STANDARDS ASSESSMENT OF BUSINESS USE CASES PROPOSED IN TDX-ASSIST

Eric LAMBERT
EDF – France
eric.lambert@edf.fr

Jérôme CANTENOT
EDF – France
jerome.cantenot@edf.fr

Francisco REIS
R&D Nester - Portugal
Francisco.reis@rdnester.com

Nermin SULJANOVIC
EIMV – Slovenia
nermin.suljanovic@eimv.si

Tiago SIMÃO
EDP-D – Portugal
tiagofilipe.simao@edp.pt

Nejc PETROVIC
Elektro Gorenjska - Slovenia
nejc.petrovic@elektro-gorenjska.si

Gareth TAYLOR
Brunel University – UK
gareth.taylor@brunel.ac.uk

Hugo MORAIS
EDF – France
hugo.morais@edf.fr

ABSTRACT

The Transmission System Operator and Distribution System Operator information exchange has been identified as a key subject to improve the performance of power systems. The standard assessment of the business objects needed to improve this exchange of information is illustrated in the paper. The standard assessment is based on the pertinent business and system Use Cases identified in European project TDX-ASSIST and on IEC Core Standards as defined in IEC 63097 Technical Report Smart Grid Roadmap. These standards are considered as standards having an enormous effect on any Smart Grid application and solution. They are seen as a backbone of a future Smart Grid. The used methodology based in three main steps is detailed and some examples of the standard assessment are described.

INTRODUCTION

Increasing share of distributed renewable energy resources (DRES) in European power system is changing the paradigms of network operations and planning. Therefore, more active collaboration between all stakeholders is required. One of the main challenges is the need for more interactions between actors not only on a horizontal level Transmission System Operator - Transmission System Operator (TSO-TSO) but also on a vertical level Transmission System Operator - Distribution System Operator (TSO-DSO), DSO – DSO and DSO – Significant Grid User (SGU). This is becoming increasingly important because most of the DRES and the SGUs are now connected to distribution networks operated by the DSOs. The European project TDX-ASSIST [1] will facilitate scalable and secure information systems and data exchange between TSO and DSO, design and develop novel Information and Communication Technology (ICT) tools and techniques for these purposes. The three novel aspects of ICT tools and techniques to be developed in the project are: scalability – ability to deal with new users and increasingly larger volumes of information and data; security – protection against external threats and attacks; and interoperability – information exchange and communications based on existing and emerging international smart grid ICT standards.

A definition of generic and realistic Business Use Cases (BUC) is essential for illustration and definition of the information exchange needs between actors in the mentioned power systems operation paradigm. As TDX-ASSIST project implements a model driven integration approach, another important aspect is to investigate how currently available standards, such as Harmonized Electricity Role Model, IEC standards like 62559 series (Use case methodology), 62913 series (Generic Smart grid Requirements), 62357-1 (Power System Management and Information exchange Reference Architecture), 61970, 61968, 62325 (CIM series), 62351 series on cyber security, 61850 series, 60870 series, meet requirements for more intensive TSO-DSO information exchange. A complete state of the art can be found in deliverable D1.1 of TDX-ASSIST project [2].

In order to assess conformity with the selected standards, a methodology based on three main steps have been proposed, namely:

Step 1: Definition of Business and System Use Cases. This definition was fully compliant with 62559 series and 62913 series, and more specifically with 62559-2 (Use Case Template) and 62913-1 (Generic Smart Grid Requirements);

Step 2: Secondly, by defining Business, we have used Roles identified in the Harmonized Electricity Role Model (HERM) [3], and we proposed new roles if appropriate roles are not available in HERM. The Roles found in the HERM can be found in the 62325 series supporting the European Style Market Profiles. The System Roles that have been used when defining the System Use Cases are also based on System Roles proposed by 61968-1, also called the Interface Reference Model (IRM) [4]. We have used the most recent version of IRM as it uses ArchiMate® [5] concepts like Business Domains, Business Functions and Business Objects.

Step 3: Thirdly we have defined a list of Business Objects that are exchanged between Roles. It is needed to assess if these Business Objects conform with some selected standards.

The use of the proposed methodology in TDX-ASSIST project is illustrated in the following sections and is illustrated by the Figure 1 based on Smart Grid

Architecture Model (SGAM).

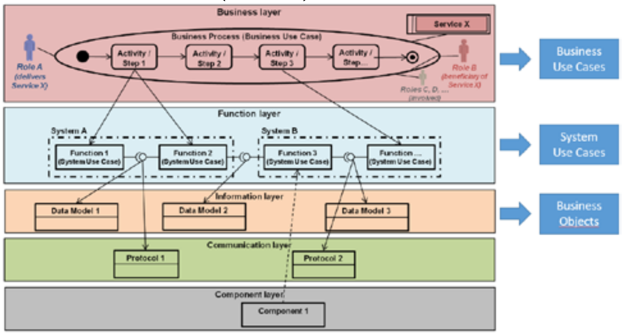

Figure 1. SGAM Usage in TDX-ASSIST

BUSINESS USE CASES

An overview of selected BUCs of interest addressed within TDX-ASSIST is provided in deliverable D1.2 [6]. An illustration of the BUCs is presented in Figure 2 and described in this section. It is important to note that BUCs may address different periods associated with different power systems' activities.

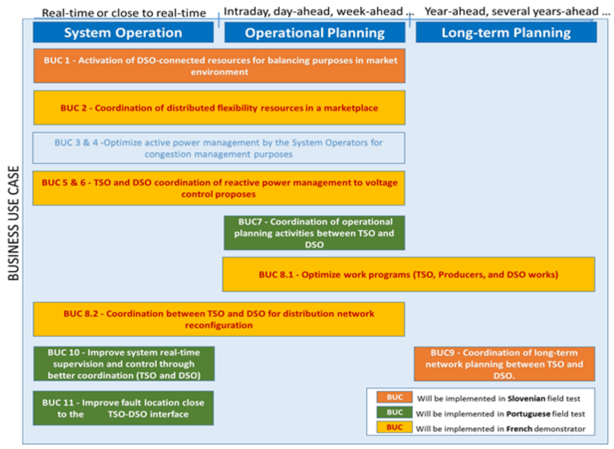

Figure 2. General control layers of the demonstrator [6]

BUC 1: Activation of DSO-connected resources for balancing purposes in market environment

The Use Case defines information exchange between TSO and DSO necessary for exploitation of DSO-connected resources for balancing purposes in the market environment. Two scenarios are identified. In particular, the first scenario describes data exchange between TSO, DSO and BSPs. The second scenario defines information exchange between TSO and DSO, when the TSO profits of DSO demand response mechanisms (e.g. Conservation Voltage Reduction) for mFRR and in some cases also for aFRR balancing service. Methodology of BUC 1 development is described in [7].

BUC 2: Coordination of distributed flexibility services in a market place

This Use Case defines information exchanges between TSO, DSO, Flexibility Operators and Market Operator necessary for procurement of flexibility provided by distributed energy resources.

Flexibility Operator interacts both with TSO and DSO and it is necessary to validate coordination mechanism that will prevent double activation of the same service at the same time. TSO and DSO should also collaborate in order to avoid negative impact of DFR (Distributed Flexibility Resource) activation on their respective networks.

Four main scenarios should be considered:

- The Flexibility Operator provides services for the TSO (national flexibility market) and the DSO should validate, in day-ahead or intraday timeframes, the activation of these flexibilities;
- The Flexibility Operator provides services for the DSO (local flexibility market). The DSO should provide, in day-ahead, the forecast load/generation for each primary substation including the activation of the procured flexibilities;
- The Flexibility Operator connected to distribution network provides services for the both TSO and DSO in a coordinated local and national market mechanism. The offers not accepted in the local market are sent to the national market.
- The Flexibility Operator provides for TSO and DSO in a single procurement platform (single market). The activation of the offers should be agreed both by TSO and DSO.

BUC 3&4: Optimize active power management by the System Operator for congesting management purposes

The present Use Case intends to describe the interactions between TSO and DSO for optimal congestion constraints management activating flexibilities connected in distribution networks. The management of congestion situations should be analysed both in operational planning (day-ahead and intraday) and real-time.

BUC 5&6: Optimize reactive power management by the TSO and DSO for Voltage control purposes

This Use Case defines the information exchanges between TSO and DSO to optimize reactive power management actions for voltage control purpose. This takes into consideration existing resources at the DSO level to support TSO operations, thus supporting the whole network.

The TSO and DSO should coordinate the reactive power at each primary substation (i.e. at the TSO-DSO interface) at different timeframes (several hours or days ahead) in operational planning. At real time, the DSO should try to meet the set point using its flexibility assets (e.g. capacitors banks, inductances, storage...) available for the DSO usage and the reactive power that can be injected/absorbed by the DG connected in MV network.

BUC 7: Coordination of operational planning activities between TSO and DSO

This Use Case defines information exchange between TSO and DSO in order to improve programming of their networks operation. DSO can forecast the load and distributed generation disaggregated by technology type (wind, PV, hydro, CHP, etc.) and location, which may be done with up to 15 minutes sampling period. Once exchanged with the TSO, in a properly aggregated manner, this information will allow having a more efficient and secure operation of the bulk power system.

In this Use Case, operational planning data exchange is done 72 hours ahead, being refreshed every 24 hours, using state of the art, standardized technological means.

BUC 8-1: Optimize work programs (TSO, DSO, and SGU works)

The Use Case should define the requirements concerning exchange of information between the TSO/DSO and SGUs in each time-horizon to assure the works planning taking into account the forecasted generation and consumption and a technical validation.

BUC 8-2: Coordination between TSO and DSO for distribution network reconfiguration

This Use Case should define the information exchanges between TSO and DSO to avoid possible DSO current constraints during a network reconfiguration.

The DSO network configuration can be demanded by the TSO due to security needs (real time) or works planning (operational planning). The DSO can also make network configurations for its security and works planning needs.

Some observability of the TSO network by the DSO is needed to validate the MV network reconfigurations.

BUC 9: Coordination of long-term network planning between TSO and DSO environment

The Use Case defines information exchange between TSO and DSO necessary for preparation of long-term power network investment, expansion and reinforcement plans in order to provide long-term network stability and robustness in light of modern challenges (e.g. DER penetration, emergence of microgrids, etc.). Parties are required to exchange network models on the TSO/DSO interface as well as planned future changes at the network (e.g. new substations, HV power lines, or similar) within the limits of an observability area. Furthermore, the DSO is required to provide the prognosis of peak demand for the upcoming years, aggregated to the level of the primary substations. Additionally, the DSO is required to provide 15 minute load and generation diagram profiles also aggregated by primary substations but divided by type of consumption and generation (e.g. industrial/residential and wind/solar/hydro/etc.) for the previous year(s).

BUC 10: Improve system real-time supervision and control through better coordination (TSO, DSO and SGUs)

The Exchange of real-time information between TSO and DSO is a common practice, however usually with existing potential for improvement. The necessary enhancements may include increasing the detail of data exchange concerning already observable parts of transmission and distribution networks, but also expanding the set of TSO-DSO data exchange to non-observable parts of each other networks.

Aiming to enable a better supervision and control of transmission and distribution networks, this Use Case focuses on guarantee that the necessary real-time information exchange between TSO and DSO is put in place. Standardization/normalization of real-time data exchange between TSO and DSO will be addressed for better understanding of counterparty signals.

The use-case will establish the needed procedures to allow periodic updates of the observability area of both TSO and DSO as well. This will ensure adequate visibility on each other networks regardless of any network topological changes over time.

BUC 11: Activation Improve fault location close to the TSO-DSO interface

This Use Case aims at improving the location of faults at distribution lines, close to the interface with the transmission network. Concretely, the focus is on distribution lines, owned and operated by the DSO, that are directly connected to transmission bays, owned and operated by the TSO. In such cases, by having access to information available at the TSO side, collected in transmission bays connecting distribution lines, the DSO will be able to improve the location accuracy of faults on its own distribution lines. This requires additional information to be exchanged in real-time.

The real-time exchange of data from the TSO to the DSO for fault location purposes is the motivation of this Use Case with the ultimate goal of optimizing operations on the DSO side.

System Use Cases

Based in described BUCs several System Use Cases (SUCs) have been proposed. The SUCs were elaborated taking into account the demonstration and field test needs of the project. However, all the business objects were analyzed taking into account the core standards use in power systems. The SUCs and their relation with the BUCs are illustrated in Figure 3.

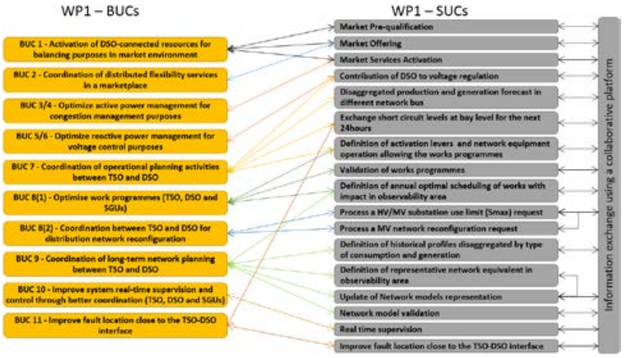

Figure 3. List of Business Use Cases and corresponding System Use Cases

ROLE MODELS

All the BUCs and SUCs were modelled in Modsarus© tool [8] using, in most of the cases, the standard roles proposed in HERM and IRM. The roles used in BUCs and SUCs are presented in Figures 4, 5 and 6 respectively.

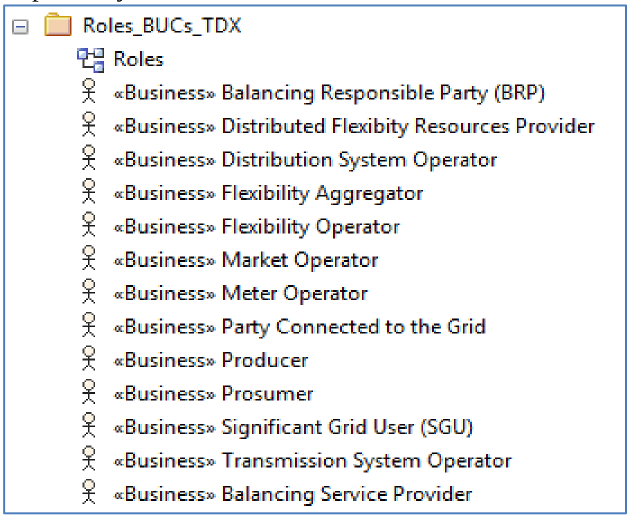

Figure 4. Business Roles used by TDX-ASSIST Business Use Cases (MODSARUS© view)

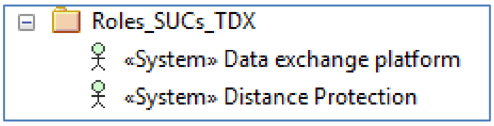

Figure 5. Business Roles used by TDX-ASSIST System Use Cases (MODSARUS© view)

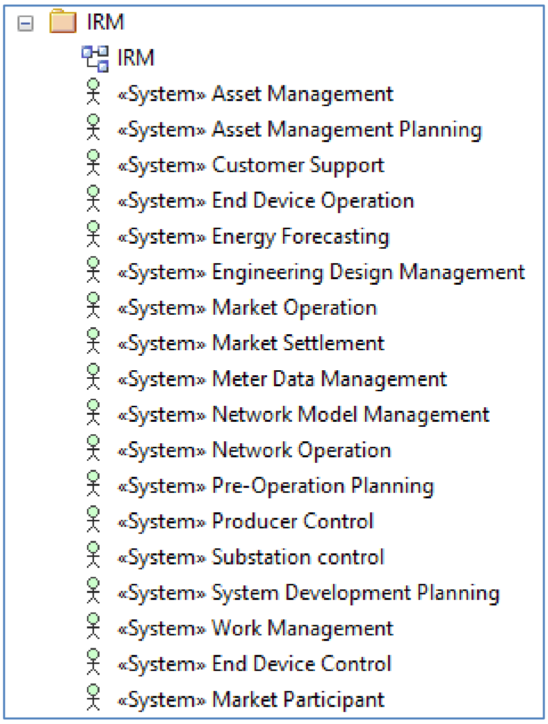

Figure 6. System Roles from IEC TC57 IRM used by TDX-ASSIST System Use Cases (MODSARUS© view)

STANDARDS ASSESSMENT

The standards assessment was performed based on the core standards identified in IEC 63097 [9] Smart Grid roadmap which has to be used for any implementation of Smart Grid now and in the future. As stated in 63097, "*Core standards are standards that have an enormous effect on any Smart Grid application and solution. They are seen as a backbone of a future Smart Grid*".
Figure 7 lists these core standards.

Core standard or series	Title	Topic
IEC 61970	Energy management system application program interface (EMS-API)	Actually the core part of the CIM (Common Information Model)
IEC 61968	Application integration at electric utilities – System interfaces for distribution management	Applying mainly to: Generation management systems, EMS (Energy Management System); DMS (Distribution Management System); DA; SA; DER; AMI; DR; E-Storage
IEC 62325	Framework for energy market communications	CIM (Common Information Model) based, Energy market information exchange Applying mainly to: Generation management systems, EMS (Energy Management System); DMS (Distribution Management System); DER; AMI; DR; meter-related back office systems; E-Storage
IEC 61850	Communication networks and systems for power utility automation	Power Utility Automation, Hydro Energy Communication, Distributed Energy Resources Communication Applying mainly to: Generation management systems, EMS; DMS; DA; SA; DER E-Storage; E-mobility
IEC 62056	Electricity metering data exchange – The DLMS/COSEM suite	COSEM Applying mainly to: DMS; DER; AMI; DR; Smart Home; E-Storage; E-mobility Data exchange for meter reading, tariff and load control
IEC 62351	Power systems management and associated information exchange – Data and communications security	Applying mainly to: Security for all systems
IEC 61508	Functional safety of electrical/electronic/programmable electronic safety-related systems	Applying to all systems

Figure 7. IEC Core Smart Grid standards

This IEC standards can be easily positioned using the SGAM domain and zones layout as described in 62357-1 standard [10], and the following Figure 8.

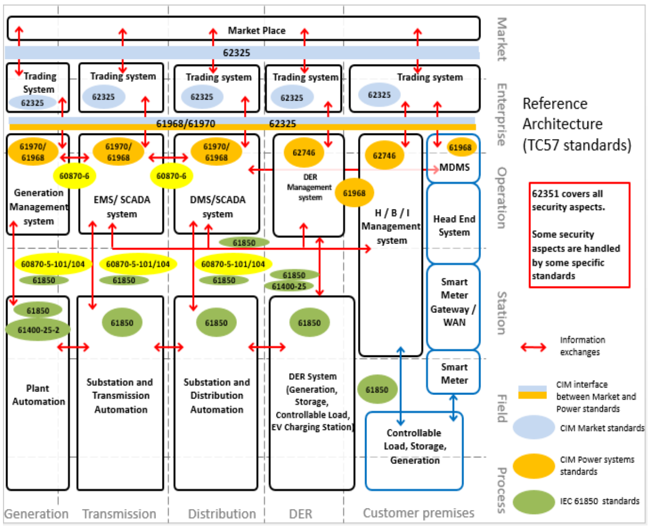

Figure 8. TSO-DSO information exchanges scope using SGAM Domain and Zone

The 48 business objects needed to the implementation of the system Use Cases proposed in TDX-ASSIST project are presented in Figure 9.

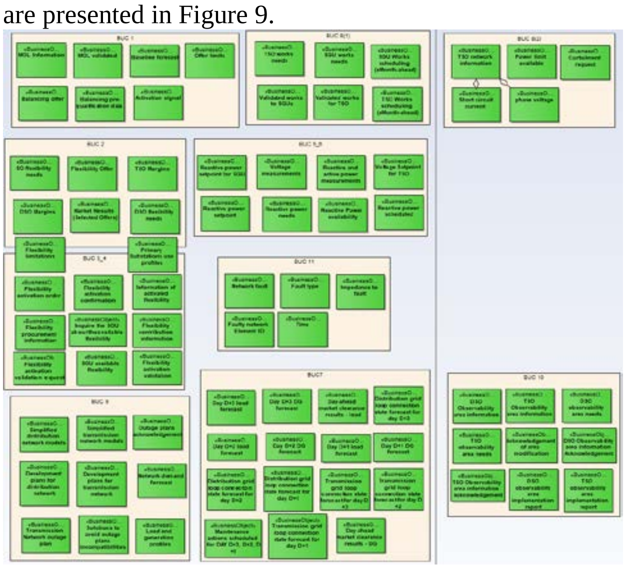

Figure 9. 48 Business Objects of Business Use Cases

Figure 10 illustrates the methodology to analyze the Business Objects requirements and defines the profiles that will be used in TDX-ASSIST demonstrators.

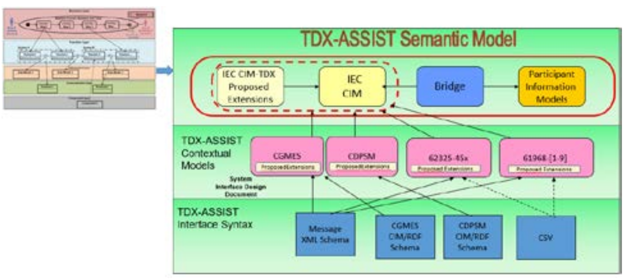

Figure 10 TDX-ASSIST Profiles definition

IEC CIM-TDX extensions to CIM Model will be proposed to IEC to be included in future IEC standards, as well as in new profiles or extensions to the existing profiles.

Some examples of the standard assessments are:

- **Day D+1 DG forecast**: Time series can be used as in 62325-451-6 and/or 61968-5 standard on DER optimization (DER UML package). We recommend to use European Style Market Profile.
- **Day-ahead market clearance results**: IEC 62325-451-4 should be analyzed (Settlement/reconciliation);
- **Development plans for distribution network:** The development plans are supported by Common Grid Model Exchange Specification (CGMES). Specificities regarding DSO will have to be supported.
- **Flexibility Offer:** The schema "bid document" defined in the standard 62325-451-3 can be a good starting point with minor modifications (the part specific to transmission capacity allocation need to be removed).
- **TSO Observability area information:** The concept of observability area will have to be supported by CGMES profiles.

CONCLUSIONS

The paper proposes a methodology to assess standard conformity based on analysing information exchanges (modelled as Business Objects) requirements specified through the Use Cases methodology. The key idea is to identify commonalities with some Smart Grid domains (Operation, Operational Planning, Long Term Planning, Real Time, Work Management, Outage Management, Flexibility Market, …), and associated Roles. For a specific domain, some existing profiles have already been defined by IEC standardisation working groups, and TDX-ASSIST Business Objects can be based on these existing profiles or use some CIM artefacts. Eventually some artefacts are not already supported by IEC CIM model and associated profiles and TDX-ASSIST will contribute to improve the international standard by proposing its Use Cases and associated requirements to IEC standardisation bodies (IEC SyC Smart Energy, IEC TC57): new profiles, new classes, new attributes, new associations… The needed profiles allowing the information exchange between TSO and DSO will be defined in future deliverables of the TDX-ASSIST project in order to be demonstrated in field test and demonstrator of the project.

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REFERENCES

[1] TDX-ASSIST project website, [Online]. Available: http://www.tdx-assist.eu/.
[2] Eric Lambert, *et al.*, "State of Art Report – TSO-DSO Interoperability", TDX-ASSIST European Project Report D1.1, 2017
[3] ENTSO-E, Harmonised Electricity Role Model, 2015
[4] IEC61968-1 https://webstore.iec.ch/publication/6197
[5] Remco Blom, "ArchiMate tutorial", 2014
[6] H. Morais *et al.*, "Agreed models, Use Case list, and Use Case description in UML", Deliverable D1.2, H2020 TDX-ASSIST, Mar. 2018.
[7] H. Morais *et al.*, "*Balancing Services Business Use Case Development for TSO-DSO Interoperability Demonstration*", The 11th Mediterranean Conference on Power Generation, Transmission, Distribution and Energy Conversion MEDPOWER 2018, Nov. 2018, Cavtat, Croatia, pp.1-5
[8] EDF, "MODSARUS user guide", 2013
[9] IEC 63097 (Smart grid standardization roadmap) https://webstore.iec.ch/publication/27785
[10] IEC62357-1 (Power systems management and associated information exchange) https://webstore.iec.ch/searchform&q=62357-1