid Information Security are available, but it needs continuous effort to incorporate existing and new technologies, architectures, use cases, policies, best practice or other forms of security diligence.

For further information on this work, the reader is referred to the detailed report of the SGIS workgroup.

6.9. Interoperability

6.9.1. Introduction

A Smart Grid as a system cannot be engineered from the ground up. Instead, Smart Grid development is most likely to follow transformation processes. This means that business models as well as roles on one hand, and technical components and architectural structures on the other, are to be transformed from the current “legacy” state into a “Smart Grid”. Due to the scale of the system and its economic importance, failures in operation and especially architectural and functional planning of the system, potentially introduce high costs. In order to enable a well-structured migration process, the requirements for a Smart Grid and the current system have to be decomposed using an appropriate model. Although the majority of Smart Grid equipment is based on (inter)national or regional standards, this has not yet resulted in an interoperable Smart Grid infrastructure. This is partly due to misunderstanding of what interoperability means, what can be expected from it and what should be done to realize it. The key to reaching Smart Grid system interoperability is through detailed specifications, use of standards and testing.

Therefore, as more and more ICT components are being connected to the physical electrical infrastructure, interoperability is a key requirement for a robust, reliable and secure Smart Grid infrastructure. The way to achieve Smart Grid system interoperability is through system specification, use of standards, and testing under applications of profiles.

Developing an understanding of and paving the way for progress in this area has been the focus of the Working Group Interoperability (WGI). The WGI report [SG-CG/I], which is summarized in this section, provides methodologies related to these aspects, in order to reach the desired level of interoperability for Smart Grid projects. It seeks to achieve this by focusing on three different aspects and therefore tasks:

- System design and use case creation
- Use of standards, specifications and profiles
- Compliance, conformance and interoperability testing

6.9.2. System design and use case creation

With respect to system design, the IT Software/System Development Life Cycle provides a widely used methodology for system development, which ensures delivery of high quality software or systems effectively and efficiently. Use cases provide a basis for the specification of functional requirements, non-functional requirements, test cases and test profiles. Therefore, as a starting point, the system interoperability must be considered and well specified in the use cases, in order to develop an interoperable Smart Grid system by design. It is for this reason that the V-model (Figure 9) was selected to describe the different kind of specifications and related tests to perform in order to reach and demonstrate interoperability.

Therefore, a generic “system interoperability method” or methodology has been developed in order to support the process of achieving system interoperability. In this methodology system design, use cases, testing, etc. were introduced.

6.9.3. Use of standards, specifications and profiles

The definition of an application profile can be an important step to achieving interoperability as it can reduce the number of options and complexity of the full standard. Interoperability in the Smart Grid domain is further facilitated by usage of the SGAM model for Smart Grid systems. A glossary defines precisely what is meant by interoperability and other related terms to avoid misunderstanding (annex of [SG-CG/I]). It contains the most suitable definitions available for interoperability purposes such as conformity, compatibility and interchangeability. WGI strongly recommends that these definitions should be implemented and harmonized in future international standardization.

Working Group Interoperability (WGI) also established a methodology for profiling alongside an inventory of profiles that are already available, based on the output from the WG Set of Standards.

6.9.4. Compliance, conformance and interoperability testing

To validate whether a system is interoperable within the Smart Grid, three types of tests will be required to be performed, namely:

- Compliance tests
  The compliance test has the purpose to demonstrate that the applicable standard(s) are correctly implemented in the Device Under Test (DUT).

- Conformance tests
  The conformance test is to ensure the implementation is in accordance with all specified requirements or standards.

- Interoperability tests
  After the conformance test, interoperability tests should be performed to verify that communicating entities within a system are interoperable, i.e. they are able to exchange information in a semantically and syntactically correct way. During interoperability testing, entities are tested against peer entities known to be correct.

Additionally, a framework for all standards, the Interoperability (IOP) tool, has been developed as a foundation for the profiling and testing process. It is helpful for identifying conformance testing and standard gaps, to select the required standards, and to derive and understand interoperability testing requirements.

6.9.5. Linkages to use cases and SGAM

It is important to recognize that how and where the methodologies described in this document are applied, depends on the business needs. Therefore, in essence, [SG-CG/I] only describes the methodology how to improve interoperability.

However, it is important to pinpoint the key relationship between the methods developed for the pre-standardization phase (refer to chapter 7) and test of interoperability in the post-standardization phase, particularly in the area of use case development and usage. In essence the degree and precision to which the use case methodology and SGAM are executed, has a direct bearing on the quality, accuracy and usefulness of the output of the interoperability methodology. Put simply, in order for the IOP methodology to be fully utilized, a clearly articulated use case, following the IEC 62559 template, is required, coupled with the graphical representation on the SGAM as illustrated by [SG-CG/G].

6.9.6. Summary of IOP methodology

The IOP methodology can generally apply to all layers with interfaces between Smart Grid objects that are required to fulfil a defined (set of) use case(s). This means that it first needs to be defined on which layers IOP is required for these use case(s), and also in detail for each function [SG-CG/I, section 6].

The intention of the IOP methodology is the functional IOP using standards on the following layers (see also [SG-CG/B)]:

- Information layer
- Communication layer
- Component layer

Please refer to [SG-CG/I] for a more detailed overview and explanation of these steps. However, the recommendation on the profile definition process is:

a. Functional analysis

1. Select a set of use cases, as the use cases and the related sequence diagrams could be considered sufficiently to define functional requirements. If no use cases are available at this stage, it needs to be created first.
2. Define on which layers IOP is required to fulfil the functional requirements of the set of use cases:
    - Business layer
    - Function layer
    - Information layer
    - Communication layer
    - Component layer

b. Standards and specification selection

1. Define required physical interfaces and communication channels between objects.
2. Select (set of) standards for each interface within each required layer with the IOP tool and also identify any gaps in conformance/compliance testing (or possibly IOP testing) in this set of standards. If necessary, specifications may be taken into account additionally.

b. Profiling
based on standards and specifications as identified above the profile is based on business/functional requirements.

1. Build IOP profiles for each (set of) standards and specifications with possible feedback into standardization development.
2. Apply profiles in system design and testing phases.
3. Manage profiles

As discussed in [SG-CG/I], by definition an IOP profile is a document that describes how standards or specifications are deployed to support the requirements of a particular set of use cases. It is therefore crucial to select the required standards or specifications as a prerequisite action for profile definition.

These relevant standards for different applications within each layer can be selected with the IOP tool (refer to 6.9.7.1). The application of the IOP tool furthermore requires the conventions used to draw the component, communication and information layer of a system mapping according to [SG-CG/B] [SG-CG/G], or another adequate mapping description. This results in multiple sets of standards for each use case cluster where all required standards within one set need to be interoperable and may require a specific IOP profile.

The selection of standards also needs to represent the requirements of the system design phase of the V-Model (Figure 9), where appropriate standards for

- Requirement analysis

- System design
- Architecture design
- Module design

can be assessed with support of the IOP tool and the given filters. Backwards, the selected standards also need to be taken into consideration for the corresponding testing phases of the V-Model for compliance, conformance, IOP and acceptance tests.

Nevertheless, how the selected standards are linked with profiles is part of the work item “IOP profiling” (refer to section 6.9.7).

6.9.7. Developing interoperability profiling

In general, profiling within a standard and between standards and specification helps to both improve interoperability and meet expectations of different projects where these will be implemented (refer to [SG-CG/I]). To reach the goal of interoperability, a common understanding and interpretation of the related standard and the identical use of functional elements and data representation for a given domain specific application function has to be achieved by defining profiles.

6.9.7.1. IOP profiles

An IOP profile is a document that describes how standards or specifications are deployed to support the requirements of a particular application, function, community, or context. A profile defines a subset of an entity (e.g. standard, model, rules). It may contain a selection of data models and services as well as protocol mapping. Furthermore a profile may define instances (e.g. specific device types) and procedures (e.g. programmable logic, message sequences) (refer to glossary of [SG-CG/I]).

The objective of profiles is to reduce complexity, clarify vague or ambiguous specifications and so aims to improve interoperability. These generally apply for both sides of the V-Model (Figure 9) in terms of Basic Application Profiles (BAP) for the design phase and as extended versions (Basic Application Interoperability Profiles (BAIOP)) in the testing phase.

6.9.7.2. Basic Application Profiles (BAP)

A Basic Application Profile (BAP) basically applies to the design phase of the V-Model and is based on system/subsystem specific basic application function descriptions / use cases.

A BAP is an agreed-upon selection and interpretation of relevant parts of the applicable standards and specifications, and is intended to be used as building blocks for interoperable user/project specifications.

The key ideas of BAPs are:

- BAPs are elements in a modular framework for specific application systems/subsystems.
- Combinations of different BAPs are used in real projects as building blocks.
- Project specific refinement additional to the BAP might be necessary to meet specific requirements for implementation in projects. These additional requirements should be frequently fed back into a user group / standardization committee and may lead to a new or revised BAP based on user experiences and group decisions.

BAPs are valid for specific application systems/subsystems (e.g. Substation automation, DER management, hydro power). They are intended to represent a user agreed common denominator of a recommended implementation or a proven best practice implementation of an application function in a specific Smart grid system/subsystem, but is not aimed to cover all possible implementation options.

BAPs must not have options, and all selected criteria are mandatory to achieve interoperability. If variants of BAPs for an application function are needed, different BAPs for the same application function have to be defined. BAPs are built on the basis of international standards and will have an influence in the further development of standards as shown in Figure 11.

BAPs may include:

- Description of the related application function (SGAM Function layer),
- Relevant data models (SGAM Information Layer),
- Communication services (SGAM Communication Layer),
- Component related requirements (SGAM Component Layer),
- Interaction diagrams, if the application function is divided into sub-functions which may be distributed in different physical devices.

BAPs do not include more than ”black box” functional behavior specification, algorithms and functional code and detailed instance definitions.

6.9.7.3. Basic Application Interoperability Profile (BAIOP)

To reach interoperability a BAP has to be extended for interoperability testing. The extended BAP is referred to as Basic Application Interoperability Profile (BAIOP).

For interoperability testing a BAP has to be extended by

- Device configuration,
- Test configuration with communication infrastructure (topology),
- BAP related test cases,
- specific capability descriptions (e.g. PICS, PIXIT, MICS in case of IEC 61850),
- Engineering framework for data modeling (instances) and communication infrastructure (topology, communication service mapping).

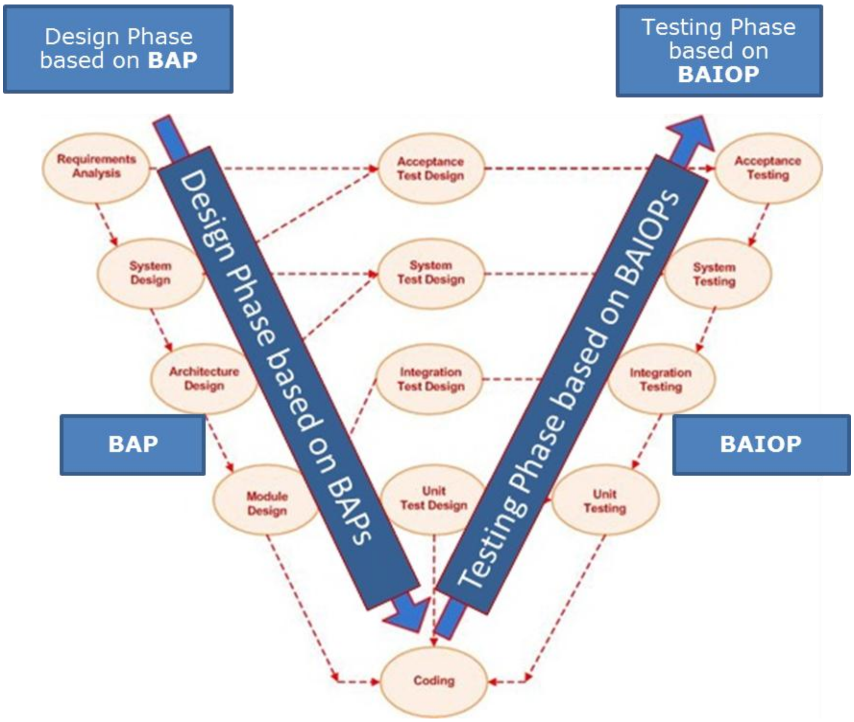

Figure 9: V-Model including BAP and BAIOP

The definition and common use of BAPs and BAIOPs should lead to a win-win situation for all stakeholders involved in a smart Grid project in general, e.g.:

- The benefit for customers (e.g. utilities) and user groups is the chance to harmonize the various company specific application function variants to a common denominator / best practice implementation for each basic application function. This reduces the risk of interoperability problems caused by products/systems as these may be selected from standardized BAP frameworks and tested according to BAIOPs.
- The benefit for vendors that will use standardized BAP's in their products is the reduction of project specific or utility specific implementation variants of application functions, and therefore reduced product complexity, development costs and parameterization efforts. BAIOPs can be used for internal tests before the product will be placed on the market.
- The benefit for Certification Bodies / Test Labs is the ability to perform interoperability tests based on BAIOPs and create a new business case out of the need for interoperability.
- The benefit for system integrators is that they can specifically select products conforming to BAPs and tested according to BAIOPs. This significantly reduces the efforts for integration of subsystems or devices.

6.9.8. Managing profiles

It is important that profiling management will be in place in order to ensure that profiles are applied and understood in the same way by all affected stakeholders, and to avoid that diverging profiles for the same purpose will be developed and applied in parallel.

Therefore WGI recommends that user groups shall take ownership of creating and managing profiles. This also means that lessons learned are fed back by users of the profiles to the corresponding user groups who are able to improve their profiles according to predefined cycles.

6.9.9. Implementation of profiles in real projects

As BAPs and BAIOPs are elements in a modular framework for specific application systems/subsystems and can be used in combination as building blocks in real projects, the user involved in the project (e.g. a company or system integrator) is responsible to develop and maintain Project Application Profiles (PAP) and Project Application Interoperability Profiles (PAIOP) based on these building blocks, but specific refinement still might be necessary to meet the project requirements. To reduce the project implementation efforts, it is desired that PAPs and PAIOPs consist of BAPs and BAIOPs to the highest possible extent, so that as little refinement as necessary needs to be performed by the user.

This process is basically illustrated in Figure 10:

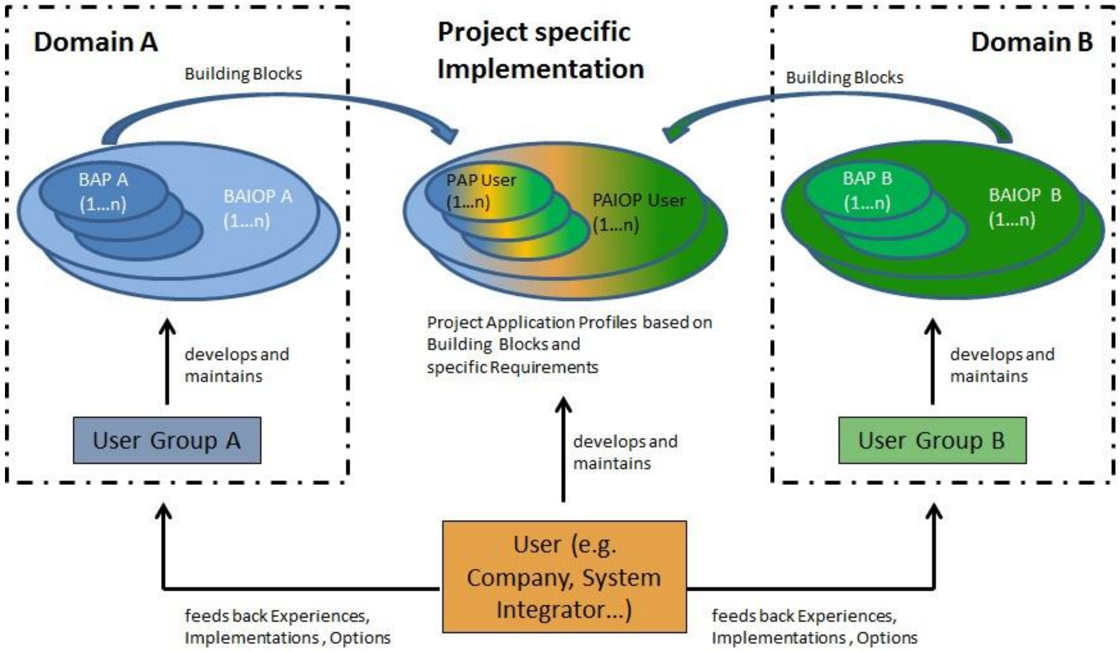

Figure 10: Workflow of project specific profiling

7. Processes and management for the Smart Grid standardization methodology

7.1. Overall process – How the elements and tools are interlinked

7.1.1. Introduction

This chapter intends to show how the different tools and elements of the concepts introduced in chapter 6 can be combined to an integrated and generic pre-standardization process recommended for the use inside standardization organizations. The description of the ideal type of process, which is based on preconditions, covers the whole design process of standards starting with new requirements (e.g. from business or regulation), use cases, SGAM, work program, new standards and profiles, and ends with a short overview of processes to prove conformance and test interoperability.

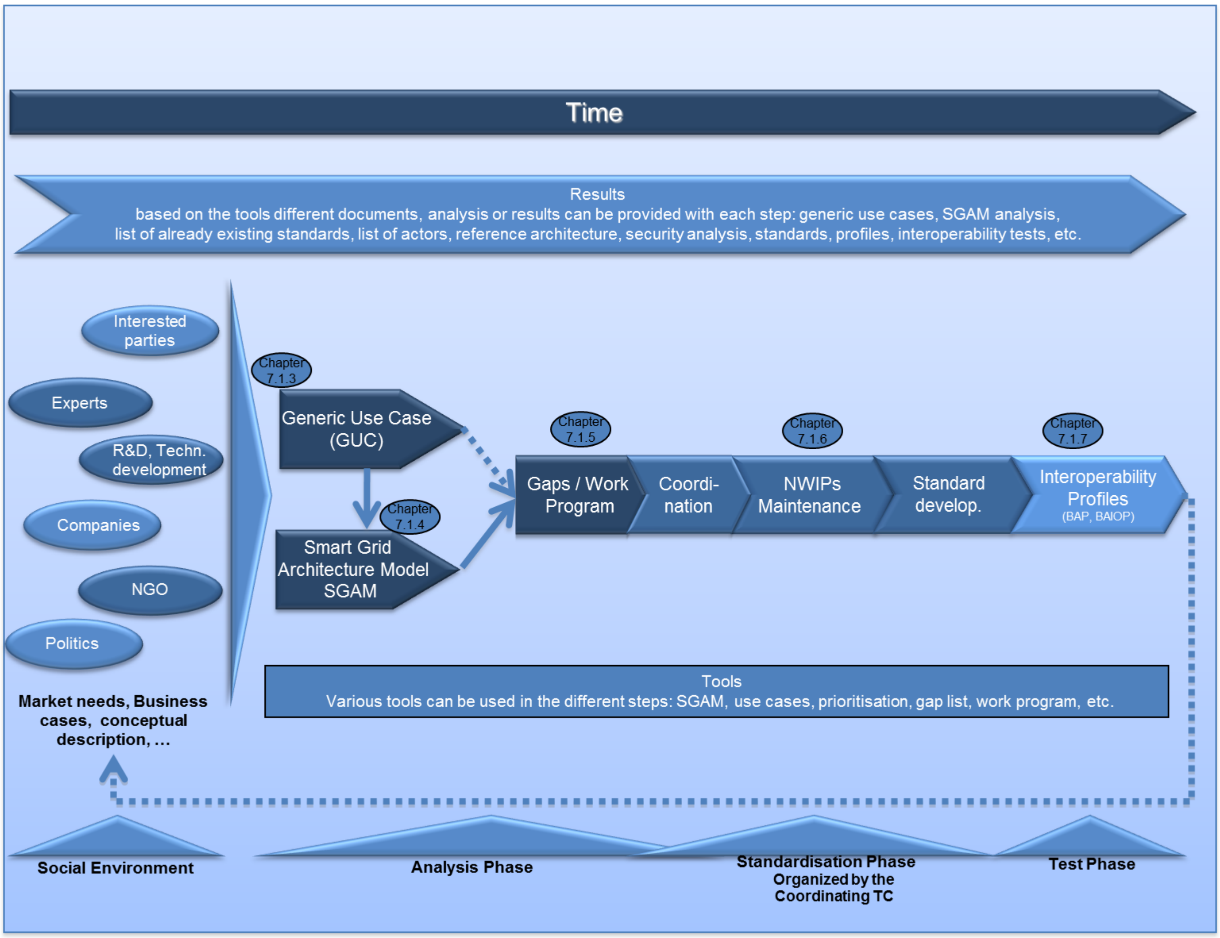

Figure 11: Smart Grids generic pre- and post-standardization process

Depending on the task the stakeholders may vary the recommended process according to their needs / application. As said for the use case template this methodology might be transferred and adopted to other systems as well, because the general principles are not specific to Smart Grids.

The process starts with new ideas, requirements, processes, systems, or business cases from

- internal sources like the experts from technical or strategic committees of the organization itself or
- external stakeholders like R&D, political request (e.g. new laws, regulation, mandates)

which express a need for standardization and require an early and coordinated activity as reaction.

This new demand has to be analyzed making use of the tools and elements introduced in chapter 6. The steps in Figure 11 are explained below – each step in one section (and in the figure a reference is made to the section number or to external source).

7.1.2. Preconditions

Before starting the description of the process some preconditions are required:

- A use case methodology is introduced throughout the standardization organization.

- Use cases are described and maintained in a central use case repository (database) with a given use case template[7].
- The system and its processes are recognized and accepted by the relevant stakeholders.
- A coordinating committee (CC) is established for coordination and quality check.
- A support team (ST) helps the standardization experts in the committees to write use cases, to find actors and to use the tools / repository. The ST might be identical to the CC[8].
- The CC establishes
    - Basic definitions, which are introduced for the system of interest such as a Smart Grid system: basic set of actor/roles definitions, zones, domains, terms.
    - A rough clustering of possible use cases, e.g. considering the conceptual model to identify affected/involved roles and responsibilities.

7.1.3. From requirements to use cases

Input:	new requirements, needs (e.g. from market)
Output:	validated generic use cases, actors
Process owner:	Coordinating Committee in a standardization organization for a specific area like Smart Grid Or Technical or strategic committee in cooperation with CC
Process contribution	Person / Organization / Committee who suggests the new requirements, technical or strategic committees within the standardization organizations
Tools:	Use case template, actor list, use case repository, conceptual model

Within the coordinating committee established for Smart Grid use cases or within a technical body (e.g. TC, WG, TF) or suggested from external sources (market needs), the new demand is described as a use case. It is recommended for the first analysis to use a short version of the use case template.

From the beginning some essential principles shall be followed:

- New use cases shall be suggested as generically as possible and shall not be project specific.
- The proposer of the new use case should check if the use case is already available or similarly available. In this case he is requested to contribute to the existing generic use case (GUC) instead of providing a new use case.
- By providing a new use case the author considers:
    - The criteria for GUC (e.g. not project specific, ...)
    - Using the use case repository,
    - Accepting the exploitation rights agreement needed for standardization,
    - Explains links to existing GUC
    - Using existing definitions like roles, actors, domain, or zones as much as possible.
      Re-use of existing actors should be stimulated as much as possible, and around the definition of new actors a clear (centralized) governance should be established (coordinating committee).
- If use cases are duplicated, they should be described explicitly as alternatives to the already existing ones and should be related to them.

NOTE This might be needed for instance, if a generic use case on international level will be modified at European or national level in order to match it to European or national specific circumstances like regulation.

[7] The description here is independent from the SDO. But it should be noted that the upcoming IEC 62559-2 is defining a template which will be the basis for an IEC use case repository currently under design and programming. It is recommended to use the existing template and repository in order to harmonize the work on use cases.

[8] E.g. for Smart Grid the IEC/TC 8 WG 6 "Generic Smart Grid Requirements" fulfills tasks which qualify the working group as CC and ST (tbd).

- Granularity and depth of description of use cases should be managed flexible. The author / committee in charge decides about the appropriate form in the relevant phase (e.g. start with a short template, detailing in iterative steps after first discussions and confirmation of the relevance of the use case).

Recommended process for the development of use cases

1. If new requirements are expressed from outside of the standardization organization for a first analysis, high level use cases / user stories are described and analyzed in order to develop generic use cases in the coordinating committee (CC).
2. A new use case might be discussed on working group / TC / CC level. Within a short time frame the new use case shall be suggested to the CC in order to allow other committees to provide further input and in order to achieve the aim of coordination by means of the use case descriptions.
3. After a rough review and quality check by CC checking the completeness and the mentioned basic principles the new GUC will be opened for discussion and further suggestions by the standardization community using the use case repository as a collaborative platform.
4. The CC leads the discussion and the development of the use case or designates a TC with this task.
5. Other TC's or even organizations considered to be relevant should be informed about the new use case, so that they can provide further input, comments, or changes.
6. After a defined time period the discussion will be finished and the use case is considered as broadly accepted.
7. The CC checks the result of the discussion phase and might hand over the use case to the next step.
8. A voting might officially document that the use case is considered as validated.
   NOTE: similar to standards a review / maintenance procedure shall define the process of revision of validated use cases.
   NOTE: established processes for database standards should be considered for the definition of processes within standardization organizations, e.g. for the voting process.
9. The CC might hand over this use case or a cluster of use cases for further elaboration to a Coordinating TC (CTC) specialized in the relevant issues. CC and CTC to suggest next steps like analysis, more detailed use cases, standards development etc.
10. The validated use case will be made available for the public (e.g. IEC mapping tool).

The same principles shall apply for the suggestion of new actors.

As use cases can be described on different levels of granularity an iterative process is recommended:

- Start with a high level use case (HL-UC) or conceptual description without going into details
- After the general ideas are accepted more detailed use cases can be established.
- The CC works mainly on high level use cases and conceptual descriptions having the whole system in view.
- The development of more detailed use cases are handed over to Coordinating TC's (CTC) which have the closest relation to the relevant use case
  EXAMPLE: electricity metering use cases -> IEC or CENELEC / TC 13

7.1.4. From use cases to the SGAM use case analysis

Input:	Use cases
Output:	Analysis / SGAM reference architecture, list of standards / set of standards (refer to [SG-CG/B] [SG-CG/G])
Process owner:	Coordinating Committee in a standardization organization for a specific area like Smart Grid Or Technical or strategic committee in cooperation with CC
Process contribution	Person / Organization / Committee who suggests the new requirements, technical or strategic committees within the standardization organizations
Tools:	Use case repository, SGAM, Conceptual Model

As mentioned before there are various reasons, demands and needs to work with use cases in standardization. This means that the authors or the readers of use cases might have very different viewpoints on a use case or a set of use cases. The structured template for the use case provides already different fields in order to take different viewpoints when analyzing use cases. The following types of analysis are already discussed:

- Capturing requirements for new functions; analyzing, if these requirements can be fulfilled with the existing set of standards, or if there is a need for new standards or modification of existing ones
- Harmonizing functions, actors, roles across different stakeholder groups, sectors or technical bodies (e.g. terminology)
- Functional analysis to derive to new requirements: e.g. risk & threat analysis for IT-security or for functional safety purposes. The analysis might lead
    - to changes in the use cases or
    - to recommendation in combination with new or existing standards (e.g. recommendation of a specific security / safety level or need for standards for new safety features according to the new functionalities laid down in the use case)
- Information collection: together with the use cases further information can be gathered (refer e.g. to field "References", e.g. standards, legal requirements, contracts, etc.)
- General classifications of a use case: depth of description, business or technical nature of the use case and the prioritization of use cases
- Classification of use cases: which use cases belong to a specific role (e.g. using the Conceptual Model and/or HEM-RM), domain, actor, interface, business process, quality of the use case description etc.
- Test use cases: which requirements or scenarios / sequences (incl. normal, alternatives, fault scenarios) can be used for test purposes
- Guidance for readers who want to know which standards are necessary for their use case (in combination with the analysis in combination with SGAM below, refer also the set of standards [SG-CG/G], or the IEC mapping tool [Mapping Tool])
- More detailed engineering, e.g.:
    - Information payload from Actor A to Actor B (interface)
    - Information for further programming, transfer to UML (scenarios / sequences, trigger events, information flow etc.)
    - Detailed requirements: e.g. quality of service, data management, information security, privacy and more (refer to the column "Requirements" in the step-by-step description of the use case
- Linking use case to a reference architecture like the Conceptual Model (for roles and responsibilities), SGAM and to standards (see also the following description)

It is expected that in future with further works in the field of use cases and reference architectures, more analysis demands will be requested.

In the following a basic process to analyse use cases to SGAM is described. A detailed example can be found in [SG-CG/K]. The mapping process can be applied to the following tasks, which are considered relevant for the present mandate M/490:

- Mapping of use cases in order to validate the support of standards on each SGAM layer
- Identifying gaps in respect to standards on each SGAM layer
- Identifying similar use cases by mapping the use case to SGAM domains and zones
- Harmonizing use cases/actors/interfaces between SGAM domains and zones
- Mapping of existing architectures into a general view
- Developing Smart Grid architectures

Depending on the objectives the following process can be done iteratively. An overview of the basic process is depicted in Figure 12.

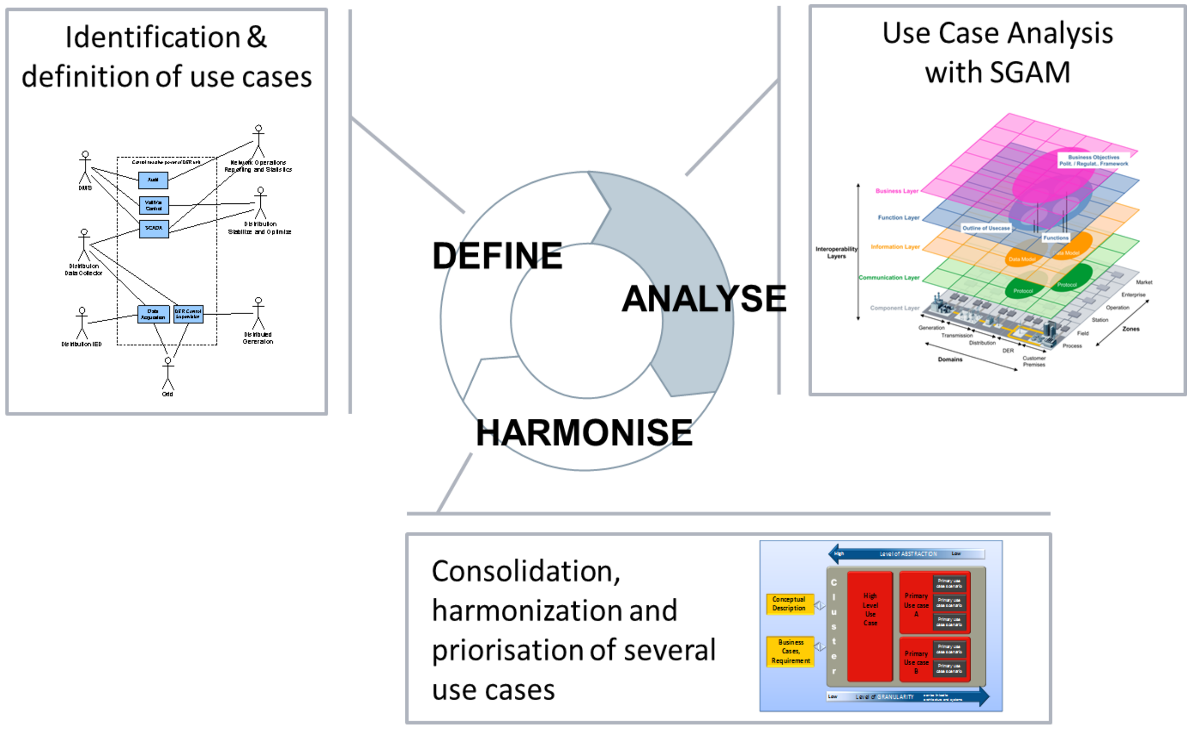

Figure 12: Basic process for SGAM Use Case Analysis

The example in [SG-CG/K] starts with a high-level use case, which is mapped to SGAM domains and zones to define use cases. Then these use cases are described and analysed with SGAM in detail.

To come from a use case description to an SGAM analysis different approaches are possible. The order in which SGAM layers are modelled depends on the use case under analysis and its viewpoint. Figure 13 describes a sequence proven-in-practice for the use case analysis with SGAM.

1. Use case description
2. Based on the use case description a business-oriented use case should provide a clear view on the involved roles as well as their responsibilities and goals.
3. The analysis is complemented with the technical view on the lower layers of SGAM starting with modelling the function layer following the objectives of the use case.
4. Then, the component layer is developed to depict where functions are realised on hardware. The component layer is derived from the use case information on system/device actors. These actors are located to the appropriate domain and zone.
5. Based on the function and component layer information flows are identified and information objects can be defined on the information layer.
6. Finally, the communication layer describes protocols and mechanisms for the interoperable exchange of information.

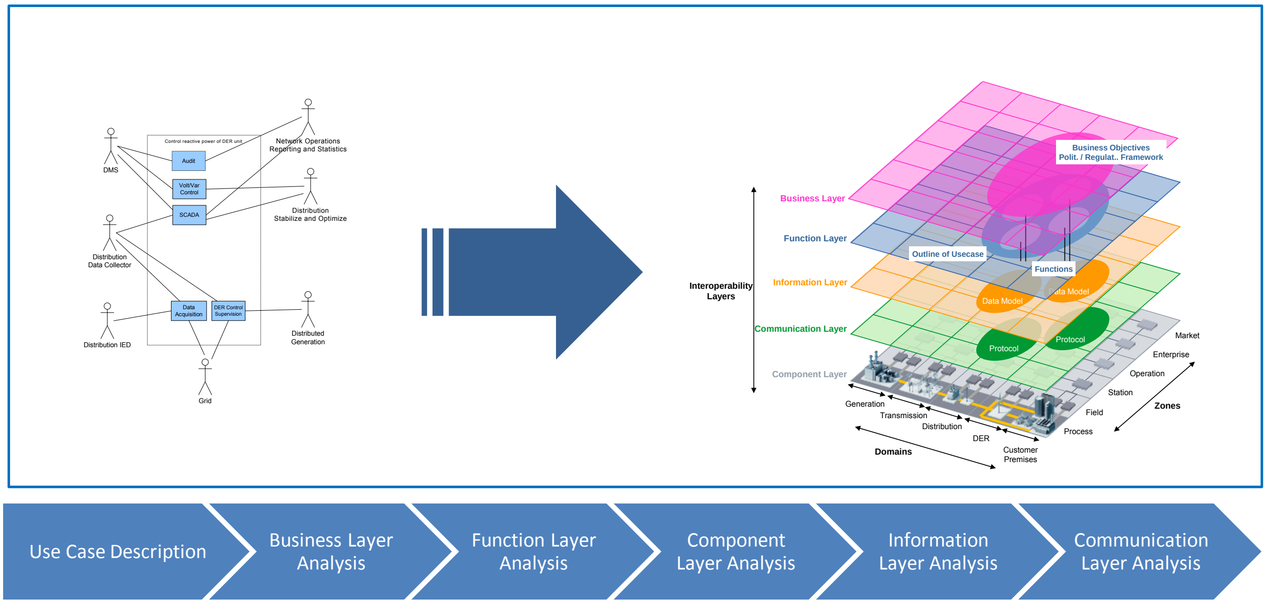

Figure 13: Use Case Analysis with SGAM – example for an analysis process

7.1.5. From use cases and SGAM analysis to standards gaps

Input:	Use case(s) and SGAM analysis
Output:	Gap list
Process owner:	Coordinating Committee in a standardization organization for a specific area like Smart Grid Or Technical or strategic committee in cooperation with CC
Process contribution	Person / Organization / Committee who suggests the new requirements, technical or strategic committees within the standardization organizations
Tools:	Prioritization, work program, dashboards

Based on the analysis, the required functionalities, actors / roles as well as related standards and a reference architecture is available. For standardization purposes it can be checked, if the use case(s) can be performed with the referenced standards or if the standards need a modification / update or if new standards (new work item proposals) are needed. If a gap is detected, the analysis done in the previous step already provides a lot of detailed information to close the gap (like information exchange needs, payload or non-functional requirements related to the specific task). In reality the analysis will be more detailed if a gap is already expected, and less detailed if the use case / reference architecture is well known and state-of-the-art in standardization.

If there is no gap identified, the analysis nevertheless supports the users of standards and can be seen as a selection guide which standard can be used for which task.

7.1.6. From standards gaps to standards

Input:	Gap list
Output:	Prioritized work program, dashboards for each gap, standardization projects, standards
Process owner:	Coordinating Committee in a standardization organization for a specific area like Smart Grid (e.g. SG-CG) And Technical committee
Process contribution	Technical or strategic committees within the standardization organizations
Tools:	Prioritization methodology, dashboard and work program templates

As already mentioned in chapter 6.6 identified gaps are summarized and prioritized. The method as described in [Gap Prioritization] might be used. The prioritized list of gaps represents the work program.

In a further step for each gap, which is part of the work program, the next action item(s) are defined – here the template for a dashboard might be used [Work program]. The work program can also be seen as a management of identified and selected / prioritized gaps.

Based on the gap list or the prioritized gap list, and in close cooperation with the relevant technical bodies, new standards (e.g. Preliminary Work Item (PWI) or New Work Item Proposal (NP), see 7.2) or necessary modifications of existing standards will be developed.

The following steps necessary to finalize the work on standards until publication are dependent on the mature practice of the relevant standardization organization as described in 7.2. If it is part of the work program of a coordinating committee (here the SG-CG/WG SS), the work progress will be monitored. This might be needed only for more complex gaps where various technical bodies are involved. Otherwise this is a task of the respective technical body.

7.1.7. From use cases and standards to interoperability profiles (BAP)

Input:	Use cases, existing standards, specifications, profiles
Output:	Interoperability profile related to use case (BAP)
Process owner:	User group, standardization committee, or individual actor using the profiles
Process contribution	User groups, standardization committees, system integrators, individual company (e.g. utility), vendors, certification bodies, test labs, regulator
Tools:	IOP tool, use case template, IEC use case repository, standards databases, selection guide according to [SG-CG/G], V-model, profile management

- It has to be defined on which layers IOP is required to fulfil the functional requirements of a use case: information layer, communication layer, component layer.
- Related existing standards, specifications and profiles are selected:
  - Define required physical interfaces and communication channels between objects.
  - Select (set of) standards for each interface within each required layer with the IOP tool and also identify any gaps in conformance/compliance testing (or possibly IOP testing) in sets of standards. If necessary, specifications may be taken into account additionally.
- Define profile definitions based on standards and specifications as identified above and on business / use case functional requirements.
  - Build IOP profiles for each (set of) standards and specifications (BAP) (with possible feedback into standardization development)
  - Apply profiles in system design (BAP) and testing phases (BAIOP, next phase).
  - Further definitions might be necessary for project specific implementations (PAP).

Figure 14 illustrates the process from a use case to interoperability testing by using BAPs and BAIOPs.

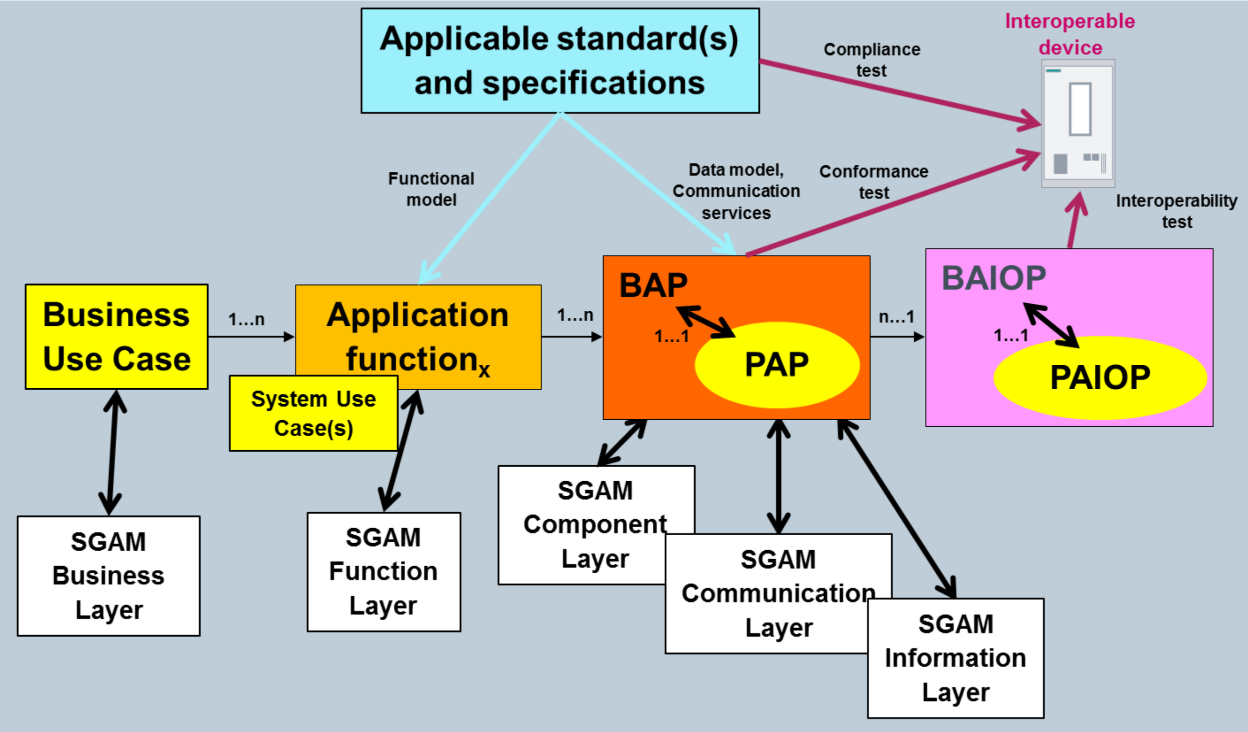

Figure 14: Process from use case to interoperability on SGAM layers

7.1.8. From interoperability profiles (BAP) to "testing profiles" (BAIOP)

Input:	BAP, specific extensions for testing purposes
Output:	BAIOP
Process owner:	user group, standardization committee, or individual actor using the profiles
Process contribution	User groups, standardization committees, system integrators, individual company (e.g. utility), vendors, certification bodies, test labs, regulator
Tools:	IOP tool, V-model[9], profile management

Extend the BAP profiles with further information as described in chapter 6.9.

Further definitions might be necessary for project specific implementations (PAIOP).

7.2. Introduction into the process of standard development in standardization organizations

Standardization organizations established rules and processes, on how to develop standards in order to guarantee basic requirements for standardization like transparency, consensus, non-discriminatory participation etc. Each standardization organization defines its products (e.g. International Standards (IS), Technical Specification (TS), Publicly Available Specification (PAS), or Technical Reports (TR)) and the relevant processes.

As example the IEC process for an International Standard (IS) is described[10] (see Table 2):

[9] The V-Model in Figure 9 represents a system or software development process.

[10] http://www.iec.ch/standardsdev/how/processes/development/approval.htm

Table 2 – IEC standardization process

Preliminary Stage	Preliminary Work Item (PWI)	Future work is announced.
Proposal stage	New Work Item Proposal (NP) (Vote)	Suggestion for a new standard or specification
Preparatory Stage	Working Draft (WD)	A working draft is usually supplied with the NP. Later the last version of the working draft of the respective project team is distributed as CD.
Committee Stage	Committee draft for comments (CD) (comments collection)	National committees are asked for comments.
Enquiry Stage	Committee draft for vote (CDV) (Vote)	The draft can be commented and there is a vote to enter to the next step.
Approval Stage	Final draft International Standard (FDIS)	Final vote without commenting. A positive vote is necessary for publication.
Publication Stage	International Standard (IS)	Publication of the official International Standard (IS)

Comparison of IEC and CENELEC processes (see Table 3):

Table 3 – Comparison of IEC and CENELEC processes

Stage	**IEC**	**Respective CENELEC**
Preliminary Stage	Preliminary Work Item (PWI)	Preliminary Work Item (PWI)
Proposal stage	New Work Item Proposal (NP) (Vote)	New Work Item Proposal (NWIP)
Preparatory Stage	Working Draft (WD)	
Committee Stage	Committee draft for comments (CD) (comments collection)	Draft
Enquiry Stage	Committee draft for vote (CDV) (Vote)	Draft prEN (CDV/ENQ)
Approval Stage	Final draft International Standard (FDIS)	Final Draft prEN (FDIS/VOTE)
Publication Stage	International Standard (IS)	European Standard (EN)

Comparison of IEC and ETSI processes (see Table 4):

Table 4 – Comparison of IEC and ETSI processes

Stage	**IEC**	**ETSI**
Preliminary Stage	Preliminary Work Item (PWI)	
Proposal stage	New Work Item Proposal (NP) (Vote)	New Work Item Proposal (TB Vote)
Preparatory Stage	Working Draft (WD)	Draft for WG Approval
Committee Stage	Committee draft for comments (CD) (comments collection)	Draft for TB Approval (TB vote) Approval and publication for Technical Specification, Group Specifications and Technical Reports
Enquiry Stage	Committee draft for vote (CDV) (Vote)	
Approval Stage	Final draft International Standard (FDIS)	Final draft for EN Approval Procedure (ENAP) of Two-step Approval Procedure (TAP)
Publication Stage	International Standard (IS)	European Standard (EN)

The intention of the process is a broad worldwide consensus and non-discriminatory participation. Therefore several information, commenting and voting steps are introduced.

IEC and CENELEC are closely interlinked according to the Dresden Agreement[11] which describes the common planning of new work items and parallel voting between IEC and CENELEC. Similar agreements are established for ISO / CEN or ETSI / ITU.

For other types of documents faster processes are established. Specialized standards are published as database with modified rules compared to the above-explained processes.

This means that for the phase in Figure 11 called "Standardization Phase" today processes are available and mature. For the interoperability phase currently processes are established inside or outside of the standardization organizations. Suggested improvements need to be evaluated by the SDOs.

The main part of the proposed new process is considering the pre- and post-standardization phase, in Figure 11 called "Analysis Phase" or “Testing”, as an addition to and supporting the established standardization processes. Starting with a structured collection of new requirements and tools for their analysis this process shall enable the Standards Developing Organization (SDO) to react quickly and competently as soon as new complex and more interlinked systems are evolving.

<u>Recommendations</u>

The following recommendations are describing a possible introduction of the suggested new processes and tools within an SDO:

- Evaluation of the suggested process
- Test with an example system and modification according to best practice experience[12]
- Establishing of
    - a use case repository[13] with a generic actor list
    - a Coordinating Committee (CC) dealing with new requirements, transferring them into generic use cases, analyzing them and providing a coordinated work program for new work item proposals[14]
    - common understanding of the need for a coordination and cooperation of different sectors and technical committees dealing with systems of cross cutting nature
    - Training on the new tools and processes / support using these tools by a Supporting Team (ST) / providing necessary templates and tools
    - Coordinating TC (CTC) – in addition to the CC use cases or clusters of use cases might be handed over to technical committees that are most interested and specialized in this area. The CTC coordinates further detailing of these use cases, reference architectures and analysis up to the standards work program in cooperation with interested other TC's.
- The process needs to be transparent. A common collaborative platform like the use case repository or the mapping tool[15] will be helpful. This collaborative platform shall provide the possibility of commenting and discussion and in some cases also voting (e.g. on use cases).

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[11] More information to the Dresden Agreement http://www.iec.ch/about/globalreach/partners/regional/iec_cenelec_agreement.htm

[12] E.g. the work on Smart Grid provides already first experience

[13] The SG-CG developed a prototype in the first phase of the mandate. IEC is building up a repository.

[14] E.g. IEC/TC 8 WG 6 "Generic Smart Grid Requirements"

[15] see http://smartgridstandardsmap.com (Best with Chrome as browser)

- The process shall enable various level of granularity: easy and quick start and exchange without detailed knowledge up to a more detailed and deep analysis which can be used for the standards, test use cases or engineering.
- New products like use cases, work program, reference architecture needs to be defined: Status of new documents, processes in detail (e.g. suggestion, commenting, voting), relation to the existing processes and products[16].

[16] E.g. new IEC 62559 parts 1 to 3 under preparation