**Distributed Intelligence for Cost-Effective and Reliable Distribution Network Operation**


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# Final report on DISCERN standardisation activities

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# Executive Summary

Deliverable D2.5 “Final report on DISCERN standardisation activities” presents the work carried out in DISCERN in relation to standardisation activities within the scope of future electricity smart grids.

Standardisation plays a major role in the implementation of smart grid solutions on electricity networks. At the early stages of the smart grid system design, standard methods and frameworks are necessary with the aim of agreeing on a common representation of requirements and architectures. This improves communication among the numerous experts that are involved in the smart grid system design coming from different organisations and fields, such as electrical engineers, ICT experts, software engineers, or industrial automation specialists. This report will show how DISCERN has significantly contributed to the development and enhancement of both the IEC 62559 Use Case methodology – an international standard maintained by the IEC TC8 WG5 (recently transferred to the IEC SyC Smart Energy WG5) to express requirements of complex systems under design – and the SGAM framework created by the European standards organisations CEN-CENELEC-ETSI to represent smart grid architectures. The document will provide details on the active participation of DISCERN members in these standardisation bodies and will highlight the most relevant contributions made by DISCERN in order to improve the standards and promote their adoption by DSOs and among other smart grid stakeholders, such as vendors, technology providers, consultants, and research institutes. As stated by the IEC SyC Smart Energy WG5 convenor, Johannes Stein: “The DISCERN project has added great value to the standardisation groups of experts in charge of creating and maintaining the Use Case methodology and the SGAM framework by adopting, promoting, and enhancing these standards in the context of real smart grid solutions deployed by large DSOs from 4 European countries”.

In addition to providing a common framework for expressing and analysing smart grid requirements, standards are also required to enable the increasing amount of information exchanges between the devices and applications that take part in smart grid solutions. This deliverable will explain how DISCERN has contributed to the promotion and improvement of communication standards and canonical data models in smart grids by developing novel approaches aimed at assessing the standards utilised by the smart grid solutions developed within DISCERN and by proposing new actions to the standardisation bodies (mainly the IEC TC57) in order to address the standardisation gaps identified during this assessment.

Although the analysis performed in the project covers various communication standards and canonical data models, DISCERN paid particular attention to the IEC TC57 CIM. Given its importance and wide adoption in the electricity sector, the IEC TC57 CIM was utilised during the project in a number of applications, which were presented at official meetings organised by the standardisation groups of experts responsible for developing and maintaining the standard. The present report gives an overview of these applications and highlights the enhancements and improvements proposed by DISCERN.

The work started by DISCERN with regard to standardisation in smart grids will be exploited beyond the project by taking advantage of the position of DISCERN members as experts of some of the standardisation bodies mentioned previously. In that way, the contributions made by DISCERN regarding standardisation activities will underpin further developments of international standards promoting interoperability in smart grids.

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# Abbreviations and Acronyms

Table 1 Acronyms

| | |
|---|---|
| CDV | Committee Draft for Vote |
| CEN | European Committee for Standardization |
| CENELEC | European Committee for Electrotechnical Standardization |
| CIM | Common Information Model |
| COSEM | Companion Specification for Energy Metering |
| D | Deliverable |
| DLMS | Device Language Message Specification |
| DMS | Distribution Management System |
| EA | Enterprise Architect |
| EPRI | Electric Power Research Institute |
| ETSI | European Telecommunications Standards Institute |
| GUI | Graphic User Interface |
| IEC | International Electrotechnical Commission |
| IOP Tool | Interoperability Tool |
| KPI | Key Performance Indicator |
| MS | Microsoft |
| PAS | Publicly Available Specification |
| PRIME | PoweRline Intelligent Metering Evolution |
| SGAM | Smart Grid Architecture Model |
| SGCG | Smart Grid Coordination Group |
| SyC | Systems Committee |
| T | Task |
| TC | Technical Committee |
| UML | Unified Modelling Language |
| WG | Working Group |
| WP | Work Package |
| XML | eXtensible Markup Language |
| XSD | XML Schema Definition |

# 1. Introduction

## 1.1. Scope of the document

D2.5 presents the final report on the work carried out in DISCERN in relation to standardisation activities. A number of tasks within DISCERN have not only adopted international standards, but also proposed extensions and improvements to those standards with the aim of promoting their utilisation at DSOs. Two main groups of standards have been employed during DISCERN: 1) standards for expressing smart grid requirements and architectures – IEC 62559 Use Case methodology and SGAM framework, and 2) communication standards and canonical data models (mainly developed by the IEC TC57) for enabling information exchanges within the smart grid solutions.

This deliverable summarises the activities undertaken in DISCERN regarding both types of standards and highlights the active participation of the project in the corresponding standardisation bodies. In particular, as shown in Figure 1-1, DISCERN leveraged and enhanced standards developed by the IEC TC8 WG5 (recently transferred to the IEC SyC Smart Energy WG5), the CEN-CENELEC-ETSI SGCG, and the IEC TC57, and provided recommendations to different smart grid stakeholders – namely, DSOs, vendors, technology providers, consultants, and academic organisations – with regard to the adoption of these standards.

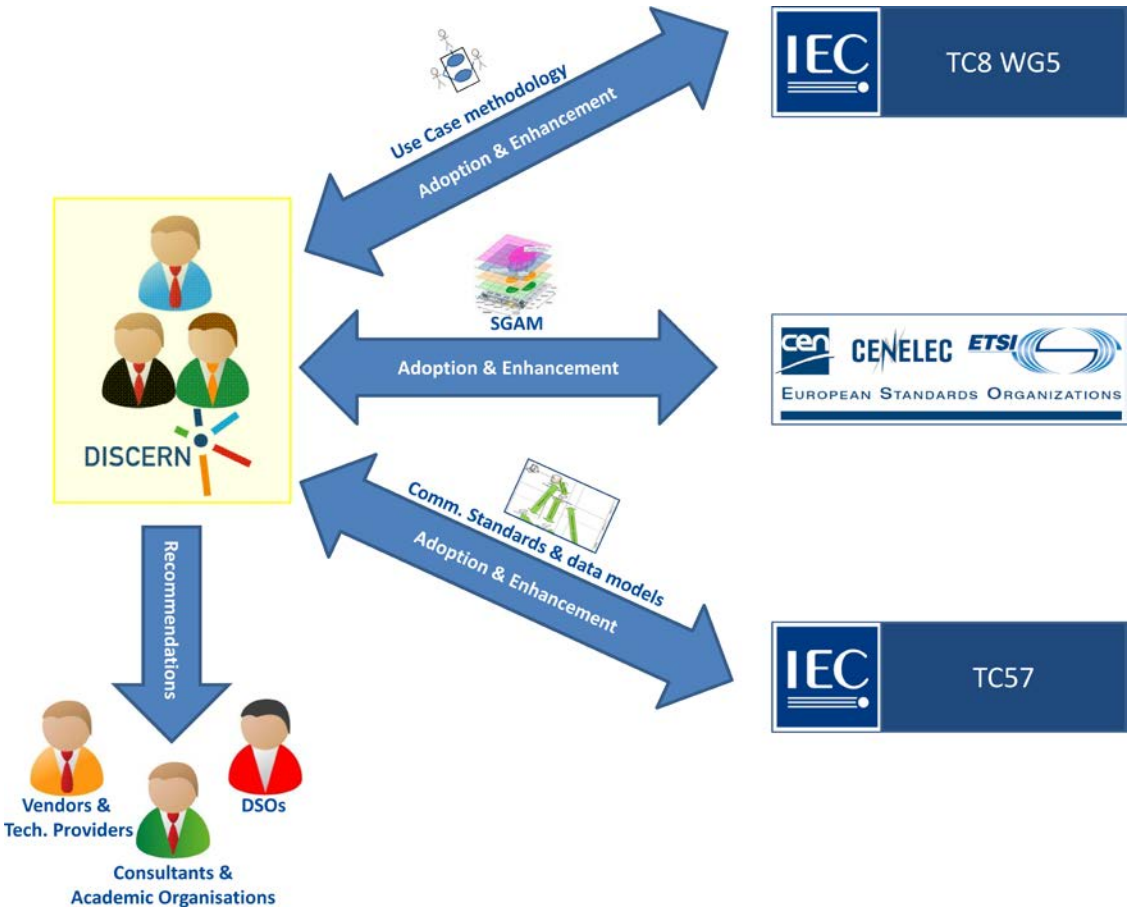



Figure 1-1. DISCERN work with regard to standardisation activities

## 1.2. Structure of the document

The document comprises the following main sections:

Section 1 introduces the document.

Section 2 reports the active participation of DISCERN in the IEC TC8 WG5, which is in charge of maintaining the IEC 62559 Use Case methodology.

Section 3 describes the DISCERN activities directly related to the CEN-CENELEC-ETSI SGCG, which is the standardisation group that developed the SGAM framework.

Section 4 presents the DISCERN activities regarding the IEC TC57, which is the standardisation body responsible for most of the communication standards and canonical data models in the context of electricity power systems.

Section 5 summarises the recommendations on standardisation activities provided by DISCERN to different stakeholders in smart grid projects, namely: standardisation bodies, DSOs, vendors, consultants, and academic organisations.

Finally, section 6 concludes this report.

# 2. DISCERN activities with regard to the IEC TC8 WG5 – Use Case methodology

The Use Case methodology has been adopted within DISCERN as a tool for identifying and expressing requirements of the smart grid solutions that were studied and implemented during the project [D4.2, D4.3]. It not only provided a structured approach for requirements elicitation and analysis, but it was also used as a common framework for successfully facilitating knowledge sharing among partners coming from different organisations and areas of expertise.

The Use Case methodology was originally developed in the early 90's by software engineers with the aim of carrying out the requirements engineering of complex software systems under design. More recently, it started to be utilised in the context of electricity smart grids [IEC 62559/PAS] and it is currently being standardised in the ongoing IEC 62559 standard series. What follows gives an overview of the standardisation body responsible for creating and maintaining the standard IEC 62559 Use Case methodology (2.1), summarises the contributions of the project to the IEC 62559 series (2.3), reports the active participation of DISCERN within this group (2.2), and sets out the exploitation of DISCERN results in this direction beyond the DISCERN project (2.4).

## 2.1. Introduction to the IEC TC8 WG5

The scope of the International Electrotechnical Commission (IEC) Technical Committee 8 (TC8) "Systems aspects for electrical energy supply" is to prepare and coordinate the development of international standards and other deliverables dealing with system aspects in the context of electricity supply systems. Within the IEC TC8, the Working Group (WG6) is aimed at collecting generic smart grid requirements by identifying common business processes and technical functions that shall be implemented in order to modernise the electricity delivery system such that it monitors, protects and automatically optimises the operation of its interconnected elements.

The methodology and tools employed by the WG6 for collecting and expressing generic smart grid requirements is given by the IEC TC8 WG5 "Methodology and Tools". This working group of experts is responsible for creating and maintaining the IEC 62559 "Use Case Methodology" international standard series, which describe the Use Case methodology as a structured approach for requirements elicitation and comprise the following parts:

- Part 1 "Concept and processes in standardisation" explains how the Use Case methodology shall be employed within the IEC for performing standardisation activities. The latest version of this part is still a Committee Draft for comments (CD). This means that the comments from the National Committees are to be studied and incorporated into the next draft version (CDV) before going to the enquiry stage, in which the National Committees give their final approval. According to the IEC development process [D2-3.3] the estimated date for the first edition of the IEC 62559-1 is approximately next summer 2016.
- Part 2 "Definition of the templates for Use Cases, actor list and requirements list" presents the Microsoft Word template for developing Use Cases. The first edition of the standard was published on 30 April 2015.
- Part 3 "Definition of Use Case template artefacts into an XML serialized format" contains the UML data model formally defining the semantics of the Use Case methodology concepts (actor,

scenario, step, etc.) together with the XML schemas derived from such a model standardising the formats for exchanging Use Cases across software applications. At present, this standard is a Committee Draft (CD) and it is planned to create the next version (CDV) by December 2015, so as to publish the first edition in March 2016.

- Part 4 will provide guidelines on how to utilise the methodology outside standardisation activities. It will replace the previous Publicly Available Specification (PAS) based on the Intelligrid Project [IEC 62559/PAS]. Currently, this part of the standard is at the preparatory stage and a Working Draft (WD) version is being written.

It is worth noting that the IEC 62559 methodology is not designed to be adopted exclusively by the IEC TC57 WG6 "Generic Smart Grid requirements" group. On the contrary, it is supposed to be utilised in other technical committees within the IEC - such as the IEC TC57 "Power systems management and associated information exchange", which follows the Use Case approach to identify interoperability requirements in the electricity sector – and even in other areas or fields beyond the Smart Grids, such as Smart Energy (including Heat and Gas), Smart Cities, Home Automation, or Ambient Assisted Living. In light of this, given the wide adoption of the Use Case methodology within and outside the IEC, the IEC TC8 WG5 has been recently transferred to the IEC System Committee (SyC) Smart Energy[1] which has a broader scope than the previous technical committee and covers all the areas of expertise mentioned previously. This decision will facilitate the coordination and liaison between the group of experts in charge of maintaining the Use Case methodology and the IEC technical committees and working groups adopting the methodology for particular purposes.

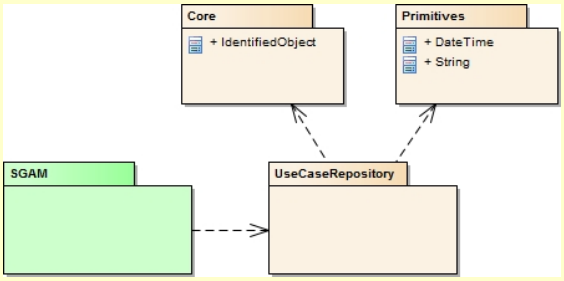
## 2.2. DISCERN contributions to the IEC 62559 Use Case methodology

Table 2-1 presents the recommendations – extensions, or modifications – proposed by DISCERN to the IEC TC8 WG5 in relation to parts 2 and 3 of the IEC 62559 series. It should be noted that the table only details those proposals from enhancements carried out in DISCERN that relate directly to standards and are to be incorporated in the final versions of the IEC 62559. It does not include, however, other enhancements performed in DISCERN relating to the mapping of the Use Case methodology into the SGAM framework (as described in [D1.3] and [D2-3.3]), which, in principle, is not within the scope of the IEC TC8 WG5.

The table highlights in green those proposals that have been accepted by the IEC TC8 WG5 to be part of the standards. The rows coloured in yellow might indicate either that the proposal is still being discussed within the standardisation group or that the extension or modification has been accepted but with some further revisions to those in DISCERN. Finally, the proposals coloured in red have not been considered for the first versions of the standards, though some of these may be included in future versions.

[1] IEC SyC Smart Energy: http://www.iec.ch/dyn/www/f?p=103:186:0::::FSP_ORG_ID:11825

Table 2-1. Proposals from DISCERN regarding the IEC 62559 standard series

| **IEC 62559-2 "Definition of the templates for Use Cases, actor list and requirements list"** | | |
|---|---|---|
| ***Proposed action*** | ***Description of the proposal*** | ***Current status of the proposal*** |
| Add Key Performance Indicator Table | Key Performance Indicators (KPIs) are performance measurements for assessing to what extent a solution meets the objectives defined in the Use Case; that is, KPIs make it possible to assess the solutions that realize the Use Case. The recommendation was to extend the IEC 62559-2 template in order to enable users to represent the KPIs that shall be used for assessing the solutions of the Use Case. Further details can be found on [D2-3.3] | The Key Performance Indicators table has been included in the first edition of the IEC 62559-2 standard.<br>It should be noted, however, that not all the columns proposed in [D2-3.3] were finally considered for the standard. Thus, the columns "Calculation" and "Target" were not added to the final standard, and the proposed column "Definition" is finally referred to as "Description" in the standard |
| Add column "Value" to the Requirements table | In order to clearly represent a requirement it is necessary to provide the following information: a) the requirement ID, that is, how the requirement is identified within the project, company, or according to an external requirement library; b) the description of the requirement, that is, an explanation of the meaning of the requirement ID, so that all readers can understand the requirement; and c) the specific value of the requirement for the associated step or information object. However, the Requirements table in the IEC 62559 CD Use Case template only included two columns: "Requirement ID", and "Requirement Description" | An additional column has been added to the Requirements table in the first edition of the standard IEC 62559-2. However, rather than "Value" the new column is called "Requirement name". Although the names of the columns are different to what was proposed by DISCERN, the final decision enables the complete description of the requirements, which was the main purpose of the proposal |
| **IEC 62559-3 "Definition of Use Case template artefacts into an XML serialized format"** | | |
| **IEC 62559-3 UML data model** | | |
| ***Proposed action*** | ***Description of the proposal*** | ***Current status of the proposal*** |
| Change data model organisation | In the latest draft version of the IEC 62559-3, the UML data model contains only one package "Primitives" with the classes DateTime and String. The rest of the classes are directly included in the main diagram of the data model. Building on this, in DISCERN we saw value in creating two additional packages within the Use Case data model: the package "Core" containing the general class IdentifiedObject and the package UseCaseRepository containing all the classes related with Use Cases and libraries. The proposed organisation makes it easier for users to carry out necessary extensions for specific purposes. For example, in the context of DISCERN, we extended the data model with SGAM concepts<br>  <br> | The discussions regarding the IEC 62559-3 were mainly focused on semantics so far; thus, no much attention has been paid to the overall organisation of the data model within the IEC TC8 WG5 for the time being. Nonetheless, the proposal made by DISCERN will be considered once all he concepts contained in the data model have been clearly defined |
| Add Area class | The final IEC 62559-2 Use Case template includes the field "Area/Domain(s)/Zone(s)", but was not represented in the IEC 62559-3 data model. In order to solve this issue, DISCERN proposed to add the class Area | The Area class has been added to the IEC 62559-3 data model as proposed in DISCERN |

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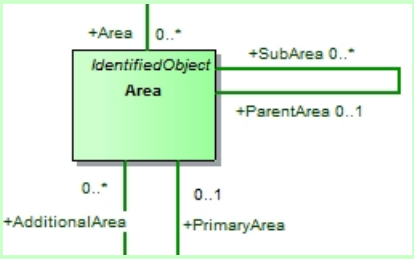
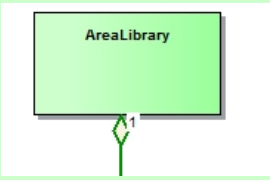
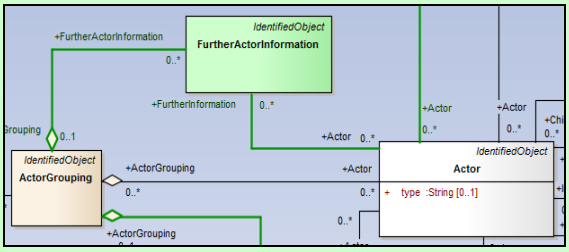
| |  | |
| Add AreaLibrary class | With the aim of enabling the creation of Area libraries, DISCERN proposed to add the class AreaLibrary associated with the Area class described above<br>  | The AreaLibrary class has been added to the IEC 62559-3 data model as proposed in DISCERN |
| Add FurtherInformation class | The FurtherActorInformation class was included in the data model in order to enable the same actor to be associated with different “further information” in different Use Cases. The FurtherActorInformation class is also associated with ActorGrouping, which in turn is associated with UseCase class. In that way, the class FurtherActorInformation can be used to represent to which Use Case any “further information” of an actor belongs.<br>  | The FurtherInformation class has been added to the IEC 62559-3 data model as proposed in DISCERN |
| Add InformationObject class | The latest version of the IEC 62559-3 data model does not enable the representation of information objects exchanges within a Use Case; for instance, “Current measurement” or “Smart Meter reading”. For that reason, DISCERN data model added the class InformationObject, which represents the information objects as defined in the IEC 62559-2 template | This extension is still being discussed within the IEC TC8 WG5. It is possible that it will not be included in the first version of the standard. |
| Add InformationExchanged class | In order to be consistent with the IEC 62559-2 template, the data model should also include also the class InformationExchanged, which is associated with the UseCase class and contains all the information objects defined in a Use Case | This extension is still being discussed within the IEC TC8 WG5. It is possible that it will not be included in the first version of the standard. |
| Add KeyPerformanceIndicator class | Key Performance Indicators (KPI) have been included in the IEC 62559-2 Use Case template. In order to formally represent KPIs, the IEC 62559-3 data model shall include the KeyPerformanceIndicator class. It shall contain the attributes “target” and be associated with the “Objective” class | The KeyPerformanceIndicator class has been added to the IEC 62559-3 data model. Nonetheless, the attribute “target” has not been included in the class, in the same way that IEC 62559-2 does not include the corresponding field |
| Add KPI_Calculation class | DISCERN proposed to add the class KPI_Calculation containing two attributes “description” (i.e., an explanation of the calculation – e.g. inputs needed and operations) and “URI” referring to the path of the file containing formula of the KPI calculation | This extension has been rejected, since the IEC 62559-2 does not include the corresponding field in the Use Case template |

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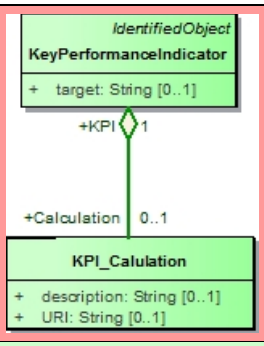
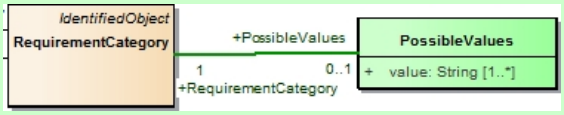
| |  | |
| Add PossibleValues class | In a Requirements library users should be able to propose "Possible Values" for the requirement categories, as in the requirement library defined in Intelligrid project [IEC PAS 62559]. For instance, for the requirement category "Number of Information Producers", the library may propose possible values, such as: one, two to a few, hundreds, etc. In order to formally represent possible values, the class "PossibleValues" has been added to the IEC 62559-3 data model. This class is associated with the "RequirementCategory" class and includes the attribute "value" with cardinality 1..*; that is, each requirement category can contain one or more possible values<br>  | The class PossibleValues has been added to the IEC 62559-3 data model as proposed in DISCERN |
| Add Requirements class | For the sake of consistency with the IEC 62559-2 template, the Requirements class should be added to the data model. This class is associated with the UseCase class and contains all the requirements described within the Use Case | This extension deals with the overall structure and organisation of the data model rather than with semantics. Therefore, it has not been considered for the time being |
| Add attributes "domain" and "zone" in Use Case class | The attributes "domains" and "zones" have been added to the UseCase class for consistency with the IEC 62559-2 template, which contains a field "Area/Domain(s)/Zone(s)". It is worth noting that the attributes "domains" and "zones" have 0..* cardinality, which means that a Use Case can relate to several domains and zones | The attributes "domains" and "zones" have been added to the IEC 62559-3 data model as proposed in DISCERN |
| Add attribute "type" as an enumeration in UseCaseRelation class | In the latest draft version of the IEC 62559-3 data model, the attribute "type" of the UseCaseRelation class is a "String". In DISCERN the value of this attribute is determined by the "UseCaseRelationType" enumeration. This enumeration can take three values: Associate, Extend and Include, which are the Use Case relations as defined in the UML Use Case meta-model by OMG (Object Management Group) | The definition of enumerations is typically carried out at profile (contextual) level instead of at data model level. For this reason, the proposed extension has been rejected |
| Remove attribute "furtherInformation" in Actor class | As explained previously, the attribute "furtherInformation" has been replaced for the class FurtherActorInformation | The attribute "furtherInformation" has been removed from the Actor class as proposed in DISCERN |
| Replace attribute "type" to "value" in Requirement class | The attribute "type" of the Requirement class has been replaced by "value". This is because the type of the requirement is already determined by the "RequirementCategory" class (e.g. "Number of Information Producers"), but, it is necessary to define the value of the requirement in a particular step (e.g. "one"). | The attribute "type" has been replaced by "value" within the Requirement class as proposed in DISCERN |
| Remove Role class | The IEC 62559-2 template does not enable users to specify the role of an actor within the Use Case. Therefore, the recommendation is either to remove this class from the data model, or to include the corresponding field in the template explaining the purpose of this concept. In the second option it is critical to differentiate the concepts actor and role | Despite not being represented in the IEC 62559-2 Use Case template, it is still not clear whether the Role class should be removed from the IEC 62559-3 or not |
| Remove "identifier" attribute in UseCase class | The UseCase class derives from the general IdentifiedObject class, which contains the attributes "description", "id", and "name". The attribute "description" is used to describe the object (e.g., the actor, or Use | The attribute "identifier" has been removed from the UseCase class as proposed in DISCERN |

| | | |
|---|---|---|
| | Case), the attribute “name” refers to the label of the object (typically, defined by humans to be understood by humans), and the attribute “id” is the unique identifier assigned by a software application to manage that object. Therefore, the attribute “Identifier” included in the UseCase class is redundant and may result in mismatches across software applications managing Use Cases. It is of course possible that data collisions occur when two or more applications assign different IDs to the same object. However, these collisions must be resolved at instance level (instance matching). Overlapping or redundant attributes at data model level do not help in addressing these problems. On the contrary, they may lead to additional mismatches. In conclusion, it is recommended to remove the attribute “Identifier” from the UseCase class | |
| **IEC 62559-3 XML schemas** | | |
| ***Proposed action*** | ***Description of the proposal*** | ***Current status of the proposal*** |
| Add ActorLibrary schema | The latest draft version of the IEC 62559-3 proposes the use of a profiling approach. According to this approach, the UML data model serves as a basis for the creation of profiles, which select the classes from the model that are required for a specific purpose or context and provide further details regarding validation constraints, e.g. more specific data types, cardinalities, and enumerations. XML schemas are then generated from the profiles defining the structure of the XML messages that shall be used to exchange instance data for the specific purposes defined in the profile. However, the profile and XML schema included in the IEC 62559-3 cover all the classes defined in the data model. Thus, instead of defining a profile selecting classes and defining more specific constraints for a specific context, the resulting XML schema represents the UML data model in a different format. Although the XML schema proposed in the IEC 62559-3 is useful when users want to exchange all the information stored in a Use Case repository (this is not the most common scenario), in DISCERN a more structured approach was proposed a that leverages the features of XML schemas in order to: develop more specific constrains for the validation of XML messages, reuse existing profiles, and define a more flexible process that can be adopted in different scenarios and domains.<br>This ActorLibrary schema proposed in DISCERN selects the classes from the UML data model for representing an Actor Library. | The ActorLibrary schema has been added to the IEC 62559-3 as proposed in DISCERN |
| Add Core schema | The Core schema includes core classes (IdentifiedObject and Ref_Object) that are reused in the other profiles | This extension has not been considered for the first version of the standard, however it will be discussed whether it is necessary or not to add it in the future |
| Add RequirementLibrary schema | This schema selects the classes from the UML data model for representing a Requirement Library. | The RequirementLibrary schema has been added to the IEC 62559-3 as proposed in DISCERN |
| Add UseCase schema | This profile selects the classes from the UML model for repenting a Use Case | For the time being, this schema will not be added to the first version of the standard, since Use Cases might be exchanged using the existing UseCaseRepository schema |
| Add validation rules | In addition to the more specific data types (enumerations) and cardinalities defined in the profiles, the XML Schemas have been extended in DISCERN with additional constraints that enable the automatic detection of inconsistencies within the XML messages. These constraints are represented by using the xsd:key and xsd:keyref terms. For instance, the validation rule shown below establishes that the “Primary Actors” of a Use Case Scenario must refer to an Actor previously defined in that Use Case in the Actor Grouping. This rule avoids the same Actor to be named differently in different parts of the Use Case. Hence, when a “Primary Actor” of a scenario does not refer to any actor previously defined in the actor groupings of the Use Case, the validation against the | Although the IEC TC8 WG5 regards the proposed validation rules as very useful, there might be a problem concerning the maintenance of the rules, since they are not automatically generated from the UML data model. In the future, if a new feature is added to the UML tools for generating this kind of XML schema validation rules, these would be added to the standard profiles |

| | | |
|---|---|---|
| | DISCERN Use Case XML Schema generates a warning indicating the error<br><br>`<!-- Rules for consistency within the Use Case description-->`<br>`<!-- References to Actors-->`<br>`<xsd:key name="actorName">`<br>`  <xsd:selector xpath="ActorGrouping/Actor"/>`<br>`  <xsd:field xpath="name"/>`<br>`</xsd:key>`<br>`<xsd:keyref name="primaryActor2actorNameRef" refer="duc:actorName">`<br>`  <xsd:selector xpath="Scenario/PrimaryActor"/>`<br>`  <xsd:field xpath="name"/>`<br>`</xsd:keyref>` | |

## 2.3. DISCERN at IEC TC8 WG5 meetings

As explained in section 2.1, the IEC 62559 standards series are still under development. Only the first edition of part 2 (Use Case template) has been recently published. In fact, when DISCERN started in February 2013 and the architectural templates were described in [D1.3] and later used in [D4.2, D4.3], none of the IEC 62559 standards were publicly available. This implied that the draft versions utilised at the early stages of the project were not mature enough and not even stable.

Consequently, with the aim of leveraging the numerous advantages associated with international standards – namely, designing tools that can be easily reused and integrated beyond the project and taking full advantage of previous work carried out by international experts – it was necessary to closely collaborate with IEC TC8 WG5 during the development of the standard series. For that purpose, DISCERN members joined this international group of experts, making it possible not only to receive the latest news on the evolution and current status of the standards, but also to contribute on the elaboration of the series by providing recommendations based on the experiences gained in the real case studies studied and implemented during DISCERN.

The following briefly reports the participation of DISCERN members at IEC TC8 WG5 meetings describing the most relevant actions with regard to DISCERN interests that were carried out in those meetings:

- DISCERN Workshop I-II “Smart grid sub-functionalities, Use Cases and KPIs” held in Brussels (Belgium) on 13 February 2014. Amongst the experts invited to the workshop there were IEC TC8 WG5 members. One of the topics of the workshop was the Use Case & SGAM approach adopted in DISCERN as a tool for knowledge sharing in smart grid projects. Some of the issues discussed during this part of the workshop included proposals made from DISCERN members to extend the IEC 62559 Use Case template in order to better represent smart grid solutions.

- IEC TC8 WG5 official meeting held in Clamant (France) on 17 June 2014. During this meeting the Use Case & SGAM approach defined by the DISCERN project was introduced and first official proposals concerning the IEC 62559-2 template (see Table 2-1) were presented. From the very beginning the IEC TC8 WG5 group of experts acknowledged the benefits of using DISCERN as a means to promote and validate the IEC 62559 methodology with real case studies developed by large DSOs from 4 countries.

- IEC TC8 WG5 conference call on 3 November 2014. This conference call was focused on the IEC 62559-3 UML data model. Some of the recommended modifications and extensions proposed in DISCERN (see Table 2-1) were discussed during the call.

- DISCERN Workshop III “Vendor Workshop” held in Brussels (Belgium) on 4 December 2014. As in the previous DISCERN workshop, IEC TC8 WG5 members took part in the event, where the

DISCERN Use Case & SGAM approach and tools were briefly introduced. The participants expressed their view that the DISCERN approach and tools are very beneficial for IEC 62559 methodology, since they facilitate the adoption of the standards for expressing and sharing requirements of smart grid solutions under design [DISCERN Workshop III].

- IEC TC8 WG5 official meeting held in Geneva (Switzerland) on 18-19 March 2015. The DISCERN Use Case & SGAM approach and tools are presented in more detail to all IEC TC8 WG5 experts. Specific recommendations from DISCERN on the IEC 62559-3 data model are further discussed. Moreover, the IEC TC8 WG5 agrees on the convenience of performing IEC 62559 interoperability tests by using DISCERN and external tools.
- IEC TC8 WG5 conference call on 23 April 2015. This conference call was specifically organised to discuss DISCERN proposals regarding the IEC 62559-3 data model and derived XML schemas (see Table 2-1).
- CIM Users Group meeting held in Gdynia (Poland) on 1-4 June 2015. During the conference, DISCERN members had another meeting with IEC TC8 WG5 experts in order to take the final decisions (presented in Table 2-1) on the DISCERN recommendations with regard to the first edition of the IEC 62559-3 data model and XML schemas.

This overview of the DISCERN & IEC TC8 WG5 meetings demonstrates the active involvement of DISCERN members within this standardisation group resulting in a number of DISCERN proposals being considered in the IEC 62559 international standard series as detailed in section 2.2.

## 2.4. Next steps

Section 2.2 showed that at this stage there are still some pending proposals from DISCERN in relation to the IEC 62559 series (parts 2 and 3), which are being discussed with other members of the IEC TC8 WG5. Moreover, some of the proposals that have been initially discarded for the first versions of the standards may be considered in future versions. Therefore, DISCERN members will continue to take part in IEC TC8 WG 5 (currently, IEC SyC Smart Energy WG5) to further discuss the proposed extensions and modifications to the IEC 62559 standards.

In addition to this, DISCERN members will provide valuable inputs to the ongoing IEC 62559-4 standard describing how to adopt the Use Case methodology beyond standardisation activities, since in DISCERN the methodology has been successfully utilised in real case studies based on smart grid solutions led by large DSOs.

Finally, it is planned that the DISCERN tools described in [D2-3.2] undergo in interoperability testing with other software applications (such as, the Modsarus UML tool employed in EvolvDSO [Modsarus], the EA SGAM UML Toolbox developed by Salzburg University of Applied Science [SGAMToolbox], and the future IEC Use Case Management Repositories), in which the standard-based XML formats will be leveraged in order to enable exchange of use-case-related data (Use Cases, libraries) across different tools.

## 2.5. Key achievements

Table 2-2 highlights the key achievements obtained by DISCERN in relation to the Use Case methodology.

Table 2-2. Key achievements obtained by DISCERN in relation to the Use Case methodology

- **DISCERN proved the Use Case methodology, originated in Software Engineering, to be of benefit in smart grid projects**, since it provides a structured approach to identify and express requirements for complex smart grid solutions under design.
- With the aim of taking full advantage of previous contributions by Software Engineering experts and promoting DISCERN Use Cases beyond the project, **DISCERN leveraged the IEC 62559 "Use Case methodology" standards series**, which are developed and maintained by the IEC TC8 WG5 – recently transferred to the IEC SyC Smart Energy WG5.
- **The work carried out in DISCERN with regard to the Use Case methodology contributed to upgrade the IEC 62559 standards series**, which were still in development during the project:
  - **DISCERN members joined the IEC TC8 WG5 in order to provide recommendations** on how to enhance the standards with a view to making the Use Case methodology of benefit in real industry environments.
  - **Some of the recommendations given by DISCERN have been already accepted and will be included in the first editions of the standards series**, while others are being discussed within the IEC TC8 WG5 and might be added in future editions.
  - **The contribution of DISCERN partners in regard to the IEC 62559 "Use Case methodology" will continue after the project**. DISCERN experiences will be particularly useful in order to develop guidelines for the adoption of the Use Case methodology in the industry (IEC 62559-4) as well as to design standard-based interfaces for exchanging use-case-related data across software applications (IEC 62559-3).

# 3. DISCERN activities with regard to the SGCG – SGAM framework

The Smart Grid Architecture Model (SGAM) was designed by the European standardisation bodies CEN-CENELEC-ETSI as a framework to facilitate development and maintenance of communication standards within the scope of European smart grids. In DISCERN, the SGAM has been adopted and enhanced with the aim of improving communication within and outside the project. Thus, in combination with the Use Case methodology, this framework enabled DSOs to represent their smart grid solutions in an intuitive manner so as to facilitate discussions with other DISCERN members and external stakeholders. In particular, the SGAM framework was utilised during the project with the following purposes: 1) to make it possible for DSOs to learn from technical solutions previously developed by other DSOs [D1.3, D4.2, D4.3]; 2) to improve communication between Learner DSOs and technology providers or vendors when procuring the systems that were implemented at the demonstration sites [D2-3.1]; and 3) to share knowledge with other DISCERN partners for carrying out simulations and assessment of the technical solutions [D6.1, D8.1, D8.3].

The following sub-sections introduce the CEN-CENELEC-ETSI Smart Grid Coordination Group (SGCG), which is the group of experts within the European standardisation bodies that was in charge of creating the SGAM framework (3.1), summarise the most relevant DISCERN contributions to the SGAM (3.2), and explain the next steps including recommendations on how the improvements proposed in DISCERN should be maintained beyond the project (3.3).

## 3.1. Introduction to the SCGC

The European Commission (EC) mandate M/490 asked the European standardisation bodies to develop a reference framework for representing smart grid architectures with a view to enabling interoperability analysis for standardisation purposes [M/490]. The main objective was to facilitate the development and maintenance of a set of communication standards improving interoperability of European smart grid solutions. With the mission of pursuing such a goal, the Smart Grid Coordination Group (SGCG) was formed, including experts from the three main European standardisation bodies within the smart grids domain: the European Committee for Standardisation (CEN), the European Committee for Electrotechnical Standardisation (CENELEC), and the European Telecommunications Standards Institute (ETSI).

The outcome of the work carried out by the SGCG was presented in a series of technical reports comprising:

- “Smart Grid Reference Architecture” report, which defines the SGAM as a framework for representing high-level smart grid architectures [SGCG-SGAM]
- “Sustainable Processes” report, which details how the SGAM should be employed by the European standardisation bodies with the aim of performing standards analysis [SGCG-SP]
- “First Set of Consistent Standards” report, which uses the SGAM in order to develop a list of communication standards and standard data models promoting interoperability within the Smart Grids, and to identify key interoperability issues that shall be resolved by the standardisation bodies in this domain [SGCG-FSS].

- "Information Security and Data Privacy" report, which provides recommendations on cyber security and data privacy within the scope of smart grids [SGCG-SGIS].

As detailed in [D1.3], the SGAM framework described in [SGCG-SGAM] enables users to represent high-level architectures of smart grid solutions covering 5 interoperability layers:

- Component Layer, presenting the physical distribution of the components (devices, application, electrical equipment) within the smart grid solution
- Communication Layer, including the communication standards that should be used within the solution in order to enable communication across the components
- Information Layer, representing the information objects exchanged within the components and the canonical data models that shall be used to achieve interoperability
- Function Layer, describing the technical functions that are realized by the smart grid solution
- Business Layer, dealing with the business objectives that explain the development of the smart grid solution

Due to its clear and intuitive way of describing smart grid solutions addressing key interoperability aspects, the SGAM rapidly started to gain momentum not only within the European standardisation bodies, but also among other smart grid stakeholders (utilities, research institutes, consultants, vendors) inside and outside Europe. Nonetheless, it is important to note three issues relating to the SGAM framework as defined by the SGCG:

- Limited scope. The SGAM was conceived as a tool for performing standardisation activities. Consequently, little attention was paid to its adoption outside the European standardisation bodies. For instance, despite being defined, the Business Layer was not used within the SGCG reports in practise, because the business needs related to the smart grid solutions were not within the scope of the standardisation analyses. As a result, until recently, no business-related symbols had been developed for the SGAM.
- Lack of formal semantics. The SGAM was defined in a set of technical reports; that is, as text documents in Microsoft Word or PDF formats that were aimed at facilitating human-to-human communications, but lacked a formal definition of the SGAM concepts. This hinders the development of software tools capable of exchanging and processing SGAM models.
- Lack of maintenance. Unlike the Use Case methodology, the SGAM has no international group of experts in charge of maintaining the framework. Therefore, there are no established procedures to maintain the SGAM framework beyond the set of SGCG technical reports.

The following sub-section summarises the enhancements performed during DISCERN in order to utilise the SGAM in the context of a large smart grid project and, in general, to overcome the abovementioned issues with the aim of promoting the adoption of the SGAM as a common framework for sharing and analysing smart grid solutions.

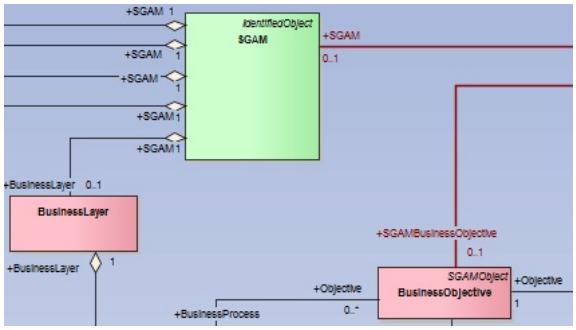
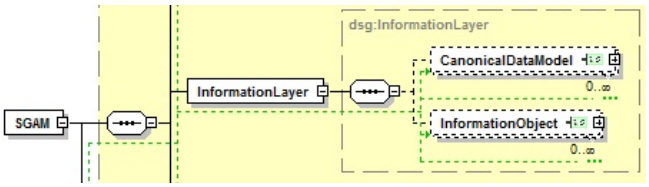
## 3.2. DISCERN contributions to the SGAM framework

Table 3-1 shows the improvements to the SGAM carried out in DISCERN grouped according to the three main issues identified in the previous sub-section. Given that there is no official group of experts currently standardising the framework, it was not possible to officially present these proposals to any standardisation body. Therefore, unlike Table 2-1 in previous section, this summary does not detail

whether the proposal has been officially accepted or rejected. Nevertheless, the work performed in DISCERN with regard to the SGAM has been presented to members of the SGCG at the workshops with external stakeholders. In that way, Table 3-1 includes the reaction or feedback received from the SGCG during the workshops [DISCERN Workshop III].

Table 3-1. Proposals from DISCERN regarding the SGAM framework

| **Limited scope** | | | |
|---|---|---|---|
| ***New concept*** | ***New SGAM symbol*** | ***Description of the extension*** | ***Current status of the proposal*** |
| Association | —Text— | A unit that represents an association between objects (Business Actors, organisation etc.) | All the symbols proposed in DISCERN to extend the SGAM (in particular, the Business Layer) were presented and used in real examples at two workshops with external partners, including experts from the SGCG.<br><br>All the SGCG experts participating at the workshops expressed their view that the new symbols make it easier for users to describe business-related aspects associated with the smart grid solutions.<br><br>The next step is to officially propose the extensions, once an international group of experts has been created that maintains the SGAM framework. |
| Business Actor |  | A business actor as a concept can cover people as well as organisations or roles | |
| Business Process |  | A business process relates to a sub-functionality under a business objective | |
| Economic Constraint |  | A specialized constraints covering economic aspects, e.g. budget | |
| Key Performance Indicator |  | Indicator that provides information on the accomplishment of a target | |
| Objective |  | With respect to the Gridwise Architecture Council interoperability layers this entity covers strategic and tactical objectives shared between businesses | |
| Organisation |  | An organization to which the Business actors (in the sense of persons) are associated to | |
| Regulatory Constraint |  | A specialized constraint covering laws and regulatory policies | |
| Target |  | A target represents the measurable decomposition of an objective | |
| **Lack of formal semantics** | | | |
| ***Extension*** | ***Description*** | | ***Current status of the proposal*** |
| SGAM UML data model | UML data model including classes, attributes and associations that formally define and relate SGAM concepts, such as Business Objective, Function, Component, or Communication Standard. The SGAM UML data model is based on and extends the IEC 62559-3 Use Case data model, establishing links between SGAM concepts and Use Case concepts. A detailed description of the SGAM UML data model is given in [D2-3.3]. What follows shows a small extract of the complete model. | | The UML data model and derived XML schema were used in DISCERN to exchange SGAM model across software tools. The methodology followed in DISCERN was presented both at the workshop with external partners |

| | | |
|---|---|---|
| |  | (including experts from the SGCG) as well as in the IEC TC8 WG5 meetings described in Section 2.2. In both cases, the members of the standardisation bodies regarded the UML data model and XML schema created in DISCERN as very useful for the adoption of the SGAM framework in smart grid projects.<br><br>The next step is to officially propose the SGAM UML data model and XML schemas, once an international group of experts has been created that maintains the SGAM framework. |
| SGAM XML schema | XML schema based on the SGAM UML data model. It defines the machine-readable format for exchanging SGAM models across software applications. A detailed description of the SGAM XML schema is given in [D2-3.3]. The image below shows a small extract of the complete schema.<br>  | |
| **Lack of maintenance** | | |
| ***Proposed action*** | ***Description*** | ***Current status of the proposal*** |
| SGAM group of experts | A new group of experts shall be created at the IEC to maintain the SGAM framework. More details on this recommendation are provided in Section 3.3. | At the first workshop with external participants, the experts of the SCGC were asked about the future management of the SGAM framework. The experts regarded the option of making the SGAM an international IEC standard as the most natural solution for the maintenance of the framework. |

## 3.3. Next steps

As future work, the most relevant task with regard to the SGAM framework is to officially propose a new action at the IEC to create an international group of experts responsible for the maintenance of the SGAM. In principle, although the Use Case methodology is closely related to the SGAM, the IEC TC8 WG5 considered this framework out of the group's scope. However, the recent transfer of the group to the IEC SyC Smart Energy, which, as explained in Section 2.1, has a broader scope covering more areas and actions, may make this group of experts the most suitable body for carrying out the proposed SGAM standardisation activity.

The maintenance of the SGAM comprises:

- Updating the sets of SGAM concepts and libraries of Actors and Functions that shall be used in the 5 layers. This includes the extensions proposed by DISCERN for the Business Layer.

- Maintaining the UML data model formally defining the semantics of SGAM-related concepts. The DISCERN SGAM UML model would be the basis of the standard data model.
- Standardising XML schemas describing the standard formats for exchanging SGAM models in a machine-readable language. The DISCERN SGAM XML schema is a strong candidate for the first version of the standard, since it was tested in real case studies based on smart grid solutions developed by 5 large European DSOs.

Moreover, the international standardisation group of experts responsible for the SGAM framework should review and update the SGCG reports to document the abovementioned enhancements, and should produce an additional report detailing how the SGAM can be utilised to bring benefits to a range of activities beyond assessment by standardisation bodies. Again, the experiences gained in DISCERN may serve as a strong starting point for such a report as SGAM has successfully be used within DISCERN to support activities at various stages of project design, specification and procurement, as well as in communicating and comparing smart grid projects between different parties. Finally, it is recommended to revise the SGCG report on smart grid cyber security [SGCG-SGIS] with a view to making it more compatible with SGAM models similar to the NISTIR 7628 report as described in [NISTIR 7628-1]. The objective would be to make it easier for users to map SGAM models developed by domain experts into reference models designed by cyber security experts in order to easily infer IT-security requirements for the smart grid solutions. Further details on the method proposed in DISCERN for extracting IT-security requirements from SGAM models are given in [D3.5].

## 3.4. Key achievements

Table 3-2 presents the key achievements obtained by DISCERN in relation to the SGAM framework.

Table 3-2. Key achievements obtained by DISCERN in relation to the SGAM framework

- **The Smart Grid Architecture Model (SGAM),** designed by the European standards organisations to identify standardisation gaps, has been utilised in DISCERN in combination with the Use Case methodology **as a common framework for producing and exchanging intuitive representations of smart grid architectures.**
- Until recently, the **SGAM had two main shortcomings**: 1) since it was mainly focused on standardisation activities, it **lacked detailed symbols for representing business-related aspects**; 2) given that it **was described as drawings in text reports, it was only used for human-to-human communications**.
- **DISCERN enhanced the SGAM** with a view to overcoming the limitations mentioned above.
  - **Business-related concepts and symbols** has been defined and utilised in the project to enable users to represent business architectures of the smart grid solutions.
  - **A UML data model has been created to formally define the semantics of SGAM elements**. The data model is aligned with the standard IEC 62559-3 data model.
  - **An XML schema has been produced** from the UML data model in order **to define a standard-based format for exchanging SGAM models across software**

**applications**.

- **DISCERN proposes that the IEC** – in particular, the IEC Systems Resource Group (SRG) – **create a new standardisation action for maintaining the SGAM framework.** The group of experts responsible for such a task shall standardise the semantics of the SGAM (that is, it is recommended to create and standardise a SGAM UML data model) as well as the XML-based formats for exchanging SGAM models. Since **DISCERN** has produced and tested in actual industry environments the aforementioned tools, the DISCERN project **will be one valuable key starting point for the standardisation of the SGAM framework**.

# 4. DISCERN activities with regard to the IEC TC57 – Communication Standards and Canonical Data Models

In addition to enhancing the Use Case & SGAM approach for exchanging knowledge about technical solutions in the context of large smart grid projects, DISCERN assessed the adoption of communication standards and canonical data models within the smart grid solutions with the aim of facilitating the development of interoperable solutions. That is, whereas Sections 2 and 3 described the contributions of DISCERN in relation to the standard methodologies and frameworks for representing requirements and architectures of smart grid solutions, Section 4 summarises the proposals made in DISCERN concerning the standards that enable information exchanges within the solutions.

All roadmaps, guidelines, technical reports, and studies on smart grid interoperability developed for the last decade highlight the International Electrotechnical Commission (IEC) as the main standardisation body in the electricity sector [NIST Framework & Roadmap]. In particular, the IEC Technical Committee 57 (TC 57) is in charge of creating and maintaining the most relevant international standards that promote interoperability for power system management. For that reason, the following gives an overview of the activities carried out during DISCERN regarding the adoption of IEC TC57 standards. Given its importance and broad utilisation within the project, sub-section 4.1 focuses on the recommendations provided by DISCERN on the IEC TC57 Common Information Model (CIM), while sub-section 4.2 covers the DISCERN proposals with regard to other IEC TC57 and related standards.

## 4.1. Recommendations regarding the IEC TC57 Common Information Model (CIM)

As explained in the reference architecture defined by the IEC TC57, previous standardisation efforts in the electricity sector were mainly focused on the definition of simple communication protocols for transferring data among the devices - such as, Remote Terminal Units - and applications - such as SCADA applications - controlling the networks [IEC 62357-1]. However, the increasing complexity of the information that has to be exchanged and processed within smart grid solutions together with the development of object modelling techniques and Model-Driven Integration (MDI) architectures has shifted the focus to the interoperability at semantic level. This means that devices and applications from different vendors not only have to exchange data, but they also need to share a common understanding on the semantics of this data in order to interoperate with each other. Therefore, semantic integration has become a key aspect for the standardisation bodies in this domain. In fact, many IEC TC57 standards for the electricity systems include canonical data models formally defining specific domain terms for information exchange, which significantly reduce semantic integration efforts when commissioning systems.

The most widely adopted canonical data model for electricity distribution networks is the IEC TC57 Common Information Model (CIM). What follows introduces the CIM (4.1.1), reports the participation of DISCERN members at IEC TC57 regarding the CIM (4.1.2), summarises the main proposals made in DISCERN to improve the canonical data model to promote its adoption at DSOs (4.1.3), and describes the future work in this direction (4.1.4).

### 4.1.1. Introduction to the IEC TC57 CIM

The CIM was originally developed by the Electric Power Research Institute (EPRI) in the U.S.A. with the aim of promoting interoperability with regard to the Energy Management Systems (EMS) that supervise and control power transmission networks. At present, it is defined in international standards developed by the IEC TC57 and has a wider scope covering information exchanges in electricity markets and Distribution Management Systems (DMS) involved in the management of power distribution networks [Uslar et al.]. The groups of experts within the IEC T57 responsible for maintaining the CIM work in close collaboration with the CIM Users Group (CIMug), which is an association of users of the CIM including utilities, software vendors, manufacturers, consultants and Research and Development (R&D) organizations "dedicated to managing and communicating issues concerning the IEC TC57 CIM standards and to serving as the primary means for developing consensus and consistency across the industry"[2]. The main objectives of the CIMug are to promote the CIM, provide a central repository for CIM issues and models, offer a single point of contact for CIM model management, facilitate awareness of CIM products and implementations, and establish liaison with other standards groups.

The CIM IEC TC57 standards are grouped in three main series: IEC 61970 transmission series, maintained by Working Group (WG) 13 within the IEC TC57, focus on energy management system applications; IEC 61968 distribution series, maintained by WG 14, are dedicated to distribution management; and, finally, IEC 62325 market series, maintained by WG16, address information exchanges about electricity markets. The central part of the standard series is the CIM UML data model; a canonical data model formally defining the semantics of the information exchanged in a broad range of applications in the context of electricity networks, such as network operation, planning, asset management, and market processes.

### 4.1.2. DISCERN at IEC TC57 meetings

Since the last decade, the CIM has been widely adopted to facilitate semantic interoperability at electricity utilities. Although most of the success stories around industry solutions based on the CIM relate to experiences at Transmission System Operators (TSOs), there is an increasing interest among the DSOs in employing the CIM as a tool to seamlessly integrate their applications and avoid data management silos. In that way, the work performed in DISCERN regarding the adoption of the CIM in the context of real solutions implemented at demonstration sites of large European DSOs was very valuable for the CIMug and the IEC TC57 working groups of experts that maintain the CIM.

It should be noted that in most DISCERN solutions the centralised DMS systems use proprietary data models, because the focus of DISCERN demonstration sites is not on the centralised systems, but on the automation and metering systems. Hence, the DMSs are simple solutions to collect the field data; that is, they comprise an application and a Graphic User Interface (GUI), and the interoperability requirements for these solutions are not relevant for the main purpose of the functionalities [D5.4]. However, in order to promote the adoption of the CIM at European DSOs, this canonical data model has been applied within DISCERN for different purposes. These applications are summarised as follows:

- The CIM Interface Reference Model was one of the main sources to agree on the common terminology for representing the actors and technical functions of DISCERN solutions [D1.3], [D2-3.1].

[2] CIM Users Group (CIMug): http://cimug.ucaiug.org/default.aspx

- The DISCERN Semantic Model developed in [D5.1] and [D5.2] in order to define common terms for expressing DISCERN smart grid solutions was based on the CIM. The analysis carried out on those deliverables helped identify possible extensions and ambiguities that should be resolved in the model.

- The CIM was also used for expressing the simulation scenarios in a standard electronic format. One of the problems identified by DISCERN regarding the definition of simulation scenarios was the lack of common electronic formats for representing the electricity networks of the DSOs. With the aim of avoiding this time-consuming task in the future, in DISCERN it was analysed how the CIM can be utilised for that purpose at smart grid projects. Moreover, a converter has been developed to automatically import network models represented in CIM into the Matpower simulation tool [D6.2].

- Finally, in DISCERN a new methodology has been proposed to go from the SGAM framework to the development of CIM message payloads, which define the structure of the messages that must be used to exchange information objects in an interoperable manner [D5.4].

Some of the work described previously has been presented at:

- CIM Users Group (CIMug) official meeting “EU Network Codes: Meeting the Transmission & Distribution Challenge Using the CIM” held in Oslo (Norway) on 17-20 June 2014. The DISCERN Semantic Model as well as the methodology to generate CIM message payloads from SGAM models were presented and discussed with members of the CIMug. The overall approach was well received and positive feedback was gathered in relation to the use of SGAM models as an intuitive starting point for producing CIM-based formats.

- IEC TC57 WG13 official meeting. The applications of the CIM within DISCERN were presented at an official meeting of the IEC TC57 WG13.

### 4.1.3. DISCERN proposals on IEC TC57 CIM

Table 4-1 summarises the extensions and ambiguities that were identified by DISCERN partners when adopting the CIM for representing their smart grid solutions in the activities described previously. Given that the focus of smart grid solutions was not on DMS applications, the work carried out in DISCERN in relation to the CIM was not aimed at exchanging CIM-data within the smart grid solutions implemented at the demonstration sites. On the contrary, the applications of the CIM in DISCERN served mainly as a learning process for the DSOs, who had the opportunity to gain experience of the structure of the canonical data model and better understand its benefits as a tool to achieve interoperability at distribution management systems. Thus, although the recommendations have been presented at the CIMug and the IEC TC57 meetings mentioned above, it would be necessary to produce messages based on the extended CIM model and to carry out interoperability tests validating the usefulness of the proposed extensions.

Table 4-1. Proposals from DISCERN regarding the IEC TC57 CIM

| IEC TC57 Common Information Model | | |
|---|---|---|
| **DISCERN Semantic Model** | | |
| ***Proposed extension to the CIM UML model*** | ***Description of the extension*** | ***Current status of the proposal*** |
| FaultPassageIndicator | This class represents a device that indicates the presence and direction of a fault current in the cables where the device is located. It derives from the existing cim:FaultIndicator class | The recommendations have been introduced at CIMug and IEC TC57 WG13 meetings. However, real case studies of CIM-based information exchanges need to be carried out in order to prove that the proposed extensions are required |
| LVSupervisor | This class represents an Intelligent Electronic Device (IED) that collects voltage and current measures from sensors in the LV side of secondary substations, perform registrations of energy (meter), measures and events, and generate alarms when some voltages or currents are out of margins.<br>As explained in [D5.4] this class could be derived from cim:Meter class or from cim:RemoteUnit class. In that way, the same concept (LVSupervisor) can be represented in CIM in two completely different (but valid) ways. It is, therefore, recommended that the standardisation bodies in charge of maintaining the CIM (i.e. IEC TC57 WG13, WG14, and WG16) analyse which of the two approaches should be followed in case there is a need to represent LV supervisors in CIM. Otherwise, the representation of LV supervisors would lead to ambiguities within the model, since different classes and relationships can be used to represent the same concept, which may result in mismatches between different representations of the same concepts in the same model | |
| MVSupervisor | This class represents a Medium Voltage Supervisor. It derives from cim:AuxiliaryEquipment and is associated with cim:RemoteUnit, cim:CurrentTransformer, cim.PowerTransformer, and cim:FaultIndicator classes | |
| SecondarySubstation | This class represents an assembly of HV switchgear, transformer and LV switchgear in an enclosure where the lower voltage is 400/230V. The definition includes transformer substation. It derives from cim:Substation | |
| Estimator | This class represents all the processes need to operate the information needed to estimate energy consumption | |
| LossCalculator | This class represents the processes needed to calculate the technical and not technical losses | |
| CalculationCore | This class is the parent class of the previous LossCalculator and CalculationCore classes | |
| EndPointMonitor | Specific monitor classes required to represent end point real time measurements for energy profile calculations | |
| FrontEndProcessor | This class represents a SCADA frontend processor performing calculations from the field data collected by Remote Terminal Units | |
| PerformanceEvaluationReportingDatabase | Application and database to handle the events, alarms and to follow up the collection performance of meter readings | |
| SubstationMonitor | Special classes may be needed for aggregation of energy profiles at the substation level for the further analysis | |
| MeterConcentrator | This class represents an asset that performs the metering concentrator role off one or several meter(s). Used for single point access to information from one or several meters | |
| AmiHeadEnd | This class represents a system for data management of meter readings, events and alarms. Not all events collected from the smart meters and Meter Data Concentrator are exported to the Enterprise systems. The system monitors the data collection from the communication system | |
| MeterDataManagementSystem | This class represents a Meter Data Management System for all meters, as well as customer information (from CIS) and information of how the meter is related to the secondary substations. The system also is the data warehouse for all the meter readings, except for those customers (>63A fuse) obliged to have an hourly meter | |
| InformationSystemDevice | This class represents a container for system devices that represent a physical system device component. | |
| **From SGAM to CIM messages** | | |

| *Proposed methodology* | *Description of the methodology* | *Current status of the proposal* |
|---|---|---|
| Approach to create CIM message payload from SGAM models | The objective of the methodology is to guide users from the development of high-level Smart Grid architectures (SGAM models) towards the definition of specific system interfaces between the components of the Smart Grid solution (CIM message payloads). The methodology comprises three steps, summarised here and detailed below:<br>1. In the first step of the methodology, the SGAM architectures are represented in UML including the information objects and the associated canonical data models.<br>2. In the second step, the SGAM information objects are mapped to the corresponding CIM classes by defining the corresponding CIM profiles; that is, users follow the profiling methodology utilized in the IEC TC57 in order to choose the CIM classes, relationships, and attributes that represent the selected SGAM information objects<br>3. In the last step, the CIM-based XML Schemas are created from the CIM profiles of the SGAM information objects. These XML Schemas define the message payloads that enable interoperability within the Smart Grid system represented in the SGAM | The approach has been presented at the CIMug meeting held in Oslo on 17-20 June 2014. Although the methodology was designed to be utilised by utilities willing to create their own CIM-based formats from intuitive SGAM representations of their solutions, it is possible that the standardisation bodies are also interested in taking advantage of the SGAM framework to define the standard CIM message payloads |

### 4.1.4. Next steps

In regard to the extensions proposed to the CIM UML data model, in order to incorporate the proposals into the standard, the next step would be to develop real case studies in which the extensions are used for generating CIM-based messages to exchange data among power system applications at the DSOs. Once these case studies have been clearly defined and interoperability tests have been performed, the formal proposals should be presented at the CIMug and IEC TC57 WG13, 14 meetings so as to be considered for a future version of the canonical data model.

The objective for the SGAM-to-CIM approach designed in DISCERN is to promote its adoption in the industry. As one action towards this aim, were the IEC TC57 to map their Use Cases into the SGAM framework, the DISCERN SGAM-to-CIM approach would be proposed as a means to generate and organise the standard CIM message payloads.

## 4.2. Recommendations regarding other IEC TC57 and related standards

Apart from the CIM, the IEC TC57 defines a number of canonical data models and communication standards promoting interoperability in smart grid solutions. Moreover, existing alliances in the electricity sector, such as PRIME and OpenADR, have developed other standards for integrating particular smart grid functionalities.

This fact motivated the development of the DISCERN methodology for assessing the standards utilised within smart grid solutions. The methodology comprised two main phases or steps:

- In the first step a high-level assessment of the communication standards and canonical data models was carried out by comparing the standards described in the SGAM model of a solution

with those recommended by international standardisation bodies in the IOP Tool, which is an Excel file created by the SGCG that contains the most relevant communication standards and canonical data models in this domain (4.2.1)

- In the second step a detailed analysis was performed studying how to apply the recommended standards in order to achieve interoperability in practice (4.2.2)

### 4.2.1. High-level assessment of communication standards and canonical data models

The approach developed in DISCERN for performing high-level assessments of communication standards and canonical data models used in smart grid solutions is shown in Figure 4-1. The SGAM models of the smart grid solutions, in particular the Communication Layer and the Information Layer – Canonical Data Model View, are compared with the recommended standards from the SGCG in the IOP Tool. The comparison is then analysed by the DSOs and results in a set of recommendations for both: the DSOs regarding communication standards and canonical data models that can be utilised to achieve interoperability in the smart grid solution, and the standardisation bodies regarding standardisation activities that should be undertaken in order to resolve standardisation issues identified in smart grid solutions.

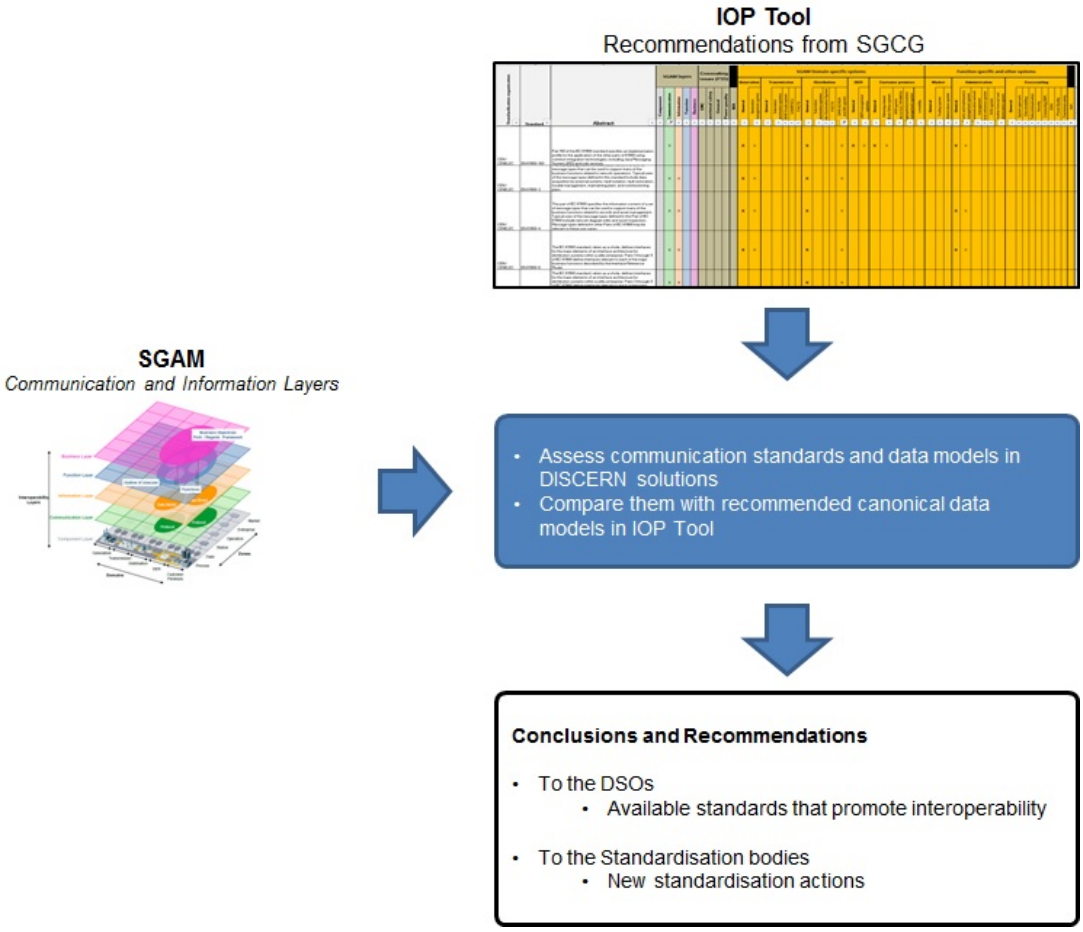



Figure 4-1. High-level assessment of standards in smart grid solutions

The approach described in Figure 4-1 was followed in DISCERN by using the SGAM models developed by the DSOs during the project. Table 4-2 summarises the most relevant proposals to the standardisation bodies that were identified as a result of this process. It should be noted that this summary does not contain the recommendations to the DSOs for the particular smart grid solutions developed during the project. Those recommendations are detailed in [D2-3.2, D5.4].

Table 4-2. Proposals from DISCERN regarding new standardisation actions at the IEC TC57

| New standardisation actions identified in DISCERN smart grid solutions | | |
|---|---|---|
| ***Proposed action*** | ***Description of the action*** | ***Current status of the proposal*** |
| CIM and STG-DC harmonisation | In the standards assessment carried out in [D5.4] a new standardisation action has been identified. This action shall guide users towards the harmonisation of the STG-DC data model initially defined by Iberdrola and currently maintained by the PRIME Alliance for exchanging meter-related data and the IEC TC57 CIM, in particular the part dedicated to meter readings (IEC 61968-9) | The proposals have not been presented to the corresponding standardisation bodies yet (see 4.2.3) |
| IEC 61850 mapping to DNP3 and Modbus TCP | No standardisation activity is being realized at the moment to harmonise or define the mapping between three communication standards widely adopted in automation systems: DNP3, Modbus TCP, and IEC 61850. The only standard that addresses this issue is the IEC 61400-25-4, which was defined specifically for wind power plant communications. Therefore, the recommendation to the standardisation bodies in this regard is to assess whether a standardisation action to harmonise DNP3, Modus TCP, and IEC 61850 communications is required | |

### 4.2.2. Detailed analysis on how to adopt standards to achieve interoperability in practice

With the aim of achieving interoperability in practice, the identification of the suitable communication standards and canonical data models is not sufficient in itself. In addition to this, a detailed analysis on how to employ the standards for a specific application is required. In DISCERN this analysis was carried out for selected standards as identified in the SGAM models developed during the project, as described in detail in [D4.3].

In general, communication standards and canonical data models need to find an optimal compromise between covering a wider scope – which enables users to adopt the standard in a broader range of Use Cases, but requires the specification of profiles (i.e. subsets of the standards)– and restricting the number of options offered by the standard – which, in principle, makes it easier to actually achieve interoperability among applications and devices compliant with the standard, but usually requires extensions. Table 4-3 summarises the main conclusions of the analysis performed in [D4.3] for four standards employed within DISCERN solutions by taking these two aspects into account.

Table 4-3. Recommendations from DISCERN on the adoption of standards to achieve interoperability

| **Need for companion standards or profiles restricting the scope of the standard** | |
|---|---|
| ***Standard*** | ***Profiling needed*** |
| IEC 62056-5-3:2013 DLMS/COSEM | The DLMS/COSEM is adopted for exchanging meter data at DISCERN solutions implemented in different countries. The comparison carried out in [D4.3] shows that the broad scope of the standard enables users to adopt a number of communication technologies (PRIME PCL, RS-485, GPRS), but hinders interoperability among DLMS/COSEM-based solutions implemented in different countries following particular companion standards or profiles |
| IEC 60870-5-104 | This standard is a transmission protocol for tele-control operations; that is, it is mainly used for communications between Remote Terminal Units (RTUs) and SCADA applications. The standard includes optional services, which makes it necessary to develop profiles selecting the options to be used in a particular application. Moreover, it does not provide a data model defining the semantics of the messages. Thus, the companion standards or profiles must determine the meaning of the bit frames exchanged within the IEC 60870-5-104 systems. This makes for difficult interoperability between IEC 60870-5-104 profiles |
| IEC 61850 | This standard was originally developed to promote interoperability at substation automation systems. More recently, it extended its scope to cover wind power plants and Distribution Energy Resources (DER) facilities. It offers a large data model formally defining the semantics of the IEC 61850 messages. However, it should be noted that the wide range of applications and the existence of optional attributes within the model calls for the development of profiles restricting the scope of the standard in particular Use Cases. This again hinders the interoperability across different IEC 61850-based implementations |
| **Need for extensions to the standard** | |
| ***Standard*** | ***Extensions needed*** |
| STG-DC | The STG-DC is a protocol initially developed by Iberdrola and currently maintained by the PRIME alliance for the communication between meter data management systems and data concentrators. It has a more restricted scope than the previous standards. Nevertheless, the comparison between the implementations of the standard at two DISCERN solutions shows the need for extensions that enable data exchanges on particular functionalities not covered by the standard [D4.3]. In particular, it is recommended to study whether to incorporate to the standard further information on Low Voltage (LV) measurements. |

### 4.2.3. Next steps

DISCERN members plan to formally propose the future standardisation actions with regard to communication standards and canonical data models as described in Table 4-2 to the IEC TC57. In particular, the most appropriate working group would be WG19 “Interoperability within TC 57 in the long term”, which will organise a physical meeting in London next January 2016 The new standardisation action for harmonising the CIM with the STG-DC will be discussed also with the PRIME alliance, which is responsible for maintaining the STG-DC. The approach to be followed in this harmonisation could be similar to the one adopted by the OpenADR alliance[3]. As for the mapping of IEC 61850 to DNP3 and Modbus TCP, it shall be analysed how the IEC 61400-25-4 addresses this issue in the particular context of wind power plants.

## 4.3. Key achievements

Table 4-4 summarises the key achievements obtained by DISCERN in relation to communication standards and canonical data models in the context of smart grid projects.

[3] http://cimug.ucaiug.org/Projects/CIM-OpenADR/Shared%20Documents/Forms/AllItems.aspx

Table 4-4. Key achievements obtained by DISCERN in relation to communication standards and canonical data models

- **The development of smart grid technology means processing larger amounts of data** as generated by smart sensors extensively placed over the networks. This implies new interoperability challenges that make the **adoption of international communication standards (mainly created by the IEC TC57) a key aspect for the deployment of future electricity smart grids.** In particular, the **increasing complexity of the data** that has to be processed across smart grid solutions **calls for the employment of canonical data models** defining the semantics of the information to be exchanged in this domain.

- **DISCERN promoted the utilisation of communication standards and canonical data models** as a means to improve interoperability and, therefore, efficiency of power system management and operation.
  - Given its importance and widely adoption in the electricity sector, **DISCERN paid special attention to the IEC TC57 Common Information Model (CIM)**. The CIM has been used in a number of applications throughout the project, which resulted in a set of proposals to extend the canonical data model in order to better represent the smart grid solutions studied in DISCERN. Despite not having been validated in actual interoperability tests during the project, the **extensions have been presented at official meetings** of the groups of experts responsible for the maintenance of the model for their consideration in future versions of the standard.
  - In addition, **DISCERN performed a high-level assessment of the communication standards and canonical data models** used in DISCERN solutions. As a result of the assessment **new standardisation actions have been identified**, namely: harmonisation of IEC TC57 CIM and STG-DG PRIME Alliance, and guidelines to map widely adopted standards in automation systems, such as IEC 61850, DNP3.0, and Modbus TCP.
  - More **detailed analyses on the employment of selected standards** in actual industry environments were also performed during DISCERN. These studies revealed the **need for producing companion standards or profiles in order to achieve interoperability** in practice.

- Apart from the specific results and conclusions obtained from the analyses carried out in DISCERN regarding communication standards and canonical data models, the **methodologies developed and adopted in DISCERN soften the learning curve that is required** (particularly for DSOs) **to take full advantage of the standards**. **DISCERN tools are recommended to fill the existing gap between utilities and standardisation bodies** and, in that way, facilitate active participation in standards development so as to make sure that the published standards are aligned with their business goals and cover their particular business needs.

# 5. Final recommendations

This section summarises the most relevant recommendations provided by DISCERN to different smart grid stakeholders with the aim of promoting adoption of standard-based solutions and, in that way, improving interoperability and efficiency of the systems in charge of managing and controlling future electricity power systems in Europe.

## 5.1. To standardisation bodies

One key target audience of the final report on DISCERN standardisation activities refers to the main standardisation bodies in the electricity sector. What follows briefly presents the most important messages from DISCERN to such a target audience.

### 5.1.1. IEC TC8 WG5 (SyC Smart Energy WG5)

The IEC TC8 WG5 (recently transferred to the SyC Smart Energy WG5) is responsible for developing and maintaining the Use Case methodology under the IEC 62559 standard series. The experience gained throughout DISCERN by adopting the Use Case methodology to undertake the requirements elicitation and analysis of actual smart grid solutions deployed by major European DSOs led to the following recommendations with regard to the IEC 62559 standards:

- **Study the extensions and modifications to the IEC 62559 standards proposed by DISCERN.** A number of extensions and modifications to the IEC 62559 standards have been officially proposed by DISCERN at IEC TC8 WG5 meetings. Some of them have been already accepted and included in the first editions of the standards. The recommendation is to carefully analyse the remaining extensions and modifications proposed by DISCERN (e.g. adding new classes such as InformationExchange and KPI_Calculation and revising the Role concept in the IEC 62559-3 data model) to be considered in future editions of the standards. The overall objectives of these extensions and modifications are: to enable users to express all the use-case-related concepts that are necessary to describe requirements for actual smart grid solutions, and to harmonise the different parts of the IEC 62559 series; for instance, the IEC 62559-3 data model shall formally define all the concepts that can be included in the IEC 62559-2 Word template.

- **Restructure the IEC 62599-3 UML data model.** It is highly recommended to reorganise the structure of the IEC 62559-3 UML data model. In particular, DISCERN proposes to add more packages (Core, UseCaseRepository) grouping the classes and relationships of the Use Case methodology with the aim of making it easier for users to search specific concepts in the data model and to extend the data model if necessary. This will help facilitate understanding and utilisation of the IEC 62559-3 data model.

- **Take DISCERN project as one of the starting points for the development of the IEC 62559-4**. In principle, the main objective of the IEC 62559 standards is to promote adoption of the Use Case methodology by standardisation bodies. However, part 4 of the standard (which is currently in development) is aimed at providing guidelines for the adoption of the methodology in industry projects. Since DISCERN has utilised the Use Case approach for identifying and expressing requirements for actual smart grid solutions designed by large European DSOs, it is recommended that full advantage be taken of the DISCERN experiences as one of the starting points for the development of the IEC 62559-4 standard.

- **Promote interoperability tests involving software tools from different projects**. With the aim of proving the benefits of the IEC 62559 standards, particularly the XML formats developed in part 3, it is recommended that the IEC TC8 WG5 promote the organisation of interoperability tests where tools (e.g. templates and Use Case repositories) developed by different organisations and projects exchange use-case-related data with each other via the IEC 62559 interfaces.

### 5.1.2. CEN-CENELEC-ETSI SGCG

The European Commission Mandate M/490 to the European Standards Organisations CEN-CENELEC-ETSI led to the creation of the Smart Grid Coordination Group (SGCG). The SGCG aims to define methodologies that facilitate representation of smart grid architectures with a view to identifying standardisation issues of relevance European smart grids. One key outcome of the SGCG technical reports was the SGAM framework. DISCERN has adopted and enhanced this framework in order to support communication and improve knowledge sharing amongst large smart grid projects. What follows summarises the recommendations provided by DISCERN to CEN-CENELEC-ETSI SGCG in relation to the SGAM.

- **Enhance the SGAM framework to express business-related aspects**. Given that the SGAM framework was originally designed to perform standards analyses, there was a lack of detailed symbols for expressing business-related aspects of the smart grid solutions. DISCERN proposes to add concepts (with their corresponding symbols) with the aim of enabling users to represent business goals, business actors, target, KPIs, and regulatory and economic constraints of the smart grid solutions as described in the SGAM models.

- **Formally define the semantics and exchange formats of SGAM models**. Until recently, the SGAM framework was defined in technical reports as a set of drawings to be utilised for human-to-human communication. DISCERN proposes that the semantics of SGAM-related concepts be defined in a UML data model aligned with the standard IEC 62559-3 data model. The SGAM UML data model enables the creation XML interfaces for exchanging SGAM models across software applications.

- **Propose an action to the IEC for ensuring the maintenance and enhancement of the SGAM framework**. Currently, the SGAM is not maintained by any group of experts within a standards organisation. The recommendation in this regard is to propose a new standardisation action to the IEC with the aim of setting up a group of experts responsible for enhancing and maintaining the SGAM as an international standard. Such a group shall update the list of concepts and symbols to be used in the SGAM, and develop and maintain the SGAM UML data model as well as the SGAM XML schemas, which shall rely on the UML data model and XML schema proposed in DISCERN. In order to select the group of experts, the standardisation action shall be proposed to the IEC Systems Resource Group (SRG), a recently created group of experts in systems engineering aimed at providing guidelines to IEC committees on methodologies and tools supporting a systems approach. One possible option would be the IEC SyC Smart Energy systems committee.

- **Revise the SGCG report on smart grid cyber security with a view to making it more compatible with SGAM models**. The objective of this recommendation is to make it easier for users to map SGAM models developed by domain experts into reference models designed by cyber security experts in order to easily infer IT-security requirements for the smart grid solutions.

- **Update the SGCG reports**. The international standardisation group of experts responsible for the SGAM framework should review and update the existing SGCG reports to document the abovementioned enhancements, and should produce an additional report detailing how the SGAM can be utilised beyond standardisation bodies.

### 5.1.3. IEC TC57

The IEC TC57 is highlighted in the literature as the most important standardisation body in relation to the development and maintenance of international communication standards and standard data models for power system applications. The standards assessments of DISCERN solutions have resulted in a series of recommendations to different groups of experts within the IEC TC57.

#### *5.1.3.1 IEC TC57 WG 13 & 14*

Working groups 13 and 14 are responsible for maintaining the CIM in the context of distribution management systems and energy management systems, respectively. Since the analyses on standard data models carried out in DISCERN were mainly focused on the CIM, as the CIM is the most widely adopted data model in the electricity sector, what follows summarises the most relevant messages from DISCERN to IEC TC57 WG13 & 14.

- **Study whether the extensions proposed by DISCERN partners should be incorporated into the standard**. The CIM does not cover all the information exchanges required in every possible power system application. Therefore, it is typically necessary to extend the model with addition classes, attributes or relationships in order to better represent the information that has to be exchanged within a particular smart grid solution. Some of the extensions created by users might be considered by the standardisation bodies for inclusion them in the next version of the standard data model. DISCERN proposed a number of extensions to better represent concepts directly related to the smart grid solutions analysed during the project. Although these extensions were not tested in actual interoperability trials, it should be interesting to consider these so as to upgrade the data model; for instance, it should be analysed which option is best for representing LV supervisors in CIM (i.e. a device that collects voltage and current measures from sensors in the LV side of secondary substations, performs registrations of energy, measures and events, and generate alarms) as a class derived from cim:Meter or from cim:RemoteUnit.

- **Take advantage of SGAM models to create standard CIM XML schemas**. The IEC TC57 WG13 follows the Use Case methodology to create CIM XML schemas defining standard formats for exchanging data in a wide range of distribution management applications. It is recommended to enhance this methodology with the SGAM framework in order to produce standard-based interfaces from more intuitive and structured representations of smart grid architectures. This would make it easier for domain experts to understand and produce standard-based interfaces and, in that way, adopt CIM and also actively participate in standardisation activities.

#### *5.1.3.2 IEC TC57 WG 19*

In addition to the analysis directly related to the CIM, DISCERN carried out standards assessments of the smart grid solutions covering other communication standards and standard data models. As a result of this, the need for new standardisation actions aimed at harmonising existing standards was identified. What follows summarises the actions recommended by DISCERN to the IEC TC57 WG19, which is responsible for interoperability within the IEC TC57 in the long term.

- **CIM and STG-DG harmonisation**. This action shall guide users towards the harmonisation of the STG-DC data model defined by the PRIME Alliance for exchanging meter-related data and the IEC TC57 CIM, in particular the part dedicated to meter readings (IEC 61968-9)

- **IEC 61850 mapping to DNP3 and Modbus TCP**. No standardisation activity is being realized at present to harmonise or define the mapping between three communication standards widely adopted in automation systems: DNP3, Modbus TCP, and IEC 61850. The only standard that

addresses this issue is the IEC 61400-25-4, which was defined specifically for wind power plant communications. Therefore, the recommendation to the IEC TC57 WG19 is to study whether a standardisation action to harmonise DNP3, Modus TCP, and IEC 61850 communications is required.

## 5.2. To other stakeholders in smart grids

Despite being mainly focused on standardisation bodies, this report provides a number of recommendations to other stakeholders of smart grid projects with a view to promoting interoperability in this domain.

### 5.2.1. DSOs

Based on the methodologies, tools, and standards assessments developed during the project, DISCERN provides two main recommendations to the DSOs with regard to standards in smart grids.

- **Develop standard profiles**. Communication standards and standard data models improve interoperability within electricity power systems. Nonetheless, as shown in a more detailed analysis performed by DISCERN on the adoption of particular standards in the smart grid solutions analysed during the project, the standards are not sufficient themselves to ensure interoperability. On the contrary, it is recommended that the DSOs take the lead on the specification of companion standards or profiles restricting the scope of and possibly extending the standards. In particular, the detailed analysis carried out in DISCERN revealed the need for producing profiles for the adoption of the IEC 62056-5-3 DLMS/COSEM, IEC 60870-5-104, and IEC 61850.

- **Actively participate in standardisation activities**. The adoption of international standards is one key aspect for the future development of the electricity networks, as this will strongly support interoperability and the efficient delivery of solutions. However, taking full advantage of international standards is not an easy task for DSOs. The existence of a large amount of standards described in complex technical documents requires a steep learning curve for utilities. Furthermore, the standards are developed and maintained by several working groups of experts where most of the members come from vendors or technology providers. With the aim of addressing these issues it is recommended that the DSOs leverage the tools and methodologies developed in DISCERN (namely, the Use Case & SGAM approach, SGAM-based standards assessment, and the methodology to obtain standard-based formats from SGAM models) so as to actively participate with standards organisations and, in that way, make sure that the published standards are aligned with their business goals and cover their particular business needs.

### 5.2.2. Vendors or technology providers

International standards are similarly of benefit for vendors or technology providers. In particular, it is recommended that vendors and technology providers **take advantage of the DISCERN Use Case & SGAM approach in order to better understand the requirements and architectures** of the solutions expressed by different utilities. As explained in [DISCERN Workshop III], during the workshop organised by DISCERN for external vendors, all vendors expressed the view that “the Use Case & SGAM approach provides a useful way for DSOs to present their project intentions to vendors in a clear and consistent format” and, therefore, “supports mutual understanding between the vendors and clients, which is very valuable in enhancing communication and building relationships between the parties”. In addition to this, some vendors pointed out that the Use Case & SGAM approach can also be used internally within a vendor organisation to support “the vendor project team in communicating

with their designers in regard to the project requirements and applicable standards".

### 5.2.3. Consultants and academic organisations

Given that the DISCERN Use Case & SGAM approach was developed to facilitate knowledge sharing among experts coming from different organisations and fields, it is recommended that, apart from the utilities, vendors, and technology providers, consultants and academic organisations also take advantage of this standard-based approach to represent and share smart grid solutions. Moreover, the DISCERN methodologies and tools to assess communication standards and standard data models can help these organisations to support the adoption of standards in smart grid solutions and, hence, improve interoperability in this domain.

# 6. Conclusions

**Standardisation is a key enabler of the development of future electricity smart grids**. On the one hand, it is necessary to agree on common methodologies and frameworks to share smart grid requirements among experts coming from different organisations and areas of expertise, such as electrical engineering, Information and Communication Technologies (ICT), software engineering, or industrial automation. On the other hand, an increasing amount of data has to be processed and exchanged across a number of devices, applications, and systems with the aim of implementing smart grid functionalities that optimize the supervision, control, and management of electricity networks.

DISCERN has contributed to the standardisation activities with regard to both of these areas. The Use Case & SGAM approach developed and adopted in DISCERN to express and analyse requirements and architectures of real solutions designed by large European DSOs enhances existing standard methodologies and frameworks. In particular, **DISCERN has actively participated within the IEC TC8 WG5 international group of experts** (recently transferred to the IEC SyC Smart Energy WG5) during the development of the IEC 62559 standard series, which define the Use Case methodology as a structured approach to identify and express requirements of smart grid solutions. Moreover, **the project has presented to SCGC members a number of improvements and extensions to the SGAM framework** (namely, the definition of new symbols for representing business-related aspects affecting smart grid solutions, a UML data model formally defining the semantics of SGAM concepts, and XML-based formats enabling the exchange of SGAM models in machine-readable languages) in order to promote its adoption as a means for creating and analysing smart grid architectures.

In regard to the communication standards and canonical data models that facilitate information exchanges within smart grid solutions, **DISCERN has developed novel methods for performing standards assessment within the scope of future electricity smart grids**. The proposed methods comprise high-level assessments of the standards as described in SGAM models by comparing them with the recommendations given by standardisation bodies, but also more detailed analysis on how to employ selected standards to achieve interoperability in practice. The high-level assessment was utilised during the project to analyse the standards employed within DISCERN smart grid solutions and resulted in a **set of recommendations to the DSOs as well as proposals to the standardisation bodies on new actions that should be realised in order to address identified gaps**, such as the harmonisation of two widely-adopted standards for exchanging smart meter data: SG-DC and the IEC TC57 CIM. For its part, the detailed **analyses carried out in DISCERN on the practical application of selected standards** provided valuable conclusions about the need for developing profiles restricting the wide scope of standards (such as, IEC DMLS/COSEM, IEC 60870-5-104, and IEC 61850) and making necessary extensions to utilise the standards (SG-DG) in particular Use Cases.

Among all the existing communication standards and canonical data models in the electricity sector, **DISCERN paid special attention to the IEC TC57 CIM**, as this is the most widely-adopted standard improving interoperability at distribution management systems. Although DISCERN solutions were mainly focused on automation and metering systems, the importance of the standard and the increasing interest at the DSOs for adopting it with the aim of avoiding silos in their data management systems motivated its application in different DISCERN activities. The IEC TC57 CIM was utilised during the project: 1) to agree on the common terminology for representing the actors and technical functions of DISCERN solutions [D1.3], [D2-3.1]; 2) to create the DISCERN Semantic Model [D5.1] and [D5.2] to formally represent the DISCERN solutions in a common modelling language; and 3) to express network models in a standard electronic format for performing simulations. Based on this work, DISCERN recommended some **extensions and improvements to the standardisation**

**bodies responsible for maintaining the standard (IEC TC57 WG13 &14) as well as to the official CIM users group (CIMug)**. In addition to this, DISCERN has also proposed a **new methodology to create CIM-based messages from intuitive SGAM representations of the smart grid solutions**. This new methodology is of use both for utilities, who can thereby easily specify standard-based formats from a representation of the solutions that is understood within and outside the company, and for standardisation bodies, who can define standard formats from representative Use Cases mapped into the SGAM framework.

To sum up, the work developed **in DISCERN shows how R&D smart grid projects can provide a channel to overcome the existing gap between DSOs and standardisation bodies**. Despite being crucial for the future development of the electricity networks, taking full advantage of international standards is not an easy task for DSOs. The existence of a large amount of standards described in complex technical documents requires a steep learning curve for utilities. Furthermore, the standards are developed and maintained by several working groups of experts where most of the members come from vendors or technology providers. DISCERN has proposed and adopted new approaches to address these issues and, therefore, promote the active participation of DSOs and other interested stakeholders with the standardisation bodies so as to make sure that the published standards are aligned with their business goals and cover their particular business needs.

# 7. References

## 7.1. Project documents

[D1.3] – DISCERN Deliverable 1.3: “Architecture templates and guidelines”

[D2-3.1] – DISCERN Deliverable 2-3.1: “Catalogues and requirements for distributed devices and communication architectures”

[D2-3.2] – DISCERN Deliverable 2-3.2: “Tool support for managing Use Cases and SGAM models”

[D2-3.3] – DISCERN Deliverable 2-3.3: “Standards assessment regarding devices and communication architectures”

[D3.5] – DISCERN Deliverable 3.5: “IT security concept”

[D4.2] – DISCERN Deliverable 4.2: “New system functionality”

[D4.3] – DISCERN Deliverable 4.3: “Preferable general system architecture, integrations and user interface”

[D5.1] – DISCERN Deliverable 5.1: “DISCERN semantic model to transfer developed solutions to DSOs and to facilitate their integration”

[D5.2] – DISCERN Deliverable 5.2: “DISCERN guide for facilitating the replication and scalability of the solutions”

[D5.4] – DISCERN Deliverable 5.4: “Standardisation assessment regarding canonical data models”

[D6.1] – DISCERN Deliverable 6.1: “Identification of the scenarios and distributed intelligence solutions”

[D6.2] – DISCERN Deliverable 6.2: “Simulation tests of DISCERN solution”

[D8.1] – DISCERN Deliverable 8.1: “Business case on Use Cases and sensitivity analysis”

[D8.3] – DISCERN Deliverable 8.3: “Final report on central findings and policy recommendations for optimised smart grid solutions”

[DISCERN Workshop III] – Minutes of the WP9 Vendor Workshop III: “Report on Experiences of using DISCERN Use Cases and SGAM Tools & Templates”, Brussels, Belgium, 4 December 2014 (www.discern.eu/datas/2015-01-14_MoM_WP9-Vendor-Workshop_2014-12-04_Brussels_v04_3.pdf)

## 7.2. External documents

[IEC 62357-1] – “Power systems management and associated information exchange - Part 1: Reference architecture”, IEC TC57, October 2012.

[IEC PAS 62559] – “Intelligrid Methodology for Developing Requirements for Energy Systems”, Publicly Available Specification, IEC&EPRI, January 2008

[Modsarus] – “Modelling Interoperable Electronic Data Interchanges for the Smart Grid Use Cases”, C. Effantin, presented at CIM Users Group Meeting, Melbourne, 25-27 February, 2014

[NIST Framework & Roadmap] – “NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0”, National Institute of Standards and Technology (NIST), U.S. Department of Commerce, January 2010

[NISTIR 7628-1] – “Guidelines for Smart Grid Cyber Security: Vol. 1, Smart Grid Cyber Security Strategy, Architecture, and High-Level Requirements”, The Smart Grid Interoperability Pane –Cyber Security Working Group, National Institute of Standards and Technology (NIST), U.S. Department of Commerce, September 2014

[SGAMToolbox] – “Towards Consistent Smart Grid Architecture Tool Support: From Use Cases to Visualization”, C. Neureiter, D. Engel, J. Trefke, R. Santodomingo, S. Rohjans, and M. Uslar, in Proceedings of IEEE Innovative Smart Grid Technologies (ISGT) 2014, Istanbul, Turkey, 2014

[IEC PAS 62559] – “Intelligrid Methodology for Developing Requirements for Energy Systems”, Publicly Available Specification, IEC&EPRI, January 2008

[SGCG-FSS] – “First Set of Standards”, CEN-CENELEC-ETSI Smart Grid Coordination Group, November 2012.

[SGCG-SGAM] – “Smart Grid Reference Architecture”, CEN-CENELEC-ETSI Smart Grid Coordination Group, November 2012

[SGCG-SGIS] – “Smart Grid Information Security”, CEN-CENELEC-ETSI Smart Grid Coordination Group (SGCG), December 2013

[SGCG-SP] – “Sustainable Processes”, CEN-CENELEC-ETSI Smart Grid Coordination Group, November 2012

[Uslar et al.] – “The Common Information Model CIM – IEC 61968/61970 and 62325 – A Practical Introduction to the CIM”, M. Uslar, M. Specht, S. Rohjans, J. Trefke, J.M. González, 2012

# 8. Revisions

## 8.1. Track changes

| Name | Date (dd.mm.jjjj) | Version | Changes | |
|---|---|---|---|---|
| | | | Subject of change | page |
| Rafael Santodomingo / OFFIS | 13.05.2015 | 0.1 | Table of contents | |
| Rafael Santodomingo / OFFIS | 29.07.2015 | 1.0 | First version for internal review | |
| Rafael Santodomingo / OFFIS | 17.09.2015 | 1.1 | Comments from GNF, IBRD, SSEPD, ZIV & RWE added to the document | |
| Carmen Calpe/ RWE | 01.10.2015 | 2.0 | Final revision | |
| Rafael Santodomingo / OFFIS | 16.10.2015 | 3.0 | Final version/ approval document | |