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Demonstrators' system use cases description

D6.1

EU-SysFlex

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ABBREVIATIONS AND ACRONYMS

AB	Advisory Board
AMR	Automatic Meter Reading
ANN	Artificial Neural Network
AP	Active Power
beeDIP	Name of the Software Platform in the German Demonstrator which collects data and calculates set-points for active and reactive power.
BESS	Battery Energy Storage System
BUC	Business Use Case
CA	Consortium Agreement
CGMES	Common Grid Model Exchange Specification
Chi2	Tool to perform a state estimation with usage of a pandapower network and actual measurements
CIM	Common Information Model
DoA	Description of Activities
DB	Demonstrator's Board
db	Database
DEMS	Distributed Energy Management System
DER	Distributed Energy Resources
DSO	Distribution System Operator
EC	European Commission
EC-GA	European Commission -Grant Agreement
EESS	Electrical Energy Storage System
EHV-HV	Extra high voltage – High Voltage
EU-SYSFLEX	Pan-European System with an efficient coordinated use of flexibilities for the integration of a large share of Renewable Energy Sources (RES)
GA	General Assembly
HV	High Voltage
ICT	Information and Communication Technology
ID	Identification
ISMS	Information security management system
Java	Programming language
LV	Low Voltage
mFRR/RR	Manual Frequency Restoration Reserve / Restoration Reserve
MO	Management Office
MV	Medium Voltage
NCAS	Network Calculation Algorithm System
OCS	Operative Control System
OLTC	On Load Tap Changer
OPF	Optimal Power Flow
PC	Project Coordinator
PMB	Project Management Board
PV	Photo-Voltaic
RDF	Resource Description Framework
RES	Renewable Energy Sources
REST	Representational State Transfer

RP	Reactive Power
RTU	Remote Terminal Unit
SE	State Estimator
STATCOM	Static Synchronous Compensator
SUC	System Use Case
TM	Technical Manager
TSO	Transmission System Operator
WP	Work Package

EXECUTIVE SUMMARY

The EU-SysFlex H2020 project aims at a large-scale deployment of solutions, including technical options, system control and a novel market design to integrate a large share of renewable electricity, maintaining the security and reliability of the European power system. The project results will contribute to enhancing system flexibility, resorting both to existing assets and new technologies in an integrated manner, based on seven European large scale demonstrators (WP 6, 7, 8 and 9). The overall objective of WP6 is the analysis of the exploitation of decentralized flexibility resources connected to the distribution grid for system services provision to the TSOs, by the means of three physical demonstrators located in Germany, Italy and Finland, using different assets located at complementary voltage levels (high, medium and low voltage) of the distribution grid. These demonstrations showcase innovative approaches in flexibility management targeted to support TSOs' and DSOs' needs and their related services, identified within the EU-SysFlex H2020 funded project. These approaches are followed by the means of suitable system processes, the specifications of which can be defined in terms of System Use Cases (SUC): the main objective of Task 6.2, in deliverable D6.1, is to describe these System Use Cases, starting from the corresponding Business Use Cases (BUC) developed within Task 3.3.

In order to facilitate harmonisation across the SUCs and to easily identify the interactions between SUCs and BUCs, the standardised IEC use case modelling method has been applied (IEC 62559) and the use cases were modelled in Unified Modelling Language (UML) with the support of the EDF Modsarus® tool.

The SUCs describe the functions and processes which support the business activities, specified in the BUCs, aimed at providing the corresponding services to the TSOs through the demonstrators' frameworks. The SUCs detail the interactions between the system actors (information and monitoring systems, devices, assets) identified within each demonstrator; since each physical framework has its own features, even if functions are conceptually similar, the identified system actors are in most cases specific to each demonstrator. This aspect, as well as the differences in technical and technology frameworks, is crucial to highlight how the same objective (i.e. WP objective) can be pursued in different ways and how these different characteristics of the demonstrators complement each other, returning a broader response to the overall Project objectives.

The approach followed for SUCs definition started from the widely accepted Smart Grids Architecture Model (SGAM) methodology, which models the general architecture of a smart grids system based on a multilayer structure. The analysis of this structure helps to identify the boundaries of BUCs and SUCs and their interactions, as well as the data exchange and communication flows between the system actors, and versus external entities. Furthermore, a dedicated two-fold iterative process was adopted before drafting the SUCs, following the standardised IEC modelling method: firstly, the demonstrators' frameworks are being analysed, for identifying their technical capabilities and the innovative functionalities they can implement; secondly, the business activities described in BUCs are being analysed for classifying the relevant functions supporting them. Finally the outcomes of these analysis are compared in order to match the functions and the functionalities needed to perform them. This approach allows to detect the links between the BUCs and physical set-ups and to specify them, by the means of standardized SUCs.

The SUCs developed in Task 6.2 serve as a basis for the next WP6 activities. They include all the functional specifications which are necessary for defining the field tests, which will be tackled by Task 6.4, as well as the sets of functionalities and the corresponding requirements, for developing the software tools to be implemented in the demonstrations, which is the goal of Task 6.3.

Since this document is the first of WP6, it also includes the description of the three demonstrators' set-ups: their main features, from a system perspective, have been reviewed and compared through a dedicated cross-analysis, in order to identify their similarities and differences and how they complement each other in respect to the WP objectives. A deeper analysis of physical set-ups will be done in the next tasks of WP6.

As Europe is targeting high renewable energy penetration in the power system, flexibilities provided at present by large conventional plants (fossil, nuclear), have also to be found from the largely distributed, variable and with smaller individual capacities RES. The cross-analysis shows that the three demonstrators cover all the voltage levels of the distribution grid (from HV to LV) and a broad range of flexible resources such as conventional power plants, renewable energy power plants, controllable loads, battery storages, EV charging stations, flexible alternating current transmission system (FACTS) devices. All three demonstrators have the capability of managing the active and reactive power flows within the distribution grid and towards transmission grid. They can manage both load and generation flexibilities, but with some restrictions regarding the usage within field testing, due to regulatory and technical constraints (e.g. currently in Germany RES scheduling is not allowed, as well as load scheduling for congestion management; in Italy the exploitation of active power flexibilities from distributed generators is currently not supported). The approaches adopted for managing the resources (from a system perspective) reflect on the market and regulatory backgrounds of each country; however the technical aggregation of distributed flexible resources is the preferred way to "transfer" flexibilities from the distribution grid to the transmission grid, for all three demonstrators. This arises the need of improving the TSO-DSO interface, which reflects on the enhanced functions and corresponding tools focused on TSO-DSO coordination developed within each demonstrator set-up.

The SUCs, from a global perspective and from demonstrator perspective, are focused to facilitate the management of distributed flexibilities and removing the barriers for their exploitation for ancillary services provision to system operators, by improving the DSO-TSO coordination fulfilling the specific requests from TSOs, while guaranteeing optimal and secure operations of distribution networks.

1. INTRODUCTION

The EU-SysFlex project seeks to enable the European power system to utilise efficient, coordinated flexibilities in order to integrate high levels of Renewable Energy Sources (RES). One of the primary goals of the project is to examine the European power system with at least 50% of electricity coming from RES, an increasing part of which from variable, distributed and Power Electronic Interfaced sources, i.e. wind and solar. Therefore the EU-SysFlex project aims at a large-scale deployment of solutions, including technical options, system control and a novel market design to integrate a large share of renewable electricity, maintaining the security and reliability of the European power system.

In order to achieve the project objectives the EU-SysFlex approach pursues the identification of technical shortfalls requiring innovative solutions, the development of a novel market design to provide incentives for these solutions, and the demonstration of a range of innovative solutions responding to the shortfalls. Other activities as data management analysis, innovative tool development and integration and testing of new system services in TSOs control centers are also included in the project approach. The project results will contribute to enhance system flexibility, resorting both to existing assets and new technologies in an integrated manner, based on seven European large scale demonstrators in Portugal, Germany, Italy, Finland, Portugal, France, and the Baltic states (WP 6, 7, 8 and 9).

It is the project's goal to increase the flexibility of the future European system by developing the capability to provide not only the energy, but also the reliability and stability, through system services, required to integrate high RES. Therefore **Work Package (WP) 6 *"Demonstration of flexibility services from resources connected to the distribution network"* analyses the opportunities arising from decentralized flexibility resources connected to the distribution grid to serve the needs of the overall power system, in coordination between DSOs and TSOs, by means of three demonstrators located in Germany, Italy and Finland**.

1.1 WP 6 OBJECTIVES AND RELATIONSHIPS BETWEEN TASKS

As stated above, the primary objective of the WP6 is to analyse and test the exploitation of decentralized flexibility resources focusing on ancillary service provision from resources connected to the distribution grid according to the needs of DSOs and TSOs. This process is very challenging for the DSOs, since they are obliged to connect RES to the distribution networks (which is not designed to host large volumes of generators) following the current policies for the decarbonisation of the energy systems and, at the same time, they have to guarantee the security and resilience of their networks; in addition they should have suitable "freedom" in network management in order to avoid congestions and constraints violations, even in presence of specific operating conditions "superimposed" by the transmission network management. These apparently conflicting requirements arise the need to enhance the cooperation between TSOs and DSOs, taking advantage of the increasing share of flexible resources.

In detail, three sub-objectives can be identified:

- Improve TSO-DSO coordination;
- Provide ancillary services to TSOs from distribution system flexibilities;
- Investigate how these flexibilities could meet the needs of both TSOs and DSOs.

WP 6 addresses these objectives through five interlinked tasks. Task 6.1 is related to needed Work Package coordination. Task 6.2 focuses on the definition of System Use Cases (SUC) based on the Business Use Cases (BUC) coming from WP3. Within Task 6.3 systems and tools are being developed in order to set up the SUC. In Task 6.4 field tests will be carried out in the three demonstrators. Furthermore the results of these field tests will be analysed and common conclusions will be drawn in Task 6.5.

The activities and achievements of each Task, and of the whole Work Package itself, will be presented through a comprehensive set of Deliverables. In the following they are shortly described, divided by Task:

- Task 6.2 *"Definition of System Use Cases"*:
    - Deliverable 6.1 *"Demonstrators Use Cases description"* presents the "translation" of Business Use Cases from WP3 into System Use Cases

- Task 6.3 *"Development of systems and tools"*:
    - Deliverable 6.2 *"Forecast: Data, Methods and Processing. A common description"* presents the description of requirements of the DSO/TSO interface, in order to harmonize the data formats and models for all the trials;
    - Deliverable 6.3 *"Grid simulations and simulation tools"* presents the first results about network models and simulations from the demonstrators;
    - Deliverable 6.4 *"General description of the used data as a basis for a general data principle"* presents the description of communication interfaces between the actors involved in the demonstrators;
    - Deliverable 6.5 *"Optimization tools and first applications in simulated environments"* presents the description of the optimization tools and the range of flexibilities used in the demonstrators;

- Task 6.4 *"Demonstrators/field tests"*:
    - Deliverable 6.6 *"Demonstrators for flexibility provision from decentralized resources, common view"* presents the deployment plan, including technical specifications, procurement procedures for technical equipment, timeline for installations, and monitoring procedures;
    - Deliverable 6.7 *"German demonstrator - Grid node based optimization"* presents the information about the German demonstrator results, including the description of the working framework;
    - Deliverable 6.8 *"Italian demonstrator - DSO support to the transmission network operations"* presents the information about the Italian demonstrator results, including the description of the working framework;
    - Deliverable 6.9 *"Finnish demonstrator – Market based integration of distributed resources in the transmission system operations"* presents the information about the Finnish demonstrator results, including the description of the working framework;

- Task 6.5 *"Common vision and conclusion"*:
    - Deliverable 6.10 *"Opportunities arising from the decentralized flexibility resources to serve the needs of the TSOs. Results from the demonstrators"* presents common conclusions and recommendations from the demonstrators' activities, in order to contribute to the WP objectives and overall Project results.

The activities of Task 6.2, which are the focus of this deliverable, are the first steps of WP 6, dealing with the definition of System Use Cases. From the SUC development process also a set of innovative functionalities and the corresponding requirements is determined: this represents the input for the activities of Task 6.3. The above functionalities, divided in groups related to the type of application (forecast, simulation, communication and optimization) will be further analysed and then implemented in innovative software tools presented and described in the four Deliverables of Task 6.3. The defined SUC will be then used as references within Task 6.4: the SUCs, grouped by demonstrator, will be used as inputs for the Deliverables aimed at presenting the field tests descriptions (D6.7, D6.8 and D6.9 respectively).

WP6 receives the Business Use Cases developed within WP3 *"Analysis of market design and regulatory options for innovative system services"* as an input. Additionally, it is also in close coordination with WP5 *"Data management for facilitation of new flexibility solutions"* and WP9 *"Demonstration of cross-border and cross-sector data management and exchanges"*, collaborating, respectively, to data models and platforms analysis and to TSO-DSO flexibility data exchange analysis.

The final outcomes of WP6 will be used as inputs for the following Work Packages:

- WP2 *"Development of new approaches for system operation with high RES-E"*: the results gathered in demonstrator activities will be used for validation process in Task 2.6 *"Demonstration and Market Modeling validation"*;
- WP4 *"Simulation of the integration of new system services into System Operator control centres"*: the concepts implemented in the demonstrators and the knowledge gained from the field tests will be taken into account in Task 4.2 *"Implementation and application of a Real-Time Dispatcher Training Simulator (DTS) of large-scale application of demonstrated solutions at high RES-E"*;
- WP10 *"Pan-European Scalability and Replicability Analysis and Flexibility roadmap"*: the results coming from simulation and field tests will be used for KPIs calculation and SRA.

A schematic overview of all the relationships described above is presented in Figure 1.1.1:

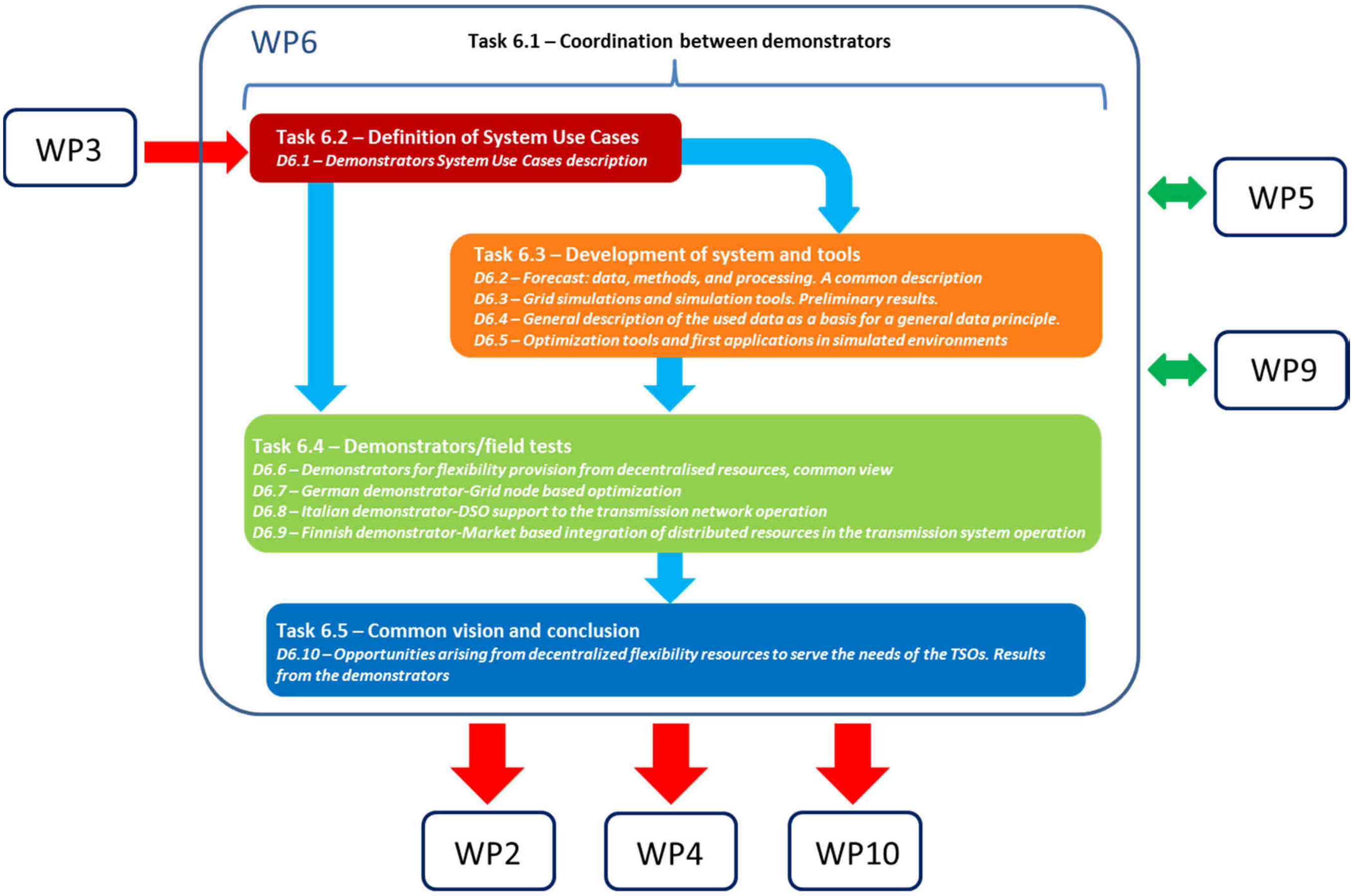

FIGURE 1.1.1 – WP6 OVERVIEW AND RELATIONSHIPS WITH OTHER WORK PACKAGES

1.2 SCOPE AND OBJECTIVES OF THIS DELIVERABLE

This document (Deliverable D6.1) presents the activities carried out in Task 6.2 and its outcomes. The achieved outcomes consist of the relevant system processes that will be tested in the demonstrators within Task 6.4 and the innovative functionalities (and corresponding requirements) that will be implemented in the systems and tools, developed within Task 6.3.

The scope of Task 6.2 is to identify the system processes (and corresponding functionalities) which support business activities, defined in the Business Use Cases (developed in Task 3.3 and presented in Deliverable 3.3 *"Business Use Cases for Innovative System Services"* [1]). Defining these system processes in the System Use Cases contributes to the WP6 objectives, within the frameworks of the German, Italian and Finnish demonstrators. As stated in section 1.1, the main objective of WP6 (briefly, analysis of exploitation of distributed resources for ancillary service provision) can be divided in three sub-objectives: improvement of TSO-DSO coordination, provision of ancillary services to TSOs from distributed resources, investigation of how the distributed flexibilities can address both the TSOs and DSOs needs. In order to verify how these sub-objectives can be met by the Task outcomes (i.e. the SUCs) it is necessary to "translate" them in a "system perspective", that is to classify the system processes based on how they realize functions which address or support these sub-objectives.

Based on this approach, the TSO-DSO coordination can be improved developing innovative processes which support an enhanced interface between TSOs and DSOs, for example novel processes for data and information exchange, for resources aggregation, for resources forecast, as well as novel coordination schemes. Furthermore, the provision of ancillary services to TSOs can be supported fulfilling specific request from TSOs, developing innovative processes for improving/allowing the exploitation of distributed resources, focusing on TSOs needs (i.e. active/reactive power management, voltage support, congestion management, balancing purposes, etc.).

Lastly, to investigate the ways distributed resources can address both DSOs and TSOs needs means identifying processes which guarantee an optimal state of distribution network, even in presence of constraints due to the distributed flexibilities exploitation for the TSOs, as well as processes which include the possibility for the DSOs to exploit some flexibilities for their own network management; such types of processes deal with network operations and enhanced optimization, state estimation, coordination of flexibilities exploitation for distribution system security, and so on. From this perspective, the System Use Cases developed within Task 6.2 describe innovative functions which include and enhance the described features. Finally, for ease of analysis, three System Use Cases groups can be identified:

- System Use Cases which describe innovative functions supporting DSO-TSO interface;
- System Use Cases which describe innovative functions supporting distributed flexibilities management focusing on TSOs needs;
- System Use Cases which describe innovative functions supporting distributed network management, in presence of constraints related to flexibilities exploitation (for both TSOs and DSOs).

The System Use Cases developed within T6.2 and presented in this document, address both the need of describing how they support the relevant business activities of the Business Use Cases presented in D3.3 [1] (and the interactions between them), and the need of supporting the demonstrators activities fulfilling the WP6 objectives.

Coherently with the approach followed in D3.3 [1], the SUCs are described using the standardized Use Case Methodology, from IEC62559, and UML graphical standardized modelling language, through the freeware modelling tool Modsarus® (developed by EDF R&D). In this way it was possible to gain advantage from the Use Cases repository already created for D3.3 [1], linking each SUC with the corresponding business activities belonging to the BUCs.

1.3 REPORT STRUCTURE

The structure of the deliverable is as follows:

- Chapter 2 introduces the adopted analysis approach, explaining the relevant concepts and definitions of the standardized methodologies used as references (IEC 62559 and SG-CG/M490);
- Chapter 3 presents the outcomes of the analysis for the German demonstrator, including all the relevant details of developed System Use Cases;
- Chapter 4 presents the outcomes of the analysis for the Italian demonstrator, including all the relevant details of developed System Use Cases;
- Chapter 5 presents the outcomes of the analysis for the Finnish demonstrator, including all the relevant details of developed System Use Cases;
- Chapter 6 carries out the cross-analysis of the three demonstrators, aiming at comparing their features, highlighting how they complement each other, and discussing the global achievements of the Task 6.2 in respect to Work Package objectives;
- Chapter 7, as a conclusive chapter, recaps the Task activities and the achieved objectives.

The annexes contain, respectively, the reference Use Case template with detailed description (ANNEX I) and the complete templates of the developed Systems Use Cases, for German demonstrator (ANNEX II), for Italian demonstrator (ANNEX III), and for Finnish demonstrator (ANNEX IV).

2. ANALYSIS METHODOLOGY

This chapter describes the analysis methodology adopted to perform the activities of Task 6.2. Starting with a brief summary of the background (i.e. the SGAM approach), the chapter reports all the relevant concepts and definitions of Use Case Methodology and finally presents the adopted approach, specifically developed for the purposes of this Task.

2.1 METHODOLOGY BACKGROUND

The methodology adopted in Task 6.2 is based on the widely accepted Use Case Methodology applied to Smart Grids, as developed by M/490 Smart Grid – Coordination Group (SG-CG) in 2014, presented in [2].

This methodology proposes a conceptual model, the Smart Grid Architecture Model (SGAM), which aims at representing Smart Grid systems in five layers – business objectives and processes, functions, information exchange and models, communication protocols, and components – as well as the interactions between them. The SGAM framework facilitates the presentation and validation of Use Cases, verification of the correlation with existing standards, and also interoperability of Use Case between different systems. A pictorial representation of SGAM is presented in Figure 2.1.1:

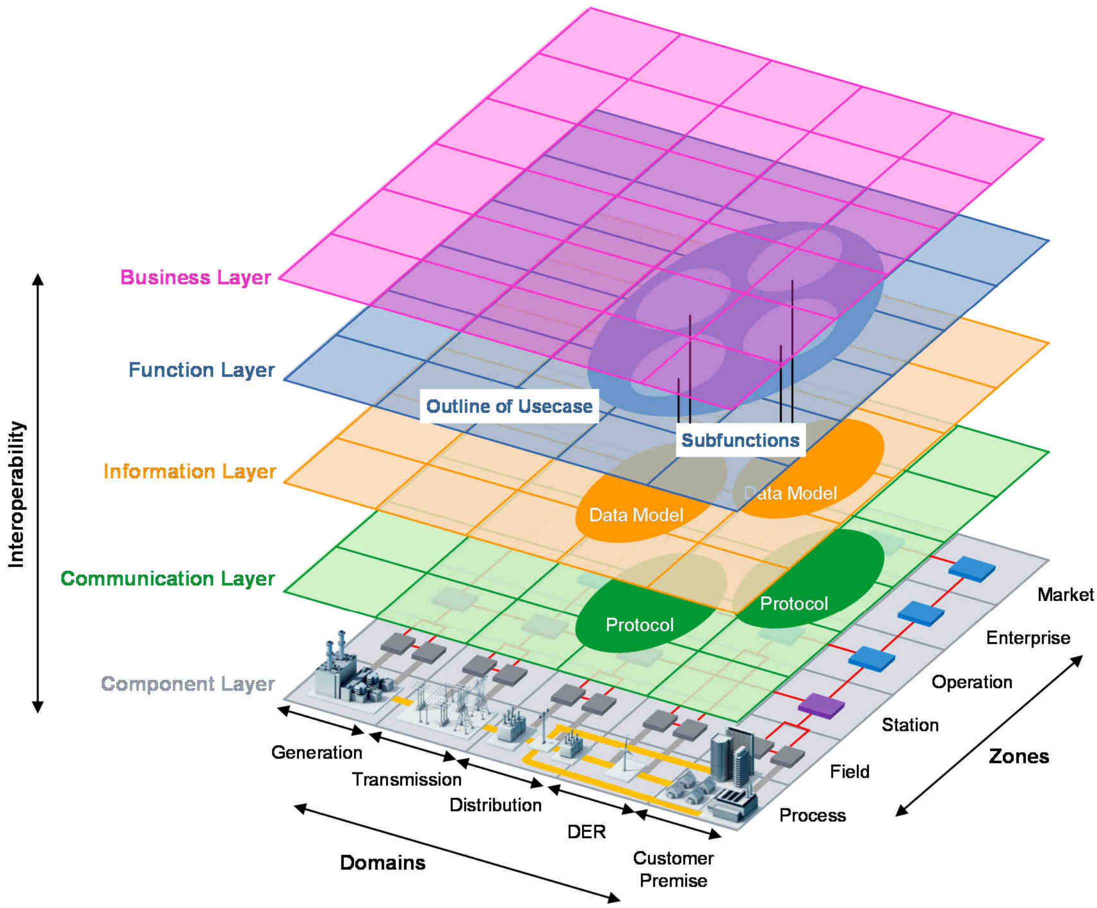

FIGURE 2.1.1 – THE SMART GRID ARCHITECTURE MODEL (FROM [2])

2.2 USE CASE METHODOLOGY DEFINITIONS

According to IEC 62559, a Use Case is defined as *"a specification of a set of actions performed by a system which yields an observable result that is of value for one or more actors or other stakeholders of the system"* [3]. Basically, it describes the way how several actors interact, within a given system, to achieve one or more goals.
In [2] a system is defined as "*a typical industry arrangement of components and systems, based on a single architecture, serving a specific set of use cases".* For the purposes of this document, systems are the physical demonstrators within the boundaries defined by project activities.

The definition of actor is linked with the definitions of party and role; a simple schematic taken from [2] is presented in Figure 2.2.1, in order to better clarify how these definitions are linked.

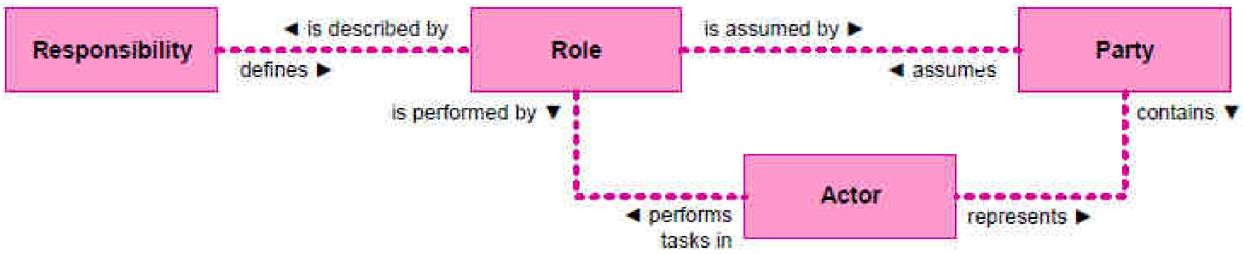

FIGURE 2.2.1 – CONCEPTS RELATED TO ACTORS AND ROLES (FROM [2])

According to [2]:

- Responsibility: Responsibilities define external behavior to be performed by parties (ex: Nominate Energy, Operate a grid, Determine the market energy price after applying technical constraints...).
- Role**:** a Role represents the intended external behavior (i.e. responsibility) of a *party*. *Parties* cannot share a *role*. Parties carry out their activities by assuming *roles*, e.g. system operator, trader. *Roles* describe external business interactions with other *parties* in relation to the goal of a given business transaction (ex: Balance Responsible Party, Grid Operator, Market Operator…).
- Party**:** Parties are legal entities, i.e. either natural persons (a person) or judicial persons (organizations). Parties can bundle different roles according to their business model (ex: real organizations, stakeholders…)
- Actor: an Actor represents a *party* that participates in a (business) transaction. Within a given business transaction an *actor* performs tasks in a specific *role* or a set of *roles* (ex: Employee, Customer, Electrical vehicle, Demand-response system…). The term *Actor* can be used in other contexts within smart grids methodology, particularly discussions around technology. If it helps, in the context of the discussion, the type of actor can be qualified, such as *business actor* in the role model and *system actor* when referring to technological systems.

Use Cases can be differentiated based on the level of goals they have to achieve; goals may be high-level, business oriented, or may be specific, related to a simple task performed by an information system, for instance.

In order to avoid confusion and potential overlapping, Use Cases have been structured in two types, based on the type of goals and the level of detail they are focused to: Business Use Cases and System Use Cases.

The Business Use Cases describe the set of activities to be performed for implementing a service, focusing on business needs and rules and the functions required to enable/execute the business process, and their associated requirements. BUC do not deal with aspects related to technology ("black-box" approach). On the opposite, System Use Cases describe the set of activities to be performed in order to execute functions, so they contain the description of all the functionalities implemented through software tools, information systems, physical devices, and so on ("white-box" approach). The main features of Use Cases types are summarized in Table 2.2.1.

Type	*Description*	*Involved actors*
Business	A business process implementing a service	Roles (organizations or organizational entities)
System	A function or sub-function (system process), performed through one or more functionalities, supporting one or several business processes	Systems and Persons (operators of an information system)

TABLE 2.2.1 – BUSINESS AND SYSTEM USE CASES DEFINITIONS

Applying these definitions to the SGAM approach, returns a more detailed classification of Business and System Use Cases: Business Use Cases, describing business processes, stay within the Business Layer and interact with Functions; System Use Cases, describing Functions, stay within the Function Layer, supporting, from a technical perspective, the business processes of the above level, and interacting with the entities of the underlying levels, i.e. data models (Information Layer), protocols (Communication Layer), and components (Component Layer).

Figure 2.2.2 (taken from [4]), shows the link between the five layers (and corresponding interactions) of SGAM and the key concepts of Use Case methodology (Roles, Services, Business Processes, Systems, and Functions).

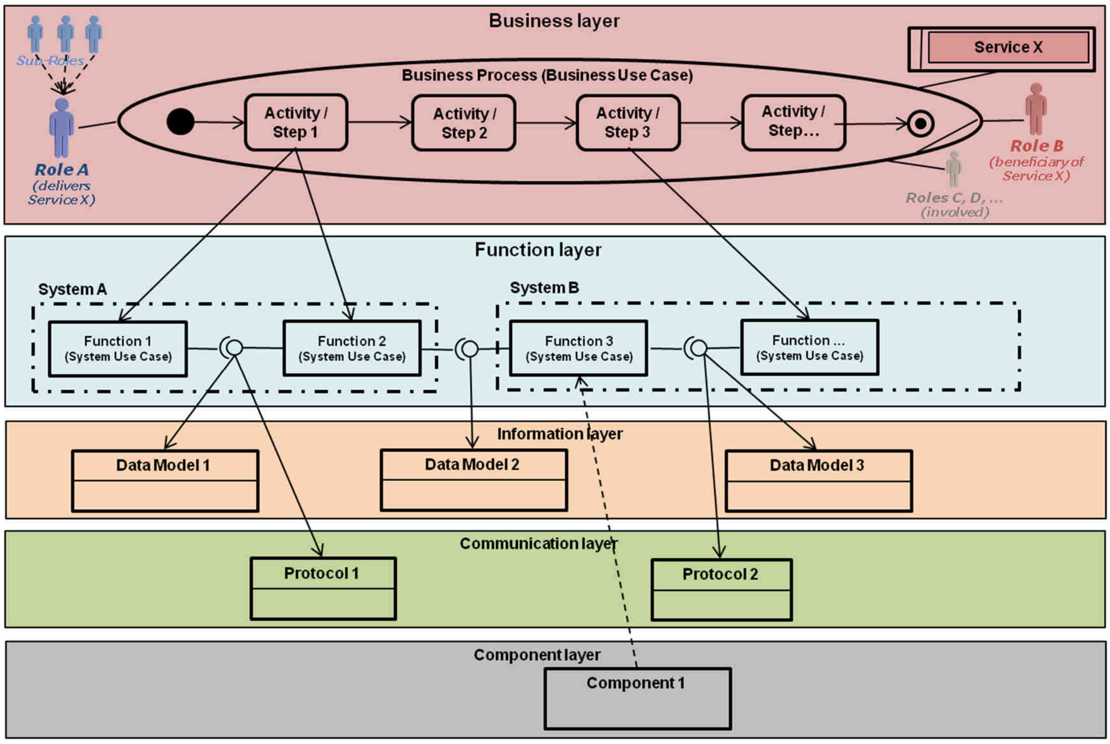

FIGURE 2.2.2 – LINK BETWEEN USE CASE METHODOLOGY AND THE SMART GRID ARCHITECTURE MODEL (FROM [4])

Based on the concepts previously explained, a schematic example is presented in Figure 2.2.3. A generic electricity company can be classified as a *party*; if it participates to a business process, it can be referred as a *Business Actor.* Within a business process, each involved actor plays a *Role*, in other words "it assumes intended external behavior (i.e. responsibility) in respect to other actors and to the goal of the process". In the considered example, the electricity company plays the role of Distribution System Operator (DSO) and so it takes the responsibility, amongst others, to "manage the distribution system in a secure and profitable way". This means that the electricity company, as a DSO, perform a set of activities aimed to support the business process and to achieve its goals, within the above mentioned responsibility (several types of business processes and goals can be considered, so that is why this example generically refers to "business process" and "goals" without specifying them). Each activity (i.e., business activity, since it belongs to a business process) may rely on one or more functions in order to be accomplished. Functions can be implemented through system processes, processes in which persons and systems belonging to the electricity company (*System Actors*, i.e. actors operating within the *Function Layer*) interact together performing suitable functionalities. Going back to the considered example, the system actors, which support the electricity company in the role of the DSO, may be SCADA systems, remote monitoring systems, interface systems and so on. System actors depend on the characteristics of the systems which implement the functions, so they are potentially unlimited. Functions are not firmly linked to any business activities; this means that the same function can support different business activities and the correspondence between a function and a business activity depends only on how they interact case by case. Similarly, the role which performs a business activity is not linked directly with the supporting functions, nor it participates directly in the system process which implements the function, since roles and system actors belongs to two different layers.

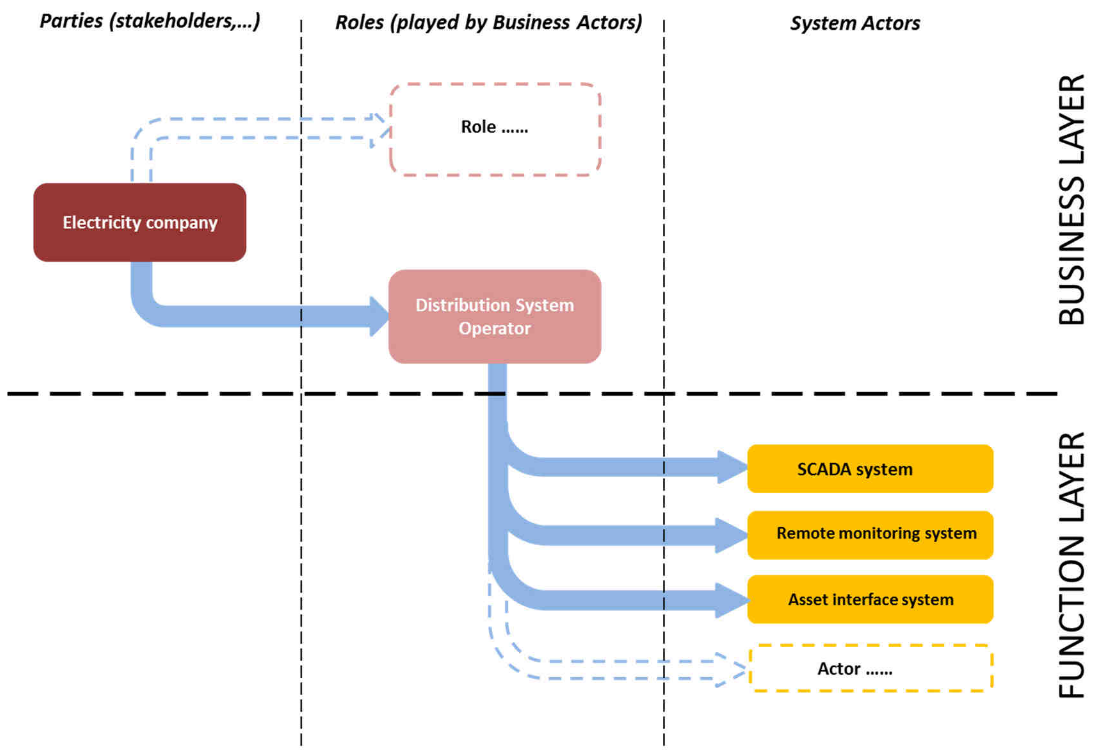

FIGURE 2.2.3 – MAPPING OF PARTIES, ROLES AND SYSTEM ACTORS ON LAYERS

The Use Case description, in addition to a clear definition of actors, goals and interactions, can efficiently support the description of user requirements. According to [2] *"Use cases gather requirements, information about functionalities, processes and respective actors in a structured form"*.

The user requirements are specific requirements which allow the execution of an activity or a function, without any link or reference with any specific technology, design or product. They can be of two types, functional or non-functional. Functional requirements depict, by the means of sequences of simple actions descriptions, the intended behavior of a given system, which may be expressed as services, tasks or functions this system is required to perform, i.e. what its associated actors must do. Non-functional requirements describe general constraints the system under study is subject to. They can be related to performance (response times, precision, latency, and other user parameters), security (confidentiality, access restrictions and other safety and/or failure issues), data management (number of devices, data access, and other data management issues) and so on.

The Use Cases are usually developed and described through standardized templates, containing textual description, figures and diagrams. The most widely accepted Use Case template within the Smart Grid community is the one proposed by IEC 62559-2. In order to facilitate drafting, writing, presentation and validation of Use Cases, many software applications have been developed and proposed. In the EU-SysFlex project, the freeware modelling tool Modsarus® (developed by EDF R&D), based on UML graphical standardized modelling language, was selected. For reference purposes, comprehensive and useful guidelines for Use Cases writing and IEC 62559-2 template filling (based on [5]) can be found in ANNEX I.

2.3 ANALYSIS APPROACH ADOPTED FOR TASK 6.2

In the previous sections, the SGAM methodology and the relevant definitions and concepts of Use Case Methodology have been presented. They can be considered as the theoretical background for the approach adopted in Task 6.2 for describing the System Use Cases for the WP6 demonstrators, presented in this section.

Due to the constraints posed by the physical demonstrators, which at least in Italian and German cases are based on existing physical set-ups already in use for testing purposes, it was not possible to follow a pure top-down approach (as should be done, in theory), starting from business activities down to functions, selecting functionalities to implement and collecting requirements for tools and then arrange a suitable physical set-up for testing. Indeed, the technical frameworks upon which demonstrators are built have their specific features which must be considered prior to describing System Use Cases, starting from the analysis of Business activities they are linked to.

For this reason, the followed approach has been organized in two different analysis processes, carried out iteratively; then, once these processes were concluded, their outcomes have been "mapped" together in order to create the basis for SUC template drafting.

The first process consisted in identifying the relevant functionalities for achieving the Task objectives, which can be tested in the demonstrators; for this purpose a questionnaire for demonstrators' responsible partners was prepared. The filling of the questionnaire followed an iterative process: Firstly it was asked to provide a schematic overview of the demonstrator set-ups, and the description of its assets and systems and the functions implemented; the second step consisted in detailing the functions descriptions in order to highlight the relevant functionalities supporting them; the third and final step consisted in detailing the links and interactions between the demonstrators elements, focusing on information exchange, communications and data management systems.

The second process took place after the consolidation of Business Use Cases from D3.3 [1] (at early stages it was carried out in parallel with Task 6.2 due to time constraints posed by Project timeline); it consisted in analyzing the business activities in detail, identifying all the relevant functions to be described in System Use Cases. Once these functions were identified, it was asked to demonstrator partners to highlight the innovative functionalities which contribute to their implementation.

Then, the outcomes of these two processes were "mapped" together through a cross analysis of the functionalities identified; the innovative functionalities, and the corresponding functions, which address both the support of business activities and the Task objectives, within the testing capabilities of the demonstrators, have been selected and been described in System Use Cases.

After this preliminary analysis, the SUC drafting started; once the first drafts were ready, they were discussed and reviewed by all the partners and then detailed and consolidated following an iterative process.

The approach described above is reported, for clarification, in the schematic workflow of Figure 2.3.1.

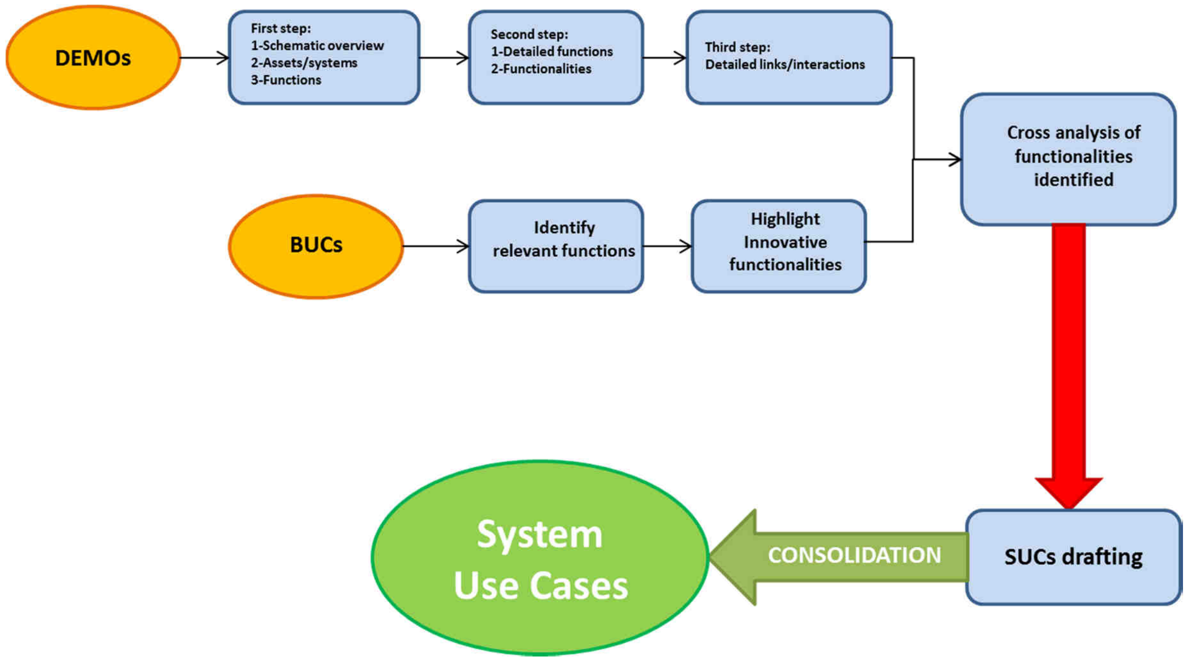

FIGURE 2.3.1 – SCHEMATIC OVERVIEW OF THE ANALYSIS APPROACH FOLLOWED IN TASK 6.2

Besides the System Use Cases (presented in ANNEX II, ANNEX III and ANNEX IV), the outcomes of the analysis approach presented in this section are described in details in the next chapters. For better understanding, the analysis results are presented separately per demonstrator. A final cross analysis between the three demonstrators is presented in Chapter 6.

3. THE GERMAN DEMONSTRATOR

The aim of this chapter is to present and describe the SUCs within the German Demonstrator and its related functionalities. As it is necessary to have a general understanding of the German Demonstrator and its objectives for detailing the SUCs, an overview is given in section 3.1. Thereafter, in section 3.2 an overview about the Business Use Cases is given, in order to describe the underlying business processes, which are related to the stakeholders involved. Then the System Use Cases are presented in section 3.3 in a high level view. The full System Use Cases are to be found in the ANNEX II. Furthermore the structure of the SUC and the interdependencies between the different SUC are explained in section 3.3. Then, in chapter 3.4 the system actor playing a role in the System Use Cases of the German Demonstrator as well as their correspondence to the business roles are presented. Section 3.5 gives a description of the functionalities implemented in the German Demonstrator and the links of these functionalities to the SUC are detailed. Finally in section 3.6, the requirements of the System Use Cases are detailed.

3.1 OVERVIEW ON THE GERMAN DEMONSTRATOR AND ITS OBJECTIVES

The aim of the German Demonstrator is to enable the provision of flexibility services from DSO connected sources to the TSO, for the TSO's congestion management due to line loadings and voltage limit violation. In addition, the DSO itself is using the same services in order to sustain a stable and secure grid operation in the distribution grid. For these flexibility services, active and reactive power provision from assets in the distribution grid are managed. Primarily, conventional as well as RES generation units in the high voltage (HV) grid – in Germany namely 110 kV - will provide these flexibility services. For active power flexibilities assets, that are not directly connected to the HV grid but rather connected to lower voltage levels, can also be utilised in general – but will not be available for the field tests. The flexibilities are not prioritised according to the voltage level but rather according to the sensitivity on the congestion and the costs.

To realise this, the following objectives will be pursued:

- forecasting generation and consumption connected to the HV grid;
- predicting power flows in the HV grid, including possible power flows due to contracted capacities for frequency stability services which might be activated by the TSO;
- taking into account all grid constraints due to security reasons in the distribution grid including flexibility activation for congestion management in the distribution grid;
- providing information of the available flexibility potential of active power (day-ahead and continuous intraday update) and reactive power (intraday - up to 6 hours ahead expected) to the TSO;
- enabling the delivery of flexibility services and the execution of the TSO's calls for flexibility.

The German Demonstrator is being implemented in the HV (110 kV) distribution grid of Mitteldeutsche Netzgesellschaft Strom mbH (MITNETZ STROM) in the south of Brandenburg and Saxony-Anhalt and in the west and south of Saxony. In the grid area of MITNETZ STROM the installed capacity sums up to 10.2 GW of distributed energy resources (DER), of which more than 8.5 GW are renewable energy resources (RES). The German demonstrator uses the assets connected to HV with an installed capacity of 5.2 GW DER. Thereof are 3.7 GW RES. These available flexibilities will be offered to the TSO, who operates the extra-high voltage (EHV) grid of 220 kV and 380 kV. The Demonstrator therefore includes 16 TSO/DSO interfaces at the EHV/HV interface with 40 transformers.

For the demonstrator, only generation resources are used for providing flexibilities. Nonetheless, the developed system is prepared to include other flexibility resources such as loads connected to the HV grid as well. Table 3.1.1 shows a summary of the resources used within the German Demonstrator.

German Demonstrator	
DSO operating voltage	110 kV
Operating voltage at TSO/DSO interface	• 380 kV / 110 kV • 220 kV / 110 kV
DSO assets	-
Flexibility resources	• 2.7 GW wind (HV grid) • 1 GW PV (HV grid) • 1.5 GW thermal power plant (HV grid)
Tools/Software/Systems	• DSO SCADA system • BeeDIP (Optimization, State Estimation, Congestion Management) • Forecast System (day ahead and intraday forecast of generation and load considering weather data) • State estimation for day-ahead and intraday load flows and voltage levels based on forecast system and grid data (e.g. maintenance, switching states, etc.)
DSO field devices	• Out of scope

TABLE 3.1.1 – RESOURCES INVOLVED WITHIN THE GERMAN DEMONSTRATOR.

The tools, software and systems used or developed in the German demonstrator include the DSO SCADA system, beeDIP system and the forecast system. The DSO SCADA system already exists and it is used. Its functions will be enhanced due to the development of the beeDIP system. The functions of beeDIP are state estimation, topology analysis, grid optimisation and congestion management. The forecast system supports the beeDIP with day ahead and intraday forecast of generation and load. To enhance the forecast, weather and grid data will be considered. DSO field devices are installed in the entire distribution grid, in order to monitor and control the assets. The DSO owned devices measure electrical parameter and asset utilisation (e.g. breaker status) and transmit set points to assets and the flexibility resources. The measured information is sent to the DSO SCADA system. The asset owner carries out the processing of the new set point. The purpose and use of these devices are independent of the EU-SysFlex project. Therefore DSO field devices will not be further developed or installed in a larger amount. Due to this, they are out of the scope of the German demonstrator.

3.2 BUSINESS USE CASE OVERVIEW IN THE GERMAN DEMONSTRATOR

As explained in section 2.2, Business Use Cases describe the activities that need to be performed for a defined business process on a "black box principle" not going into details of the system level. The BUCs contain the definition of the business processes for the interactions (information exchanges) between stakeholders as business roles participating in the provision of the service. Within this section a brief overview is given about the defined Business Use Cases of the German Demonstrator which were defined within the activity performed in Task 3.3 *Functional specification of system services in terms of Business Use Cases* (also see Deliverable D3.3 [1]). Table 3.2.1 gives an overview of the two Business Use Cases defined for the German demonstrator.

Demonstrator	Business Use Case	BUC ID
German	Manage active power flexibility to support congestion management and voltage control in the German demo	DE-AP
German	Manage reactive power flexibility to support voltage control and congestion management in the German demo	DE-RP

TABLE 3.2.1 – OVERVIEW ON GERMAN BUSINESS USE CASES.

The German BUCs help to alleviate scarcities that occur in a future energy system with a high share of RES. The BUC DE-AP addresses active power management mainly for solving congestions and the BUC DE-RP describes the reactive power management mainly for voltage control, both services delivered to the transmission grid.

In 2030, an increasing share of RES is expected. This increasing share makes more efficient congestion management processes for both TSOs and DSOs necessary. Also today, events occur that cause congestions in the transmission and distribution grid. For example, the use of conventional power plants in distribution grids for reserve requirements (frequency control or frequency restoration) carried out by TSOs can cause congestions in the corresponding distribution grids. Therefore, if TSOs and DSOs do not coordinate their actions, DSOs must solve these kind of congestions by e.g. reducing the production of RES in the distribution grid, counteracting the action done by the TSO. A high share of volatile feed-in causes new challenges for active and reactive power management in the same manner in order to guarantee a reliable energy supply. Therefore voltage control also needs an enhancement that will be realised in the German demonstrator.

Due to the already high share of wind power in the northern and eastern part of Germany, substantial ReDispatch measures (schedule adjustments) are necessary. The first image (Figure 3.2.1) shows grid congestions in the German transmission grid (red lines), if ReDispatch measures had not been undertaken – meaning that generators would feed in as originally traded without intervention of system operators.

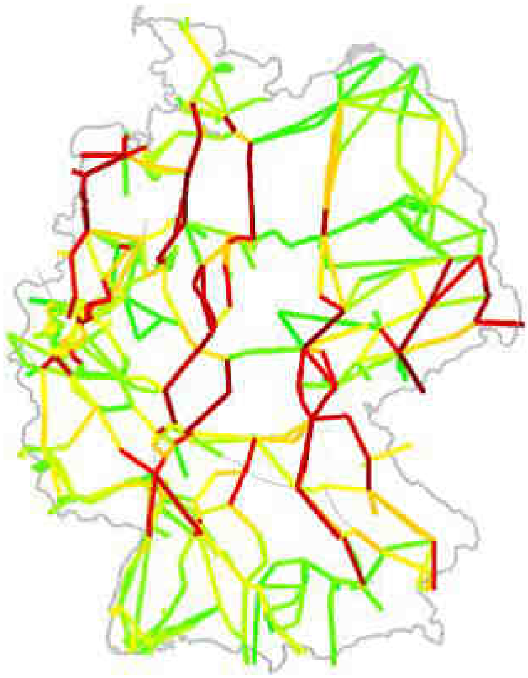

FIGURE 3.2.1 – LINE LOADING IN THE EHV GRID AFTER MARKET CLOSURE AND BEFORE CONGESTION MANAGEMENT (SOURCE: BNETZA, GERMAN REGULATORY AUTHORITY, 2017)

After performing ReDispatch at transmission level (see Figure 3.2.2), there are still some lines with more than 100% use of capacity already in the (n-0)-case (red bubbles). The goal is to reach a line loading of less than 100% in the (n-1)-scenario to fulfil the (n-1)-criterion.

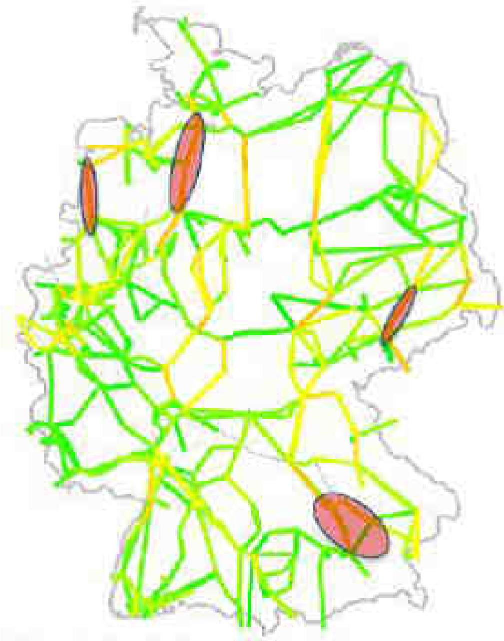

FIGURE 3.2.2 – LINE LOADING IN THE EHV GRID AFTER CONGESTION MANAGEMENT WITHOUT RES INCLUDED IN THE REDISPATCH PROCESS (SOURCE: BNETZA, GERMAN REGULATORY AUTHORITY, 2017)

As the generation from RES will increase in the future, the number of conventional power plants will decrease and a partially decentralised power system will result. Due to this, the flexibility potential in transmission grid will face a strong decrease and therefore, some flexibilities have to be provided by RES in the distribution grid. If RES connected to the distribution grid were included, this would increase the ReDispatch potential within the ReDispatch process, and help achieve a lower than 100% line loading in the transmission grid for the (n-1)-scenario.
The German BUCs are designed to use all possible generator flexibilities in the distribution grid in order to support solving congestions and voltage issues in the transmission and distribution grid in the most cost-efficient way. However, in the demonstration phase, the focus will be on RES as most probable reason of congestions in the testing area. Both of the described services therefore are performed and supported by using DSO and private assets connected to the distribution grid.

The Roles, which act in the description of the business process of the defined Business Use Cases are the Business Roles, as explained in section 2.2. The main business roles, related to the German Demonstrator, in the two German Business Use Cases are:

1) Distribution System Operator (DS_O);
2) Transmission System Operator (TS_O);
3) Forecast Provider (FCP);
4) Metered Data Operator (MDO);
5) Generation Aggregator (GA);
6) Generation Asset Operator (G_O).

The System actors perform the specific functionalities in order to provide the services described in the BUCs from a technical point of view. It shows that for example the Business Role of the Forecast Provider (FCP) has three related System actors, namely the Forecast Provider, the Power Forecast Provider and the Numerical Weather Prediction Center.

For any additional information about the BUCs, a complete explanation is given by the Deliverable D3.3 [1].

3.3 SYSTEM USE CASES OF THE GERMAN DEMONSTRATOR

As explained in section 2.2, the SUCs in contrast to the BUCs go deeply into the detailed description of the process itself. The SUCs give the functional description needed to support the BUCs by detailing which activities are performed exactly for the whole process and which System actor are going to execute them. In order to describe in detail which activities are performed exactly in the German Demonstrator for the whole process and by which System actors, six System Use Cases have been defined within Task 6.2.

The detailed descriptions of German System Use Cases are presented in ANNEX II: in the following, Table 3.3.1 presents their scopes and objectives, i.e. "which activities are performed" within the boundary of each Use Case and what are the "goals" achieved through each Use Case. The full description of the parts which build the Use case template is presented in ANNEX I.

SUC ID	Description	
DE-COM Perform data communication for the German Demo	Scope	The scope of this SUC are the communication and data exchange between DSO, TSO and external systems. The latter are in detail, the German demonstrator platform and the controllable assets in the field (110 kV grid).
	Objective	The following activities are necessary within this SUC: • Receive and send data between actors; • Mapping and conversion in dedicated communication protocols and data standards; • Check and validation of application status.
DE-DATA Perform data management for the German Demo	Scope	This use case describes the internal data exchange and communication within the BeeDIP system platform between all integrated modules. Data exchange and administration plays an important role in BeeDIP system.
	Objective	The objective of this SUC in the German demonstrator is to enable the internal communication between the different modules and how the different data are administered. Therefore the following activities are necessary within this SUC: • Transformation and validation of different data and its formats;

		• Administration of data bases; • Monitoring and administration of different communication.
DE-FC Forecast of load and infeed for German Demo	Scope	Delivering of up-to-date energy forecasts (Wind, PV and Consumption) to the Demonstrator System.
	Objective	Forecasting plays a crucial role within all other SUC, since it is the basis for generating and optimizing schedules for flexibility potentials. Within this SUC, the handling of input and output forecast data will be described. Therefore the following activities are necessary within this SUC: • Read and process current measurement data from field devices; • Read and process numerical weather prediction data; • Computation of intraday and day ahead forecast data; • Provision of resulting forecasting data.
DE-OPF Optimize network state for the German Demo	Scope	This SUC performs basic processing of grid related tasks in order to prepare the grid and network state for optimization purposes.
	Objective	The tasks performed in this SUC are in detail: • Grid topology processing; • State Estimation; • Contingency Analysis; • Congestion management DSO side; • Forecast mapping; • Basic loss reduction optimization using reactive power.
DE-APC Enabling Provision of Active Power Flexibility from DSO for TSO in the German Demo	Scope	This system use case explains how the DSO supports the TSO in managing the active power flow in the transmission grid in the case of congestion by providing active power flexibilities from assets in the distribution grid.
	Objective	The objective of this SUC in the German demonstrator is to enable the provision of active power flexibilities connected to the distribution grid (110 kV) for managing congestion in transmission grid (380 kV + 220 kV). Therefore the following activities are necessary within this SUC: • Calculating available flexibilities at interconnection point between TSO and DSO; • Allocate information about feed-in/consumption schedule and available flexibility potential for TSO; • Process update of data.
DE-RPC Enabling Provision of Reactive Power Flexibility from	Scope	This system use case explains how the DSO supports the TSO in managing the reactive power flow in the transmission grid in the case of congestion or voltage control by providing reactive power flexibilities.
	Objective	The objective of this SUC in the German demonstrator is to enable the provision of reactive power flexibilities connected to the distribution grid

DSO for TSO in the German Demo		(110 kV) for managing voltage control in transmission grid (380 kV + 220 kV). Therefore the following activities are necessary within this SUC: Calculating available flexibilities at interconnection points between TSO and DSO; • Allocate information about load flow and available flexibility offers for TSO; • Process update of data.

TABLE 3.3.1 – OVERVIEW ON SCOPES AND OBJECTIVES OF THE GERMAN SYSTEM USE CASES.

All the System Use Cases are interlinked and need to work together in order to fulfil the service defined in the two Business Cases of the German Demonstrator. The visualisation in Figure 3.3.1 displays this relation between the System Use Cases and in addition also shows which System Use Cases are needed to fulfil which Business Use Case of the Demonstrator.

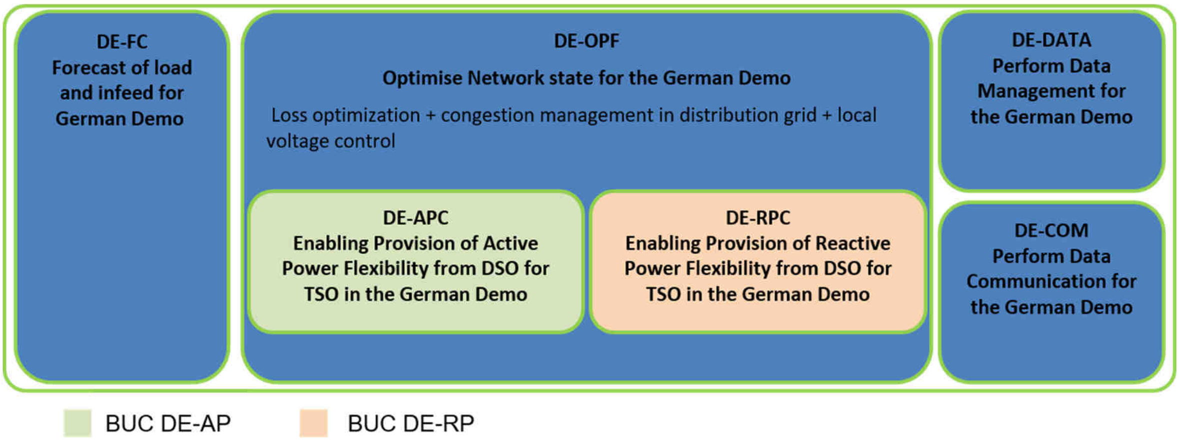

FIGURE 3.3.1 – RELATION BETWEEN SYSTEM USE CASES IN THE GERMAN DEMONSTRATOR

The layout of the System Use Cases in the visualisation shows that the System Use Cases, namely DE-FC, DE-DATA and DE-COM, along the left and right hand side are supportive System Use Cases. The System Use Case DE-OPF in the back is the central base System Use Case. This System Use Case is needed for loss optimization, congestion management and local voltage control in the own distribution grid. Therefore this System Use Case needs to run all the time in the back even though no service, as defined in the Business Use Cases, is delivered to the TSO. Extending this base System Use Case, the two System Use Cases DE-APC and DE-RPC are set up to enable the provision of active and reactive power flexibilities connected to the distribution grid for managing congestion and voltage control in transmission grid, while ensuring an congestion and voltage violation free distribution grid.

The colouring shows which System Use Cases are needed to fulfil the respective Business Use Cases. The blue colour represents that the System Use Cases are needed for both Business Use Cases: the BUC DE-AP and BUC DE-RP. In contrast to that, green indicates that the System Use Case DE-APC is needed only for the BUC DE-AP and DE-RPC in orange only for BUC DE-RP.

3.4 SYSTEM ACTORS IN THE GERMAN SYSTEM USE CASES

The System actors perform the specific functionalities in order to provide the services described in the BUCs from a technical point of view.The correspondence between Business and System actors in the System Use Cases of the German Demonstrator is shown in Figure 3.4.1. It shows that for example the Business Role of the Forecast Provider (FCP) has two related System actors, namely the Forecast Provider and the Numerical Weather Prediction Center.

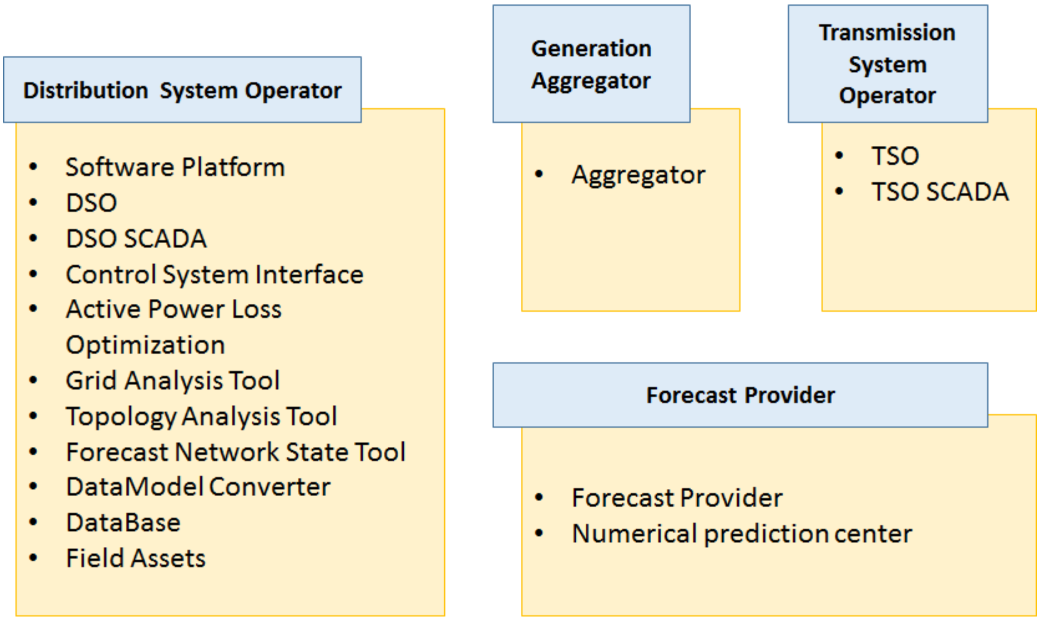

FIGURE 3.4.1 – CORRESPONDENCE BETWEEN BUSINESS ROLES AND SYSTEM ACTORS IN GERMAN SUCS

For the German Demonstrator the following system actors are described in the SUCs, which can be found in the ANNEX II:

- **The Software Platform** collects data and calculates set-points for active and reactive power. The name of the software platform in the German Demonstrator is BeeDIP.
- **The DSO** operates the distribution grid, elaborates network development plans (including flexibility call for tenders) and processes data to optimize network operation and maintenance programs across managed voltage levels and timeframes (from planning to real-time) using available levers (e.g. flex activation, network tariffs). The role also defines technical needs at distribution level in collaboration with TSO and commercial players (e.g. aggregators) to call flexibility products. Assess and broadcast network status to eligible actors (e.g. aggregators). Another task of the DSO is to define, jointly with the TSO, technical processes and mechanisms for optimal procurement and activation of flexibility resources directly connected to the distribution grid.
- **The TSO** operates the transmission network over a specific region in a secure, reliable and efficient way. It ensures a transparent and non-discriminatory access to the transmission network for each user, manages

the active and reactive flows and ensures the security of the transmission network (congestion and voltage). The role also technically provides in a secure and efficient way the services of voltage control and restoration of supply. The TSO applies, if required, the defence plan (load shedding orders) in case of a succession of events (overload, voltage collapse) and provides data to the interconnection capacity market operator for the management of cross border transactions.

- The roles **DSO SCADA** and **TSO SCADA** represent respectively the SCADA systems of the DSO and TSO with all their functionalities.
- **The Field Assets** connect to the DSO with assets of MDO (Metering Data Operator) and G_O (Generation Operator) for data exchange (e.g. set point signals, metering data) purposes.
- **The Aggregator** provides a set of generating means for mobilization.
- **The DataModel Converter** is a system which converts the data from the CIM datamodel into the PandaPower (a grid computation and analysis framework developed by Fraunhofer IEE) datamodel and adds further relevant information for the optimisation. The reason for this is to ensure the processing of the data throughout the whole grid calculation and optimisation process.
- **The Forecast Provider** provides power forecast of infeed and load at a needed aggregation level.
- **The DataBase** stores and archives CIM, forecast and set-points.
- The system actor **Control System Interface** represents the interface to the control system of DSO and provides the CIM data.
- **The Numerical Weather Prediction Center** is a system actor which delivers up-to-date weather prediction data of the area to forecast to the Demonstrator forecast systems.
- The main purpose of t**he Active Power Loss Optimization Tool** is the reduction of active power losses in the HV grid using the reactive power capability of decentralized power plants directly connected to the HV grid.
- **The Grid Analysis Tool** operates four sub-functions: State Estimation, Contingency Analysis Congestion Management and Short-Circuit Calculation.
- Concerning the **Topology Analysis Tool**, an analysis and reduction of this topology will be performed, based on the grid topology in PandaPower data model. Therefore this system actor enables a fast processing of the grid calculation and optimisation.
- Finally, the **Forecast Network State Tool** will be mapped on current and predicted grid topology. With this the system actor Forecast Network State Tool determines network states for the time domain of forecast.

3.5 DESCRIPTION OF FUNCTIONALITIES IMPLEMENTED IN THE GERMAN DEMONSTRATOR

In order to fulfil the tasks defined in the System Use Cases several functionalities need to be implemented. For the German Demonstrator the following 14 functionalities and their action will be developed:

- **CIM-Parsing**
    - to validate the CIM/RDF file (syntax, semantic),
    - to create JAVA objects (CIM data model)

  - to transfer these objects to CIM database

- **CIM-over-REST**
  - to read CIM information via SQL from DB
  - to transfer it to JSON format
  - to provide it via REST
- **Database functionalities**
  - to read or write in the DB via Rest queries
- **CIM-to-PandaPower** (PandaPower is a grid computation and analysis framework developed by Fraunhofer IEE)
  - to read CIM Data from CIM REST interface
  - to build upon these a PandaPower network for load flow calculations (this network contains all assets stored in the CIM DB)
- **Topology Analysis**
  - to reduce the full PandaPower net to the region of interest (e.g. only 110kV and 400kV)
  - to aggregate generation and consumption in defined voltage levels and regions if this is needed
- **State Estimation**
  - to perform a state estimation (Chi2 or ANN) with usage of a PandaPower network and actual measurements
- **Forecast Network States**
  - to map the forecast data for generation and consumption on the dedicated grid nodes of generators and loads for each predicted time point
  - to generate a future network state based on the forecast (if there are switching schedules available, then they will be included as well)
- **Contingency management**
  - to check all generated network states on n-1 security
  - to apply active power reduction to specific generating units, If there are unsecure states detected
  - to identify units to be reduced via sensitivity analysis and merit-order lists
- **PV Forecast**
  - to calculate PV forecasts based on weather forecasts and measurements from transformer stations with direct feeding from PV farms
- **Wind Forecast**
  - to calculate wind power forecasts based on weather forecasts and measurements from transformer stations with direct feeding from wind farms
- **Consumer Forecast**
  - to calculate load forecasts based on weather forecasts and measurements from transformer stations between high and medium voltage

- **Grid-Optimization**
    - to optimise active and reactive power flows mathematically
    - to calculate the active and reactive power capabilities of the network
    - to calculate the set points for the flexibility assets based on user inputs and under consideration of network constraints (voltage, loading, …)
- **Active Power Capability Calculation**
    - to determine the active power range of production from decentralized generation with respect to grid constraints
    - to calculate it for the actual moment and the next 24 h
- **Reactive Power Capability Calculation**
    - to determine the reactive power range of production from decentralized generation with respect to grid constraints
    - to calculate it for the actual moment and the next 4 h

Each functionality is needed for fulfilling a different System Use Case. Figure 3.5.1 shows the mapping of functionalities with the respective System Use Case.

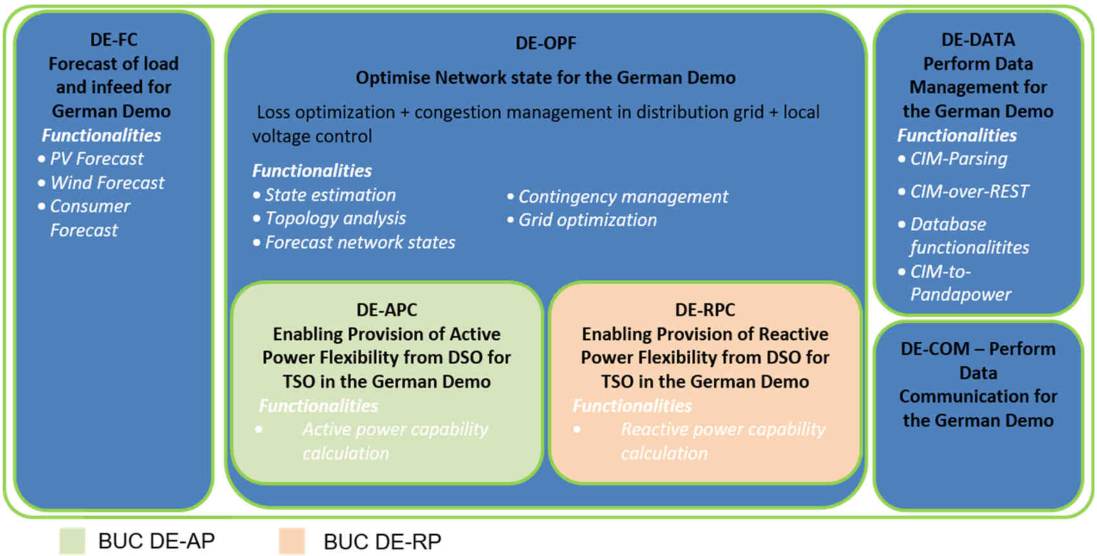

FIGURE 3.5.1 – MAPPING OF SUCS AND FUNCTIONALITIES

It becomes clear that the definition of the System Use Cases will be utilised as an input for the development of these new tools. The development will take place in Task 6.3 "*Development of systems and tools"* as explained in chapter 1. The tools are divided into four categories:

- **Observability and forecasting tools** (see Deliverable D6.2)
  Existing forecasting and observability tools will be adapted in the context of the different demonstrators and evolved to meet the specific needs. With the help of these tools the operation of the system can be substantially improved with forecasts of variable resources, of the market situation, the network needs

and of how the distributed resources would behave with or without price and control signals. This leads also to a higher observability of the system and hence more accurate network states.

- **Communication and data usage** (see Deliverable D6.4):
  The communication interfaces between the actors involved in the demonstrators are being implemented in these tools.
- **Optimisation tools** (Deliverable D6.5):
  Optimization tools are being developed to determine and utilize the range of flexibilities. This will create the different services and products for the TSO.
- **Grid simulation** (Deliverable D6.3):
  The grid simulation is being used to model and simulate the networks from the different demonstrators in order to assess the flexibility that could be provided from the decentralised resources to the TSO, respecting the distribution network constraints. In addition, those models are being used to assess the impact of the flexibility measures in order to help the operator of the flexible resources to take better decisions.

According to the categories the System Use Cases of the Demonstrator can be matched with these categories of tool developments, as it is illustrated in Figure 3.5.2. More detailed information is given in the respective Deliverables.

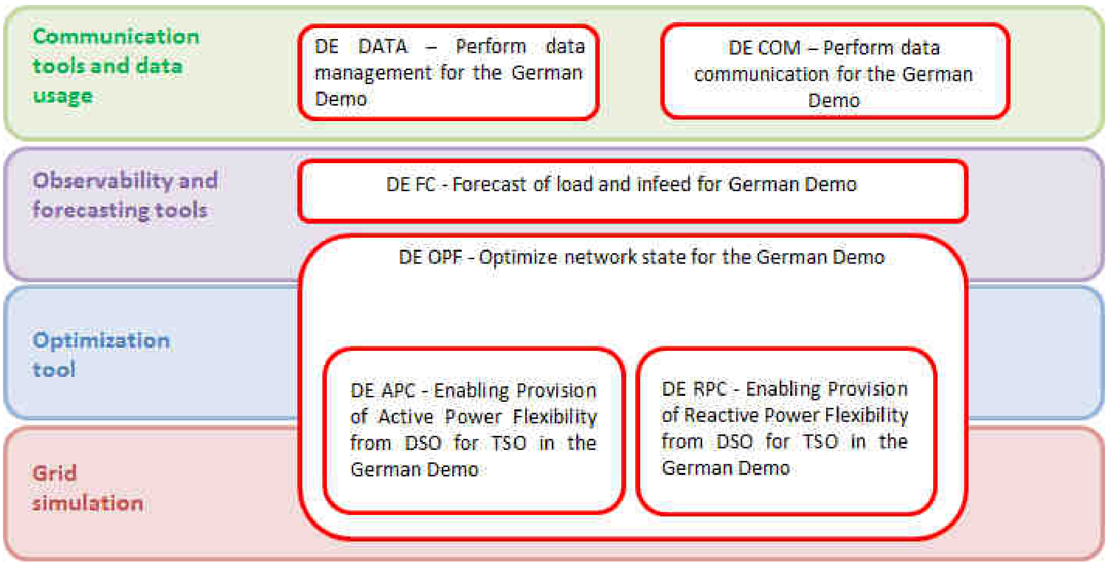

FIGURE 3.5.2 – MAPPING OF GERMAN SYSTEM USE CASES WITH CATEGORIES OF TOOLS

3.6 REQUIREMENTS OF THE SYSTEM USE CASES

The WP6 objectives contribute to the project objective to demonstrate the ability of coordinated flexibilities to address future system needs with consideration of technologies' performances, aggregation concepts, TSO/DSO interaction and ICT tools. The WP6 objectives are as followed:

- to improve the coordination between TSO and DSO
- to provide ancillary services to TSOs from flexibilities in the distribution system
- to show how flexibilities in the distribution network can be used to meet the requirements from both DSO and TSO

To achieve these objectives, the German demonstrator's objectives are mapped with the SUCs as followed:

German Demonstrator Technologies performances:

- to enhance optimisation tool: DE-OPF
- to improve forecasts: DE-FC
- fast integration in congestion process: DE-APC, DE-COM

German Demonstrator Aggregation concepts:

- to offer flexibilities at DSO/TSO interface: DE-APC, DE-RPC
- to cluster flexibility potential for TSO by price and sensitivities: DE-APC
- to aggregate flexibility potential for TSO at TSO/DSO-interface: DE-RPC

German Demonstrator DSO/TSO interaction:

- to establish a coordinated process in cooperation with one German TSO: DE-APC, DE-RPC, DE-COM

German Demonstrator ICT tools:

- to enhance grid simulation: DE-OPF
- to enhance state estimation: DE-OPF
- to integrate data management tools: DE-DATA
- to integrate communication tools: DE-COM

To put the described processes into practice, some requirements must be met beforehand. These requirements can be separated into two clusters. The first cluster is for data management and communication requirements and the second cluster is for system operator requirements.

Data management and communication requirements are as followed:

- Existing Interfaces: Already installed interfaces and implemented data models will be used. These are IEC60870-5-104, CIM CGMES, TASE.2,REST, FTP
- Security Data Protection: Already formulated requirements for ISMS.

System operator requirements are as followed:

- HV grid optimization: Since MITNETZ STROM only controls generation via HV controllers; assets located in MV are aggregated and projected onto HV.
- No EHV-HV tap changer control: The transformers at interconnection points are owned by the TSO and hence not direct controllable by the DSO. Due to this, no tap changer optimization will be performed.
- Loss reduction via reactive power: Since reactive power has to be provided by DER in a fixed range, only reactive power is used in loss optimization and no active power optimization is performed.
- Computable network states: It is required, that the exported grids are computable and that load flows converge.
- Cyclical import of measurements and forecast: In order to compute current and future network states, measurements and their predictions are needed.
- Price Lists: Up to date price lists are needed in order to compute the most cost efficient solutions.

4. THE ITALIAN DEMONSTRATOR

This chapter presents the relevant information about Italian Demonstrator and the SUCs developed within Task 6.2. In sections 4.1 and 4.2, respectively, general overviews of the demonstrator features and the corresponding BUCs are given. They represent the background for the SUCs development, which are presented in section 4.3 in a high level view, and in ANNEX III fully detailed in IEC62559-2 template form. Section 4.4 presents the system actors participating in the system processes described in SUCs and their relationships with business roles from the BUCs. Section 4.5 and 4.6 show, respectively, the functionalities and requirements identified within the SUCs.

4.1 OVERVIEW ON THE ITALIAN DEMONSTRATOR AND ITS OBJECTIVES

The Italian demonstrator is developed leveraging on an existing MV network control system, specifically developed for testing smart grids solutions. The MV network included in the Italian demonstrator is located in the Forlì-Cesena province (Emilia Romagna region), in an area with high RES penetration (mainly PV) and low load consumptions, resulting in frequent back-feeding phenomenon (several times a month, in particular during spring and summer seasons, when the PV production is high). This distribution network portion includes one HV/MV (132/15 kV) substation (Quarto primary substation) and all the MV feeders connected to it. The central management of the MV network portion (and of the Italian demonstrator) is carried out by the Operating Center located in Bologna. Figure 4.1.1 presents a schematic picture of the MV network arrangement of the Italian demonstrator:

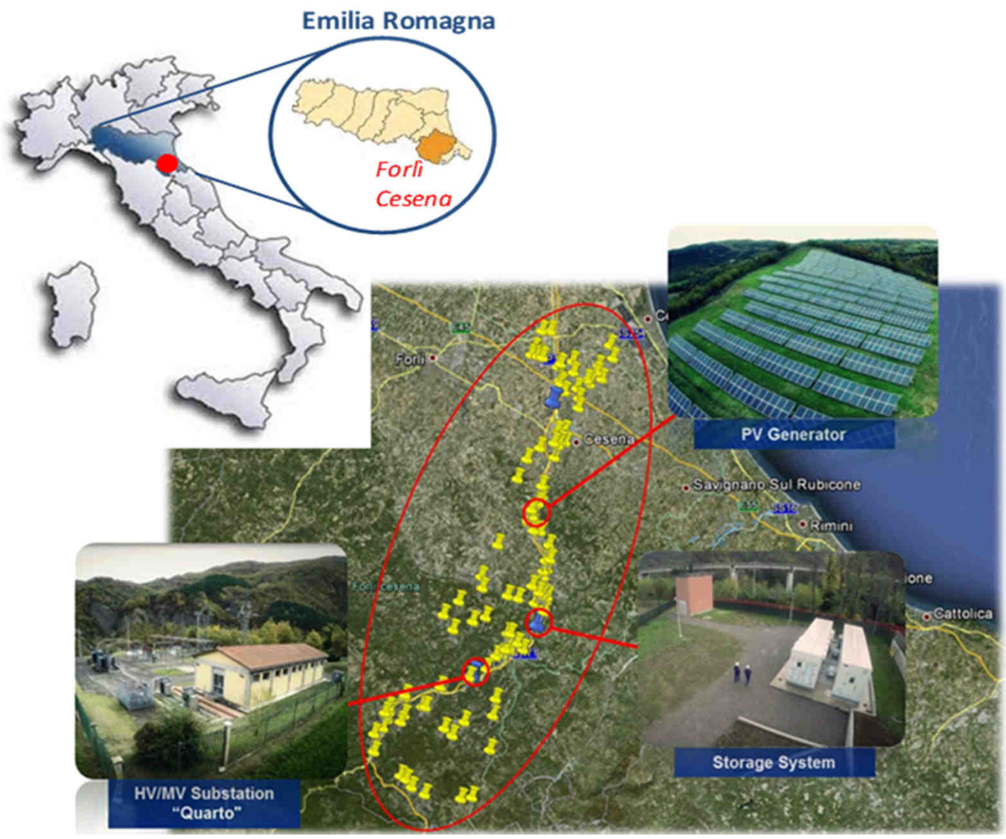

FIGURE 4.1.1 – LOCATION OF THE ITALIAN DEMONSTRATOR

The Italian Demonstrator explores the DSO infrastructure evolution in order to create a developed smart grid, by integrating the remote control systems with a new generation of Intelligent Electronic Devices (IEDs), fully involving the RES connected to the distribution network and the DSO assets into the provision of ancillary services to the TSO, taking into account TSO and DSO's needs and constraints mutually.

The provision of ancillary services includes amongst others voltage support and congestion management. This is fully supported by the improvement of TSO-DSO data exchange, increasing the observability of MV network for the DSO, thanks to new requirements for capability aggregation at the Primary Substation interface and exploiting a platform of network calculation algorithms, which performs an optimization procedure with some techno-economic constraints to maximize and optimise the involvement of RES and DSO assets. The management of RES and DSO Assets will be facilitated from an enhanced quality of real time measurements of electrical quantities and the forecast of the monitored MV generators. The demonstrator also includes a communication infrastructure which is based on some standard protocols, like the IEC 61850, targeted to a better devices integration.

The Italian demonstrator includes different types of flexible resources: four PV generators, a 1MVA/1MWh Battery Energy Storage System (BESS), two 1,2 MVAr Static Synchronous Compensators (STATCOMs) modules. The BESS and the STATCOM are controlled by the DSO, within the limits of the present Italian regulations. The activities of the Italian demonstrator will investigate the potential of these assets in supporting the ancillary services provision from distributed resources. Table 4.1.1 summarizes the relevant features of the Italian demonstrator:

Italian Demonstrator	
DSO operating voltage	15 kV
Operating voltage at TSO/DSO interface	132 kV / 15 kV
DSO assets	• OLTCs • STATCOMs • BESS
Controllable resources	4 PV generators (MV grid)
Tools/Software/Systems	• Grid control centre • DSO SCADA system • Substation Control System (at HV/MV substation) with local control and Network Calculation Algorithm System • Forecast System
DSO field devices	• Remote Terminal Units (RTUs) • Fault detectors • Energy regulation interfaces • Assets interfaces

TABLE 4.1.1 – MAIN CHARACTERISTICS OF THE ITALIAN DEMONSTRATOR.

4.2 BUSINESS USE CASE OVERVIEW IN THE ITALIAN DOMAIN

The Italian BUCs were defined within the activity performed in Task 3.3 *Functional specification of system services in terms of Business Use Cases* and are detailed in Deliverable D3.3 - *Business use cases for innovative system services* [1] and are respectively:

Demonstrator	Business Use Case	BUC ID
Italian	Manage active power flexibility to support mFRR/RR and congestion management in the Italian demo	IT-AP
Italian	Manage reactive power flexibility to support voltage control and congestion management in the Italian demo	IT-RP

TABLE 4.2.1 – OVERVIEW OF ITALIAN BUSINESS USE CASES.

The BUC IT-AP describes a business process focused on provision of active power flexibilities from distribution grid for mFRR/RR and congestion management services to the transmission network, in real-time operations. The main role in this process is represented by the market operator at distribution level (MO_D), i.e. the "local" market operator, which manages a local flexibility market, collects and aggregates flexibility offers from customers and aggregators and provide them to the centralized market operator at transmission level (MO_T). The distribution system operator (DS_O) is the role responsible for distribution network security and so, it is allowed to exploit flexibilities to solve congestions in distribution grid. The definition of these two roles (MO_D and DS_O) allows to keep the business process description as general as possible: anyway they can be played by the same stakeholder, as it is assumed specifically for the Italian case.

The main scopes of this business process are the provision of aggregated flexibilities at Primary Substation interface, guaranteeing secure operations of the distribution grid, and the increase of distributed energy resources participation in the transmission network mFRR/RR market. Therefore the business process described in the BUC IT-AP needs, specifically, the support of functions for network state and flexibilities availability forecast and functions for network techno-economical optimization.

The Italian demonstrator contains some DSO-owned assets, as explained in the previous section; specifically the battery storage, through the injection/absorption of active power, may alter the network state and potentially harm the local market operations. Furthermore, since it is owned and managed by a system operator (which are not allowed to trade energy by current regulations), it cannot participate to the market like other flexible resources. For these reasons, within the boundaries of the BUC IT-AP and the project activities, it is employed only for solving imbalances (counter-activations in case of activation of flexibilities for local congestion managements) and, in general, for market facilitation purposes. More details about these assumptions can be retrieved in [1].

The BUC IT-RP describes a business process focused on the management of the reactive power exchange at primary substation interface, for supporting voltage control and congestion management services for the transmission network, in real-time operations. In this business process, it was assumed that the DSO-TSO coordination scheme is based on a shared balancing responsibility and so the DS_O is the final responsible of services provision to the TS_O. For this reason , the DS_O exploits reactive power flexibilities both from private DERs connected to the distribution network and from its own assets, specifically the battery storage and the STATCOM modules. The resulting flexibilities portfolio may, potentially, drive to a broader capability area in order to constantly guarantee the provision of the agreed reactive power exchange between the distribution and transmission networks.

The main scopes of this business process are the management of a reactive power flexibility portfolio, focused at the provision of a broad reactive capability area at primary substation interface, and the optimisation of the distribution network, allowing the DS_O to procure the contracted reactive while maintaining secure operations of the distribution network. Therefore the business process described in the BUC IT-RP needs, specifically, the support of functions for network state and flexibilities availability forecast, functions for capability aggregation and functions for network optimization.

The relevant supporting functions selected for these BUCs are described in the SUCs presented in the following section (4.3). Section 4.4 presents a detailed description of the system actors identified in the SUCs and their correlation with the business roles.

4.3 SYSTEM USE CASES OF THE ITALIAN DEMONSTRATOR

This section presents the System Use Cases developed for the Italian demonstrator: they describe the relevant functions supporting the business processes defined in the Business Use Cases. The system processes described in SUCs may potentially be performed for different timeframes; in this case, it is assumed that the reference timeframe is the one specified in the BUCs.

The detailed descriptions of Italian System Use Cases are presented in ANNEX III: in the following, Table 4.3.1 presents their scopes and objectives, i.e. "which activities are performed" within the boundary of each Use Case and what are the "goals" achieved through each Use Case. The full description of the parts which build the Use case template is presented in ANNEX I.

SUC ID	Description	
IT – NT SE Perform network state analysis for Italian Demo	Scope	Collect the information about the network state, the customers' profiles and the generation forecast DN-connected. Collect the information about the network operation to assess the state analysis: - historical customers' profiles and typical curves to estimate the load diagram; - historical generation profiles to the connection point and forecast

		algorithms to estimate the generation diagram.
	Objective	Update network information for optimization and management processes.
IT – RPC Perform reactive capability calculation for the Italian Demo	Scope	Collect the reactive power capability curves from the resources connected to the distribution network. Calculate the resulting aggregated capability at the Primary Substation interface.
	Objective	Provide a total reactive power capability curve at the Primary Substation interface.
IT – AP OP Perform distribution network optimization after local market closure for the Italian Demon	Scope	Optimize the distribution network, avoiding/solving congestions, imbalances and constraints violations, in order to guarantee the maximum exploitation of private resources for services to the transmission network (maximization of aggregated flexibility curve at PS interface). Based on the network state provided by the DS_O Central SCADA, the MO_D (through its own SCADA) may use DS_O assets to solve congestions or, alternatively, exploit some flexibility bids from local market. The DS_O own assets may be used also for solving imbalances created by flexibility activations.
	Objective	Calculate optimal set points for the distribution network assets. Create an active power vs cost curve, aggregating the flexibilities collected from local market.
IT – RP OP Perform distribution network management and optimization for the Italian Demo	Scope	Optimize the distribution network, avoiding/solving congestions and constraints violations, in order to guarantee the agreed reactive power capability at the Primary Substation interface and to follow the reactive power set-points send by the TS_O. The DS_O Local SCADA manage both private resources and its own assets in order to follow the agreed exchange profile at Primary Substation, taking into account the actual operating conditions.
	Objective	Provide optimal set points for the assets connected to the distribution network. Provide the agreed reactive power exchange at Primary Substation interface.

TABLE 4.3.1 – OVERVIEW ON SCOPES AND OBJECTIVES OF THE ITALIAN SYSTEM USE CASES

Figure 4.3.1 and Figure 4.3.2 shows the links between the System Use Cases and the Business Use Cases of the Italian demonstrator: the BUC IT-AP is supported by the SUCs IT-NT SE and IT-AP OP, while the BUC IT-RP is supported by the SUCs IT-NT SE, IT-RPC and IT-RP OP.

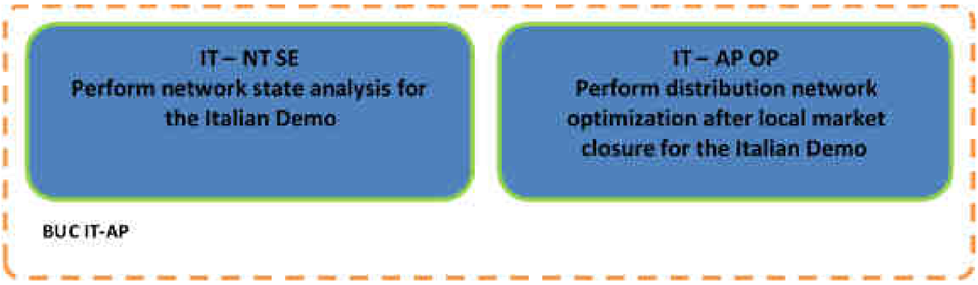

FIGURE 4.3.1 – OVERVIEW ON SYSTEM USE CASES LINKED TO BUC IT AP

FIGURE 4.3.2 – OVERVIEW ON SYSTEM USE CASES LINKED TO BUC IT RP

4.4 SYSTEM ACTORS IN THE ITALIAN SYSTEM USE CASES

This section presents the system actors which performs the activities of the system processes described in the SUCs, and also the correspondence between them and the overarching business roles.
In the following, these system actors, and the corresponding activities, are shortly described (refer to ANNEX III for further details):

- **The Central SCADA (OCS – Operative Central System)** is the monitoring and remote control system. It includes the database of the electrical network and can acquire events both from the Primary and Secondary Substations RTUs and measurements from the Primary Substations RTUs; it send commands to the devices in the Primary Substations and the remote controlled Secondary Substations; the DSO operator can do record manual updates. It perform all its activities in all the four SUCs. Central SCADA role corresponds to the DSO SCADA system listed in Table 4.1.1, that manages an area with a high number of Primary and Secondary Substations. The resources/DSO assets activation is described within the two BUCs and performed by the DS_O.

- **The Local SCADA (SCS)** is located in the Primary Substation and acquires the database and the recorded events from the Central SCADA. It is classified in a monitoring section, a state estimation section and a voltage regulation section and sends the request to the Central SCADA, in order to complete the activities described in IT BUC RP. For this reason, it plays an important role in SUCs IT – NT SE, IT – RP and IT – RP OP.

- **The Remote Terminal Units (RTUs)** are installed in the Primary Substation and the Secondary Substations. They collect all the events happening in the medium voltage network, measurements and breaker status from devices in field; therefore RTUs send them to the connected SCADA. Furthermore Remote Terminal

Units make correlation of events, perform automation cycle; finally, they send activation signals and commands to asset.

- **The Field Devices** include the Transformer Integrated Protections, all the feeders' protections, the secondary substation Fault Detectors, the Energy Regulation Interfaces (ERI), the Storage interface and Statcom interface. The Field devices participate with RTUs to remote control, network automation, collection of measurements and breaker status and acquire the set points to send to the regulation assets. The RTUs and the Field Devices perform their activities in SUCs IT – NT SE and IT – RP OP.

- **The Market Operator SCADA** is located in the Primary Substation and acquires the database and the recorded events from the Central SCADA. It is divided in a monitoring section, a state estimation section, an aggregation platform of the bids and a regulation section. It plays in the SUC IT – AP OP since it manages the local market and sends the request to the Central SCADA, in order to complete the activities described in IT BUC AP.

Figure 4.4.1 shows the relationship between the business roles and the system actors, within the links defined between the Business and System Use Cases developed for the Italian demonstrator. The DS_O role, which has the responsibility of the business activities related to the management of the distribution network relies on the Central SCADA, the Local SCADA, the Remote Terminal Units and the Field Devices actors which perform the functions supporting its activities. The Market Operator SCADA is the system actor which perform the functions supporting the business activities of MO_D role.

It has to be noted that the Local SCADA and Market Operator SCADA, from a technical perspective, basically perform the same activities: indeed, within the physical set-up of the Italian demonstrator, they are performed by the same system. This differentiation follows the assumption made within the Business Use Case IT-AP, i.e. to split the network optimization responsibility and the network security responsibility between, respectively, the MO_D and the DS_O. Further details about the assumptions made for BUCs can be retrieved in [1].

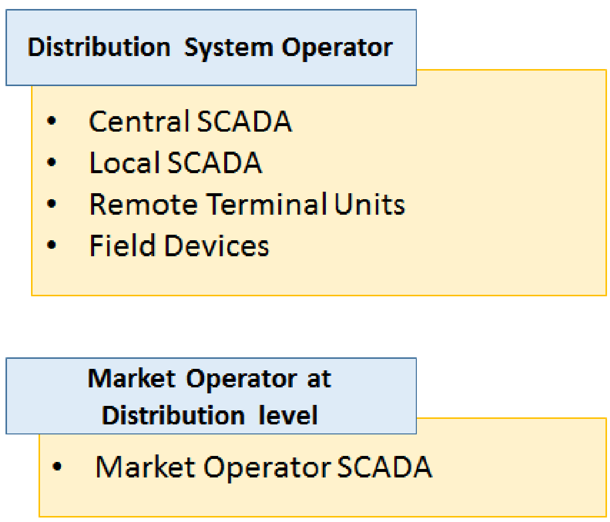

FIGURE 4.4.1 – CORRESPONDENCE BETWEEN BUSINESS ROLES AND SYSTEM ACTORS IN THE ITALIAN SUCS

4.5 DESCRIPTION OF FUNCTIONALITIES IMPLEMENTED IN THE ITALIAN DEMONSTRATOR

This section presents the functionalities identified for each System Use Case of the Italian demonstrator. A brief description of the communication channels between the system actors is also presented, as well as the impact of the SUCs on the tool development within Task 6.3.

The **SUC IT – NT SE** "*Perform network state analysis for the Italian Demo*" performs data collection and transmission, network topology pre-processing, state estimation and forecast of network state and generation. The result of this SUC does not reach the WP6 objectives standalone but, nevertheless, it is necessary in order to start the activities of all the other SUCs. In this SUC, every field device sends to the central system the real time measurements and the breakers' status with a timeframe of 10 s. The timeframe can be modified. These data consists of electrical quantities (voltage, current measurements…), the current states of breakers and assets, network topologies (primary and secondary substations, medium voltage distribution network), ~~e~~electrical characteristics of network components, the load and generation forecast. After the data transmission, the network topology pre-processing is performed. The Central SCADA updates network topology and sends the new database to the Local SCADA. Loads and generation forecast are performed respectively by considering the tracing of the historical curves of many sets of customers (acquiring metering information about the class of customers) and computing P, Q profiles of PV generators, by using data from an external weather provider. Once the Local SCADA receives the updated network state and the forecast information, the algorithm for the State Estimation (SE) is triggered after a period of 15 minutes and after significant network changes (reconfiguration, restoration after faults). The electrical quantities are estimated in each node of the network. The estimation is therefore calculated at the HV side of the primary substation that corresponds to the interconnection point between DSO and TSO.

The **SUC IT - RPC** "*Perform reactive power capability calculation for the Italian Demo"* describes the reactive power capability calculation implemented in the NCAS module of Local SCADA. Using basic features of the optimization algorithm, the reactive capability curves of the participating DERs and assets are aggregated at the primary substation level. The aggregation process is performed taking into account all the network constraints.

The implemented functionalities in **SUC IT - AP OP** "*Perform network optimization after local market closure in the Italian Demo"* are necessary in order to start the optimization of the distribution network in the Local Market scenario, by means of the Central and Local SCADA, which interact with the Market Operator SCADA. The Market Operator SCADA, after receiving the network info from the Central SCADA, can start the OPF (Optimal Power Flow) routine and aggregate the bids in a parametric curve, in order to solve congestions. During this process, the selected bids are aggregated in a single parametric curve (power vs cost), built in the NCAS module of Local SCADA; in the Local Market scenario it is tuned in order to maximize the active power capability at primary substation. Furthermore the Local SCADA can manage the DSO assets in order to solve imbalances occurring after Local Market.

The functionalities included in **SUC IT - RP OP** "*Perform network optimization and management in the Italian Demo"* consists on network optimization that in this case is managed by Central and Local SCADA. The network optimization in the constrained profile scenario is implemented through an OPF routine, built in the NCAS module Local SCADA; it is tuned in order to follow the reactive power exchange constraints at the primary substation, pursuing a balanced exploitation of the capabilities of all the participating DERs.

A schematic overview of the functionalities and how they are linked with the SUCs and the BUCs is presented in Figure 4.5.1 and Figure 4.5.2.

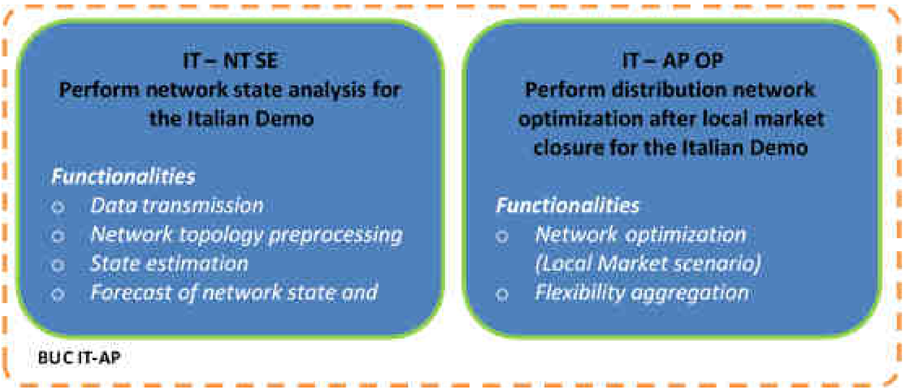

FIGURE 4.5.1 – OVERVIEW ON FUNCTIONALITIES IMPLEMENTED IN SYSTEM USE CASES RELATED TO IT AP

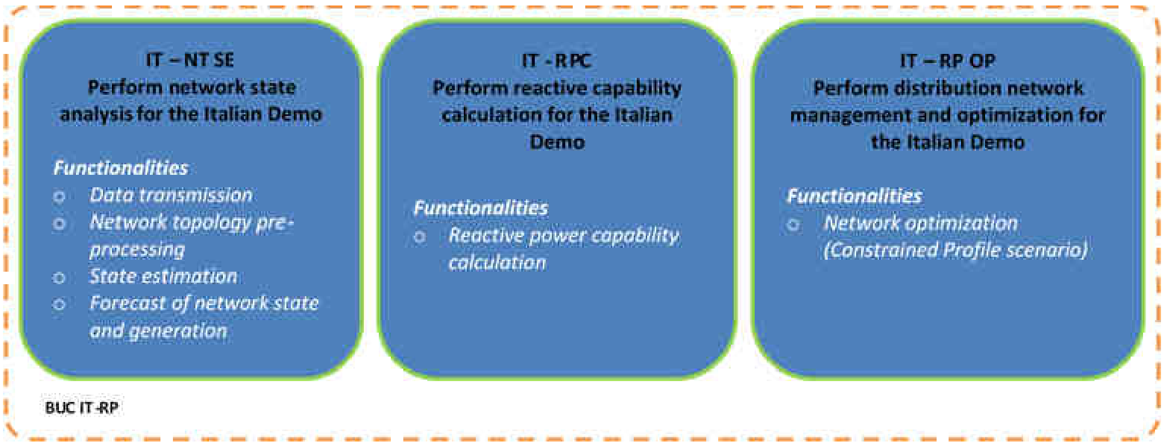

FIGURE 4.5.2 – OVERVIEW ON FUNCTIONALITIES IMPLEMENTED IN SYSTEM USE CASES RELATED TO IT RP

The functionalities related to the systems communication are not presented here since they are analysed within the WP5 activities. Anyway, since they are of primary relevance for the correct execution of the activities described in the SUCs, here the main features of the communication channels, and corresponding protocols, between the systems involved in the Italian demonstrator (i.e. the system actors) are briefly presented.

System Communication is performed by means of several protocols that are customized or standardized (IEC 104, IEC 61850). The communication channel between the Central SCADA and the Local and Market Operator SCADAs is customized. The information exchanged between the Central SCADA, the Remote Terminal Units and the Field Devices can be transmitted with a customized protocol, if the information exchanged comes from or arrive to the Remote Terminal Units, or with a standard protocol, if the information is exchanged between a Fault Detector and an ERI with the Primary Substation RTU.

Figure 4.5.3 shows a schematic of the communication channels between the system actors in the SUCs of the Italian Demonstrator: it also represents a different way to highlight the correspondence between business roles and system actors, described in section 4.4. Within the Local SCADA (and Market Operator SCADA) the Substation Control System (at HV/MV substation) is implemented: it includes network local control and Network Calculation Algorithm System and it can perform the same monitoring actions as the Central SCADA, but just for one specific Primary Substation. Red arrows make evidence of a communication channel with a customized protocol; the blue ones represent standardized communication protocol.

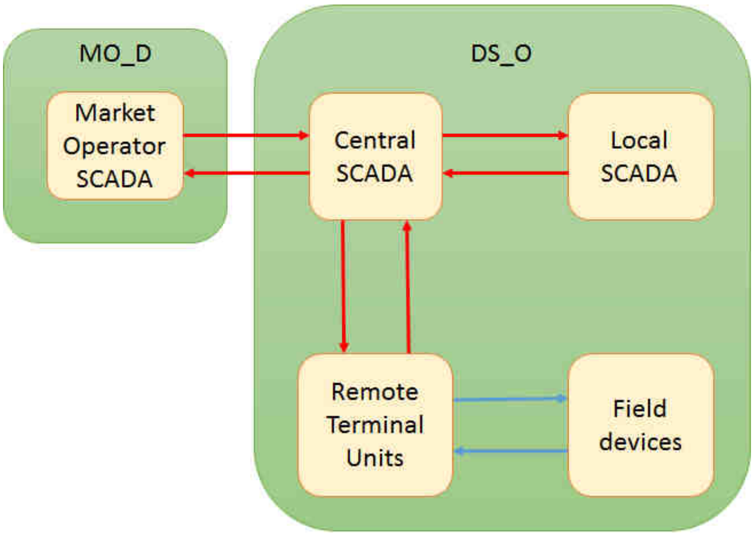

FIGURE 4.5.3 – OVERVIEW ON COMMUNICATION CHANNELS BETWEEN THE ITALIAN SYSTEM ACTORS

The relevant functionalities identified in the SUC descriptions will be implemented in the software tools developed within the activities of Task 6.3. Figure 4.5.4 shows how the Italian demonstrator' SUCs maps into the four tools categories considered in Task 6.3:

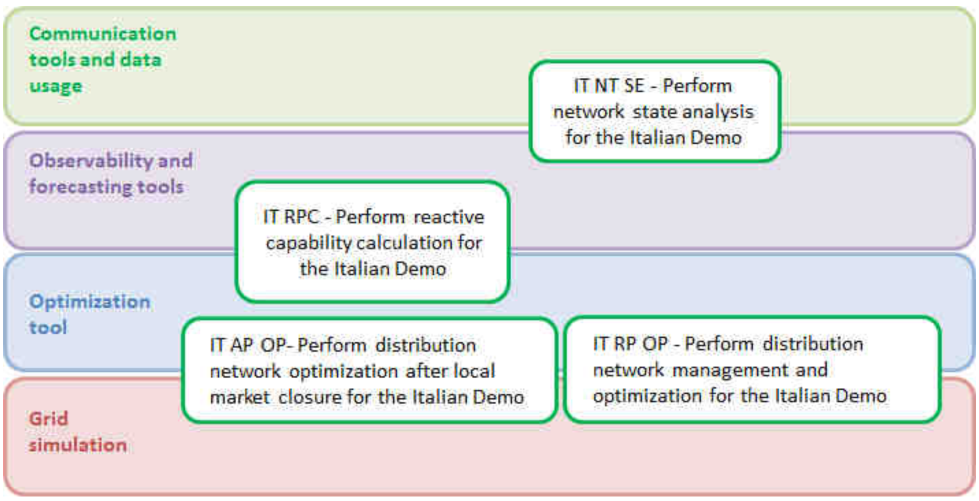

FIGURE 4.5.4 – MAPPING OF ITALIAN SYSTEM USE CASES WITH CATEGORIES OF TOOLS

4.6 REQUIREMENTS OF THE SYSTEM USE CASES

Once the SUCs are described, it is necessary to define a set of requirements which contribute to achieve the objectives stated in chapter 1. These requirements are related to the objectives of WP6 and refer to the functionalities listed in section 4.5.

To achieve these objectives, the Italian Demonstrator's objectives are mapped with the SUCs as follows:

Italian Demonstrator Technologies performances:

- to enhance optimization tool: IT-AP OP, IT-RP OP
- fast integration in congestion process: IT-AP OP, IT-RP OP

Italian Demonstrator Aggregation concepts:

- to offer flexibilities at DSO/TSO interface: IT-RPC, IT-AP OP, IT-RP OP
- to aggregate flexibility potential for TSO at TSO/DSO-interface: IT-RPC

Italian Demonstrator DSO/TSO interaction:

- to establish a coordinated process in cooperation with one Italian TSO: IT-RPC, IT-AP OP, IT-RP OP

Italian Demonstrator ICT tools:

- to enhance grid simulation, to enhance state estimation, to integrate data management tools: IT-NT SE.

In the Italian Demonstrator, all the requirements are divided in several clusters, as shown below:

- **Load and Generation Forecast:**
  A better DSO-TSO coordination could be possible by improving the Load and Generation Forecast. For this reason the weather forecast can help the observability of the distribution network.

- **Network topology pre-processing:**
  The quality of the State Estimation can be improved by installing new measurement devices in strategic secondary substations (end of feeders, border areas between two Control Rooms etc.). A too frequent time updating of the measurements can create a bottle neck in the communication layer. Time horizon of all the operations has to be taken into account.

- **Flexibility aggregation:**
  The update of the flexibility aggregation should be provided to the TSO in order to facilitate the transmission of the aggregated power capability at the HV/MV interface. As a consequence, it is crucial that the TSO should have all the necessary information for requesting a service at the interface with the DSO, by respecting all the network/security constraints. Time horizon of all the operations has to be taken into account.

- **Network optimization (Local Market Scenario and Constrained Profile Scenario):**
  At this point a regulation framework does not exist. This kind of requirement is not directly connected to the Italian SUCs but mostly linked to the BUCs IT AP and IT RP. Time horizon of all the operations has to be taken into account. The process should be addressed for both the DSO and TSO needs, by guaranteeing the agreement dealt between the DSO and the DERs, during prequalification process described in BUCs.

- **Communication:**
  The communication infrastructure has to be stable and must guarantee a minimum level of quality, in order to perform both the remote control procedures for normal operation and the management of the flexibilities. Thus, because of the network latency, it would not be possible to involve the resources, by sending the calculated set-point values to them.

5. THE FINNISH DEMONSTRATOR

In this chapter an overview on the Finnish Demonstrator is given and its objectives are described. Finland is part of the Nordic electricity system, where the share of RES (e.g. wind production) is rapidly increasing. As a result of this intermittent capacity, more resources with fast response time are needed to balance the power system reliably and cost efficiently. The general objective of the Finnish demonstrator is to show how flexibility resources, i.e. small, distributed resources that are connected to the low voltage distribution network can be aggregated to be traded on TSO's existing market places and for DSO's balancing need.

The Finnish Demonstrator is carried out in Helsinki and the parties included are Helen, Helen Electricity Network and VTT. Helen Ltd. is the energy company operating in Helsinki, the capital of Finland. Helen generates electricity, district heating and cooling for its customers (over 400 000). In addition to Helen's own electricity production, the company acquires electricity through its power assets. Furthermore, Helen actively develops and brings to the market new energy-related innovative services for customers, including:

- Solar production as a service (for industry and private customers)
- Public and private electric transport charging network
- Home automation
- Demand response
- Battery energy storage functionality as a service.

Helen as a retailer and aggregator of electricity brings flexible resources to TSO markets. Fingrid is the TSO in Finland and part of the Nordic electricity system. Fingrid is responsible for the Finnish main grid performing the tasks of electricity transmission, balancing services, guarantee-of-origin certificates, electricity market information and information exchange in the retail (wholesale) markets. Through TSO ancillary regulating power and reserve markets, Fingrid has more flexibility for balancing the national transmission grid cost efficiently.

In Finland, 77 DSOs take care of the electricity distribution. The distribution networks consist of medium 20 kV (10 kV) and low 0.4 kV voltage networks. Some DSOs also have 110 kV network. In this Finnish demonstrator, Helen Electricity Network Ltd. (Helen Sähköverkko Oy, HSV) is the local licenced DSO in Helsinki. Helen Electricity Network Ltd. has 383.000 customers with 35.000 connection points. The grid in Helsinki is strongly built, and thus congestion is not experienced in the distribution grid. Due to this fact, the provision of active power from LV to the TSO is not an issue for the DSO regarding voltage control or line overloadings. Since the beginning of 2013 in Helsinki, every metering point of a customer has an Automatic meter reading (AMR meter) and each customer has access to his own AMR consumption data via internet platform. It is the DSO's responsibility to offer this data to customers. The DSO can arrange the service by itself or buy the service from outside the company. In Helsinki, the platform is formed together with the parent company, Helen.

5.1 OVERVIEW ON THE FINNISH DEMONSTRATOR AND ITS OBJECTIVES

An overview of the Finnish demonstrator and its objectives is necessary for later going in detail into the description of the Finnish SUCs. Like mentioned above, the general objective of the Finnish demonstrator is to show how flexibility resources, i.e. small, distributed resources that are connected to the low voltage distribution network can be forecasted and aggregated to be traded on TSO's existing market places and for DSO's needs.

In Finland, the provision of ancillary services to the TSO is completely market-based. Today, the assets participating in the market are typically industrial-sized loads or generation connected to the medium or high voltage grid. This demonstrator brings consumer-sized loads and generation assets to the market. Assets connected to the low voltage grid are so far an untapped resource in this context, and there lies a vast potential for providing flexibility to the power system. The ultimate goal of the demonstrator parties is to ensure the maximal utilisation of RES by increasing the market-driven flexibility of the electricity system.

The TSO is responsible for the voltage control of the transmission system. In the TSO/DSO connection points, reactive power balance of the local DSO's area is to be kept within acceptable limits by using controllable reactive power assets. Thus, the other general objective of this Finnish demonstrator is to show how the reactive power assets situated in the local distribution network can be applied for DSO's reactive power balancing needs.

The Finnish demonstrator includes forecasting, aggregating and trading of the active and reactive power of the LV assets for TSO's ancillary services and for DSO's balancing needs. The demonstrator is going to be implemented in the low voltage distribution network (400 V), with the exception of the industrial sized BESS and PV power plant, which are connected to the medium voltage grid, as well as in the TSO/DSO connection point (400kV/110kV). The industrial sized BESS and the PV power plant are MV customers for practical reasons. Table 5.1.1 summarizes the resources involved in the Finnish demonstrator.

The section *Tools/Software/Systems* includes:

- The Aggregation, which functions as a platform that coordinates the forecasts of the different resources and creates bids for the trading system: active power bids for the TSO's market places and reactive power bids for DSO's market place for balancing the reactive power in DSO's grid;
- The DSO SCADA that manages all the distribution network area;
- The market mechanism for reactive power that manages the reactive power bids received from the aggregator and sends activation request to asset operators;
- The forecasting tool, which receives data from internal and external sources and calculates the estimated available flexibility from each type of asset for a certain market place.

DSO Field devices in the Finnish Demonstrator consist of AMR meters. In Finland, every customer has an AMR meter. These devices are DSO's property. In the demonstrator area, a part of the electricity heating load of the storage electricity heated houses can be controlled through AMR meters.

Finnish Demonstrator	
DSO operating voltage	400 V (230 V single phase)
Operating voltage at TSO/DSO interface	400 kV / 110 kV
DSO assets	-
Controllable resources	• PV solar power plants (only Q) • Charging infrastructure for electric vehicles • Industrial sized BESS (Q and P) • Distributed, customer scale batteries • Electric heating loads with smart control • Electric heating loads with AMR
Tools/Software/Systems	• Aggregation • DSO SCADA system • Market mechanism for reactive power • Forecasting tool
DSO field devices	• AMR metering

TABLE 5.1.1 – RESOURCES INVOLVED WITHIN THE FINNISH DEMONSTRATOR.

5.2 BUSINESS USE CASE OVERVIEW IN THE FINNISH DEMONSTRATOR

The Finnish BUCs were defined within the activity performed in Task 3.3 *Functional specification of system services in terms of Business Use Cases* and are detailed in Deliverable D3.3 - *Business use cases for innovative system services* [1] and are respectively:

Demonstrator	Business Use Case	BUC ID
Finnish	Manage active power flexibility to support FCR-N in the Finnish demo	FI-AP1
Finnish	Manage active power flexibility to support mFRR/RR in the Finnish demo	FI-AP2
Finnish	Manage reactive power flexibility to support voltage control in the Finnish demo	FI-RP

TABLE 5.2.1 – FINNISH BUSINESS USE CASES.

The first and second BUCs are related to provide active power ancillary services to the TSO. The first one, FI-AP1, describes how distributed resources can participate to the hourly market for frequency containment reserves for normal operation in Finland (FCR-N). The main objective of the FI-AP1 is to stabilize the frequency in response to deviations occurring due to the normal variations in production and consumption. On the other hand, the aggregator aims to increase its own and the asset owners revenue as it aggregates suitable resources to the TSO's FCR-N markets.

The second BUC, FI-AP2, describes how the aggregator can use distributed resources to participate to the manual balancing power market (mFRR/RR) of the TSO. The objective of the balancing power market is to bring frequency back to the required value and on the other hand, the aggregator aims to increase its revenue as it aggregates suitable and available resources to the TSO's mFRR market.

The third business case, FI-RP, concerns supporting voltage at the TSO/DSO connection point by controlling the reactive power flow. The reactive power within DSO's area should be kept within acceptable limits and if exceeding, penalty payments occur. Traditionally, the DSO controls the reactive power with reactors and capacitors. This BUC introduces a new ancillary mechanism for the reactive power control through reactive power market place. In this market place, the controllable reactive power of LV assets are aggregated by an aggregator and offered to the DSO's reactive power market place. This market place for reactive power does not exist at the moment. In the EU-SysFlex project, a proof of concept of this market will be demonstrated and has been proposed as a BUC.

The aim of the Finnish SUCs related to forecasting and flexibility aggregation is to enable participation of distributed resources to the TSO's market places described in the Finnish BUCs FI-AP1 and FI-AP2. All the four Finnish SUCs (forecasting, aggregation, reactive power management and reactive power market) are included in the Finnish BUC FI-RP. The reactive power of the small assets are forecasted (FIN–FC) and aggregated (FIN–FL AG) and further brought to the reactive power market (FIN–RE MK). Additionally, this market in question has input from a SUC of reactive power management of the DSO (FIN–RE MN). The roles related to the Finnish Demonstrator in these BUCs are:

1) Asset Operator (AO)
2) Aggregator (A)
3) Distribution System Operator (DS_O)
4) Transmission System Operator (TS_O)
5) Market Operator for P (MO)
6) Market Operator for Q (MO)
7) Metered Data Operator (MDO)
8) Balance responsible party (BRP)

Of these eight business roles, roles one to six are considered in the following chapters as those that are linked to the system actors.

5.3 SYSTEM USE CASES OF THE FINNISH DEMONSTRATOR

In order to understand the objectives and structures of the Finnish SUCs, it is necessary to first refer back to the goals of the demonstrator, which are to improve TSO-DSO coordination, provide ancillary services to TSO from flexibilities in the distribution system as well as show, how flexibilities in the distribution grid can be used to meet requirements of both DSO and TSO.

The Finnish SUCs considerably contribute to these targets. Practically, all the Finnish SUCs form a procedure which aims to support the voltage at the TSO/DSO connection point and thus improve the TSO - DSO coordination. All the Finnish SUCs form the entity where the starting point are the flexible assets of active and reactive power in the distribution network. They are harnessed to meet the various requirements of both DSO and TSO. In addition, the main task of two Finnish SUCs, forecasting and aggregation, is to provide ancillary services to TSO from active power flexibilities in the distribution system.

The detailed descriptions of Finnish System Use Cases are presented in ANNEX IV: the following Table 5.3.1 presents their scopes and objectives, i.e. "which activities are performed" within the boundary of each Use Case and what are the "goals" achieved through each Use Case. The full description of the parts which build the Use case template is presented in ANNEX I.

SUC ID	Description	
FIN – RP MK Perform DSO reactive power market for the Finnish Demo	Scope	Operate the reactive power market and the market mechanism. Send activation requests to the asset operators of accepted bids.
	Objective	Increase revenue: The aggregator uses resources to provide reactive power compensation to the DSO market place and receive a remuneration for it. Minimize tariff payments: The DSO wants to minimize the fees it may face for being outside the required PQ-window by using the market mechanism.
FIN – RP MN Manage reactive power for the Finnish Demo	Scope	Calculate the demand of reactive power from DSO market place and send it to the DSO market place (to SUC FIN-RP MK).
	Objective	Increase revenue: The aggregator uses resources to provide reactive power compensation to the DSO market place and receive a remuneration for it. Minimize tariff payments: The DSO wants to minimize the fees it may face for being outside the required PQ-window. Decision about market use: Decide if the DSO reactive power market is used for the considered time periods.
FIN – FL AG Aggregate flexibilities for the Finnish Demo	Scope	This SUC aggregates the flexibilities from different assets by creating bids from their forecasted behaviour. The bids are submitted to the TSO or DSO and later dispatched to the specific resources if they are activated.
	Objective	Increase aggregator revenue: The aggregator wishes to maximize the income it can obtain from operating its resources on the different markets.

		Increase market liquidity: Increase the liquidity on the different markets, and the reliability of the services, by introducing resources that would not otherwise be available
FIN – FC Forecast available resources for the Finnish Demo	Scope	The aggregator forecasts the assets it has access to in order to be able to, in FIN SUC - FL AG, aggregate them and offer them to the markets.
	Objective	Accurate Forecasts: The forecasting tool should be designed so that it can produce accurate forecasts in a timely manner. The goal is to increase the forecasting accuracy and through this increase the performance of ancillary services for TSO and DSO, increase the revenue for retailer as well as increase the reliability of services. Robustness: The system should be designed so that if ones of the forecasting tools does not update its data in time, the whole system is not stopped or stuck.

TABLE 5.3.1 – OVERVIEW ON SCOPES AND OBJECTIVES OF THE FINNISH SYSTEM USE CASES.

The scheme illustrated in Figure 5.3.1 and Figure 5.3.2 provides an overview of the Finnish SUCs by considering also the BUCs in the background. As it can be seen from the figures below, SUC FIN-FC and SUC FIN-FL AG are related to the active power BUCs (BUC FI-AP1 &FI-AP2) and all Finnish SUCs are connected to the reactive power BUC (BUC FI-RP).

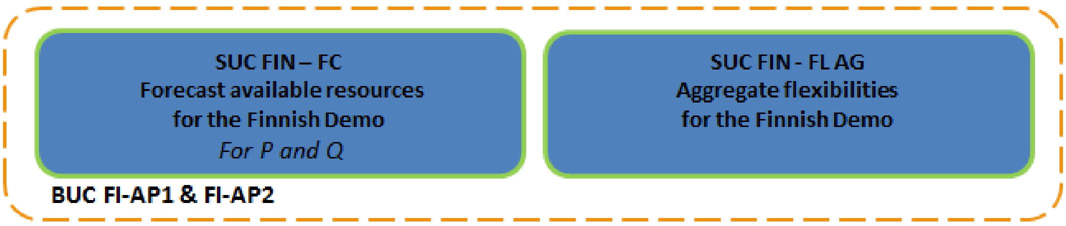

FIGURE 5.3.1 – OVERVIEW ON SYSTEM USE CASES RELATED TO BUC FI AP1 & AP2

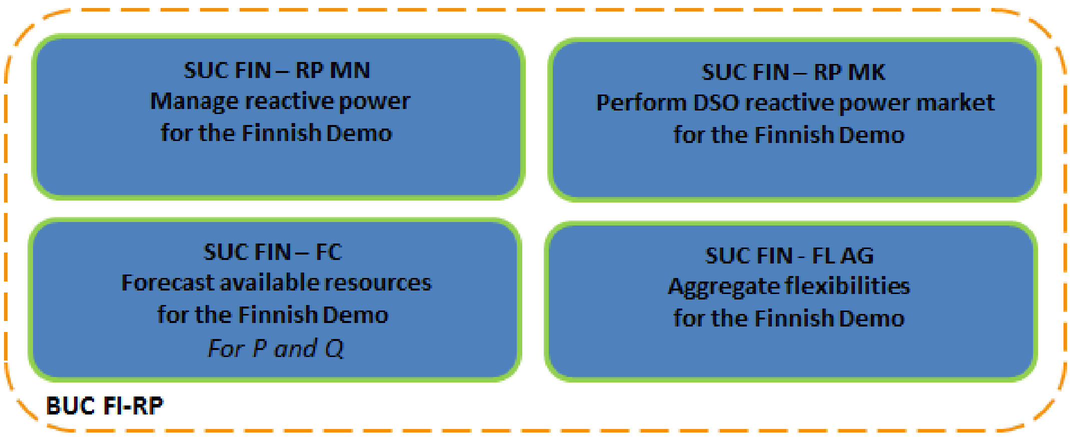

FIGURE 5.3.2 – OVERVIEW ON SYSTEM USE CASES RELATED TO BUC FI RP

In the Finnish demonstrator, the flexible resources are small active and reactive power assets in the local distribution electricity network. As business cases, both active and reactive power of these assets are forecasted and aggregated to be offered and to proceed to various markets. In the Finnish demonstrator, three business uses cases were introduced and explained in the section 5.2. In the Finnish demonstrator, the two SUCs, namely FIN-FC and FIN-FL AG are needed for all three Finnish BUCs. Forecasting (FIN-FC) and aggregation (FIN-FL AG) are the needed two steps in proceeding to the FCR-N market (BUC: FI-AP1) or to the mFRR market (BUC: FI-AP2). The third BUC FI-RP includes also the SUCs FIN-RP MN and FIN-RP MK, which together determine the operation of the DSO's market place.

5.4 SYSTEM ACTORS IN THE FINNISH SYSTEM USE CASES

Figure 5.4.1 shows the relationship between the Business Roles and the reflected System actors.

System actors are connected with the business roles within which they operate. In the Finnish demonstrator, the market operator for active power is the TSO and the market operator for reactive power is the DSO. In Figure 5.4.1 below, business roles are depicted in blue whereas system actors are depicted in yellow.

The business role of an aggregator is performed by Helen. The roles of DSO and market operator for reactive power are performed by Helen Electricity Network. In Finland, Fingrid is the TSO and market operator for active power. The business role of an asset operator is performed by the asset owner or by an aggregator when the service is contracted.

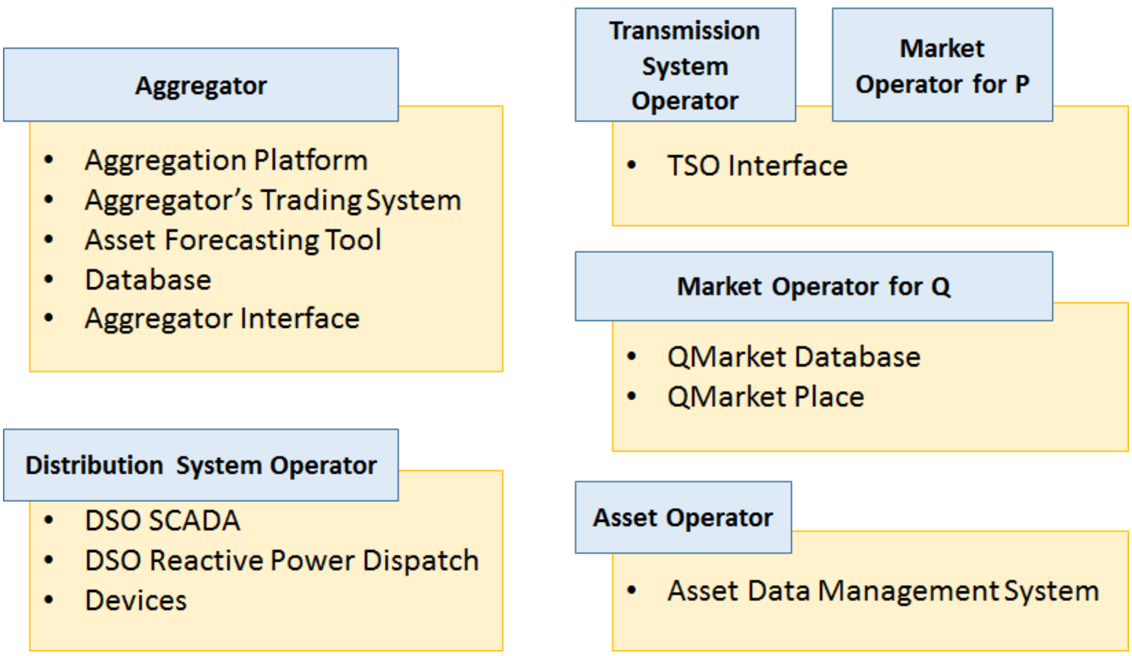

FIGURE 5.4.1 – CORRESPONDENCE BETWEEN BUSINESS ROLES AND SYSTEM ACTORS

The description of each system actor and the SUCs in which it operates is given below. A clearer explanation of all these interactions is available in the attached SUCs contained in the ANNEX IV.

- The **Aggregation platform** manages the portfolio of resources that the aggregator wishes to use in the scope of the EU-SysFlex project. Its role is to coordinate the forecasts of the different resources and to form the bids requested by the trading system in a timely fashion. For the time being, this will consist of a "main" aggregation platform (DEMS), which aggregates larger units, and of a "secondary" system that will aggregate the smaller units as inputs for the "main" platform. This system actor appears in SUCs FIN–FC and FIN–FL AG.
- The **Asset forecasting tool** is a piece of software in charge of forecasting the availability of an asset type.
- The **Database** is the system in charge of keeping the inputs and outputs related to the different forecasting operations.
- The **Asset data management system** collects and/or stores the asset data. Its structure depends on the considered asset. The complete description of this actor is included in SUC FIN–FC, presented in ANNEX IV. The Asset forecasting tool and Asset data management system actors relate to the SUC FIN–FC, Database role relates to the SUCs FIN–FC and FIN–FL AG.
- **Aggregator's trading system** is a platform, in the aggregator's system, which is responsible for coordinating the resources and interacting with the various markets.
- The **TSO interface / DSO Qmarket Database** receives market bids for active power (interface of the TSO) and for reactive power (interface of the DSO); it sends bid acceptance and activations signals. These two roles perform their functionalities in SUC FIN–FL AG.
- The **QMarket place** operates the market mechanism for the requested reactive power within SUCs FIN–RP MN and FIN–RP MK. The task is to decide the shares that will be asked from aggregators, sending the result of market mechanism to aggregators and receiving the data of fulfilled activation from aggregators.
- The **Devices** consist of all the measurement devices and the 110 kV reactors and capacitors used in monitoring and controlling the reactive power balance within the PQ window. They relate to SUC FIN–RP MN.
- **SCADA** is the monitoring and remote control system. It includes the database of the electrical network. The SCADA performs many activities within SUC FIN–RP MN. It can acquire events and measurements both from the 110 kV reactor/capacitors, primary and secondary substations RTUs. Furthermore, it sends commands to 110 kV reactor/capacitors**,** to the devices in the primary substations and to the remote controlled secondary substations.
- **DSO Reactive Power Dispatch** is a DSO database that transmits the historical measurement data and calculates the need for reactive power from the DSO market place. It relates to SUC FIN–RP MN.
- The **QMarket Database** contains the information about accepted resources in the market place.

- Finally, the **Aggregator Interface** provides the compensation asked by the DSO market place. It gets the result of market mechanism and sends the data of fulfilled activation to the market place. Both the QMarket Database and Aggregator Interface relate to SUC FIN RP–MK.

5.5 DESCRIPTION OF FUNCTIONALITIES IMPLEMENTED IN THE FINNISH DEMONSTRATOR

In order to clarify how to reach the objectives of each SUC, a complete summary of the functionalities is needed. Figure 5.5.1 and Figure 5.5.2 give an overview of these functionalities within the SUCs, while considering also the BUC framework.

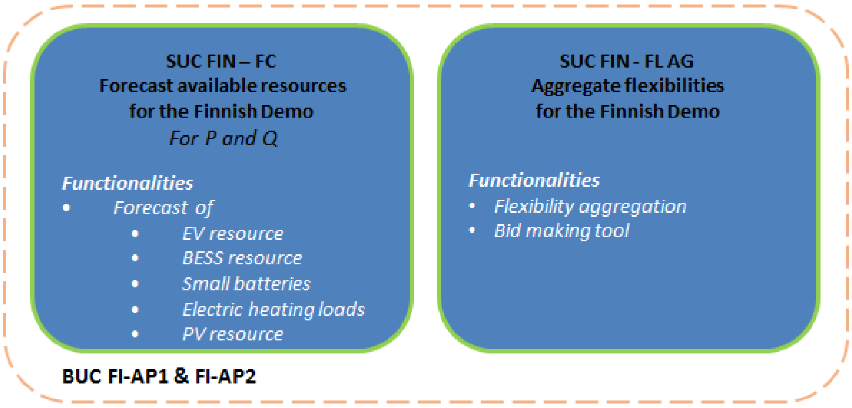

FIGURE 5.5.1 – OVERVIEW ON FUNCTIONALITIES IMPLEMENTED IN SYSTEM USE CASES RELATED TO BUCS FI AP1 & FI AP2

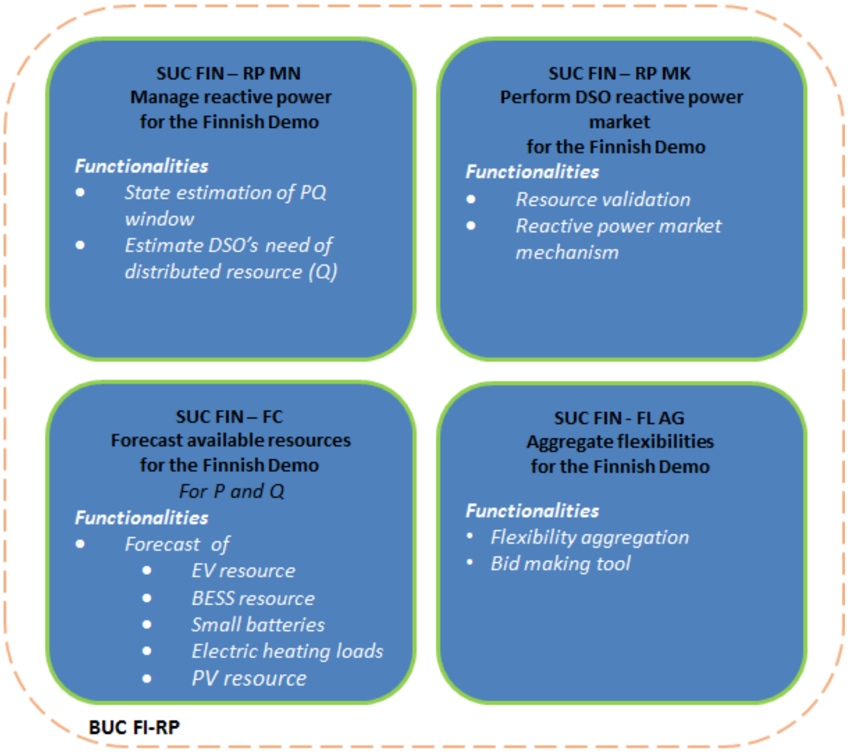

FIGURE 5.5.2 – OVERVIEW ON FUNCTIONALITIES IMPLEMENTED IN SYSTEM USE CASES RELATED TO BUC FI RP

The SUC FIN-RP MN, *Manage reactive power for the Finnish Demo*, includes functionalities of **State estimation of PQ window** and **Estimation of DSO's need of distributed resource (Q)**. The aim of the SUC FIN-RP MN is to manage the reactive power by determining if in addition to the automatic traditional reactive power control any ancillary reactive power resource will be needed. Thus, the state estimation of the PQ window is the starting point of the SUC and an estimate of the amount of ancillary reactive power is formulated within this SUC.

The SUC FIN-RP MK, *Perform DSO reactive power market for the Finnish Demo*, includes functionalities for **Resource validation** and **Reactive power market mechanism**. The goal of the SUC FIN-RP MK is, if started by SUC FIN-RP MN, to run the market mechanism of the reactive power. In this market, the reactive power bids from an aggregator and reactive power needs from the DSO are managed. Only those reactive power controllable resources that have been validated by a DSO are able to participate to the SUC.

The implemented functionality in SUC FIN – FC, *Forecast available resources for the Finnish Demo*, is **Forecast of distributed assets** (EV resource, BESS resource, small batteries, electrical heating loads, PV resource). The forecasting tool that is developed during the project receives data from internal and external sources and calculates the expected available flexibility capacity. Availability of each type of asset for each suitable market place in required time scale will be provided for the aggregator platform. Various sets of data can be used as input for the forecasting tool, including asset properties data, weather forecast, historical data and market data.

The implemented functionalities in SUC FIN-FL AG, *Aggregate flexibilities for the Finnish Demo*, are the **Flexibility aggregation** and the **Bid making tool**. The aim of the flexibility aggregation is to aggregate small distributed resources to the TSO's ancillary markets (active power) and to the DSO's reactive power market place. The bid making tool is needed to create bids from the aggregated resources to the various market places.
Communication is a general functionality that is implemented across all Finnish SUCs. Without this functionality, the involved processes within the four SUCs cannot be performed. For this reason, one of the most critical requirements of this study is a good communication infrastructure between different system actors. In the Figure 5.5.3, the communication channels between the System actors in Finnish SUCs are illustrated. The system actors are allocated to bigger entities, such as aggregator, DSO or TSO to demonstrate the overall communication structure of the demonstrator. Red arrows make evidence of a communication channel.

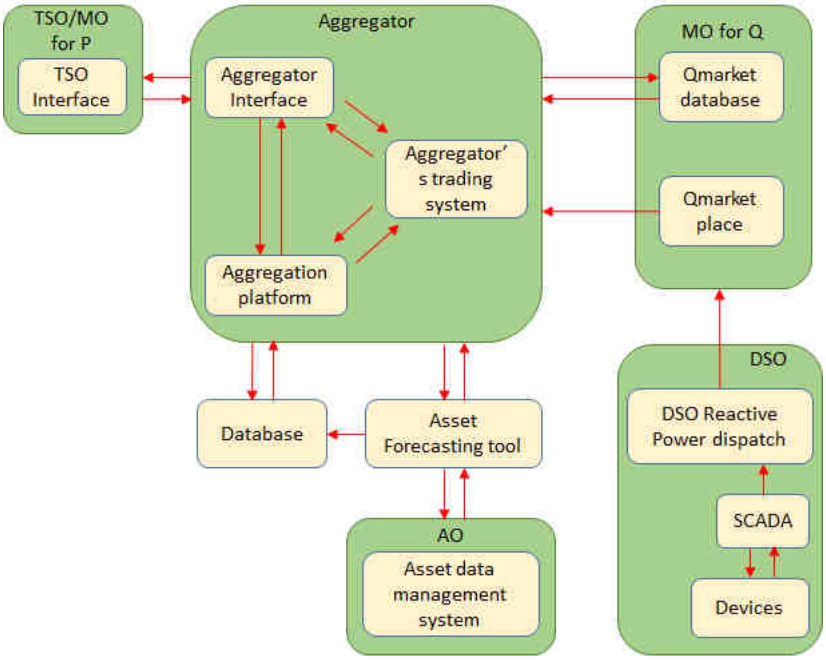

FIGURE 5.5.3 – OVERVIEW ON COMMUNICATION CHANNELS BETWEEN THE SYSTEM ACTORS

As stated in chapter 1, all the functionalities within the System use cases that are described in this section, will be used for the development of systems and tools in Task 6.3. Below, Figure 5.5.4 shows an overview of the Finnish SUCs and their correspondence with the different development areas of task 6.3.

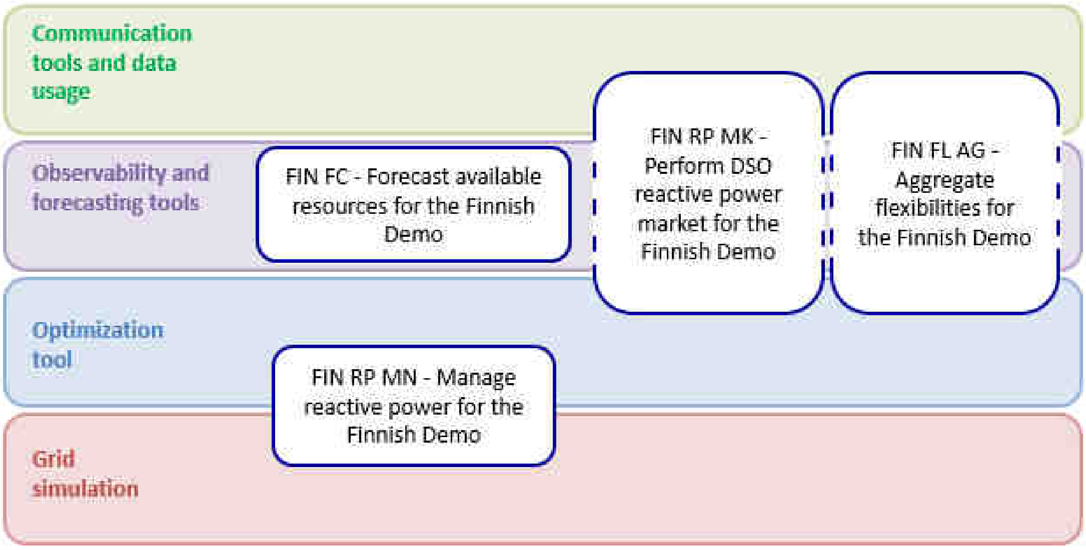

FIGURE 5.5.4 – MAPPING OF FINNISH SYSTEM USE CASES WITH CATEGORIES OF TOOLS

5.6 REQUIREMENTS OF THE SYSTEM USE CASES

After the Finnish System Use Cases have been defined in the previous chapters, it is necessary to describe the requirements of the system use cases which contribute to achieve the WP6 objectives stated in the chapter 1. The requirements described in this section are related to the objectives of WP6 and refer to the Finnish functionalities defined in section 5.5. To achieve the objectives of the WP6, the Finnish demonstrator objectives are mapped in four categories as followed:

Finnish Demonstrator Technologies performances:

- to develop forecasting tool: FIN-FC
- to enhance the aggregation platform: FIN-FL AG
- to evolve reactive power market place: FIN-RP MK

Finnish Demonstrator Aggregation concepts:

- to offer flexibilities to TSO ancillary markets: FIN-FL AG
- to offer reactive power flexibilities to the DSO market place: FIN-FL AG

Finnish Demonstrator DSO/TSO interaction:

- to support the voltage at the TSO/DSO connection points: FIN-RP MN

Finnish Demonstrator ICT tools:

- to develop forecasting tool: FIN-FC
- to enhance the aggregation platform: FIN-FL AG
- to evolve reactive power market place: FIN-RP MK

In order to implement these processes described in the system use cases into practice, some requirements must be taken into account beforehand. In the Finnish demonstrator, the requirements for active and reactive power are described separately and divided into two clusters. The first cluster presents the active power requirements and the second cluster the reactive power requirements.

Active power requirements are as followed:

- Forecasting tool: The tool does not exist and it will be developed for the EU-SysFlex project. There needs to be a sufficient amount of data (weather-, asset- and market-related) to make an accurate forecast that is useful for the aggregator.
- Aggregation platform: The platform will be further enhanced including also the aggregation of the small flexibilities.
- Aggregator's trading system: The aggregated resources must fulfil the requirements imposed on reserve capacity by the TSO. To prove these qualifications and to work on the ancillary markets, the resource needs to undergo regulatory test measurements.
- Communication between the forecasting tool and aggregation platform will be generated

Reactive power requirements are as followed:

- State estimation of PQ window: The requirements for the state estimation of the PQ window include successful data collection and processing. The state estimation of PQ window is an existing process and it will not be further developed.
- Estimate DSO's need of additional reactive from distributed resource (Q): The requirements for the estimation of the need for Q include successful calculation based on collected data. The estimation will be developed during EU-SysFlex.
- Market mechanism for Q: When first ensuring the local technical acceptability of the distributed resources (approved by the DSO) these new controllable assets could be cost efficiently managed through a reactive power market mechanism. Another requirement for the market mechanism is a sufficient amount of flexible reactive power resources. The market mechanism will be developed in the EU-SysFlex.
- Flexibility aggregation & forecasting: Currently, the reactive power availability of an asset is not aggregated nor forecasted and there is no market place for it and thus, no regulatory framework exists. In the EU-SysFlex project, the proof of concept will be developed.

6. CROSS ANALYSIS OF WP6 DEMONSTRATORS

This chapter presents an overview of the demonstrators and the corresponding System Use Cases: all the relevant features and Task 6.2 outcomes are here analysed and compared in order to show the complementarity of the solutions identified and how they address the WP6 objectives.

6.1 OVERVIEW OF DEMONSTRATORS FEATURES

In Table 6.1.1 all the relevant features of WP6 demonstrators, from a system process perspective, are summarized. Some limitations may apply to physical set-ups due to current regulatory constraints, specifically for German and Italian demonstrator, as it will be explained later in this section.

	German Demonstrator	Italian Demonstrator	Finnish Demonstrator
Voltage level	HV	MV	MV, LV
TSO/DSO interface	16 EHV/HV substations	1 HV/MV substation	3 HV/MV connection points through 2 substations; 1 common PQ window
Type of regulation	Active power, reactive power	Active power, reactive power	Active power, reactive power
Flexibility resources	• 2.7 GW wind • 1 GW PV • 1.5 GW thermal • Aggregated MV resources	1 MW PV (4)	• BESS (MV) • PV solar power plant (MV) • Charging infrastructure for electric vehicles • Electric heating loads with smart control • Electric heating with AMR
System Operator resources	-	• STATCOM • BESS	-
Control mechanism	• Re-dispatching • Aggregation	• Aggregation • Direct management	Aggregation
Flexibility procurement	Mandatory participation, fixed cost market	Voluntary participation (only for demonstrator purposes)	Market based

TABLE 6.1.1 – SUMMARY OF MAIN FEATURES OF WP6 DEMONSTRATORS

The most obvious recognizable feature of the demonstrators that make them complementary is the voltage level: The German Demonstrator is located in the HV level, the Italian in the MV level and the Finnish mainly in the LV level. While MV and LV voltage levels are typical, in European countries, to be part of the distribution networks, this is not always the case for the HV level. In some countries the HV level also belongs to the distribution grid, like in Germany, and it is partly distribution grid and partly transmission grid like in Finland.

Furthermore the three Demonstrators include different characteristics of interfaces between the distribution and the transmission networks. Indeed, for the Italian and Finnish demonstrators, the boundary corresponds to the single connection (in Italy a single primary substation, in Finland a single PQ window), while in the German Demonstrator 16 interconnection points (16 EHV/HV substations) with the transmission network are included. This allows the German Demonstrator to use re-dispatching as a control lever for congestion management. On the other hand it is not possible in the German and Finnish Demonstrator to use on-load tap changers (OLTCs) since they are managed and owned by the TSO. In contrast, the Italian Demonstrators does use OLTCs for voltage control measures. These peculiarities potentially allow a complete replicability of the tested smart grid solutions for different network frameworks.

National regulatory frameworks have an impact on the way flexibilities are procured and, most important from systems perspective, which system processes are necessary to manage procurement and exploitation of flexibilities. Again, each Demonstrator has its own features; for example, in Finland a market framework for flexibility used in the transmission grid is already operating for distributed resources, but it cannot be accessed by small LV consumer-based resources. Therefore the activities of the demonstrator focus on the forecasting and aggregation of LV flexibility resources in order to facilitate their market participation.

The German and Italian Demonstrators face completely different conditions: In Germany flexibility provision from distributed resources is mandatory and it is managed by the DSO through a regulated market at fixed costs, while in Italy flexibility provision from distributed resources is not allowed. In both national cases, the DSOs are responsible of the power exchange at interconnection nodes and so both demonstrators focus on the improvement/increase of the power regulation window towards TSOs. This is done through the optimization of resources for the purpose of both transmission and distribution networks. From this perspective, the Italian Demonstrator considers also the exploitation of DSO-controlled flexibility resources, completing the range of flexibility resources included in the demonstrators (from HV RES and conventional plants to smart LV customer-size loads).

All the demonstrators consider both active and reactive power modulation and corresponding services. However, as mentioned briefly at the beginning of the section, some limitations apply to physical set-ups due to regulatory constraints: currently, in the German demonstrator case it is not possible to exploit load flexibilities, while in Italian demonstrator it is not possible to exploit active power flexibilities from private generators. In both cases the relevant functions are included in the developed System Use Cases and corresponding functionalities will be included in software tools developed in Task 6.3, so these limitations will be taken into account for field testing activities in Task 6.4. Since the challenges posed by the increasing availability of distributed flexible resources are encouraging the evolution of national regulations, it may be the case that, in the near future, such constraints will be dropped, allowing to perform comprehensive field tests. Anyway, all the relevant functions of the demonstrators will be also tested in a simulation environment, derived from the actual physical set-up.

6.2 OVERVIEW OF DEVELOPED SYSTEM USE CASES

In chapter 1, the WP6 sub-objectives have been analysed from a "system perspective", and then linked with relevant System Use Cases groups:

- System Use Cases which describe innovative functions supporting DSO-TSO interface (Improvement of TSO/DSO interface);
- System Use Cases which describe innovative functions supporting distributed flexibilities management focusing on TSOs needs (Fulfilment of specific request from TSOs);
- System Use Cases which describe innovative functions supporting distributed network management, in presence of constraints related to flexibilities exploitation for both TSOs and DSOs (Guaranteeing an optimal state of distribution network).

The developed System Use Cases are here mapped with these groups in order to assess the fulfilment of WP6 objectives, as showed in Figure 6.2.1.

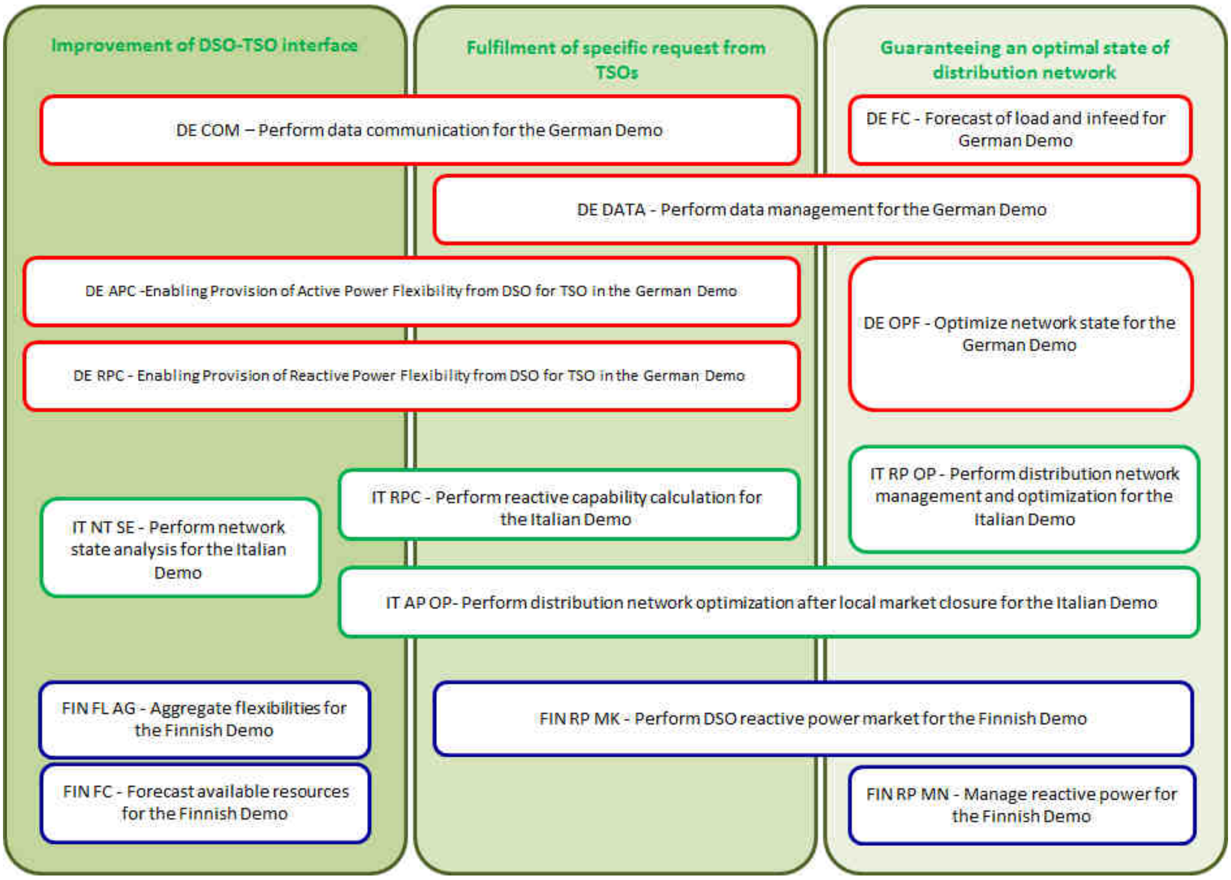

FIGURE 6.2.1 – MAPPING OF DEVELOPED SYSTEM USE CASES IN TO WP6 OBJECTIVES

The System Use Cases developed within Task 6.2 cover all the identified groups, if considered as whole set as well as if considered from demonstrators' perspective. All the System Use Cases describe innovative network optimization and aggregation functions, aimed at facilitating the management of distributed flexibilities and removing the barriers for their exploitation for ancillary services provision to system operators. The forecast of available resources, as well as their power curve, also play a major role in the system functions of the demonstrators.

In the Finnish demonstrator, the system processes rely mainly on innovative market management and resources aggregation functions, in order to allow the retailer and the DSO to collect and manage active and reactive power flexibility bids aimed both at TSO's ancillary service provision and DSO's balancing issues.
In the German demonstrator special attention is given to the analysis of the impact of different re-dispatching operations and HV and (aggregated) MV generators flexibility exploitation following a specific request from the TSO. Alongside this feature, enhanced communication and increased data exchange capabilities are crucial to improve the TSO-DSO coordination and to give the TSO more complete and suitable data sets for its own network optimization process, as well as accuracy of flexibility forecasting. All these features and the corresponding system functions have been described in dedicated SUCs.

The Italian demonstrator focuses on the flexibility aggregation within the primary substation interface aimed to provide ancillary services to the DSO through the exploitation of distributed flexible resources. One of the innovative features pursued in this Demonstrator is the use of DSO-owned assets for increase the equivalent reactive capability at DSO-TSO interface. Improved optimization and calculation functions to aggregate active power flexibility bids for service provision in the centralized markets, to calculate the total reactive power capability at primary substation and to exploit DSO assets for increasing reactive power capability and for market facilitation purposes, have been all included in SUC descriptions.

The chapters dedicated to each individual demonstrator describe in detail the relevant functionalities identified through the developed System Use Cases; they represent the core input for the development of software tools in Task 6.3. In order to highlight how identified functionalities contribute to Task 6.3, a schematic picture is presented in Figure 6.2.2: it shows the mapping of System Use Case on four specific tools categories, linked to Task 6.3 activities. As can be seen, the System Use Cases (i.e. the functionalities included in them) developed in Task 6.2 completely cover the range of software tools relevant for Task 6.3 and WP6 activities.

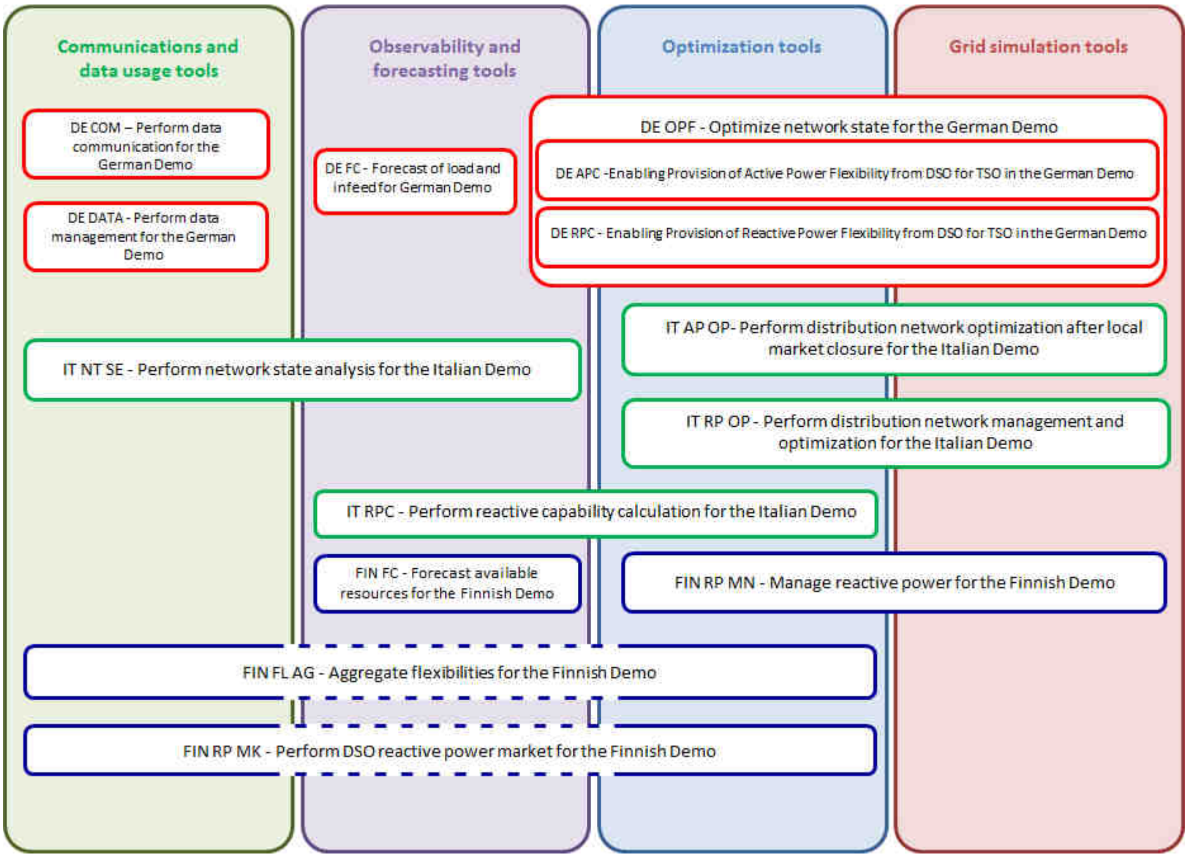

FIGURE 6.2.2 – MAPPING OF DEVELOPED SYSTEM USE CASES ON SOFTWARE TOOLS CATEGORIES (LINK WITH TASK 6.3)

7. CONCLUSION

In this deliverable D6.1 the relevant System Use Cases of the three demonstrators tested within WP6 are defined. All of them describe innovative system processes developed to perform the crucial activities behind the BUCs presented in the Deliverable D3.3 [1].

The analysis methodology adopted for System Use Cases definition followed two parallel directions: analysis of the demonstrators' set-ups to identify the functionalities to be tested in the field, and analysis of business activities in order to identify the relevant functions (and functionalities) that support them. Then, the outcomes of these processes have been merged together and modeled through Use Case methodology in order to create standardized System Use case templates.

The tight correlation between the system processes, business processes and the demonstrators, required an accurate analysis of the physical set-ups and their impact on System Use Cases. For this reason, the activities' description are structured in demonstrators chapters, in which the correlations between Demonstrator features, Business Use Cases, business actors, system actors are analyzed and explained, as well as the System Use Cases and corresponding functionalities. Finally the three demonstrators and the developed System Use Cases are compared together in order to show how they fulfill WP6 objectives. The impacts of System Use Cases and, in general, of Task 6.2 outcomes, on Task 6.3 activities have also been investigated.

The activities performed within Task 6.2, allowed to define 14 System Use Cases (6 for the German demonstrator, 4 each for the Italian and Finnish demonstrators). They cover the relevant functions for pursuing the exploitation of decentralized flexibility resources focusing on the ancillary service provision to the TSO's: forecast of flexible resources (to identify the volume of flexibilities available in a certain time period), communication management (DSO/TSO), aggregation of resources, network optimization, enabling of provision of power flexibility to the TSO, flexibility market management for distributed resources. They also identify the functionalities, and corresponding requirements, needed for the development of the software tools for carrying out the above functions. Furthermore, the analysis carried out for developing the Systems Use Cases highlighted all the different peculiarities of the demonstrators, showing their added value and the way they complement each other in respect to WP6 objectives and, from a broader perspective, to the EU-SysFlex Project objectives.

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9. COPYRIGHT

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ANNEX I. EMPTY IEC 62559-2 USE CASE TEMPLATE

Description of the Use Case

Name of Use Case

This section includes many labels related to the identification of the use case and its author.

Use Case Identification
Name of Use Case

Version Management

Version Management			
Version No.	*Date*	*Name of Author(s)*	*Changes*

Name of Use Case: A short name, which refers to the activity of the Use Case itself using "Verb + description", shall be used.

Version No.: Sequential number to identify the version of the document.

Date: Date, when the version was created.

Name of Author(s): This field is used to document who has provided the current version. It can be a person or an organization.

Changes: When changing the use case, general changes shall be documented shortly in the column "Changes", multiple changes are separated with sections.

Scope and objective of the use case

Scope	
Objective(s)	

Scope: The scope defines the boundaries of the use case, i.e. what is in and what is out of the scope of the use case. This section may refer to the domain being considered (network, market…), the associated sub-domains (LV network, balancing market…), and time horizons (planning, real-time operations…) for instance.

Objectives: List of goals the use case is expected to achieve (not for the writer or reader of the use case, but for the actor(s) using the system).

Narrative of the use case

Narrative of Use Case
Short description
Complete description

Short description: Short text intended to summarize the main idea as service for the reader who is searching for a use case or looking for an overview. This description may refer to the main steps of the use case. It should not have more than 10 lines.

Complete description: Provides a complete narrative of the use case from a domain expert user's point of view, describing what occurs when, why, with what expectation, and under what conditions. This narrative should be written in plain text so that non-domain experts can understand it. The length of this section can range from a few sentences to a few pages, depending on the complexity and / or newness of the use case. This section often helps the domain expert to reflect about the requirements for the use case before getting into the details in the next sections of the use case template.

Key Performance Indicators (KPI)

Key Performance Indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*

Key performance indicators (KPI): they are classification numbers, which have been appointed in the respective project and are described in Sect. 1.5 of the template. They have a unique ID and name, a description in form of a few sentences and, usually, they are associated to one of the above-listed use case objectives, which is stored in the field reference to mentioned use case objective.

Use case conditions

Use case conditions	
Assumptions	
Prerequisites	

Assumptions: they are general presumptions about conditions or system configurations.

Prerequisites: they specify which requirements have to be met so that the basis scenario use case can be successfully accomplished. They often contain properties and states of actors or the condition of a triggering event. If there are more than one assumptions or prerequisites, a greater number of tables has to be created.

Further information to the use case for classification/mapping

Classification information
Relation to other use cases
Level of depth
Prioritisation
Generic, regional or national relation

Nature of use case
Further keywords for classification

Classification information: includes the relation to other use cases in the same project or thematic area.

The level of depth: it reflects the degree of specialisation of the use case. Although no common notation is settled, descriptions like high level use case, generic, detailed, or specialised use case are often used.

Prioritisation: it helps to rate the use cases in a project from very important to nice-to-have with labels like obligatory/mandatory or optional which have to be agreed upon beforehand. Often use cases are applied to areas where restrictions by law or similar issues occur, so for purpose of generalisation the generic, regional or national relation has to be specified.

Nature of the use case: it describes the viewpoint and field of attention like technical, political, business/market, test, etc.

Further keywords for classification: They should follow a pre-described manner of notation, so that sorting and grouping use cases on behalf of these keywords is possible.

General remarks

General remarks: they consist on additional information.

Diagram of Use Case

Diagram(s) of use case

Diagrams of use case: UML use case, activity, and sequence diagrams help to provide a good understanding of the procedures of the use case. It shows the interactions between a System and one or more Actors. This section may include other UML Diagrams, such as the Sequence Diagram (which describes the information exchanged during the use case) and the Activity Diagram (which describes the activities performed by the actors of the use case).

Technical Details

Actors		
Actor Name *see Actor List*	*Actor Type* *see Actor List*	*Actor Description* *see Actor List*

Actor Name: name of the involved actor.

Actor Type: it can be a Role (a DSO, a Balance Responsible Party, an Aggregator…), a Person (a Distribution Management System Operator), a System (a Weather Forecast System, a Demand Response Management System, a Building Management System…), a Device (a charging spot), or an Application.

Actor Description: Short description of the actor.

References						
No.	*Reference Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organisation*	*Link*

References: They get a number or ID to refer to and the reference type like publication, website, law/contract, or standard is indicated. The reference gets a short descriptive label and the publication status (e.g. draft, final) is remarked upon. To enable the sorting through the references by importance, their impact on the use case is stated. Finally, the person or organisation which authored the respective reference document is noted in originator/organisation and, if available, a public weblink can be given in the field link.

Step by step analysis of use case

Scenario conditions						
No.	*Scenario name*	*Scenario description*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post-condition*

Scenario conditions: they contain a consecutive number, where usually the normal scenario without failure cases is listed first.

The scenario gets a distinct scenario name and a short precise scenario description in a plain text.

The primary actor: it is the first actor appearing in the scenario.

Triggering event: it causes the beginning of the scenario.

The precondition: it indicates which terms have to be fulfilled for the scenario to be executed and the post-condition says which ones should be valid after the scenario.

The post-condition: it can also specify whether a scenario has been successfully completed or not.

Scenario								
Scenario name								
Step No	*Event*	*Name of process/activity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information exchanged (IDs)*	*Requirement, R-IDs*

Scenarios: Corresponding to the name of the scenario, its steps are listed in consecutive execution order with

their step number and a triggering event.
The event often just states that the last step has been performed successfully. Each step represents a process or activity which gets a unique name and a brief explanation of the procedure taking place in its description. The second half of the columns of this table deals with the information which are exchanged in the respective step.
The Service addresses the nature of the information flow with the following possibilities.
The information producer and the information receiver are both actors from the actor.
Following the IDs of the information exchanged and requirements.

Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information exchanged*	*Requirement, R-IDs*

Information exchanged: it is presented with a detailed description. The information ID is used to refer to the respective information object and its name is a unique label for the main purpose of it. The description is an accurate plain text description as usual.

Requirements

Requirements		
Categories ID	*Category name for requirements*	*Category description*
Requirement R-ID	*Requirement name*	*Requirement description*

Requirements: this section identifies the requirements needed in the range of the project. They are divided into categories with a unique Category ID.
Each category gets a name and a short precise description and is supplied in a separate table. The requirements in each category have also a requirements ID which is based on the ID of its category. Again, a requirement name and requirement description are provided.

ANNEX II. GERMAN SYSTEM USE CASES COMPLIANT WITH THE IEC62559-2 TEMPLATE

DE – APC: ENABLING PROVISION OF ACTIVE POWER FLEXIBILITY FROM DSO FOR TSO IN THE GERMAN DEMO

Description of the Use Case

Name of Use Case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
DE - APC	SGAM Domain	Enabling Provision of Active Power Flexibility from DSO for TSO in the German Demo

Version Management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-11-01	IEE	First version	
2	2018-12-03	IEE	Change requests from the first review	
3	2019-01-15	Carla Marino (E-distribuzione)	Contribution	
4	2019-01-18	IEE	Change requests from the second review	
5	2019-01-24	Carla Marino (E-distribuzione)	ModSarus fixes	

Scope and objectives of use case

Scope and objectives of use case	
Scope	This system use case explains how the DSO-demonstrator supports the TSO in managing the active power flow in the transmission grid in the case of congestion by providing active power flexibilities from assets in the distribution grid.
Objective(s)	The objective of this SUC in the German demonstrator is to enable the provision of active power flexibilities connected to the distribution grid (110 kV) for managing congestion in transmission grid (380 kV + 220 kV). Therefore the following activities are necessary within this SUC: • calculating available flexibilities at interconnection point between TSO and DSO • allocate information about feed-in/consumption schedule and available flexibility offers for TSO • process update of data
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
This SUC describes the process to coordinate the use of active power flexibilities in the distribution grid for the TN_O. The SUC is based on calculation and optimisation done as described in SUC OPF. With this SUC the TN_O can address its needs to be considered in calculation and optimisation done in SUC OPF.
Complete description
Description This SUC supports the coordination between TSO and DSO in using active power flexibilities from the distribution grid. The coordination is needed to prevent congestions in the distribution grid due to activation of active power flexibilities for the needs of the TSO. The coordination process starts day ahead and ends intraday 2 hours before activation of flexibility. This SUC shows the consideration of demands of the TSO in load flow calculation and grid optimisation of the DSO done in SUC DE-OPF. The output of this SUC will be used by TSO in order to determine possible activations of flexibilities from assets in the distribution grid. The SUC DE-OPF confirms the ability of the distribution grid of fulfilling the activation of the requested flexibilities. In SUC DE-DATA it is checked whether the requested flexibilities are in the beforehand sent data of available range of flexibilities. The calculated new schedules and the confirmation of the requested flexibilities from SUC DE-OPF is being sent to TSO via SUC DE-COM. In addition the schedules are sent to the flexibility providers. This SUC has an iterative structure and is being restarted every x minutes if the TSO does not call for flexibilities and/or changes in the distribution grid occur in the meantime. Summary of use case • **Active Power Flexibilities** Description: Calculation of maximal and minimal active power per network group Per network group, the OPF determines within given grid constraints maximal and minimal active power flexibilities. As input for the cost function sensitivities, cost per MW per asset and active power range per assets are used. Determination of active power flexibilities and sensitivities per controllable asset From the results of the first step, the allowed flexibilities per asset are determined. The assets will be clustered according to their sensitivities on each interconnection point and their cost per MWh. If activation requests from TSO are existent, the requested amount of active power per cluster has to be disaggregated onto the individual assets. This the individual set points per asset will then be applied on current forecasts and schedules via the SUCs DE-DATA and DE-OPF. ▪ Calculate available flexibilities Description: On each of the forecast grids, the active power flexibilities for each generating unit will be determined. For this, the whole flexibility for the grid (sum over all interconnection points) will be determined under consideration of grid constraints. From these results, the individual flexibility per generating unit will be deduced. Each generating unit flexibility will also be assigned with sensitivities for each interconnection point and price per MWh.

- CheckFlexibilities
  Description: TSO receives active power flexibilities and determines possibles measures and requests.

- Clustering of Flexibility
  Description: All flexibilities from generating units with approximately same interconnector sensitivities and prices per MWh will be grouped together.

- Processing requests
  Description: The flexibility requests are read and realted to concerned flexibility groups

- Read Data
  Description: Read Input data from SUC Base OPF. Forecast grid data for the next 36 hours will be read and provided for further steps.

- Receiving and Forewarding Requests
  Description: The active power flexibility requests are received from the TSO and forwarded to beeDIP

- Segregation of requests
  Description: The requests for each group are segregated to the individual generating units. For each generating unit, an active power setpoint is generated.

- Send Flexibilities
  Description: The list of clustered flexibilities will be sent to the TSO.

- Send Request
  Description: The TSO sends active power flexibility requests to the DSO.

- Validationg setpoints on related grid states
  Description: The setpoints for generating units are applied on the related grid state (time) and under consideration of grid constraints and flexibility potential validated.

Key performance indicators (KPI)

Key performance indicators			
ID	***Name***	***Description***	***Reference to mentioned use case objectives***
1	Keeping deadlines of day-ahead process		DE-APC
2	Meet TSO need in delivering data		DE-APC
3	Percentage of scheduled Flexibility		DE-APC
4	Intraday update process duration		DE-APC
5	Active Power Adjustment Error		DE-APC

Use case conditions

Use case conditions

Assumptions	
1	Congestion free network states: The handling of congestions is performed in SUC OPF and it is assumed, that the network states on which the active power flexibility determination is performed on are free of congestions.
2	SUC OPF Assumptions: These assumptions are here valid as well, and should be fulfilled automatically.
Prerequisites	
1	Price Lists: Up to date price lists are needed in order to compute the most cost efficient solutions.
2	SUC OPF Prerequisites: These prerequisites are here valid as well, and should be fulfilled automatically.
3	Up to date information from TSO, DSO, forecast and schedules: In order to compute valid results, cyclically updated information are needed.

Further information to the use case for classification/mapping

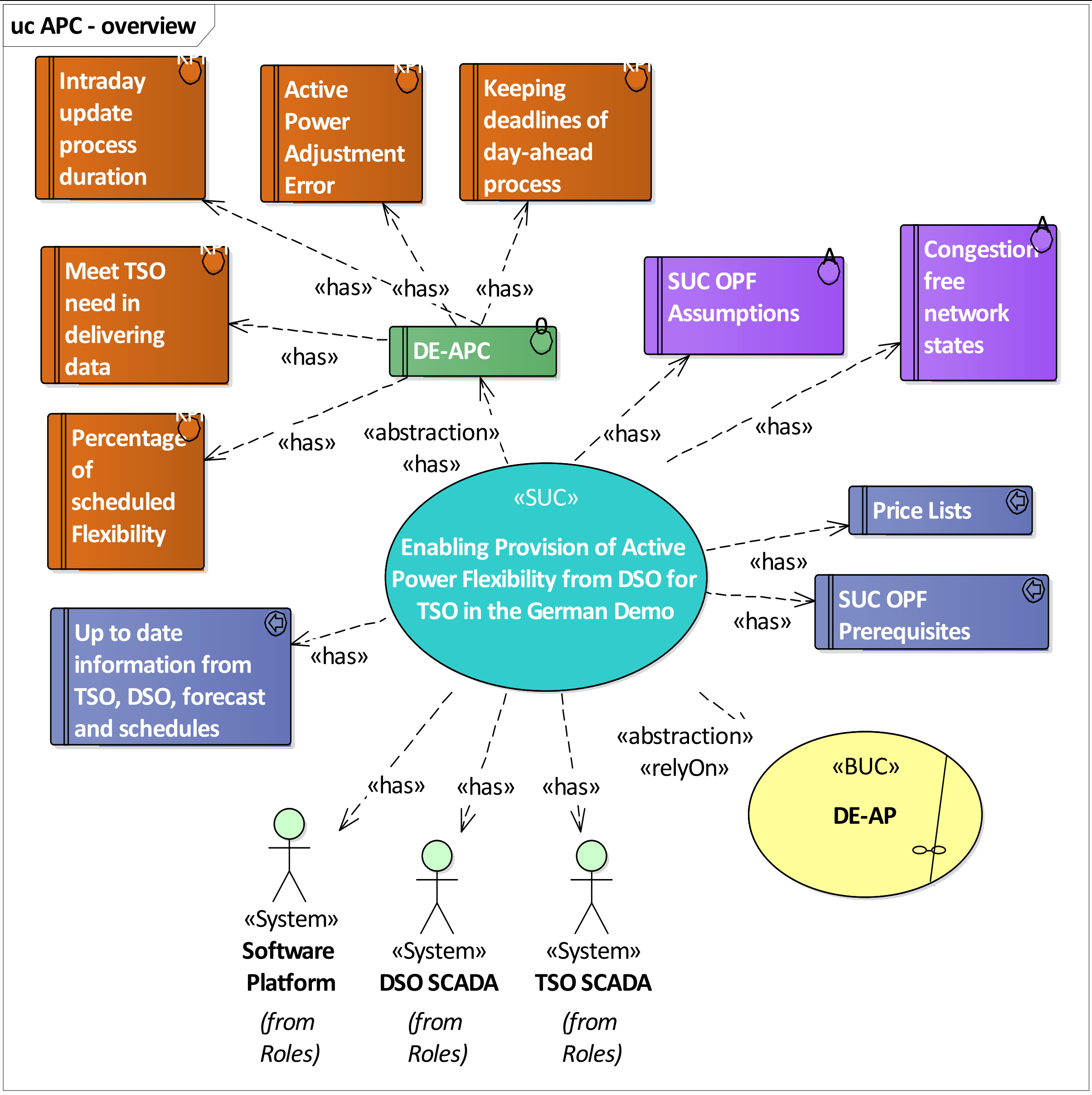
Classification information
Relation to other use cases
<<BUC>> DE-AP
Level of depth
White Box
Prioritisation
Generic, regional or national relation
Regional TAR (Grid Connection Code)
Nature of the use case
SUC
Further keywords for classification
Optimization, State Estimation, Congestion management

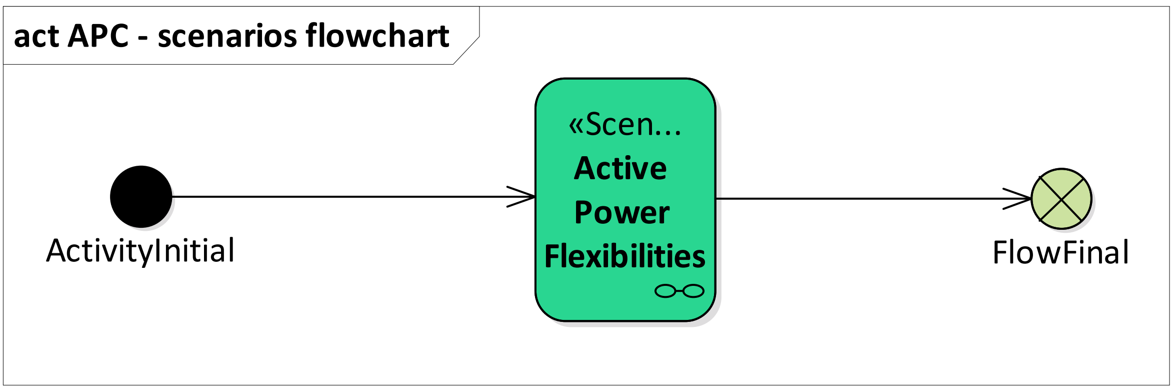
General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case





Technical details

Actors

Actors			
Grouping (e.g. domains, zones)	***Group description***		
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
Software Platform	System	Software platform (name: BeeDIP) for data collection and calculation for setpoints (reactive power / active power)	
DSO SCADA	System	SCADA System of the DSO	
TSO SCADA	System	SCADA of the TSO.	

References

Step by step analysis of use case

Overview of scenarios

Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	Active Power Flexibilities	Calculation of maximal and minimal active power per network group Per network group, the OPF determines within given grid constraints maximal and minimal active power flexibilities. As input for the cost function sensitivities, cost per MW per asset and active power range per assets are used. Determination of active power flexibilities and sensitivities per controllable asset From the results of the first step, the allowed flexibilities per asset are determined. The assets will be clustered according to their sensitivities on each interconnection point and their cost per MWh. If activation requests from TSO are existent, the requested amount of active power per cluster has to be disaggregated onto the individual assets. This the individual set points per asset will then be applied on current forecasts and schedules via the SUCs DE-DATA and DE-OPF.				

Steps - Scenarios

Active Power Flexibilities

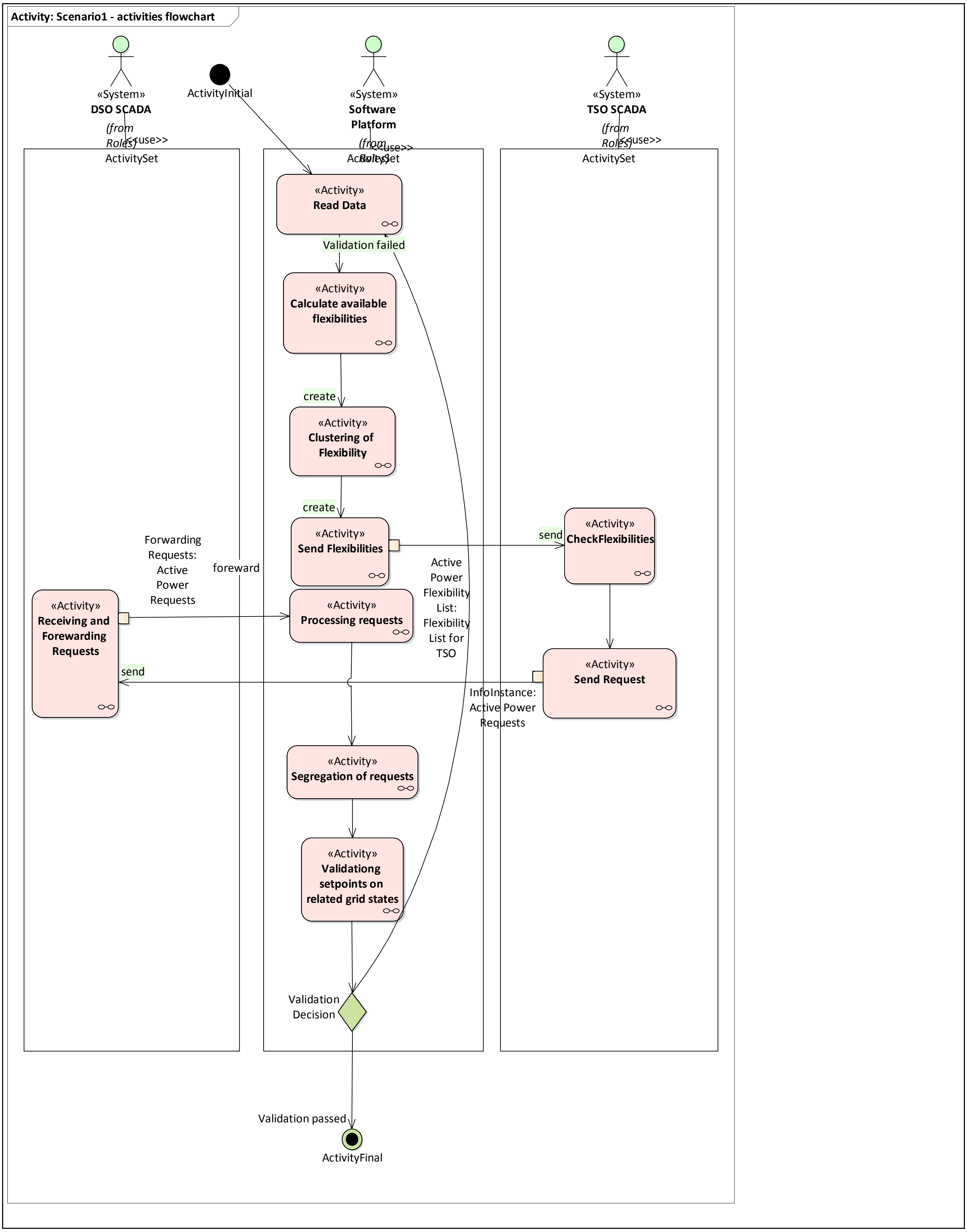
Calculation of maximal and minimal active power per network group

Per network group, the OPF determines within given grid constraints maximal and minimal active power flexibilities. As input for the cost function sensitivities, cost per MW per asset and active power range per assets are used.

Determination of active power flexibilities and sensitivities per controllable asset

From the results of the first step, the allowed flexibilities per asset are determined.

The assets will be clustered according to their sensitivities on each interconnection point and their cost per MWh. If activation requests from TSO are existent, the requested amount of active power per cluster has to be disaggregated onto the individual assets. This the individual set points per asset will then be applied on current forecasts and schedules via the SUCs DE-DATA and DE-OPF.


Activity: Scenario1 - activities flowchart
«System»
DSO SCADA
(from Roles)
ActivityInitial
«System»
Software Platform
(from Roles)
«System»
TSO SCADA
(from Roles)
<<use>>
<<use>>
<<use>>
ActivitySet
ActivitySet
ActivitySet
«Activity»
Read Data
Validation failed
«Activity»
Calculate available flexibilities
create
«Activity»
Clustering of Flexibility
create
«Activity»
Send Flexibilities
send
«Activity»
CheckFlexibilities
Active Power Flexibility List: Flexibility List for TSO
Forwarding Requests: Active Power Requests
foreward
«Activity»
Receiving and Forewarding Requests
«Activity»
Processing requests
send
«Activity»
Send Request
InfoInstance: Active Power Requests
«Activity»
Segregation of requests
«Activity»
Validationg setpoints on related grid states
Validation Decision
Validation passed
ActivityFinal

Scenario step by step analysis

Scenario								
Scenario name	Active Power Flexibilities							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.1		Calculate available flexibilities	On each of the forecast grids, the active power flexibilities for each generating unit will be determined. For this, the whole flexibility for the grid (sum over all interconnection points) will be determined under consideration of grid constraints. From these results, the individual flexibility per generating unit will be deduced. Each generating unit flexibility will also be assigned with sensitivities for each interconnection point and price per MWh.		Software Platform			
1.2		CheckFlexibilities	TSO receives active power flexibilities and determines possibles measures and requests.		TSO SCADA			
1.3		Clustering of Flexibility	All flexibilities from generating units with approximately same interconnector sensitivities and prices per MWh will be grouped together.		Software Platform			
1.4		Processing	The flexibility		Software			

		requests	requests are read and realted to concerned flexibility groups		Platform			
1.5		Read Data	Read Input data from SUC Base OPF. Forecast grid data for the next 36 hours will be read and provided for further steps.		Software Platform			
1.6		Receiving and Forewarding Requests	The active power flexibility requests are received from the TSO and forwarded to beeDIP	foreward	DSO SCADA	Software Platform	Info1-Active Power Requests	
1.7		Segregation of requests	The requests for each group are segregated to the individual generating units. For each generating unit, an active power setpoint is generated.		Software Platform			
1.8		Send Flexibilities	The list of clustered flexibilities will be sent to the TSO.	send	Software Platform	TSO SCADA	Info2-Flexibility List for TSO	
1.9		Send Request	The TSO sends active power flexibility requests to the DSO.	send	TSO SCADA	DSO SCADA	Info1-Active Power Requests	
1.10		Validationg setpoints on related grid states	The setpoints for generating units are applied on the related grid state (time) and under consideration of grid constraints and flexibility potential validated.		Software Platform			

- Calculate available flexibilities

Business section: Active Power Flexibilities/Calculate available flexibilities

On each of the forecast grids, the active power flexibilities for each generating unit will be determined. For this, the whole flexibility for the grid (sum over all interconnection points) will be determined under consideration of grid constraints.

From these results, the individual flexibility per generating unit will be deduced.
Each generating unit flexibility will also be assigned with sensitivities for each interconnection point and price per MWh.

- CheckFlexibilities

Business section: Active Power Flexibilities/CheckFlexibilities
TSO receives active power flexibilities and determines possibles measures and requests.

- Clustering of Flexibility

Business section: Active Power Flexibilities/Clustering of Flexibility
All flexibilities from generating units with approximately same interconnector sensitivities and prices per MWh will be grouped together.

- Processing requests

Business section: Active Power Flexibilities/Processing requests
The flexibility requests are read and realted to concerned flexibility groups

- Read Data

Business section: Active Power Flexibilities/Read Data
Read Input data from SUC Base OPF. Forecast grid data for the next 36 hours will be read and provided for further steps.

- Receiving and Forewarding Requests

Business section: Active Power Flexibilities/Receiving and Forewarding Requests
The active power flexibility requests are received from the TSO and forwarded to beeDIP
Information sent:

Business object	*Instance name*	*Instance description*
Active Power Requests	Forwarding Requests	Flexibility Requests are forewarded to the beeDIP

- Segregation of requests

Business section: Active Power Flexibilities/Segregation of requests
The requests for each group are segregated to the individual generating units.
For each generating unit, an active power setpoint is generated.

- Send Flexibilities

Business section: Active Power Flexibilities/Send Flexibilities

The list of clustered flexibilities will be sent to the TSO.

Information sent:

Business object	*Instance name*	*Instance description*
Flexibility List for TSO	Active Power Flexibility List	A list of active power flexibilities is send via SUC Data Communication

- Send Request

Business section: Active Power Flexibilities/Send Request

The TSO sends active power flexibility requests to the DSO.

Information sent:

Business object	*Instance name*	*Instance description*
Active Power Requests	InfoInstance	Active Power requests are sent to the DSO via SUC Data Communication

- Validating setpoints on related grid states

Business section: Active Power Flexibilities/Validationg setpoints on related grid states

The setpoints for generating units are applied on the related grid state (time) and under consideration of grid constraints and flexibility potential validated.

Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information exchanged*	*Requirement, R-IDs*
Info2	Flexibility List for TSO	This list contains active power flexibilities for groups of generating units. Each group is assigned with sensitivities on all iteconnnection points and prices per MWh.	

DE – COM: PERFORM DATA COMMUNICATION FOR THE GERMAN DEMO

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
DE - COM	SGAM Domain	Perform data communication for the German Demo

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-11-01	IEE	First version	
2	2018-12-03	IEE	Change requests from the first review	
3	2019-01-15	Carla Marino (E-distribuzione)	Contribution	
4	2019-01-18	IEE	Change requests from the second review	
5	2019-01-24	Carla Marino (E-distribuzione)	Modsarus fixes	

Scope and objectives of use case

Scope and objectives of use case	
Scope	The scope of this SUC in the German demonstrator are the communication and data exchange between DSO, TSO and external systems. The latter are in detail, the German demonstrator platform and the controllable assets in the field (110 kV grid).
Objective(s)	The objectives of this SUC in the German demonstrator are the communication and data exchange between DSO, TSO and external systems. The latter are in detail, the German demonstrator platform and the controllable assets in the field (110 kV grid). Therefore the following activities are necessary within this SUC: • Receive and send data between actors • Mapping and conversion in dedicated communication protocols and data standards • Check and validation of application status
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
This SUC is used for communication between DSO and all external systems. These are in detail TSO, field assets, forecasting systems and the German demonstrator platform. It will be described what kind of information will be exchanged between the named actors.
Complete description
This use case describes the communication between the individual systems: DSO, TSO, Forecast, Aggregator and Field Assets. The data exchange is required to implement the SUC RPC, APC and OPF. The data exchange looks as follows: DSO writes out the measured values as a CIM file. These are forwarded to the forecast provider. The TSO provides flexibility for real and reactive power to the DSO. The forecast provider sends the forecast to the DSO. These data (readings, forecast, etc.) are passed on to the software platform BeeDIP. This calculates setpoints, flexibilities and potentials. Then the setpoints are sent to the field assets and aggregators. Summary of use case • **Data communication between the different actors** Description: ▪ a: Generate TSO flexibilities for active and reactive power Description: Communication between DSO and TSO o From DSO: The DSO sends to TSO flexibilities for active and reactive power as well as for voltage. Also status information for the reception of requests and information from TSO as well as the status of actual processing of those requests. o To DSO: Requests based on delivered flexibilities ▪ a: Write Measurement in CIM file Description: Communication between DSO and forecasting o From DSO: Measurements in CIM CGMES format including topology data as well as master data which contain also geo locations and installed capacity. ▪ b: Generate forecast for field assets and aggregated data Description: Communication between DSO and forecasting o From DSO: Measurements in CIM CGMES format including topology data as well as master data which contain

also geo locations and installed capacity.

- To DSO:

Computed forecasting data for required field assets and aggregated data on certain connection points.

- c: Catch forecast, TSO requests
  Description: Communication between DSO and beeDIP
  - From DSO: CIM files, schedules, forecast, TSO requests, DSO requests

- d: Calculate current, setpoints, schedules, flex. potentials
  Description: Communication between DSO and beeDIP
  - To DSO: current setpoints, schedules, flexibility potentials

- e: Operating signals for adjust actual reactive/active power
  Description: Communication between DSO and aggregator/field assets
  - From DSO:

Adjusted operating schedules for active power (day ahead and intraday).

- To DSO:

Master data and in some special cases information of planned and scheduled active power output. Also are costs for flexibilities communicated.

- f: Adjust setpoints for field assets
  Description: Communication between DSO and field assets
  - From DSO:

Operating signals in order to adjust actual reactive power output.

- To DSO:

Metering data which consists of actual power output, voltage measurements and service status.

- f: Adjust setpoints for aggregator
  Description: Communication between DSO and aggregator
  - From DSO:

Adjusted operating schedules for active power (day ahead and intraday).

- To DSO:

Master data and in some special cases information of planned and scheduled active power output. Also are costs for flexibilities communicated.

Key performance indicators (KPI)

Key performance indicators			
ID	***Name***	***Description***	***Reference to mentioned use case objectives***
1	Percentage of scheduled Flexibility		
2	Data Volume		
3	Meet TSO need in delivering data		
4	Intraday update process duration		

Use case conditions

Use case conditions	
Assumptions	
1	Existing Interfaces: Already installed interfaces and implemented data models will be used. These are IEC60870-5-104, CIM CGMES, TASE.2,REST, FTP
Prerequisites	
1	Security Data Protection: Already formulated requirements for ISMS

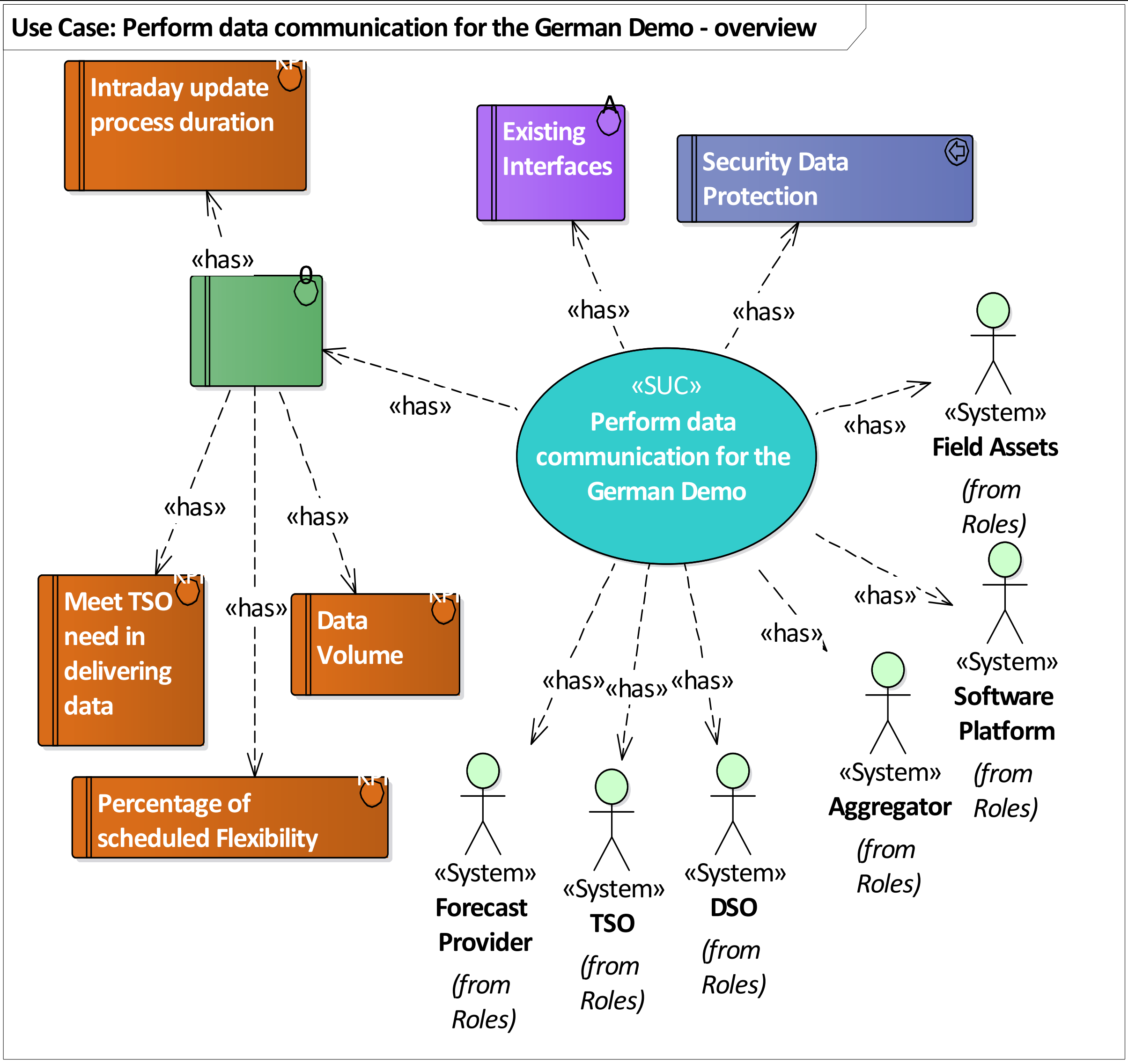
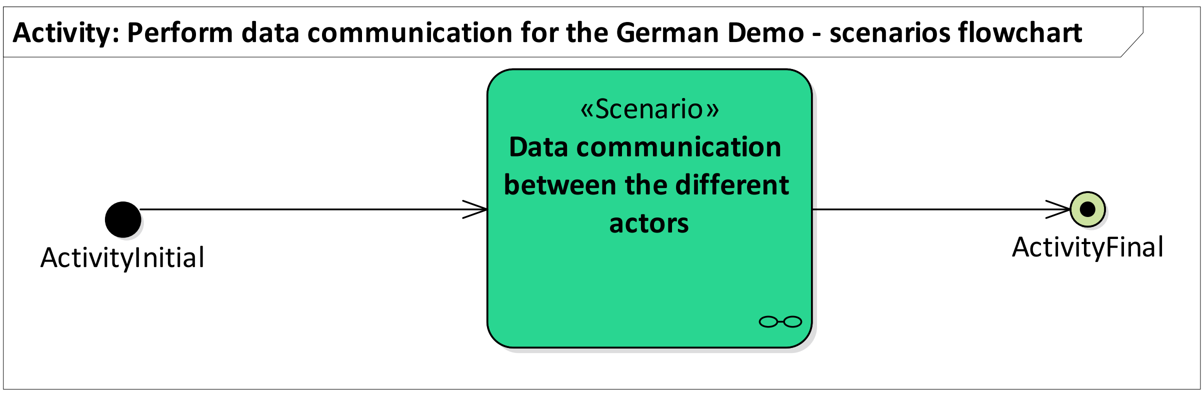
Further information to the use case for classification/mapping

Classification information
Relation to other use cases
Level of depth
White Box
Prioritisation
Generic, regional or national relation
ISMS
Nature of the use case
SUC
Further keywords for classification
TSO-DSO coordination, communication, data standards, interfaces

General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case
 

Technical details

Actors

Actors			
Grouping (e.g. domains, zones)	***Group description***		
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
Field Assets	System	Connect DSO with assets of MDO (Metering Data Operator) and G_O (Generation Operator) for data exchange (e.g. set point signals, metering data)	
Software Platform	System	Software platform (name: BeeDIP) for data collection and calculation for setpoints (reactive power / active power)	
Aggregator	System	Provides a set of generation means to mobilization.	
DSO	System	Elaborate network development plan (incl. flexibility call for tenders). Process data to optimize network operation and maintenance programs across managed voltage levels and timeframes (from planning to real-time) using available levers (e.g. flex activation, network tariffs). Define technical needs at distribution level in collaboration with TSO and commercial players (e.g. aggregators) to call flexibility products. Assess and broadcast network status to eligible actors (e.g. aggregators). Define, jointly with the TSO, technical processes and mechanisms for optimal procurement and activation of flexibility resources directly connected to the distribution grid.	
TSO	System	Operate the transmission network over a specific region in a secure, reliable and efficient way. Ensure a transparent and non-discriminatory access to the transmission network for each user. Manage the active and reactive flows and ensure the security of the network (congestion and voltage). Technically provide in an secure and efficient way the services of voltage control and restoration of supply. Apply, if required, the defence plan (load shedding orders) in case of a succession of events (overload, voltage collapse) management of cross border transactions. Provide data to the interconnection capacity market operator for the management of cross border transactions	
Forecast Provider	System	It provides power forecast in a 0 to 36h timeframe.	

References

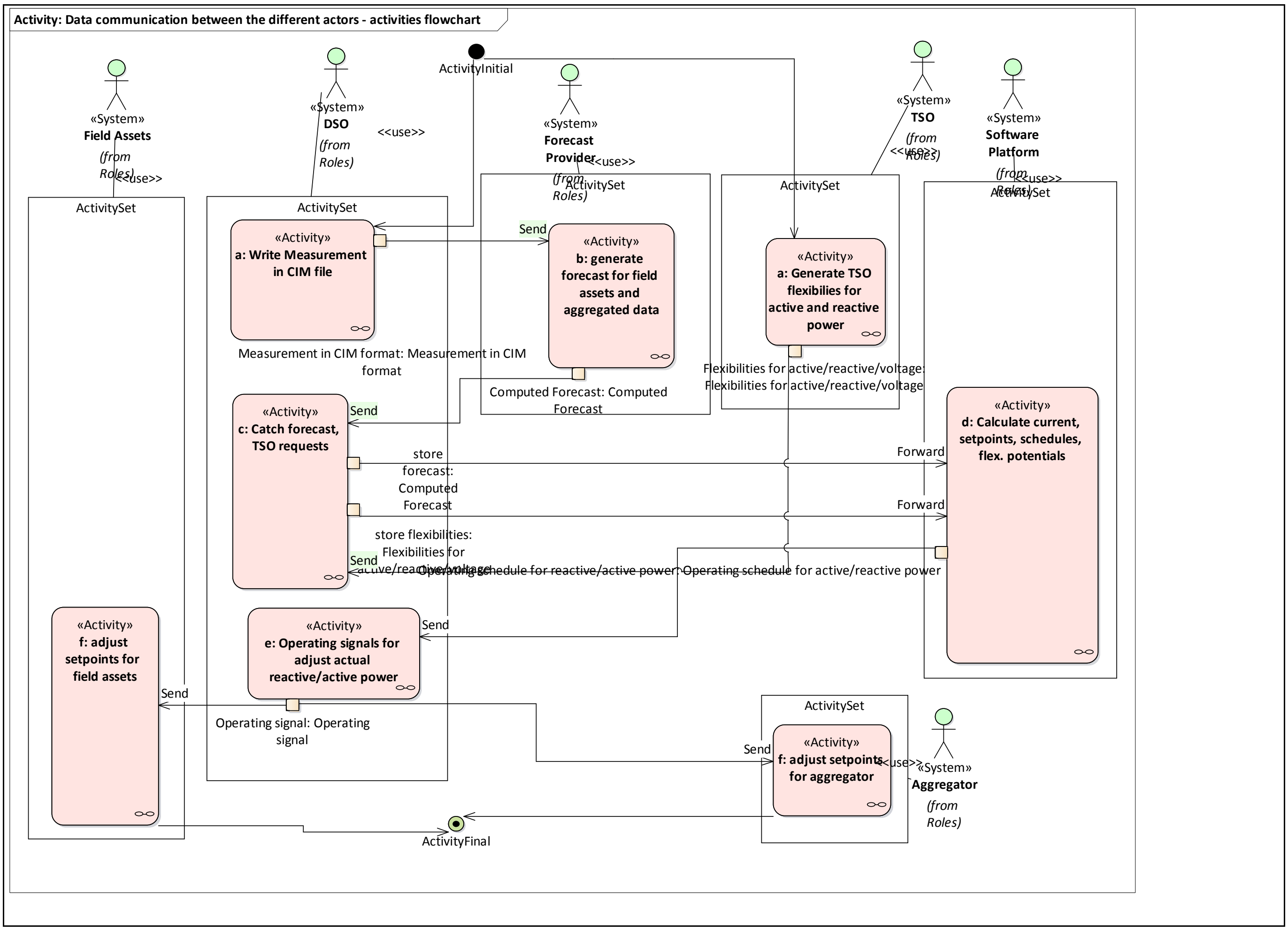
Step by step analysis of use case

Overview of scenarios

Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	Data communication between the different actors					

Steps - Scenarios

<u>Data communication between the different actors</u>



Scenario step by step analysis

Scenario								
Scenario name	Data communication between the different actors							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.1		a: Generate TSO flexibilities for active and reactive power	Communication between DSO and TSO • From DSO: The DSO sends to TSO flexibilities for active and reactive power as well as for voltage. Also status information for the reception of requests and information from TSO as well as the status of actual processing of those requests. • To DSO: Requests based on delivered flexibilities	Send	TSO	DSO	Info1-Flexibilities for active/reactive/voltage	
1.2		a: Write Measurement in CIM file	Communication between DSO and forecasting • From DSO: Measurements in CIM CGMES format including topology data as well as master data which contain also geo locations and installed capacity.	Send	DSO	Forecast Provider	Info2-Measurement in CIM format	

1.3		b: Generate forecast for field assets and aggregated data	Communication between DSO and forecasting • From DSO: Measurements in CIM CGMES format including topology data as well as master data which contain also geo locations and installed capacity. • To DSO: Computed forecasting data for required field assets and aggregated data on certain connection points.	Send	Forecast Provider	DSO	Info3-Computed Forecast	
1.4		c: Catch forecast, TSO requests	Communication between DSO and beeDIP • From DSO: CIM files, schedules, forecast, TSO requests, DSO requests	Forward	DSO	Software Platform	Info1-Flexibilities for active/reactive/voltage, Info3-Computed Forecast	
1.5		d: Calculate current, setpoints, schedules, flex. potentials	Communication between DSO and beeDIP • To DSO: current setpoints, schedules, flexibility potentials	Send	Software Platform	DSO	Info4-Operating schedule for active/reactive power	
1.6		e: Operating signals for adjust	Communication between DSO and	Send	DSO	Aggregator, Field Assets	Info5-Operating signal	

		actual reactive/active power	aggregator/field assets • From DSO: Adjusted operating schedules for active power (day ahead and intraday). • To DSO: Master data and in some special cases information of planned and scheduled active power output. Also are costs for flexibilities communicated.					
1.7		f: Adjust setpoints for field assets	Communication between DSO and field assets • From DSO: Operating signals in order to adjust actual reactive power output. • To DSO: Metering data which consists of actual power output, voltage measurements and service status.		Field Assets			
1.8		f: Adjust setpoints for aggregator	Communication between DSO and aggregator • From DSO: Adjusted operating schedules for		Aggregator			

			active power (day ahead and intraday). • To DSO: Master data and in some special cases information of planned and scheduled active power output. Also are costs for flexibilities communicated.					

- a: Generate TSO flexibilies for active and reactive power

Business section: Data communication between the different actors/a: Generate TSO flexibilies for active and reactive power

Communication between DSO and TSO

- From DSO:

The DSO sends to TSO flexibilities for active and reactive power as well as for voltage. Also status information for the reception of requests and information from TSO as well as the status of actual processing of those requests.

- To DSO:

Requests based on delivered flexibilities

Information sent:

Business object	***Instance name***	***Instance description***
Flexibilities for active/reactive/voltage	Flexibilities for active/reactive/voltage	Flexibilities for active and reactive power as well as for voltage. Also status information for the reception of requests and information from TSO as well as the status of actual processing of those requests

- a: Write Measurement in CIM file

Business section: Data communication between the different actors/a: Write Measurement in CIM file Communication between DSO and forecasting

- From DSO:

Measurements in CIM CGMES format including topology data as well as master data which contain also geo locations and installed capacity.

Information sent:

Business object	*Instance name*	*Instance description*
Measurement in CIM format	Measurement in CIM format	Measurements in CIM CGMES format including topology data as well as master data which contain also geo locations and installed capacity

- b: Generate forecast for field assets and aggregated data

Business section: Data communication between the different actors/b: generate forecast for field assets and aggregated data

Communication between DSO and forecasting

- From DSO:

Measurements in CIM CGMES format including topology data as well as master data which contain also geo locations and installed capacity.

- To DSO:

Computed forecasting data for required field assets and aggregated data on certain connection points.
Information sent:

Business object	*Instance name*	*Instance description*
Computed Forecast	Computed Forecast	for required field assets and aggregated data on certain connection points

- c: Catch forecast, TSO requests

Business section: Data communication between the different actors/c: Catch forecast, TSO requests
Communication between DSO and beeDIP

- From DSO: CIM files, schedules, forecast, TSO requests, DSO requests

Information sent:

Business object	*Instance name*	*Instance description*
Flexibilities for active/reactive/voltage	store flexibilities	store flexibilities
Computed Forecast	store forecast	store forecast

- d: Calculate current, setpoints, schedules, flex. potentials

Business section: Data communication between the different actors/d: Calculate current, setpoints, schedules, flex. potentials

Communication between DSO and beeDIP

- To DSO: current setpoints, schedules, flexibility potentials

Information sent:

Business object	*Instance name*	*Instance description*
Operating schedule for active/reactive power	Operating schedule for reactive/active power	day ahead and intraday

- e: Operating signals for adjust actual reactive/active power

Business section: Data communication between the different actors/e: Operating signals for adjust actual reactive/active power

Communication between DSO and aggregator/field assets

- From DSO:

Adjusted operating schedules for active power (day ahead and intraday).

- To DSO:

Master data and in some special cases information of planned and scheduled active power output. Also are costs for flexibilities communicated.

Information sent:

Business object	*Instance name*	*Instance description*
Operating signal	Operating signal	in order to adjust actual reactive power output

- f: adjust setpoints for field assets

Business section: Data communication between the different actors/f: adjust setpoints for field assets Communication between DSO and field assets

- From DSO:

Operating signals in order to adjust actual reactive power output.

- To DSO:

Metering data which consists of actual power output, voltage measurements and service status.

- f: adjust setpoints for aggregator

Business section: Data communication between the different actors/f: adjust setpoints for aggregator Communication between DSO and aggregator

  - From DSO:

Adjusted operating schedules for active power (day ahead and intraday).

  - To DSO:

Master data and in some special cases information of planned and scheduled active power output. Also are costs for flexibilities communicated.

Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
Info1	Flexibilities for active/reactive/voltage	Flexibilities for active and reactive power as well as for voltage. Also status information for the reception of requests and information from TSO as well as the status of actual processing of those requests	
Info2	Measurement in CIM format	Measurements in CIM CGMES format including topology data as well as master data which contain also geo locations and installed capacity	
Info3	Computed Forecast	for required field assets and aggregated data on certain connection points	
Info4	Operating schedule for active/reactive power	day ahead and intraday	
Info5	Operating signal	in order to adjust actual reactive power output	

DE – DATA: PERFORM DATA MANAGEMENT FOR THE GERMAN DEMO

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
DE - DATA	SGAM Domain	Perform data management for the German Demo

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-11-01	IEE	First version	
2	2018-12-03	IEE	Change requests from the first review	
3	2019-01-15	Carla Marino (E-distribuzione)	Contribution	
4	2019-01-18	IEE	Change requests from the second review	
5	2019-01-24	Carla Marino (E-distribuzione)	ModSarus fixes	

Scope and objectives of use case

Scope and objectives of use case	
Scope	This use case describes the internal data exchange and communication within the BeeDIP system platform between all integrated modules. Data exchange and administration plays an important role in BeeDIP system. The objective of this SUC in the German demonstrator is to enable the internal communication between the different modules and how the different data is administered.
Objective(s)	Therefore the following activities are necessary within this SUC: • Transformation and validation of different data and its formats • Administration of data bases • Monitoring and administration of different communication
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
This SUC is used for all data management and internal communication within the BeeDIP system. This contains

monitoring and persistence of different data and its formats.
Complete description
This use case describes how the individual data is stored and managed.

Summary of use case

- **CIM2BeeDIP**
  Description: The control room or its subordinate systems (here PCOM) provides CIM data. The BeeDIP platform records these and saves them in a database
  - a: ProvideCIM
    Description: produce a CIM file and copy it to the CIM file Folder
  - b: RegCIMFile
    Description: Register new CIM file
  - c: ParseCIMFile
    Description: Parse CIM file and save to SQL database
- **CIM2PP**
  Description: Here the CIM information is converted as Pandapower for the grid calculation.
  - a: ReadCIM
    Description: Read the CIM information via REST
  - b: database2Rest
    Description: Provide the database via REST
  - c: CIMConvert2PP
    Description: CIM information will be converted to pandapower
- **CIMVIAREST**
  Description: Here, the CIM data is provided via REST in JSON format to the other modules (e.g., grid computation).
  - a: readFromDB
    Description: Read CIM information from DB
  - b: convert2JSON
    Description: Convert the SQL information 2 JSON format
  - c: RepresentViaREST
    Description: Represent the JSON via REST

- **Forecast2CIM**
  Description: Forecast information (for example, for reactive power delivery) is converted to CIM format and archived.
  - a: ForecastProvide
    Description: Provide forecast information
  - b: readForecastInformation
    Description: Read the forecast information (custom format)
  - c: saveToSQLDatabase
    Description: Save forecast as CIM to database

Key performance indicators (KPI)

Key performance indicators			
ID	***Name***	***Description***	***Reference to mentioned use case objectives***
1	Data Volume		
2	Intraday update process duration		

Use case conditions

Use case conditions	
Assumptions	
1	Existing Interfaces: Already installed interfaces and implemented data models will be used. These are IEC60870-5-104, CIM CGMES, TASE.2,REST, FTP
Prerequisites	
1	Security Data Protection: Already formulated requirements for ISMS

Further information to the use case for classification/mapping

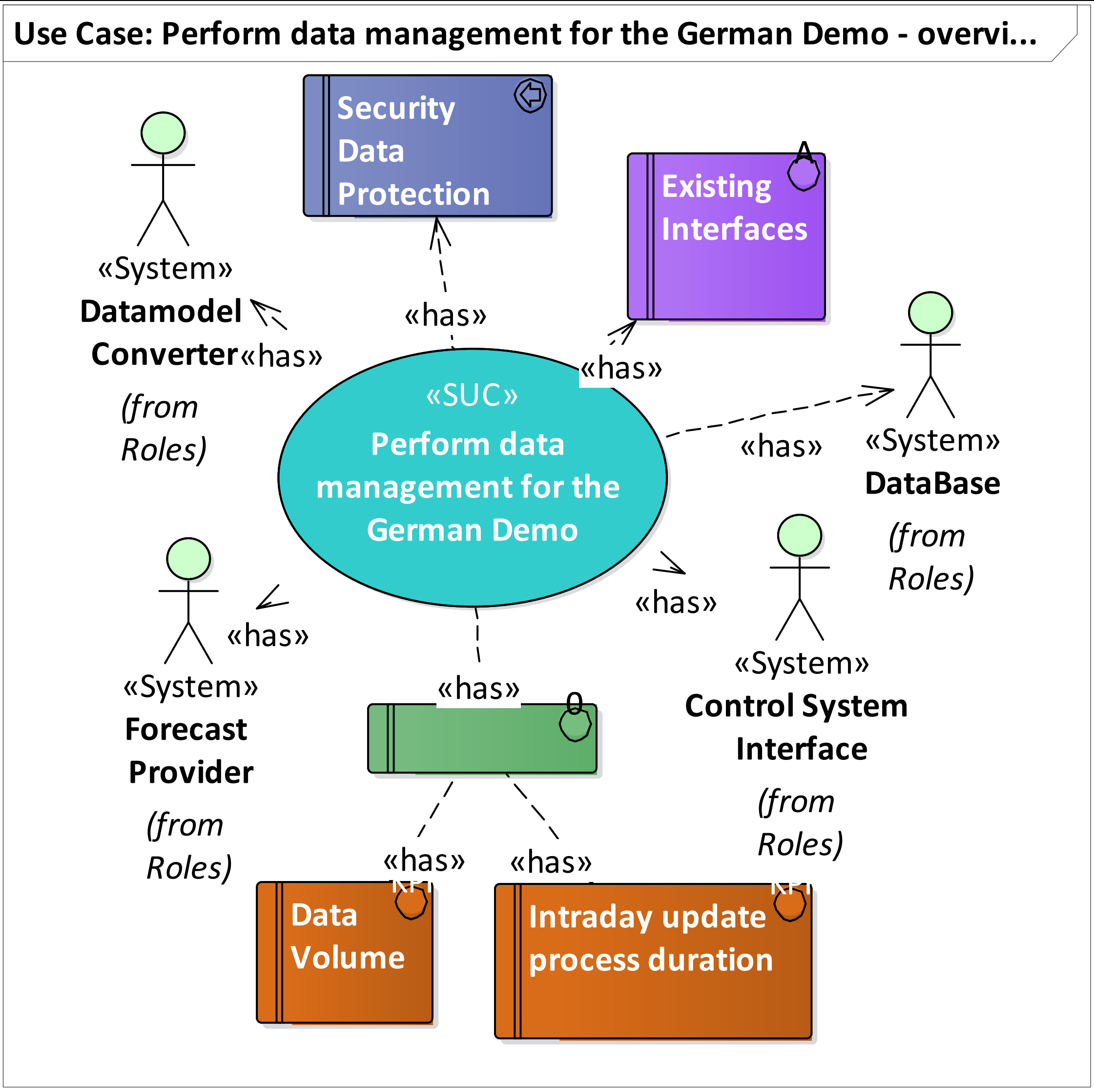
Classification information
Relation to other use cases
Level of depth
White Box
Prioritisation
Generic, regional or national relation
ISMS
Nature of the use case
SUC
Further keywords for classification
Communication, data standards, interfaces, data management

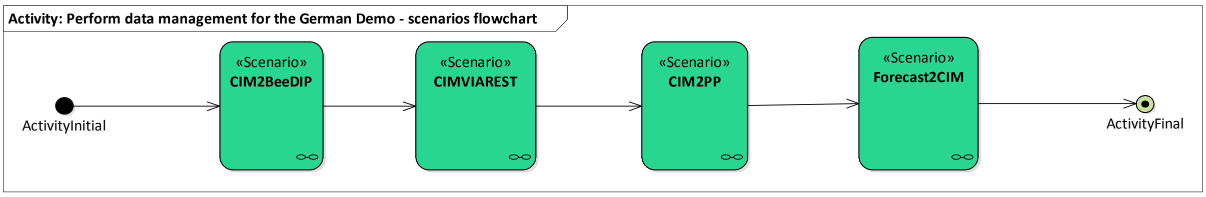
General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case





Technical details

Actors

Actors			
Grouping (e.g. domains, zones)		***Group description***	
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
Datamodel Converter	System	This system converts the datamodel into the PandaPower datamodel (for better processing).	
Forecast Provider	System	It provides power forecast in a 0 to 36h timeframe.	
DataBase	System	In this database, CIM, forecast and setpoints are stored and archived.	
Control System Interface	System	It is the interface to the control system (PCOM) and provides the CIM data.	

References

Step by step analysis of use case

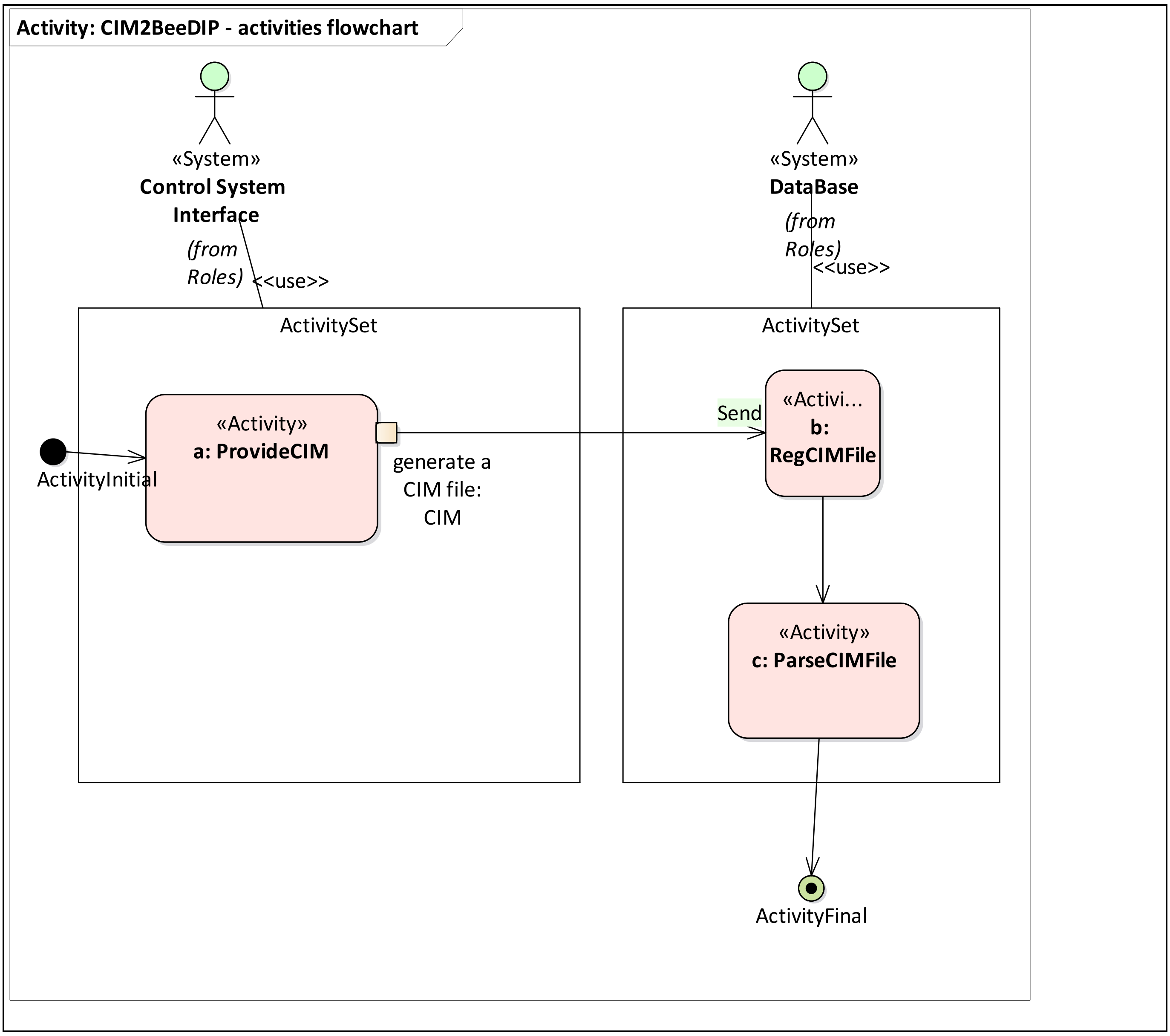
Overview of scenarios

Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	CIM2BeeDIP	The control room or its subordinate systems (here PCOM) provides CIM data. The BeeDIP platform records these and saves them in a database				
2	CIM2PP	Here the CIM information is converted as Pandapower for the grid calculation.				
3	CIMVIAREST	Here, the CIM data is provided via REST in JSON format to the other modules (e.g., grid computation).				
4	Forecast2CIM	Forecast information (for example, for reactive power delivery) is converted to CIM format and archived.				

Steps – Scenarios

CIM2BeeDIP

The control room or its subordinate systems (here PCOM) provides CIM data. The BeeDIP platform records these and saves them in a database



Scenario step by step analysis

Scenario								
Scenario name	CIM2BeeDIP							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.1		a: ProvideCIM	produce a CIM file and copy it to the CIM file Folder	Send	Control System Interface	DataBase	Info1-CIM	
1.2		b: RegCIMFile	Register new CIM file		DataBase			
1.3		c: ParseCIMFile	Parse CIM file and save to SQL database		DataBase			

- a: ProvideCIM

Business section: CIM2BeeDIP/a: ProvideCIM

Produce a CIM file and copy it to the CIM file Folder

Information sent:

Business object	*Instance name*	*Instance description*
CIM	generate a CIM file	generate a CIM file

- b: RegCIMFile

Business section: CIM2BeeDIP/b: RegCIMFile

Register new CIM file

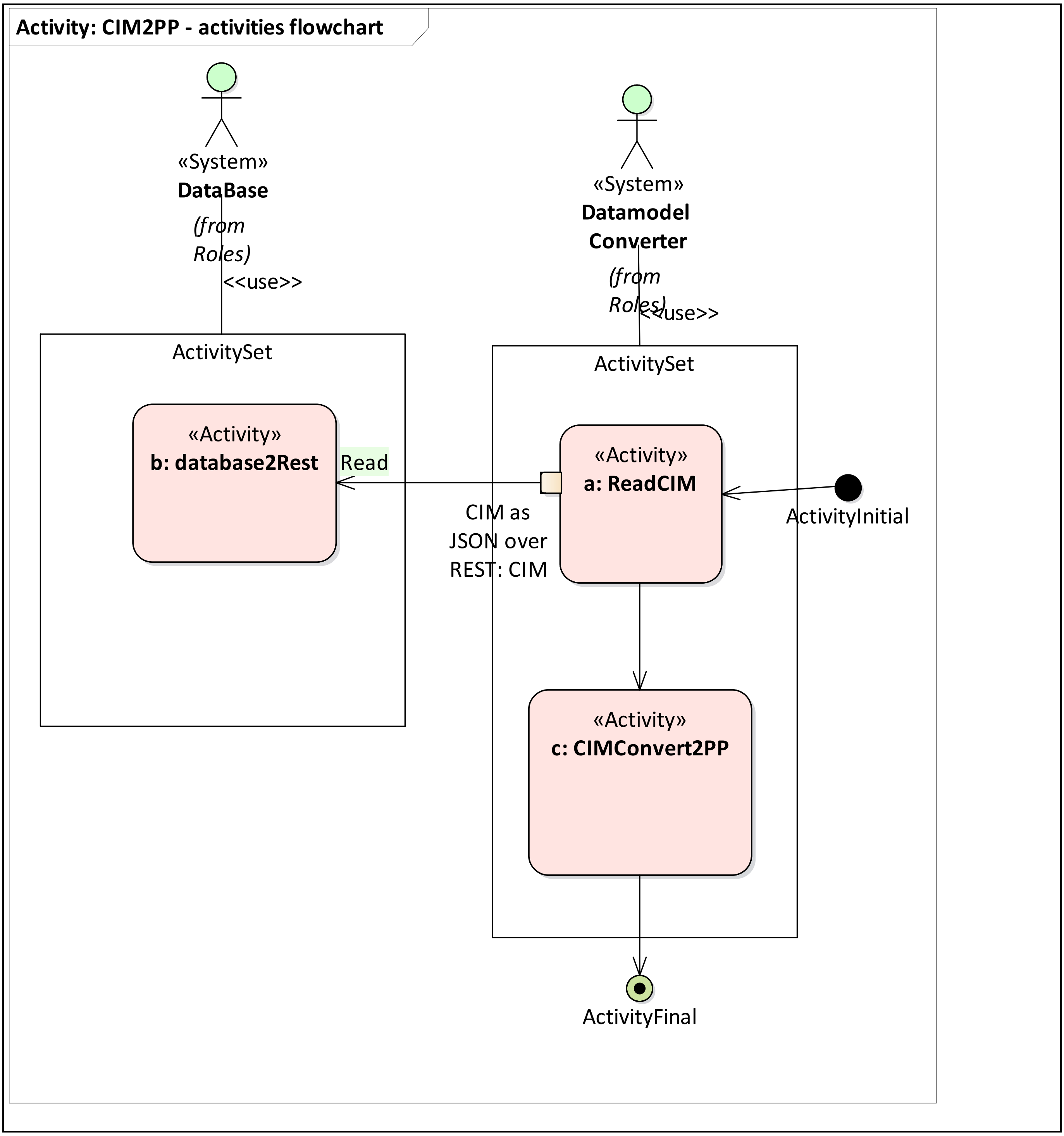
- c: ParseCIMFile

Business section: CIM2BeeDIP/c: ParseCIMFile

Parse CIM file and save to SQL database

CIM2PP

Here the CIM information is converted as Pandapower for the grid calculation.


Activity: CIM2PP - activities flowchart
«System»
DataBase
(from
Roles)
<<use>>
«System»
Datamodel
Converter
(from
Roles)
<<use>>
ActivitySet
«Activity»
b: database2Rest
Read
ActivitySet
«Activity»
a: ReadCIM
CIM as
JSON over
REST: CIM
ActivityInitial
«Activity»
c: CIMConvert2PP
ActivityFinal

Scenario step by step analysis

Scenario								
Scenario name	CIM2PP							
Step No	**Event**	**Name of process/activity**	**Description of process/activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information exchanged (IDs)**	**Requirement, R-IDs**
2.1		a: ReadCIM	Read the CIM information via REST	Read	Datamodel Converter	DataBase	Info1-CIM	
2.2		b: database2Rest	Provide the database via REST		DataBase			
2.3		c: CIMConvert2PP	CIM information will be converted to pandapower		Datamodel Converter			

- a: ReadCIM

Business section: CIM2PP/a: ReadCIM

Read the CIM information via REST

Information sent:

Business object	Instance name	Instance description
CIM	CIM as JSON over REST	

- b: database2Rest

Business section: CIM2PP/b: database2Rest

Provide the database via REST

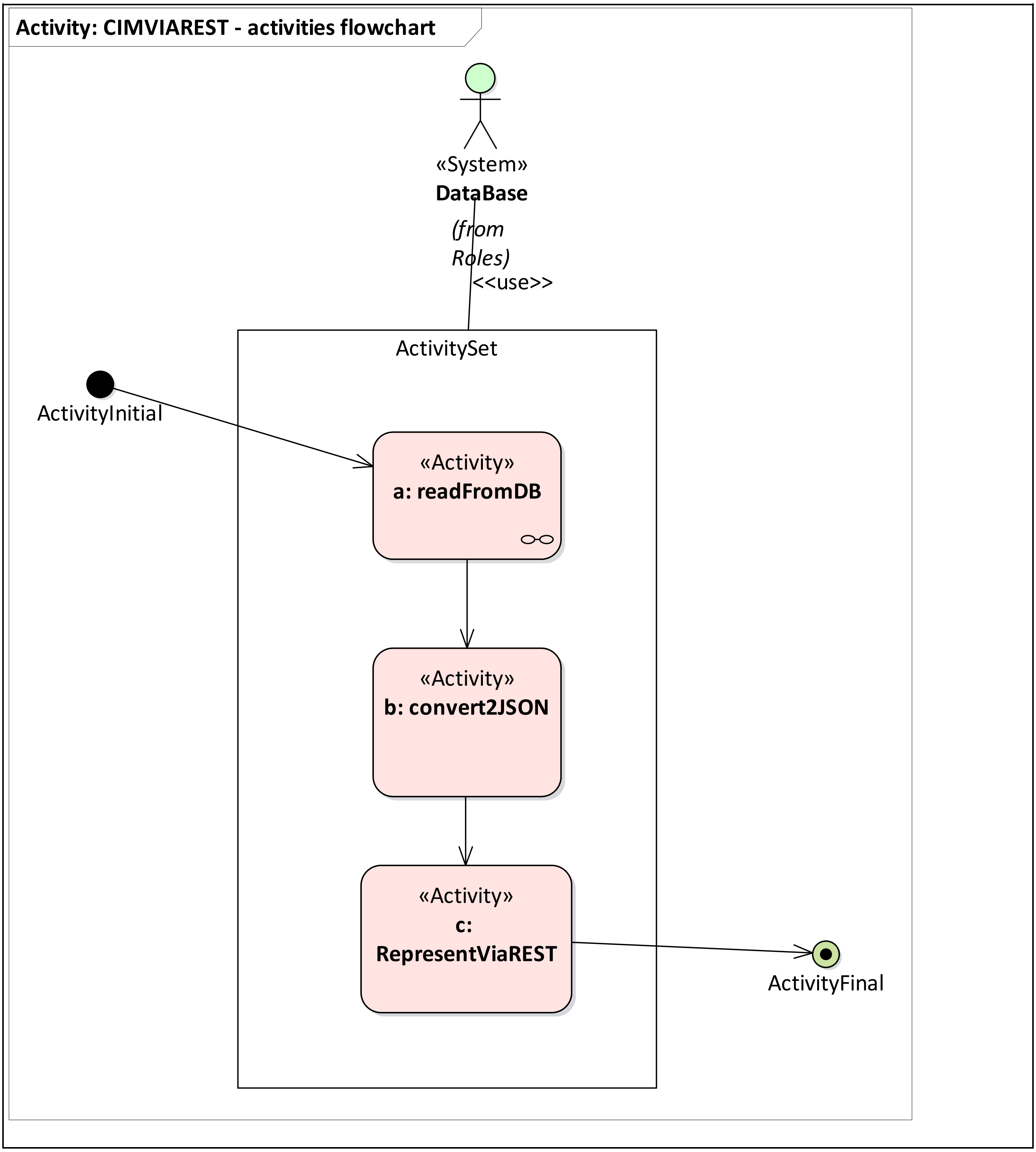
- c: CIMConvert2PP

Business section: CIM2PP/c: CIMConvert2PP

CIM information will be converted to pandapower

CIMVIAREST

Here, the CIM data is provided via REST in JSON format to the other modules (e.g., grid computation).



Scenario step by step analysis

Scenario								
Scenario name	CIMVIAREST							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
3.1		a: readFromDB	Read CIM information from DB		DataBase			
3.2		b: convert2JSON	Convert the SQL information 2 JSON format		DataBase			
3.3		c: RepresentViaREST	Represent the JSON via REST		DataBase			

- a: readFromDB

  Business section: CIMVIAREST/a: readFromDB

  Read CIM information from DB

- b: convert2JSON

  Business section: CIMVIAREST/b: convert2JSON

  Convert the SQL information 2 JSON format

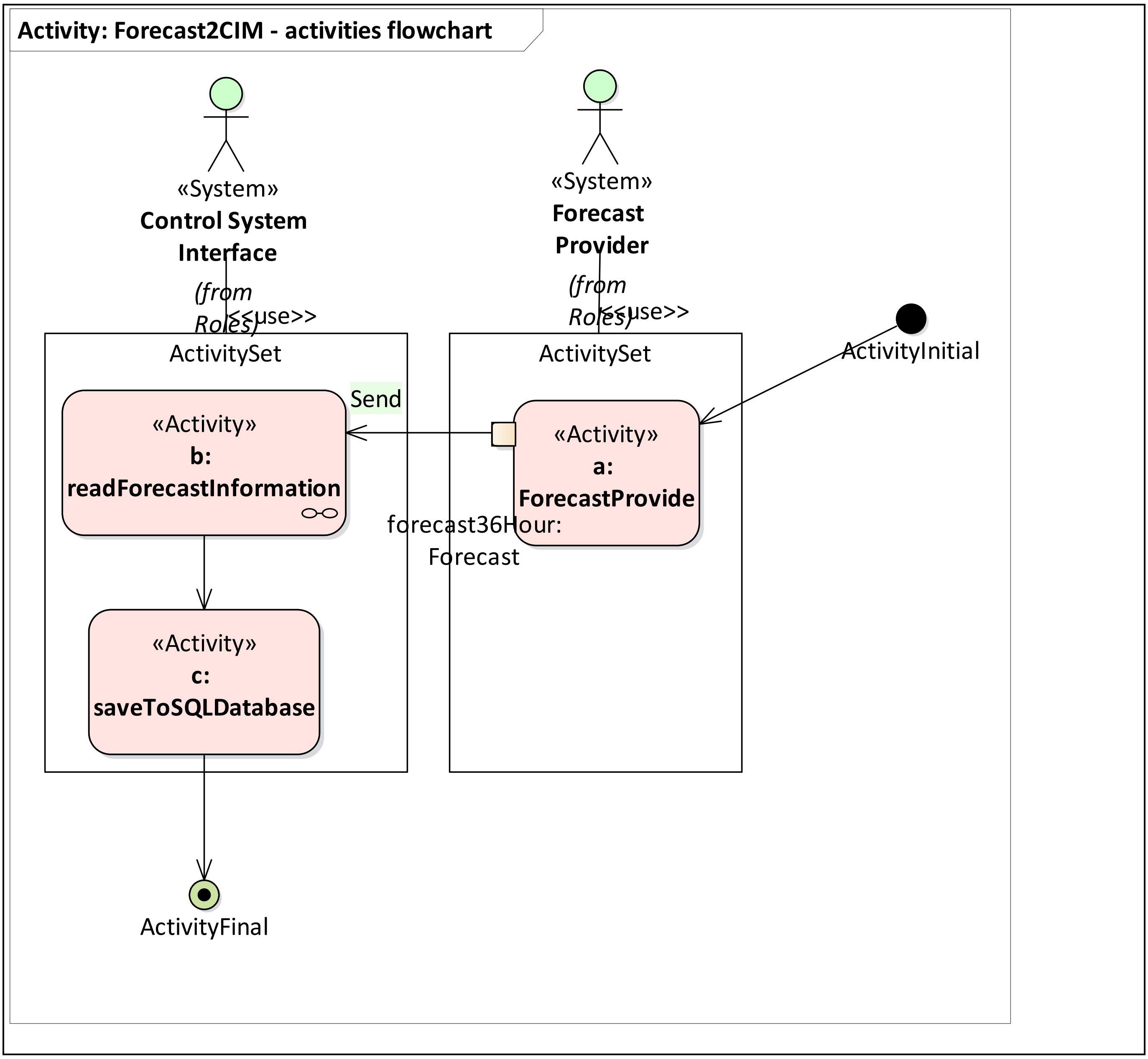
- c: RepresentViaREST

  Business section: CIMVIAREST/c: RepresentViaREST

  Represent the JSON via REST

Forecast2CIM

Forecast information (for example, for reactive power delivery) is converted to CIM format and archived.



Scenario step by step analysis

Scenario								
Scenario name	Forecast2CIM							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
4.1		a: ForecastProvide	Provide forecast information	Send	Forecast Provider	Control System Interface	Info2-Forecast	

4.2		b: readForecastInformation	Read the forecast information (custom format)		Control System Interface			
4.3		c: saveToSQLDatabase	Save forecast as CIM to database		Control System Interface			

- a: ForecastProvide

  Business section: Forecast2CIM/a: ForecastProvide

  Provide forecast information

  Information sent:

Business object	*Instance name*	*Instance description*
Forecast	forecast36Hour	forecast for the next 36 hours

- b: readForecastInformation

  Business section: Forecast2CIM/b: readForecastInformation

  Read the forecast information (custom format)

- c: saveToSQLDatabase

  Business section: Forecast2CIM/c: saveToSQLDatabase

  Save forecast as CIM to database

Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information exchanged*	*Requirement, R-IDs*
Info1	CIM	All grid information as CIM data.	
Info2	Forecast	The forecast data is displayed in a custom format (for example, CSV files).	

DE – FC: FORECAST OF LOAD AND INFEED FOR THE GERMAN DEMO

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
DE - FC	SGAM Domain	Forecast of load and infeed for the German Demo

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-11-01	IEE	First version	
2	2018-12-03	IEE	Change requests from the first review	
3	2019-01-15	Carla Marino (E-distribuzione)	Contribution	
4	2019-01-18	IEE	Change requests from the second review	
5	2019-01-24	Carla Marino (E-distribuzione)	ModSarus fixes	

Scope and objectives of use case

Scope and objectives of use case	
Scope	Delivering of up-to-date energy forecasts (Wind, PV and Consumption) to the Demonstrator System.
Objective(s)	Forecasting plays a crucial role within all other SUCs, since it is the basis for generating and optimizing schedules for flexibility potentials. Within this SUC, the handling of input and output forecast data will be described. Therefore the following activities are necessary within this SUC: • Read and process current measurement data from field devices • Read and process numerical weather prediction data • Computation of intraday and day ahead forecast data • Provision of resulting forecasting data
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
The Demonstrator optimizes the "grid" based on the consumption and power production forecast of the renewables in the electrical grid. For this reason, the control center system at DSO regularly retrieves up-to-date forecasts from the forecasting systems hosted at the software provider via the Control System Interface (P-COM).
Complete description

Summary of use case

- **Data Input**
  Description: The grid measurements are from HV substations under which MV grids are located and they represent pure generation, consumption and mix of consumption and generation. These measurements consist of different kinds of injection and are separated in order to be processed in next steps.
  - a: Provide the CIM data
    Description: PCOM produce a CIM file and copy it to the CIM file Folder
  - b: ParseCIMFile
    Description: Parse CIM file and save to Warehouse
  - c: TheSplitter
    Description: Split Power data into Consumption, Wind and PV
  - d: ParseGribData
    Description: Parse NWP Gribdata

- **Data Output**
  Description: The resulting data will then be provided to the DSO in order to be processed further.
  - a: ParseOutputFile
    Description: Parse forecast to output file format
  - b: receive forecast
    Description: receive forecast in specify file format

- **Forecast Processing**
  Description: Based on NWP data and historical measurements machine learning algorithms were trained and now used to generate with the help of online measurements from scenario 1 and NWP up to date forecast for consumption, Wind and PV for the next 36 hours. The results are valid for HV side of the substations.
  - a: Create the IntraDay forecast
    Description: Creates Intraday Forecast
  - b: Create the Day- Ahead forecast

Description: Create the Day- Ahead forecast ▪ c: TheMerger Description: Create a seamless forecast

Key performance indicators (KPI)

Key performance indicators			
ID	***Name***	***Description***	***Reference to mentioned use case objectives***
1	Active Power Flow Forecast Quality - Intraday		
2	Active Power Flow Forecast Quality – Day Ahead		

Use case conditions

Use case conditions	
Assumptions	
1	Existing Interfaces: Already installed interfaces and implemented data models will be used. These are P-COM communication, CIM CGMES, REST
Prerequisites	
1	Available Online data: The forecast module can only calculate a forecast if all data from the external data sources are available when the scheduler starts the calculation.
2	Up to date Measurements: The vertical load should not be delivered later than defined amounts of minutes after the measurement has been taken.

Further information to the use case for classification/mapping

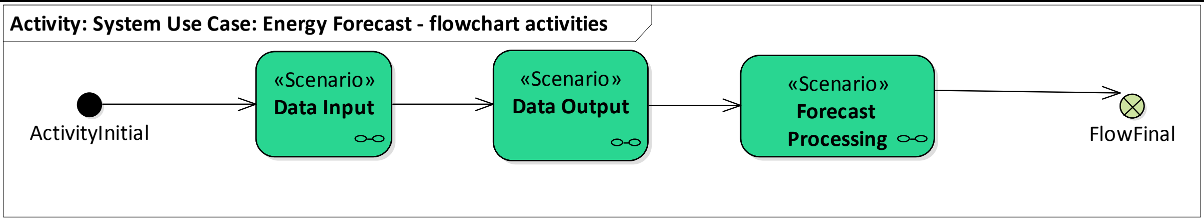
Classification information
Relation to other use cases
Level of depth
White Box
Prioritisation
Generic, regional or national relation
Nature of the use case
SUC
Further keywords for classification
Forecast, Consumption, Wind, PV, Vertical Load

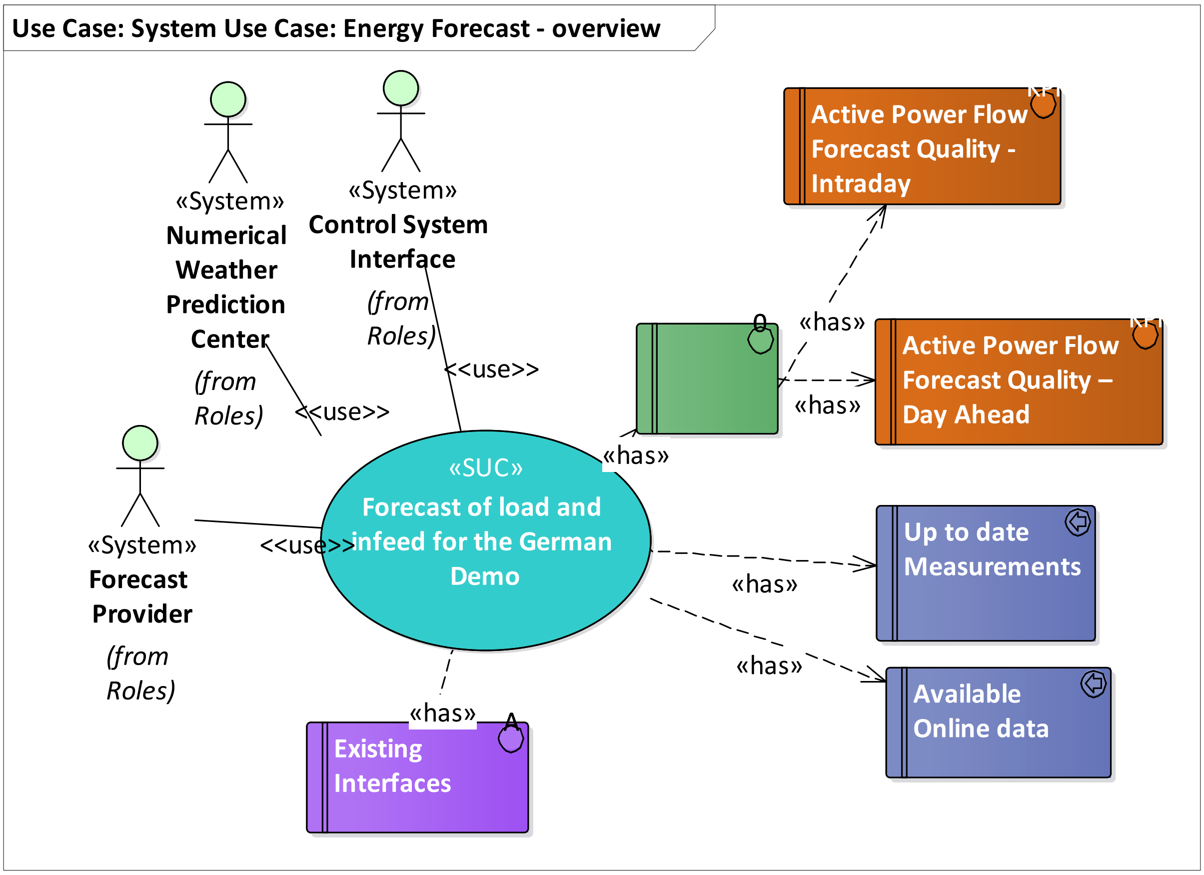
General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case





Technical details

Actors

Actors			
Grouping (e.g. domains, zones)		*Group description*	
Actor name	*Actor type*	*Actor description*	*Further information specific to this use case*
Forecast Provider	System	It provides power forecast in a 0 to 36 h timeframe.	
Control System Interface	System	It is the interface to the control system (PCOM) and provides the CIM data.	
Numerical Weather Prediction Center	System	Delivers up-to-date weather prediction data of the area to forecast to the Demo forecast systems	

References

Step by step analysis of use case

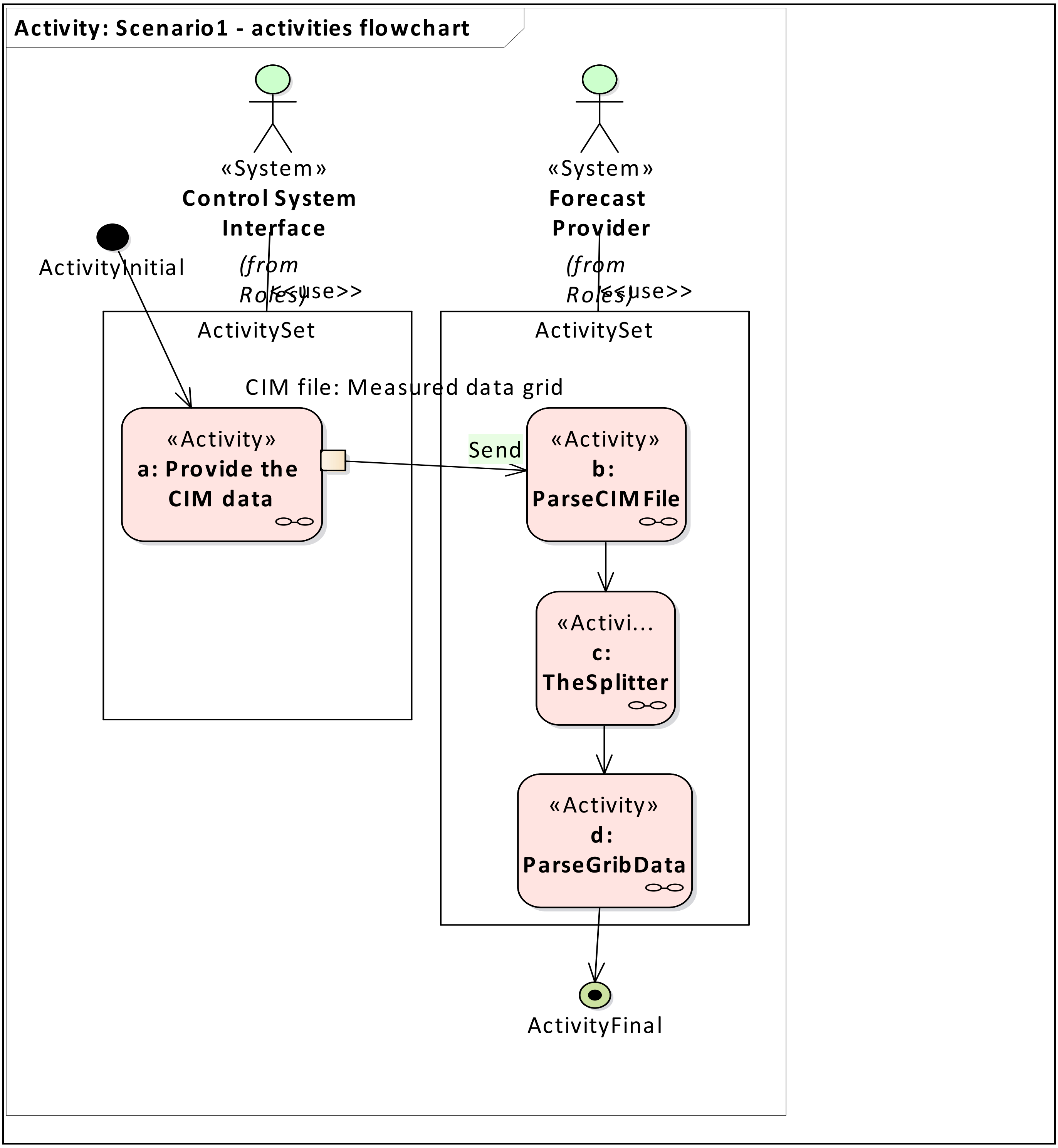
Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario description*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post-condition*
1	Data Input	The grid measurements are from HV substations under which MV grids are located and they represent pure generation, consumption and mix of consumption and generation. These measurements consist of different kinds of injection and are separated in order to be processed in next steps.				
2	Data Output	The resulting data will then be provided to the DSO in order to be processed further.				
3	Forecast Processing	Based on NWP data and historical measurements machine learning algorithms were trained and now used to generate with the help of online measurements from scenario 1 and NWP up to date forecast for consumption, Wind and PV for the next 36 hours. The results are valid for HV side of the substations.				

Steps – Scenarios

Data Input

The grid measurements are from HV substations under which MV grids are located and they represent pure generation, consumption and mix of consumption and generation. These measurements consist of different kinds of injection and are separated in order to be processed in next steps.



Scenario step by step analysis

Scenario								
Scenario name	Data Input							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.1		a: Provide the CIM data	PCOM produce a CIM file and copy it to the CIM file Folder	Send	Control System Interface	Forecast Provider	Info1-Measured data grid	
1.2		b: ParseCIMFile	Parse CIM file and save to Warehouse		Forecast Provider			
1.3		c: TheSplitter	Split Power data into Consumption, Wind and PV		Forecast Provider			
1.4		d: ParseGribData	Parse NWP Gribdata		Forecast Provider			

- a: Provide the CIM data

  Business section: Data Input/a: Provide the CIM data

  PCOM produce a CIM file and copy it to the CIM file Folder

  Information sent:

Business object	*Instance name*	*Instance description*
Measured data grid	CIM file	meas data grid as CIM file

- b: ParseCIMFile

  Business section: Data Input/b: ParseCIMFile

  Parse CIM file and save to Warehouse

- c: TheSplitter

  Business section: Data Input/c: TheSplitter

  Split Power data into Consumption, Wind and PV

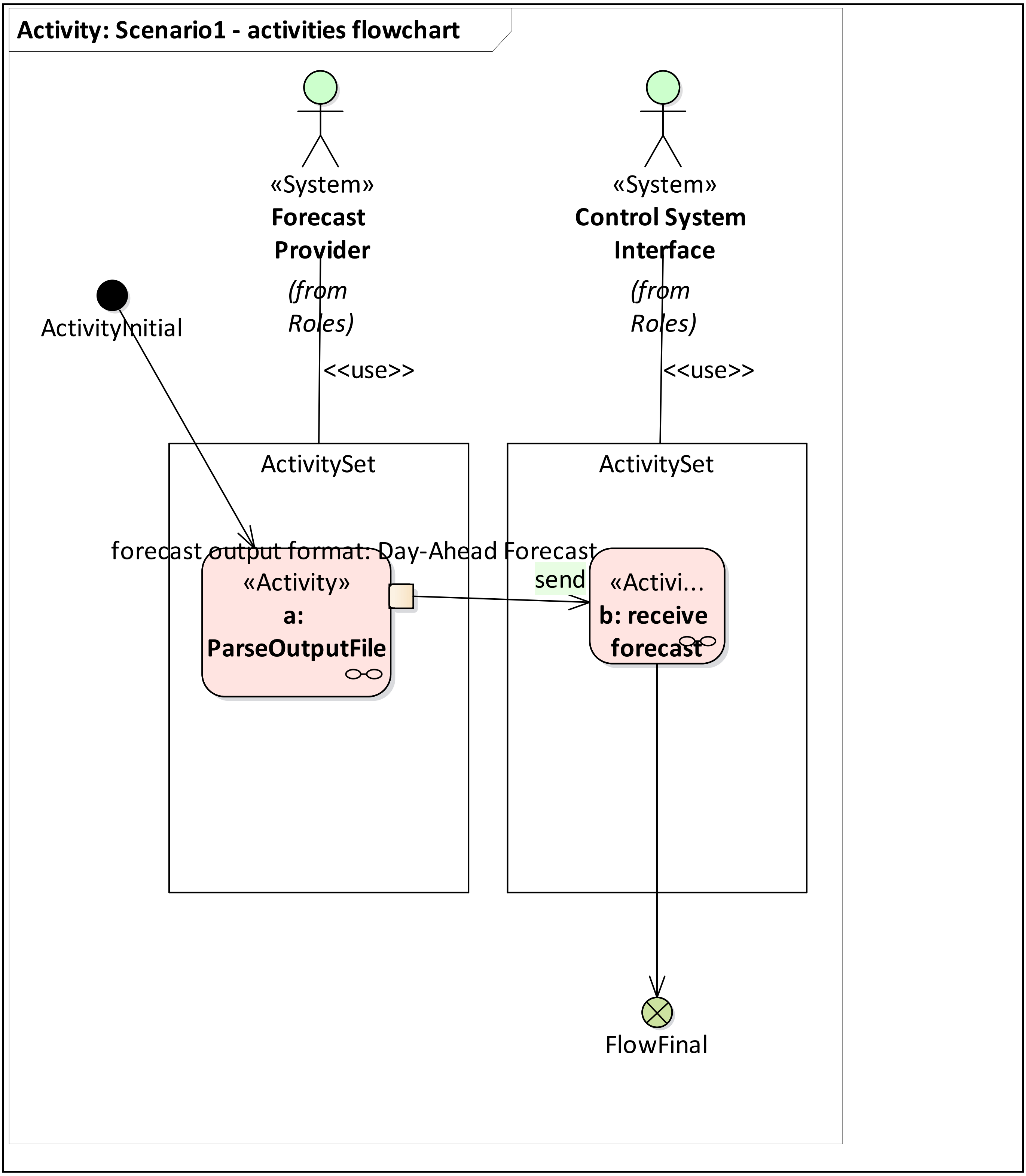
- d: ParseGribData

  Business section: Data Input/d: ParseGribData

  Parse NWP Gribdata

Data Output

The resulting data will then be provided to the DSO in order to be processed further.


Activity: Scenario1 - activities flowchart
«System»
Forecast Provider
(from Roles)
«System»
Control System Interface
(from Roles)
ActivityInitial
<<use>>
<<use>>
ActivitySet
ActivitySet
forecast output format: Day-Ahead Forecast
send
«Activity»
a: ParseOutputFile
«Activi...
b: receive forecast
FlowFinal

Scenario step by step analysis

Scenario								
Scenario name	Data Output							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
2.1		a: ParseOutputFile	Parse forecast to output file format	send	Forecast Provider	Control System Interface	Info2-Day-Ahead Forecast	
2.2		b: receive forecast	receive forecast in specify file format		Control System Interface			

- a: ParseOutputFile

  Business section: Data Output/a: ParseOutputFile

  Parse forecast to output file format

  Information sent:

Business object	*Instance name*	*Instance description*
Day-Ahead Forecast	forecast output format	forecast as output format

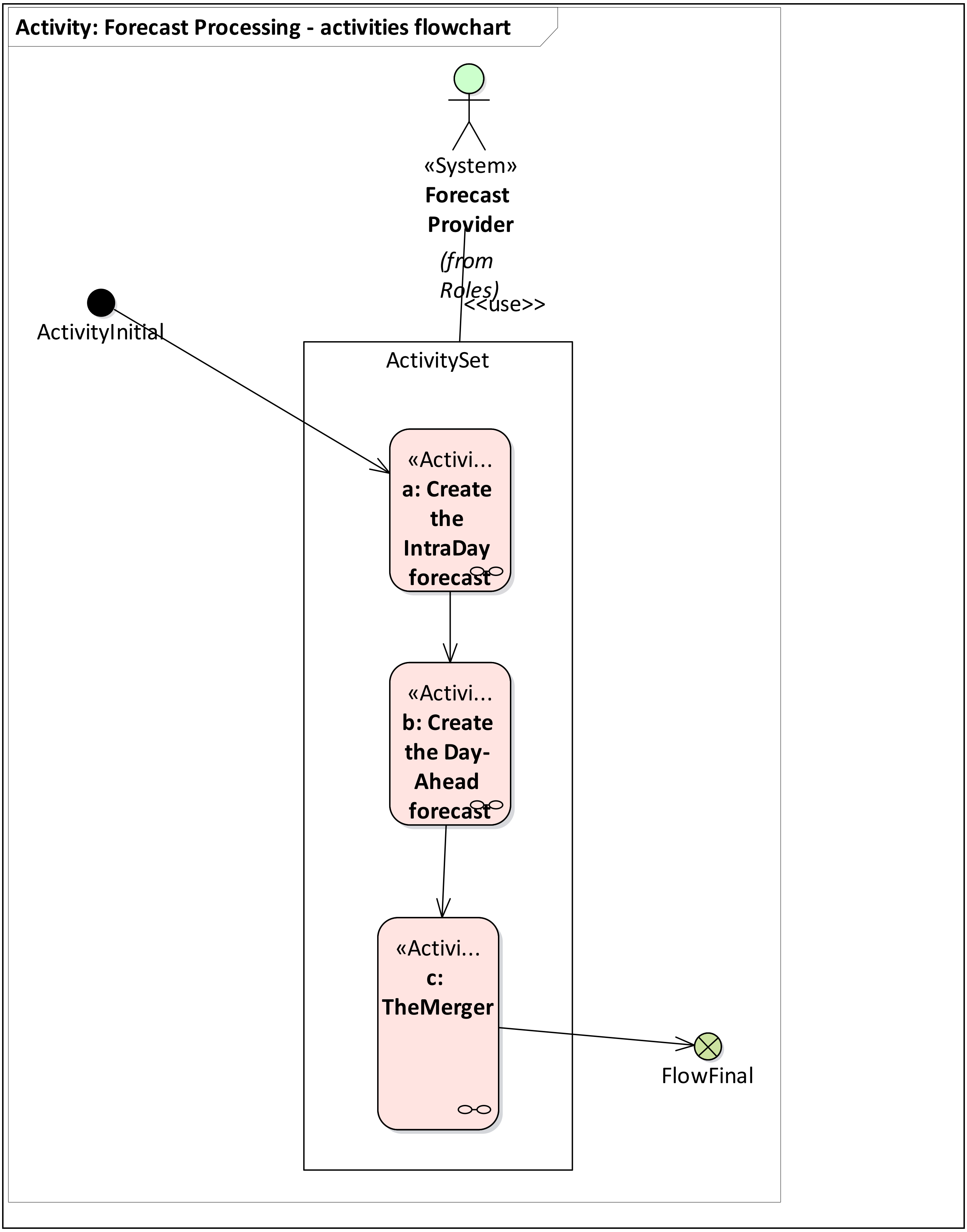
- b: receive forecast

  Business section: Data Output/b: receive forecast

  Receive forecast in specify file format

Forecast Processing

Based on NWP data and historical measurements machine learning algorithms were trained and now used to generate with the help of online measurements from scenario 1 and NWP up to date forecast for consumption, Wind and PV for the next 36 hours. The results are valid for HV side of the substations.


Activity: Forecast Processing - activities flowchart
«System»
Forecast Provider
(from Roles)
<<use>>
ActivityInitial
ActivitySet
«Activi...
a: Create the IntraDay forecast
«Activi...
b: Create the Day-Ahead forecast
«Activi...
c: TheMerger
FlowFinal

Scenario step by step analysis

Scenario								
Scenario name	Forecast Processing							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
3.1		a: Create the IntraDay forecast	Creates Intraday Forecast		Forecast Provider			
3.2		b: Create the Day-Ahead forecast	Create the Day-Ahead forecast		Forecast Provider			
3.3		c: TheMerger	Create a seamless forecast		Forecast Provider			

- a: Create the IntraDay forecast

  Business section: Forecast Processing/a: Create the IntraDay forecast

  Creates Intraday Forecast

- b: Create the Day- Ahead forecast

  Business section: Forecast Processing/b: Create the Day- Ahead forecast

  Create the Day- Ahead forecast

- c: TheMerger

  Business section: Forecast Processing/c: TheMerger

  Create a seamless forecast

Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
Info1	Measured data grid	Measurements of the power in the electrical grid	
Info2	Day-Ahead Forecast	Day Ahead Forecast	

DE – OPF: OPTIMIZE NETWORK STATE FOR THE GERMAN DEMO

Description of the use case

Name of use case

Use case identification		
ID	*Area(s)/Domain(s)/Zone(s)*	*Name of use case*
DE - OPF	SGAM Domain	Optimize network state for the German Demo

Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
1	2018-11-01	IEE	First version	
2	2018-12-03	IEE	Change requests from the first review	
3	2019-01-15	Carla Marino (E-distribuzione)	Contribution	
4	2019-01-18	IEE	Change requests from the second review	
5	2019-01-24	Carla Marino (E-distribuzione)	ModSarus fixes	

Scope and objectives of use case

Scope and objectives of use case	
Scope	This SUC performs basic processing of grid related tasks in order to prepare the grid and network state for optimization purposes.
Objective(s)	The tasks performed in this SUC are in detail: • Grid topology processing • State Estimation • Contingency Analysis • Congestion management DSO side • Forecast mapping • Basic loss reduction optimization using reactive power
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
This SUC is the basic and surrounding use case for further optimization applications and SUCs APC and RPC. In this SUC, all necessary preceding steps for later optimizations will be performed. The grid optimization is always active, if no other requests from TSO received on active or reactive power.

Complete description
1. **Topology Analysis** Description: Based on the grid topology in pandapower data model from the SUC "Data management – CIM2PP", an analysis and reduction of this topology will be performed. The topology resulting from CIM2PP is very detailed and contains beside the region of interest also parts from neighbouring grid regions and voltage levels. In a first step, a topological search is performed, in order to identify all active elements which are electrical connected with the slack (voltage stabilizing power plant which is most times located in EHV grid). Collecting all elements and disregard all other elements reduces the amount of data and increase the performance of the following applications. In a second step, generation and consumption from MV can be aggregated and projected directly on HV-nodes. This is useful, since the SCADA controls active and reactive power of DER at HV-side of the interconnecting transformers between HV and MV. It also further reduces the amount of data which needs to be processed by further applications. 2. **Grid Analysis** Description: This functionality contains four sub-functions; State Estimation, Contingency Analysis Congestion Management and Short-Circuit Calculation. The state estimation based on the reduced topology and a set of measurement values in the CIMDB. Missing and erroneous measurements are replaced and improved. In the contingency analysis, possible n-1 contingencies are identified by performing detailed loadflow analysis which will then be cleared by solutions determined in the congestion management module. In case of no grid constraint violation, the next step of loss optimization can be started. Short-Circuit calculations are only performed if needed. 3. **Forecast Network States** Description: From the SUC "Forecast", for two time domains predicted generation and consumption is available. The first domain is the short term forecast which ranges up to 6 hours ahead, the second domain is the intraday domain, which ranges up to 36 hours ahead. With those predicted values and the current or planned grid topology, future network states can be generated. For this, the prediction for each generation or consumption node is projected onto the related grid node on the resulting grids from the module "grid analysis". There are predictions for every node in the HV grid which then results in a unique state for a load flow calculation. No predictions for EHV nodes are included here, that means that variations taking place in EHV are neglected. The result is a set of intended network states on which further calculations and optimizations can take place. Especially the grid analysis will be performed on every predicted network state. 4. **Active Power Loss Optimization** Description: The main purpose of this optimization is the reduction of active power losses in the HV grid using the reactive power capability of decentralized power plants directly connected to the HV grid. The optimization considers following network constraints (boundary conditions) under which the loss minimization takes place. These are: 1. Bus voltage boundaries Individual voltage limits (a minimum and a maximum value) will be taken into account for any single bus. 2. Line and transformer loading boundaries The maximum current value of each line and transformer is being taken into account. Whereas this current value normally is directly given for lines (I_r), it is being calculated for the transformers taking the rated apparent power data (S_r) as well as the actual voltages at the transformer into account. In case of any circumstances which lead to a limitation of those current values, e.g. a duct laying in case of a cable or the rule that the transformer loading should not reach e.g. 90% of the apparent power value, additional current limitation factors have to be

announced to the optimization algorithm.

3. Active to reactive power ratio in lines and transformers

The protection concept specifies that the phase angle of the impedance does not exceed an angle of -30°

4. Changing reactive power set-points for DER may only be performed in small steps of 3 MVAr in at least 2 minutes.

5. Reactive Power potential of DER

Summary of use case

- **Basic Grid Preparations and OPF**
  Description: In this SUC, basic grid calculations are performed. From a raw grid with measurements, analysing steps are performed in order to prepare the grid for optimization applications. Also a basic loss minimization is performed in this SUC.

  - a. Read full grid
    Description: Read the direct output from cim2db

  - b. Process full grid
    Description: Reduce the grid to the region of interest and aggregate lower voltage levels

  - c. Provide reduced grid
    Description:

  - c. Provide reduced grid
    Description: Build a reduced pandapower grid and provide it for next service

  - d. Gather Forecast
    Description: Forecast data for each node (generation and consumption) is obtained via SUC Forecast.

  - e. create Forecast Grids
    Description: The forecast data is used and applied on the latest network state in order to evolve it into time

  - f. State Estimation
    Description: Using measurements in order to estimate network state

  - g. Contingency Check
    Description: Performing an n-1 analysis. Results are possible points of congestions.

  - h. Congestion Management
    Description: Using rules, sensitivities and merit order lists in order to clear possible congestion. Produce new setpoints for active power.

  - i. Perform OPF
    Description: The grid is optimized considering grid constraints and minimization of power losses using reactive power capability from generating units.

  - j. Sending set points
    Description: The results in terms of set points for generating units will be provided as a CGMES set

	point object

Key performance indicators (KPI)

Key performance indicators			
ID	***Name***	***Description***	***Reference to mentioned use case objectives***
1	Active Power Adjustment Error		DE - OPF
2	Intraday update process duration		DE - OPF
3	Reduction in Distribution Grid Losses		DE - OPF
4	Voltage Adjustment Error		DE - OPF
5	Percentage of scheduled Flexibility		DE - OPF
6	Reactive Power Adjustment Error		DE - OPF

Use case conditions

Use case conditions	
Assumptions	
1	HV grid optimization: Since DSO only controls generation via HV controllers, assets located in MV are aggregated and projected onto HV.
2	Loss reduction via reactive power: Since reactive power has to be provided by DER in a fixed range, only reactive power is used in loss optimization and no active power optimization is performed.
3	No EHV-HV tap changer control: The transformers at interconnection points are owned by the Tso and hence not direct controllable by the DSO. Due to this, no tap changer optimization will be performed.
Prerequisites	
1	Computable network states: It is required, that the exported grids are computable and that load flows converge
2	Cyclical import of measurements and forecast

Further information to the use case for classification/mapping

Classification information
Relation to other use cases
<<BUC>> DE-RP <<BUC>> DE-AP
Level of depth
White Box
Prioritisation
Generic, regional or national relation
Regional TAR (Grid Connection Code)
Nature of the use case

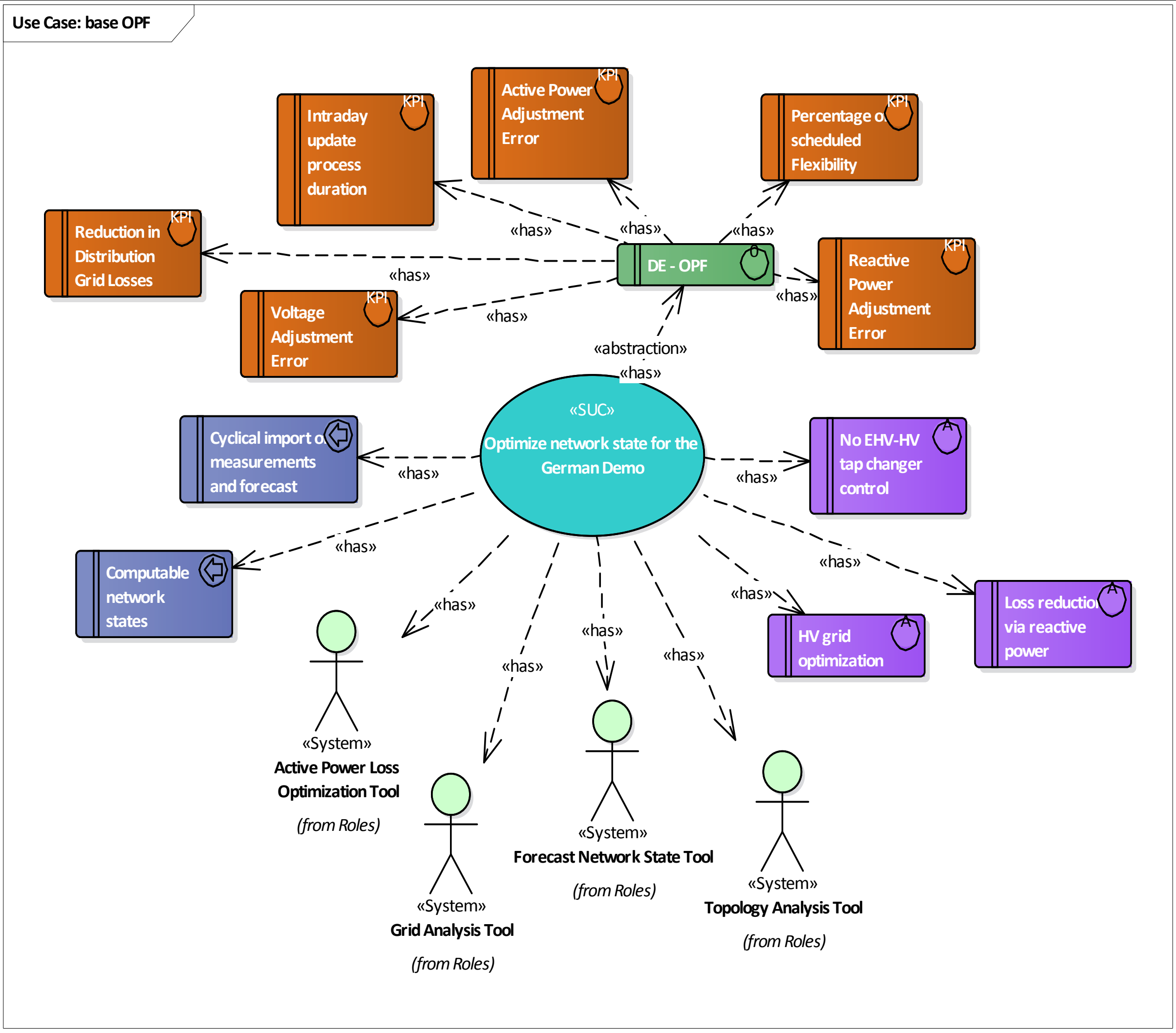
SUC
Further keywords for classification
Optimization, State Estimation, Congestion management

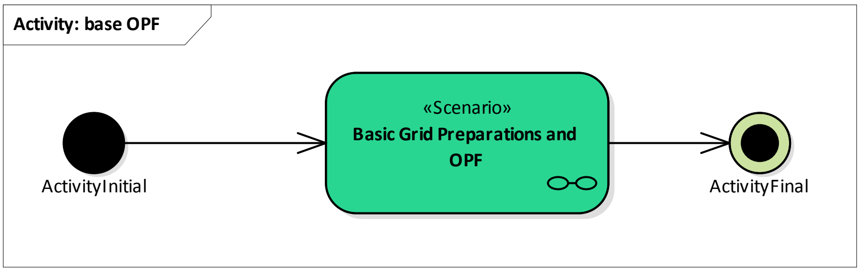
General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case





Technical details

Actors

Actors			
Grouping (e.g. domains, zones)	***Group description***		
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
Active Power Loss Optimization Tool	System	If neither the SUC APC nor RPC are called, active power loss optimization will take place. The main purpose of this optimization is the reduction of active power losses in the HV grid using the reactive power capability of decentralized power plants directly connected to the HV grid.	
Grid Analysis Tool	System	This functionality contains four sub-functions; State Estimation, Contingency Analysis Congestion Management and Short-Circuit Calculation.	
Topology Analysis Tool	System	Based on the grid topology in pandapower data model from the SUC "Data management – CIM2PP", an analysis and reduction of this topology will be performed. The topology resulting from CIM2PP is very detailed and contains beside the region of interest also parts from neighboring grid regions and voltage levels.	
Forecast Network State Tool	System	Forecast data will be mapped on current and predicted grid topology. This way, network states for the time domain of forecast can be determined.	

References

Step by step analysis of use case

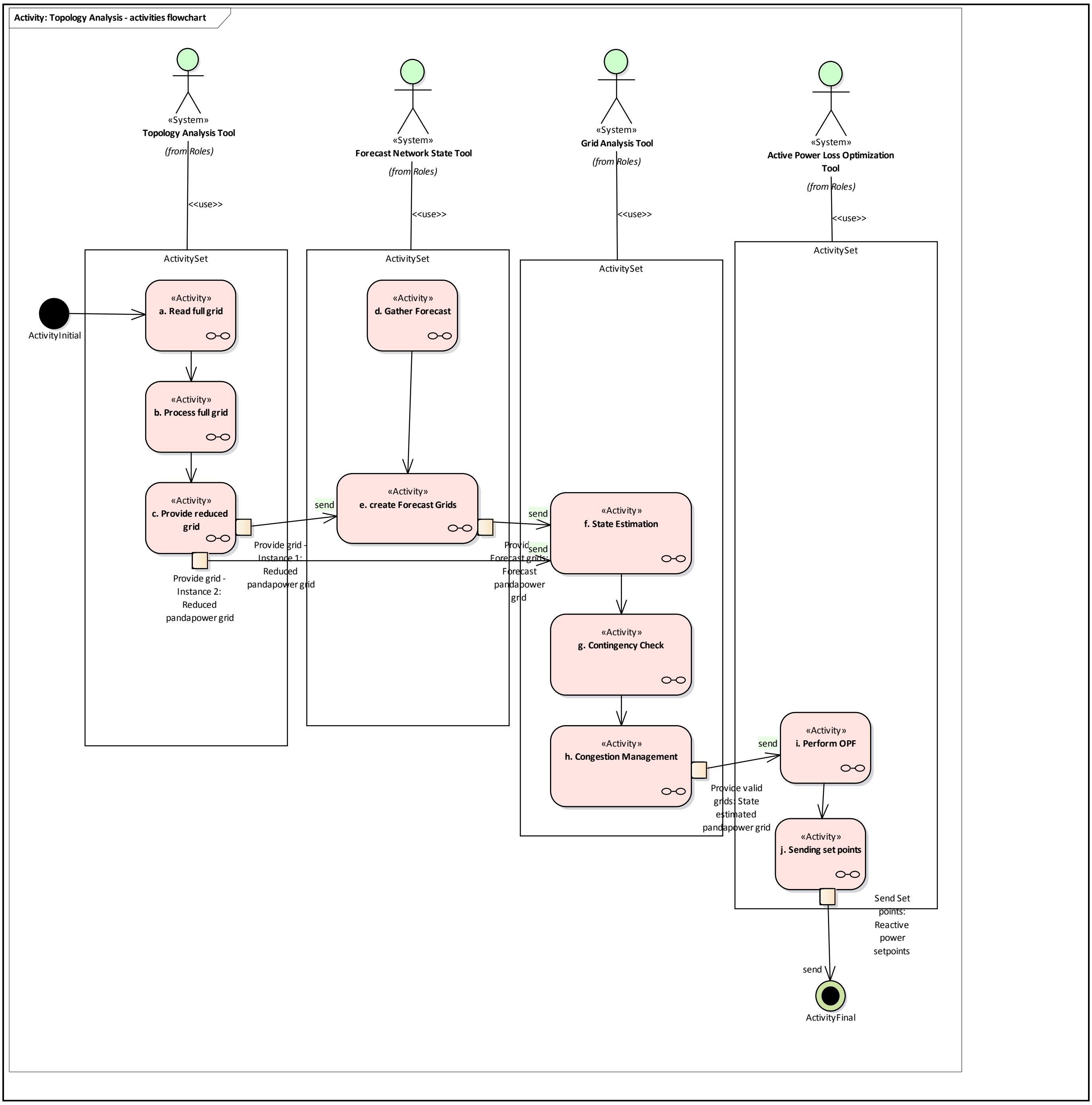
Overview of scenarios

Scenario conditions							
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	Basic Grid Preparations and OPF	In this SUC, basic grid calculations are performed. From a raw grid with measurements, analysing steps are performed in order to prepare the grid for optimization applications. Also a basic loss minimization is performed in this SUC.				

Steps – Scenarios

Basic Grid Preparations and OPF

In this SUC, basic grid calculations are performed. From a raw grid with measurements, analysing steps are performed in order to prepare the grid for optimization applications. Also a basic loss minimization is performed in this SUC.



Scenario step by step analysis

Scenario

Scenario name	Basic Grid Preparations and OPF							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.1		a. Read full grid	Read the direct output from cim2db		Topology Analysis Tool			
1.2		b. Process full grid	Reduce the grid to the region of interest and aggregate lower voltage levels		Topology Analysis Tool			
1.3		c. Provide reduced grid			Topology Analysis Tool		Info1-Reduced pandapower grid	
1.4		c. Provide reduced grid	Build a reduced pandapower grid and provide it for next service	send	Topology Analysis Tool	Grid Analysis Tool	Info1-Reduced pandapower grid	
1.5		d. Gather Forecast	Forecast data for each node (generation and consumption) is obtained via SUC Forecast.		Forecast Network State Tool			
1.6		e. create Forecast Grids	The forecast data is used and applied on the latest network state in order to evolve it into time	send	Forecast Network State Tool	Grid Analysis Tool	Info2-Forecast pandapower grid	
1.7		f. State Estimation	Using measurements in order to estimate network state		Grid Analysis Tool			
1.8		g. Contingency Check	Performing an n-1 analysis. Results are possible points of congestions.		Grid Analysis Tool			
1.9		h. Congestion Management	Using rules, sensitivities and merit order lists in order to clear possible congestion. Produce new setpoints for active power.	send	Grid Analysis Tool	Active Power Loss Optimization Tool	Info3-State estimated pandapower grid	
1.10		i. Perform OPF	The grid is optimized considering grid constraints and minimization of power losses using reactive power capability from generating units.		Active Power Loss Optimization Tool			
1.11		j. Sending set points	The results in terms of set points for generating units will be provided as a CGMES set point	send	Active Power Loss Optimization Tool		Info4-Reactive power setpoints	

			object					

- a. Read full grid

  Business section: Basic Grid Preparations and OPF/a. Read full grid

  Read the direct output from cim2db

- b. Process full grid

  Business section: Basic Grid Preparations and OPF/b. Process full grid

  Reduce the grid to the region of interest and aggregate lower voltage levels

- c. Provide reduced grid

  Business section: Basic Grid Preparations and OPF/c. Provide reduced grid

  Information sent:

Business object	*Instance name*	*Instance description*
Reduced pandapower grid		

- c. Provide reduced grid

  Business section: Basic Grid Preparations and OPF/c. Provide reduced grid

  Build a reduced pandapower grid and provide it for next service

  Information sent:

Business object	*Instance name*	*Instance description*
Reduced pandapower grid	Provide grid - Instance 2	The selected grid regions will be provided for next service

- d. Gather Forecast

  Business section: Basic Grid Preparations and OPF/d. Gather Forecast

  Forecast data for each node (generation and consumption) is obtained via SUC Forecast.

- e. create Forecast Grids

  Business section: Basic Grid Preparations and OPF/e. create Forecast Grids

The forecast data is used and applied on the latest network state in order to evolve it into time

Information sent:

Business object	***Instance name***	***Instance description***
Forecast pandapower grid	Provide Forecast grids	

- f. State Estimation

Business section: Basic Grid Preparations and OPF/f. State Estimation

Using measurements in order to estimate network state

- g. Contingency Check

Business section: Basic Grid Preparations and OPF/g. Contingency Check

Performing an n-1 analysis. Results are possible points of congestions.

- h. Congestion Management

Business section: Basic Grid Preparations and OPF/h. Congestion Management

Using rules, sensitivities and merit order lists in order to clear possible congestion. Produce new setpoints for active power.

Information sent:

Business object	***Instance name***	***Instance description***
State estimated pandapower grid	Provide valid grids	

- i. Perform OPF

Business section: Basic Grid Preparations and OPF/i. Perform OPF

The grid is optimized considering grid constraints and minimization of power losses using reactive power capability from generating units.

- j. Sending set points

Business section: Basic Grid Preparations and OPF/j. Sending set points

The results in terms of set points for generating units will be provided as a CGMES set point object

Information sent:

Business object	*Instance name*	*Instance description*
Reactive power setpoints	Send Set points	

Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information exchanged*	*Requirement, R-IDs*
Info1	Reduced pandapower grid	Current grid topology of a certain region and voltage level	
Info2	Forecast pandapower grid	day ahead and intraday grids on which were forecast data applied	
Info3	State estimated pandapower grid	Current network state corrected by a state estimation	
Info4	Reactive power setpoints	Results from OPF	

DE – RPC: ENABLING PROVISION OF REACTIVE POWER FLEXIBILITY FROM DSO FOR TSO IN THE GERMAN DEMO

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
DE – RPC	SGAM Domain	Enabling Provision of Reactive Power Flexibility from DSO for TSO in the German Demo

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-11-01	IEE	First version	
2	2018-12-03	IEE	Change requests from the first review	
3	2019-01-15	Carla Marino (E-distribuzione)	Contribution	
4	2019-01-18	IEE	Change requests from the second review	
5	2019-01-24	Carla Marino (E-distribuzione)	ModSarus fixes	

Scope and objectives of use case

Scope and objectives of use case	
Scope	This system use case explains how the demonstrator supports the TSO in managing the reactive power flow in the transmission grid in the case of congestion or voltage control by providing reactive power flexibilities.
Objective(s)	The objective of this SUC in the German demonstrator is to enable the provision of reactive power flexibilities connected to the distribution grid (110 kV) for managing voltage control in transmission grid (380 kV + 220 kV). Therefore the following activities are necessary within this SUC: • calculating available flexibilities at interconnection points between TSO and DSO • allocate information about load flow and available flexibility offers for TSO • process update of data
Related business case(s)	

Narrative of Use Case

Narrative of use case

Short description
This SUC describes the process to coordinate the use of reactive power flexibilities connected to the distribution grid for the needs of the TSO. The SUC is based network states reconstructed in SUC DE-OPF based on current measurements and forecast data. Within this Use Case, the DSO can integrate needs and requirements from TSO in its own load flow calculations and optimisations in order to calculate free reactive power flexibilities for assets in the distribution grid.
Complete description

Description

This SUC describes the coordination between TSO and DSO in using reactive power flexibilities from the distribution grid. The coordination is needed to prevent failures in the distribution grid due to activation of reactive power flexibilities for the needs of the TSO. The coordination process starts day ahead and ends real time with activation of flexibility. This SUC shows the consideration of demands of the TSO in load flow calculation and grid optimisation of the DSO done in SUC DE-OPF. As one output of this SUC, the new requirements received from the TSO will eventually call the SUC DE-OPF to evaluate the received requirements in terms of contingencies. The SUC DE-OPF confirms the ability of fulfilling the activation of the requested flexibilities. In SUC DE-DATA it is checked whether the requested flexibilities are in the beforehand sent data of available range of flexibilities. The calculated new schedules and the confirmation of the requested flexibilities from SUC DE-OPF are being sent to TSO via SUC DE-COM. In addition the operation signals are sent to the flexibility providers (G_O). This SUC has an iterative structure and is being restarted every 5 minutes or by request of the operator if the TSO does not call for flexibilities and/or changes in the distribution grid occur in the meantime.

Summary of use case

- **Calculation of maximal and minimal reactive power**
  Description: 1. Calculation of maximal and minimal reactive power per network group.
  The OPF determines within given grid constraints maximal and minimal reactive power flexibilities. As input for the cost function sensitivities and reactive power range per assets are used.

  2. Determination of reactive power flexibilities interconnection point. From these reactive power flexibilities, the relating voltage flexibility per interconnection point will be deduced.

  3. If activation requests from TSO are existent, the requested amount of reactive power per interconnection points is disaggregated onto the individual assets. The individual set points per asset will then be applied on the current network state via the SUCs DE-DATA and DE-OPF.

  - Calculate available flexibilities
    Description: On each of the forecast grids, the reactive power flexibilities from selected generating unit will be used and a resulting reactive power flexibility for each interconnection point will be determined.
    For this, the whole flexibility for the grid (sum over all interconnection points) will be determined under consideration of grid constraints.
    From these results, the individual flexibility per interconnection point unit will be deduced.

  - CheckFlexibilities
    Description: TSO receives reactive power flexibilities and determines possible measures and

requests. ▪ Processing requests Description: The reactive power requests per interconnection point are processed and individual setpoints for concerned generating units are determined. ▪ Read Data Description: Read Input data from SUC Base OPF. Forecast grid data for the next 36 hours will be read and provided for further steps. ▪ Receiving and Forwarding Requests Description: The reactive power flexibility requests are received from the TSO and forwarded to beeDIP ▪ Receiving and processing setpoints Description: The reactive power setpoints per generating unit will be received and processed within DSO operating system and then sent via DSO communication protocols to the assets. ▪ Send Flexibilities Description: The flexibilities will be provided to the TSO via data files or graphical representation ▪ Send Request Description: The TSO sends reactive power flexibility requests to the DSO. ▪ Validating setpoints on related grid states Description: The setpoints for generating units are applied on the related grid state (time) and under consideration of grid constraints and flexibility potential validated and the send to DSO in order to be sent to generating units.

Key performance indicators (KPI)

Key performance indicators			
ID	***Name***	***Description***	***Reference to mentioned use case objectives***
1	Meet TSO need in delivering data		DE-RPC
2	Percentage of scheduled Flexibility		DE-RPC
3	Intraday update process duration		DE-RPC
4	Reactive Power Adjustment Error		DE-RPC

Use case conditions

Use case conditions
Assumptions

1	Congestion free network states: The handling of congestions is performed in SUC OPF and it is assumed, that the network states on which the reactive power flexibility determination is performed on are free of congestions.
2	SUC OPF Assumptions: These assumptions are here valid as well, and should be fulfilled automatically.
Prerequisites	
1	SUC OPF Prerequisites: These prerequisites are here valid as well, and should be fulfilled automatically.
2	Up to date information from TSO, DSO, forecast and schedules: In order to compute valid results, cyclically updated information are needed.

Further information to the use case for classification/mapping

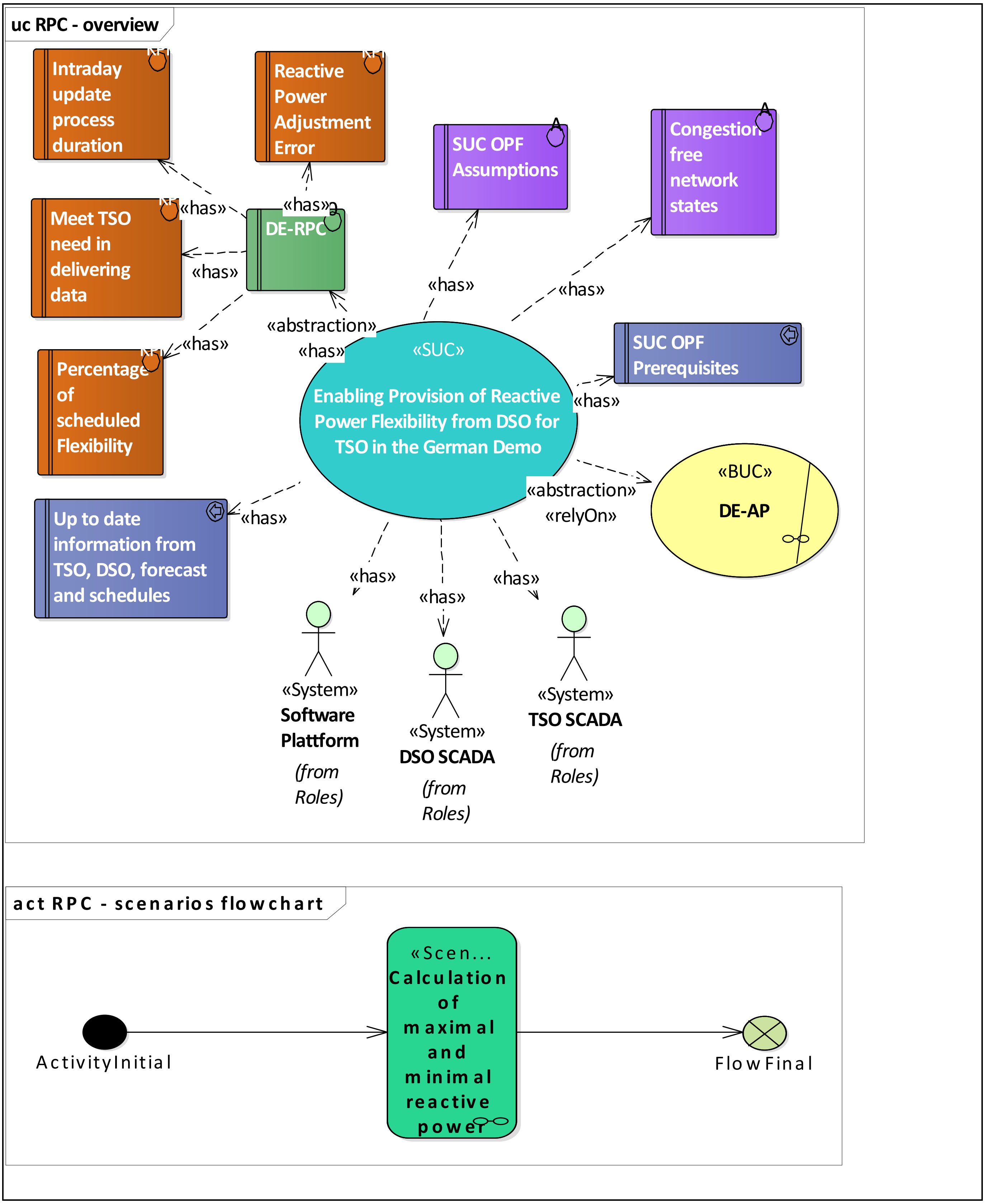
Classification information
Relation to other use cases
<<BUC>> DE-AP
Level of depth
White Box
Prioritisation
Generic, regional or national relation
Regional TAR (Grid Connection Code)
Nature of the use case
SUC
Further keywords for classification
Optimization, State Estimation, Congestion management

General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case



Technical details

Actors

Actors			
Grouping (e.g. domains, zones)		***Group description***	
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
Software Plattform	System	Software platform (name: BeeDIP) for data collection and calculation for setpoints (reactive power / active power)	
DSO SCADA	System	SCADA System of the DSO	
TSO SCADA	System	SCADA of the TSO.	

References

Step by step analysis of use case

Overview of scenarios

Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	Calculation of maximal and minimal reactive power	1. Calculation of maximal and minimal reactive power per network group. The OPF determines within given grid constraints maximal and minimal reactive power flexibilities. As input for the cost function sensitivities and reactive power range per assets are used. 2. Determination of reactive power flexibilities interconnection point. From these reactive power flexibilities, the relating voltage flexibility per interconnection point will be deduced. 3. If activation requests from TSO are existent, the requested amount of reactive power per interconnection points is disaggregated onto the individual assets. The individual set points per asset will then be applied on the current network state via the SUCs DE-DATA and DE-OPF.				

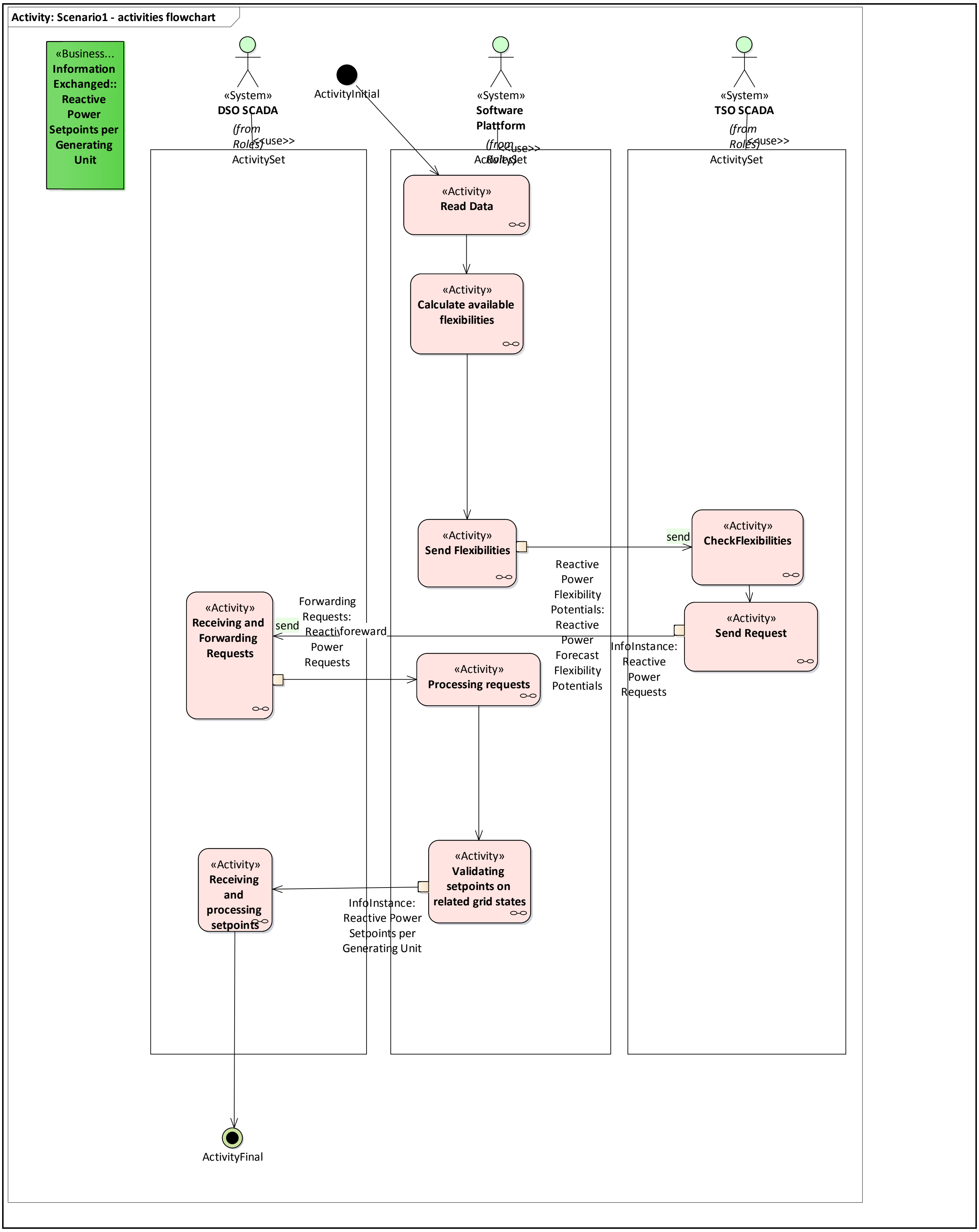
Steps – Scenarios

Calculation of maximal and minimal reactive power

1. Calculation of maximal and minimal reactive power per network group.
The OPF determines within given grid constraints maximal and minimal reactive power flexibilities. As input for the cost function sensitivities and reactive power range per assets are used.

2. Determination of reactive power flexibilities interconnection point. From these reactive power flexibilities, the relating voltage flexibility per interconnection point will be deduced.

3. If activation requests from TSO are existent, the requested amount of reactive power per interconnection points is disaggregated onto the individual assets. The individual set points per asset will then be applied on the current network state via the SUCs DE-DATA and DE-OPF.


Activity: Scenario1 - activities flowchart
«Business... Information Exchanged:: Reactive Power Setpoints per Generating Unit
«System» DSO SCADA
(from Roles)
«use»
ActivitySet
ActivityInitial
«System» Software Plattform
(from Roles)
«use»
ActivitySet
«System» TSO SCADA
(from Roles)
«use»
ActivitySet
«Activity» Read Data
«Activity» Calculate available flexibilities
«Activity» Send Flexibilities
send
«Activity» CheckFlexibilities
Reactive Power Flexibility Potentials: Reactive Power Forecast Flexibility Potentials
«Activity» Send Request
InfoInstance: Reactive Power Requests
«Activity» Receiving and Forwarding Requests
send
Forwarding Requests: Reactive Power Requests
foreward
«Activity» Processing requests
«Activity» Validating setpoints on related grid states
«Activity» Receiving and processing setpoints
InfoInstance: Reactive Power Setpoints per Generating Unit
ActivityFinal

Scenario step by step analysis

Scenario								
Scenario name	Calculation of maximal and minimal reactive power							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.1		Calculate available flexibilities	On each of the forecast grids, the reactive power flexibilities from selected generating unit will be used and a resulting reactive power flexibility for each interconnection point will be determined. For this, the whole flexibility for the grid (sum over all interconnection points) will be determined under consideration of grid constraints. From these results, the individual flexibility per interconnection point unit will be deduced.		Software Plattform			
1.2		CheckFlexibilities	TSO receives reactive power flexibilities and determines possible measures and requests.		TSO SCADA			
1.3		Processing requests	The reactive power requests per interconnection point are processed and individual setpoints for concerned generating units are determined.		Software Plattform			
1.4		Read Data	Read Input data from SUC Base OPF. Forecast grid data for the next 36 hours will be read and provided for further steps.		Software Plattform			
1.5		Receiving and Forwarding Requests	The reactive power flexibility requests are received from the TSO and forwarded to beeDIP	foreward	DSO SCADA	Software Plattform	Info1-Reactive Power Requests	
1.6		Receiving and processing	The reactive power setpoints per generating		DSO SCADA			

		setpoints	unit will be received and processed within DSO operating system and then sent via DSO communication protocols to the assets.					
1.7		Send Flexibilities	The flexibilities will be provided to the TSO via data files or graphical representation	send	Software Plattform	TSO SCADA	Info2-Reactive Power Forecast Flexibility Potentials	
1.8		Send Request	The TSO sends reactive power flexibility requests to the DSO.	send	TSO SCADA	DSO SCADA	Info1-Reactive Power Requests	
1.9		Validating setpoints on related grid states	The setpoints for generating units are applied on the related grid state (time) and under consideration of grid constraints and flexibility potential validated and the send to DSO in order to be sent to generating units.		Software Plattform	DSO SCADA	Info3-Reactive Power Setpoints per Generating Unit	

- <u>Calculate available flexibilities</u>

  <u>Business section</u>: Calculation of maximal and minimal reactive power/Calculate available flexibilities On each of the forecast grids, the reactive power flexibilities from selected generating unit will be used and a resulting reactive power flexibility for each interconnection point will be determined. For this, the whole flexibility for the grid (sum over all interconnection points) will be determined under consideration of grid constraints.

  From these results, the individual flexibility per interconnection point unit will be deduced.

- <u>CheckFlexibilities</u>

  <u>Business section</u>: Calculation of maximal and minimal reactive power/CheckFlexibilities

  TSO receives reactive power flexibilities and determines possible measures and requests.

- <u>Processing requests</u>

  <u>Business section</u>: Calculation of maximal and minimal reactive power/Processing requests

  The reactive power requests per interconnection point are processed and individual setpoints for concerned generating units are determined.

- <u>Read Data</u>

Business section: Calculation of maximal and minimal reactive power/Read Data

Read Input data from SUC Base OPF. Forecast grid data for the next 36 hours will be read and provided for further steps.

- Receiving and Forwarding Requests

Business section: Calculation of maximal and minimal reactive power/Receiving and Forwarding Requests

The reactive power flexibility requests are received from the TSO and forwarded to beeDIP
Information sent:

Business object	*Instance name*	*Instance description*
Reactive Power Requests	Forwarding Requests	Flexibility Requests are forewarded to the beeDIP

- Receiving and processing setpoints

Business section: Calculation of maximal and minimal reactive power/Receiving and processing setpoints

The reactive power setpoints per generating unit will be received and processed within DSO operating system and then sent via DSO communication protocols to the assets.

- Send Flexibilities

Business section: Calculation of maximal and minimal reactive power/Send Flexibilities

The flexibilities will be provided to the TSO via data files or graphical representation

Information sent:

Business object	*Instance name*	*Instance description*
Reactive Power Forecast Flexibility Potentials	Reactive Power Flexibility Potentials	A list of reactive power flexibilities is send via SUC Data Communication

- Send Request

Business section: Calculation of maximal and minimal reactive power/Send Request

The TSO sends reactive power flexibility requests to the DSO.

Information sent:

Business object	*Instance name*	*Instance description*

Reactive Power Requests	InfoInstance	Active Power requests are sent to the DSO via SUC Data Communication

- Validating setpoints on related grid states

Business section: Calculation of maximal and minimal reactive power/Validating setpoints on related grid states

The setpoints for generating units are applied on the related grid state (time) and under consideration of grid constraints and flexibility potential validated and the send to DSO in order to be sent to generating units.

Information sent:

Business object	***Instance name***	***Instance description***
Reactive Power Setpoints per Generating Unit	InfoInstance	Reactive Power Setpoints per Generating Unit

Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
Info1	Reactive Power Requests	In case the TSO requests reactive power at an interconnection point, the request is communicated via SUC Data Communication to the DSO.	
Info2	Reactive Power Forecast Flexibility Potentials	Reactive Power Flexibility Potentials per interconnection point for the current grid state and the next 36 hours.	
Info3	Reactive Power Setpoints per Generating Unit	Each generating unit which was selected will receive a dedicated reactive power setpoint.	

ANNEX III. ITALIAN SYSTEM USE CASES COMPLIANT WITH THE IEC62559-2 TEMPLATE

IT – NT SE: PERFORM NETWORK STATE ESTIMATION FOR THE ITALIAN DEMO

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
IT - NT SE	SGAM Domain	Perform network state estimation for the Italian Demo

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-08-03	Carla Marino (E-distribuzione) Daniele Clerici (RSE)		
2	2018-11-23	Alessio Pastore (E-distribuzione)	Review	
3	2018-12-19	Carla Marino (E-distribuzione)		

Scope and objectives of use case

Scope and objectives of use case	
Scope	Collect the information about the network state, the customers' profiles and the generation forecast
Objective(s)	Update network information for optimization and management processes
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
The SUC is aimed to build the infrastructure of the topological scheme of the grid and all data input necessary for the State Estimation, by collecting: • the position, the graphic symbol and the connection mode of each grid component • the electrical characteristic of each grid component • output from the primary and secondary substations Remote Terminal Units, which include the measurements received from the fault detectors along the grid and the current state of HV and MV switches/breakers • the load curves of customers • the forecast of PV plants

and exporting the corresponding database from the Operative Control SCADA to the Local Control SCADA, in which the block of State Estimation is contained.
Complete description

In order to implement the pre-processing, as a first step it is necessary that all the useful information are acquired, for describing the network and building its scheme.

This is possible by transmitting a set of data.

Summary of use case

- **Network state updating**
  Description: As first, in order to implement the pre-processing, it is necessary that all the useful information are acquired, for describing the network and building its scheme.
  This is possible by transmitting a set of data.

  - Request measurement collection
    Description: The OCS asks to the Primary Substation RTU the information collected from each field device.
    Furthermore it asks the infomation about breaker status from the Secondary Substation RTUs.

  - Collect Data from field
    Description: Every Fault Detector sends the real time measurements and the breaker status with a variable timeframe (generally of 10 s);

    The measurements at HV busbar are collected from the Integrated protection of transformer and wired devices.
    The measurements at MV busbar are collected thanks to:
    - the Integrated protection of transformer
    - the feeders' protections
    - the fault detectors installed along the feeders.

    The current state of HV switches is received from the Integrated protection of transformers and wired devices.

    The current state of MV switches is received from feeders' protections.

  - Transmit data
    Description: RTUs collect data from Field devices and transmit them to the Central SCADA (OCS) with the current state of MV switches collected from all the automated and remote controlled secondary substations.

  - Collect data from RTUs
    Description: The transmitted data from field devices are collected to monitor the current state of the network.

    The manual switched updates can't be collected by the Remote Terminal Units.
    For this reason it's possible to put the information into the OCS by doing a manual functional

order.

- Calculate load and generation forecasts
  Description: A server sends the metering information about class of customers.
  Taking into account of the tracing of the historical curves of different set of customers, the Active and Reactive Power profiles of each load and generation customer are built.

  The Active and Reactive Power profiles of forecast generation is obtained by computing the information coming from an external weather provider.

- Store data in a database and re-route them to Local SCADA
  Description: The OCS collects all the measurement, the current state of breakers and assets, as well as the calculated forecasts, and stores them in a database.

- Retrieve all the necessary data from the Central SCADA (OCS)
  Description: The relevant data for network topology updating and state estimation are collected by the Local SCADA from the Central SCADA databases; these data consist of:
  - voltage and current measurements;
  - the current state of breakers and assets;
  - Primary Substation network topology;
  - Secondary Substation network topology;
  - Medium voltage distribution network topology;
  - Electrical characteristics of network components;
  - Load and generation forecast.

- Build update network topology
  Description: Based on the data collected from the Central SCADA databases, the Local SCADA updates the network topology

- Perform network state estimation
  Description: Since the network state is updated, the algorithm for the State Estimation (SE) is triggered:

  - After a period of 15 minutes;
  - After network changes (reconfiguration, restoration after fault).

  The quantities are estimated in each node of the network.

  The estimation is therefore calculated at HV side of the Primary Substation which corresponds to the interconnection point between DSO and TSO.

- Store the updated network information and provide them to the optimization/management processes
  Description: The LCS reports the result of network state estimation on the OCS: it calculates the reserve for each section of line, taking into account of a preset value of threshold current on the OCS.

Key performance indicators (KPI)

Use case conditions

Use case conditions	
Assumptions	
1	Assumption1: The medium voltage network is in normal state.
2	Assumption2: Communication network latency allows normal grid operations.
Prerequisites	
1	PreCondition: The network is out normal state or, if it's in normale state, the customers' profiles changes.

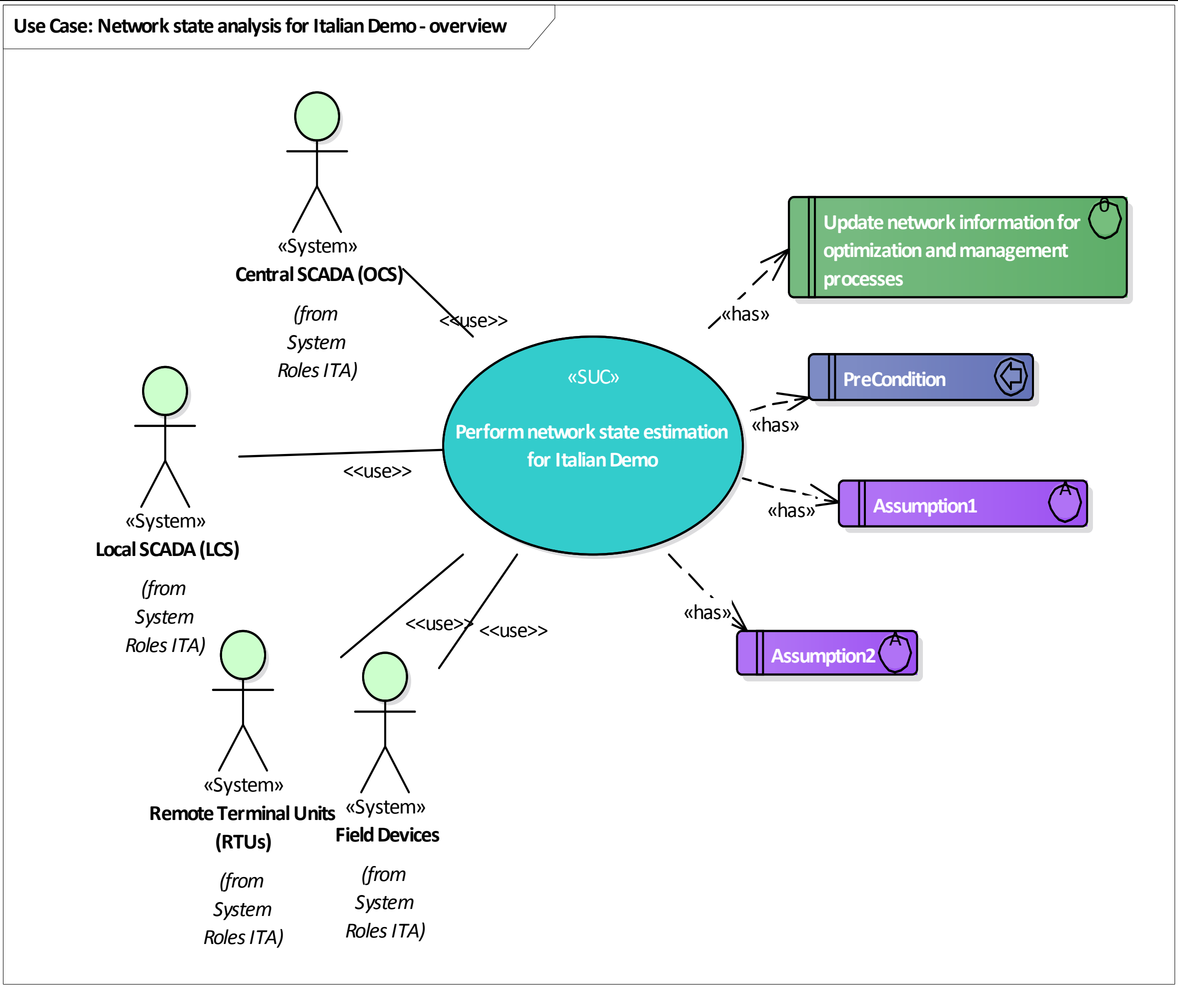
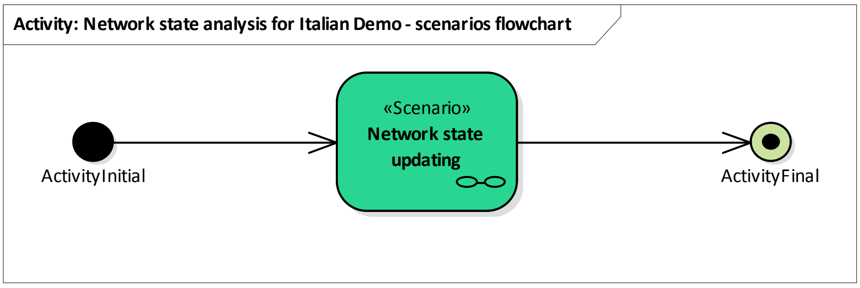
Further information to the use case for classification/mapping

Classification information
Relation to other use cases
<<BUC>> [IT-AP] Manage active power flexibility to support mFRR/RR and congestion management in the Italian demo <<BUC>> [IT-RP] Manage reactive power flexibility to support voltage control and congestion management in the Italian demo
Level of depth
White Box
Prioritisation
Generic, regional or national relation
National
Nature of the use case
SUC
Further keywords for classification

General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case
 

Technical details

Actors

Actors			
Grouping (e.g. domains, zones)	***Group description***		
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
Remote Terminal Units (RTUs)	System	They are the Remote Terminal Units (RTUs) of Primary and Secondary Substations. They: • collect all the events happening in the medium voltage network send them to the connected SCADA. • collect measurements and breaker status from devices in field; • make correlation of events; • perform automation cycles; • send activation signals, commands to asset;	
Local SCADA (LCS)	System	The Local SCADA is located in the Primary Substation and acquires the database and the recorded events from the Central SCADA. It's divided in: • a monitoring section; • a state estimation section; • a voltage regulation section.	
Central SCADA (OCS)	System	The Central SCADA is the monitoring and remote control system. It includes the database of the electrical network. The Central SCADA: • acquires events both from the Primary and Secondary Substations RTUs; • acquires measurements from the Primary Substations RTUs; • sends commands to the devices in the Primary Substations; • sends commands to the remote controlled Secondary Substations; • records manual updates.	
Field Devices	System	The Field devices include: -Transformer Integrated Protections; -Feeders' protections;	

		-Secondary substation Fault Detectors; -Energy regulation Interfaces; -Storage interface; -Statcom interface.	

References

Step by step analysis of use case

Overview of scenarios

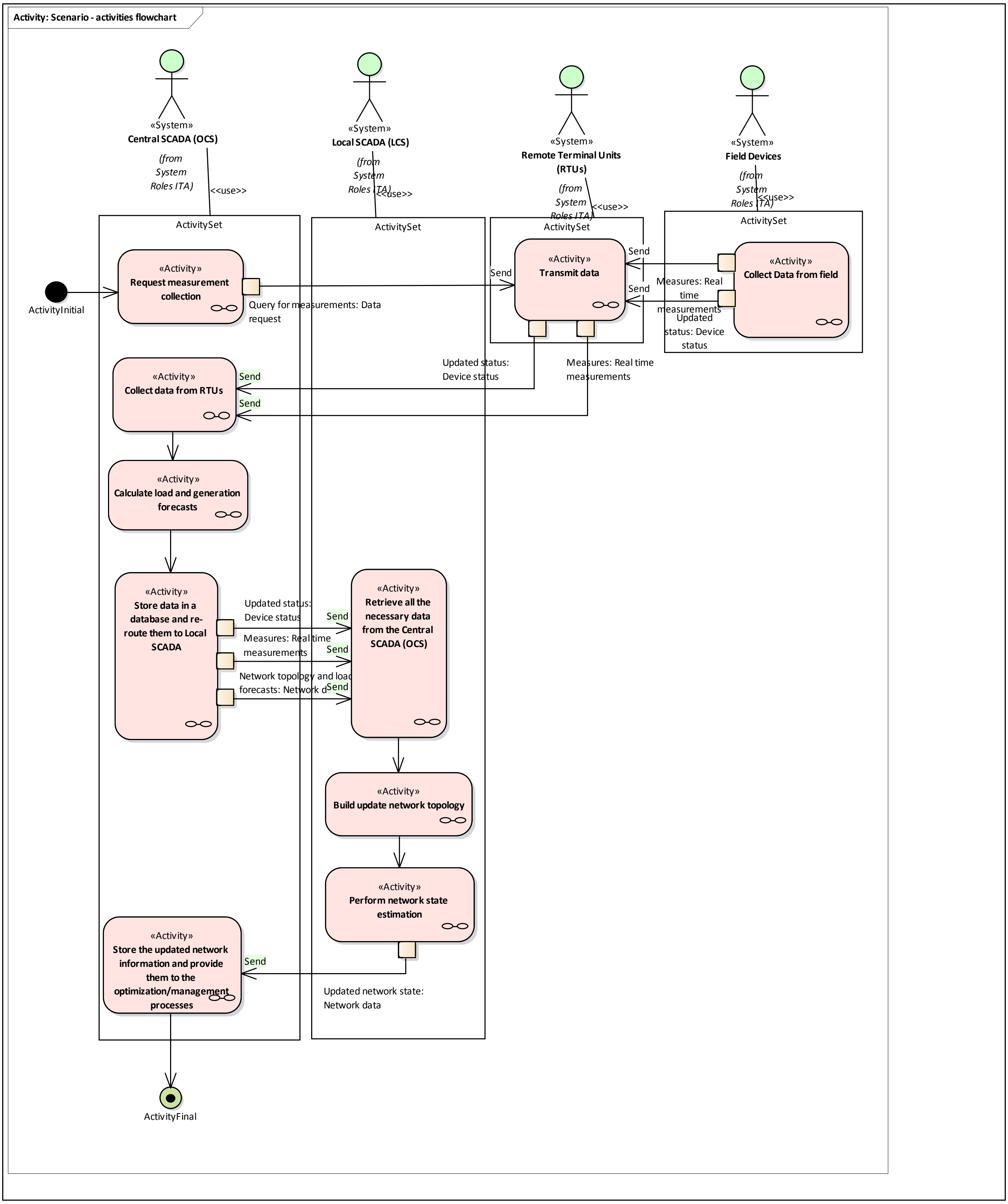
Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	Network state updating	As first, in order to implement the pre-processing, it is necessary that all the useful information are acquired, for describing the network and building its scheme. This is possible by transmitting a set of data.				

Steps – Scenarios

Network state updating

As first, in order to implement the pre-processing, it is necessary that all the useful information are acquired, for describing the network and building its scheme.

This is possible by transmitting a set of data.


Activity: Scenario - activities flowchart
«System»
Central SCADA (OCS)
(from System Roles ITA)
«System»
Local SCADA (LCS)
(from System Roles ITA)
«System»
Remote Terminal Units (RTUs)
(from System Roles ITA)
«System»
Field Devices
(from System Roles ITA)
<<use>>
ActivitySet
ActivityInitial
«Activity»
Request measurement collection
Query for measurements: Data request
«Activity»
Transmit data
Send
Measures: Real time measurements
Updated status: Device status
«Activity»
Collect Data from field
«Activity»
Collect data from RTUs
«Activity»
Calculate load and generation forecasts
«Activity»
Store data in a database and re-route them to Local SCADA
Network topology and load forecasts: Network data
«Activity»
Retrieve all the necessary data from the Central SCADA (OCS)
«Activity»
Build update network topology
«Activity»
Perform network state estimation
«Activity»
Store the updated network information and provide them to the optimization/management processes
Updated network state: Network data
ActivityFinal

Scenario step by step analysis

Scenario								
Scenario name	Network state updating							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.1		Request measurement collection	The OCS asks to the Primary Substation RTU the information collected from each field device. Furthermore it asks the infomation about breaker status from the Secondary Substation RTUs.	Send	Central SCADA (OCS)	Remote Terminal Units (RTUs)	Info1-Data request	Cat1.Req1
1.2		Collect Data from field	Every Fault Detector sends the real time measurements and the breaker status with a variable timeframe (generally of 10 s); The measurements at HV busbar are collected from the Integrated protection of transformer and wired devices. The measurements at MV busbar are collected thanks to: • the Integrated protection of transformer • the feeders' protections • the fault detectors installed along the feeders.	Send	Field Devices	Remote Terminal Units (RTUs)	Info2-Real time measurements, Info3-Device status	

			The current state of HV switches is received from the Integrated protection of transformers and wired devices. The current state of MV switches is received from feeders' protections.					
1.3		Transmit data	RTUs collect data from Field devices and transmit them to the Central SCADA (OCS) with the current state of MV switches collected from all the automated and remote controlled secondary substations.	Send	Remote Terminal Units (RTUs)	Central SCADA (OCS)	Info2-Real time measurements, Info3-Device status	
1.4		Collect data from RTUs	The transmitted data from field devices are collected to monitor the current state of the network. The manual switched updates can't be collected by the Remote Terminal Units. For this reason it's possible to put the information into the OCS by doing a manual functional order.		Central SCADA (OCS)			
1.5		Calculate load and generation forecasts	A server sends the metering information about class of customers. Taking into account of the tracing of the historical curves of different set of customers, the Active and Reactive Power profiles of each load and generation		Central SCADA (OCS)			

			customer are built. The Active and Reactive Power profiles of forecast generation is obtained by computing the information coming from an external weather provider.					
1.6		Store data in a database and re-route them to Local SCADA	The OCS collects all the measurement, the current state of breakers and assets, as well as the calculated forecasts, and stores them in a database.	Send	Central SCADA (OCS)	Local SCADA (LCS)	Info2-Real time measurements, Info3-Device status, Info4-Network data	
1.7		Retrieve all the necessary data from the Central SCADA (OCS)	The relevant data for network topology updating and state estimation are collected by the Local SCADA from the Central SCADA databases; these data consist of: • voltage and current measurements; • the current state of breakers and assets; • Primary Substation network topology; • Secondary Substation network topology; • Medium voltage distribution network topology; • Electrical characteristi		Local SCADA (LCS)			

			cs of network components; • Load and generation forecast.						
1.8		Build update network topology	Based on the data collected from the Central SCADA databases, the Local SCADA updates the network topology		Local SCADA (LCS)				
1.9		Perform network state estimation	Since the network state is updated, the algorithm for the State Estimation (SE) is triggered: • After a period of 15 minutes; • After network changes (reconfiguration, restoration after fault). The quantities are estimated in each node of the network. The estimation is therefore calculated at HV side of the Primary Substation which corresponds to the interconnection point between DSO and TSO.	Send	Local SCADA (LCS)	Central SCADA (OCS)	Info4-Network data	
1.10		Store the updated network information and provide them to the optimization/management processes	The LCS reports the result of network state estimation on the OCS: it calculates the reserve for each section of line, taking into account of a preset value of threshold current		Central SCADA (OCS)				

			on the OCS.						

- Request measurement collection

Business section: Network state updating/Request measurement collection

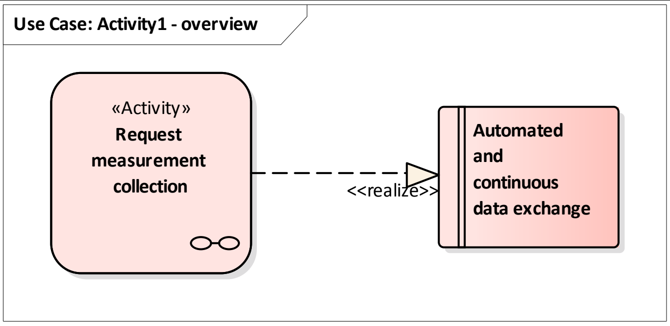
The OCS asks to the Primary Substation RTU the information collected from each field device.

Furthermore it asks the infomation about breaker status from the Secondary Substation RTUs.

Requirement list (refer to "Requirement" section for more information)	
Requirement R-ID	***Requirement name***
Cat1.Req1	Automated and continuous data exchange

Information sent:

Business object	*Instance name*	*Instance description*
Data request	Query for measurements	



- Collect Data from field

Business section: Network state updating/Collect Data from field

Every Fault Detector sends the real time measurements and the breaker status with a variable timeframe (generally of 10 s). The measurements at HV busbar are collected from the Integrated protection of transformer and wired devices.

The measurements at MV busbar are collected thanks to:

- the Integrated protection of transformer
- the feeders' protections
- the fault detectors installed along the feeders.

The current state of HV switches is received from the Integrated protection of transformers and wired devices.
The current state of MV switches is received from feeders' protections.

Information sent:

Business object	*Instance name*	*Instance description*
Real time measurements	Measures	
Device status	Updated status	

- Transmit data

Business section: Network state updating/Transmit data

RTUs collect data from Field devices and transmit them to the Central SCADA (OCS) with the current state of MV switches collected from all the automated and remote controlled secondary substations.

Information sent:

Business object	*Instance name*	*Instance description*
Real time measurements	Measures	
Device status	Updated status	

- Collect data from RTUs

Business section: Network state updating/Collect data from RTUs

The transmitted data from field devices are collected to monitor the current state of the network. The manual switched updates can't be collected by the Remote Terminal Units.

For this reason it's possible to put the information into the OCS by doing a manual functional order.

- Calculate load and generation forecasts

Business section: Network state updating/Calculate load and generation forecasts

A server sends the metering information about class of customers.

Taking into account of the tracing of the historical curves of different set of customers, the Active and Reactive Power profiles of each load and generation customer are built.

The Active and Reactive Power profiles of forecast generation is obtained by computing the information coming from an external weather provider.

- Store data in a database and re-route them to Local SCADA

Business section: Network state updating/Store data in a database and re-route them to Local SCADA

The OCS collects all the measurement, the current state of breakers and assets, as well as the calculated forecasts, and stores them in a database.

Information sent:

Business object	*Instance name*	*Instance description*
Real time measurements	Measures	
Device status	Updated status	
Network data	Network topology and load/gen forecasts	

- Retrieve all the necessary data from the Central SCADA (OCS)

Business section: Network state updating/Retrieve all the necessary data from the Central SCADA (OCS)

The relevant data for network topology updating and state estimation are collected by the Local SCADA from the Central SCADA databases; these data consist of:

- voltage and current measurements;
- the current state of breakers and assets;
- Primary Substation network topology;
- Secondary Substation network topology;
- Medium voltage distribution network topology;
- Electrical characteristics of network components;
- Load and generation forecast.

- Build update network topology

Business section: Network state updating/Build update network topology

Based on the data collected from the Central SCADA databases, the Local SCADA updates the network topology

- Perform network state estimation

Business section: Network state updating/Perform network state estimation

Since the network state is updated, the algorithm for the State Estimation (SE) is triggered:

- After a period of 15 minutes;
- After network changes (reconfiguration, restoration after fault).

The quantities are estimated in each node of the network.

The estimation is therefore calculated at HV side of the Primary Substation which corresponds to the interconnection point between DSO and TSO.

Information sent:

Business object	*Instance name*	*Instance description*
Network data	Updated network state	

- Store the updated network information and provide them to the optimization/management processes

Business section: Network state updating/Store the updated network information and provide them to the optimization/management processes

The LCS reports the result of network state estimation on the OCS: it calculates the reserve for each section of line, taking into account of a preset value of threshold current on the OCS.

Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information exchanged*	*Requirement, R-IDs*
Info1	Data request	The Central SCADA (OCS) operates a request to the Primary Substation RTU.	
Info2	Real time measurements	The field devices send to the Central SCADA the information about: • Voltage; • Current; • Active Power; • Reactive Power.	
Info3	Device status	The Primary Substation RTU receives the current state of the breakers: • CLOSED • OPEN • UNKNOWN	

		• FATAL ERROR	
Info4	Network data	It contains: • the primary substation network topology (x,y coordinates and the coupling of each elements: switches, busbars, feeders, HV/MV transformers, coils, static compensators, words etc…); • the secondary substation network topology (x,y coordinates and the coupling of each elements: switches, MV/LV transformers, generators, words, substation codes etc…); • the medium voltage distribution network topology (x,y coordinates and the coupling of each elements: the primary substation, feeders, switches, secondary substations etc…); • the electrical characteristics of network components to each element, specified in previous points several electrical parameters are associated: cables, transformers, line length, resistance etc…); • the real time measurements; • the current state of the breakers; • the information about each class of customers; • the generation forecast; • Power Capability values.	

Requirements (optional)

Requirements (optional)		
Categories ID	***Category name for requirements***	***Category description***
Cat1	Functional	
Requirement R-ID	***Requirement name***	***Requirement description***
Req1	Automated and continuous data exchange	The DS_O should ensure the continuous data exchange (including measurements, network state and topology and generation and load forecasts) between the different actors involved.The DS_O should ensure the continuous data exchange (including measurements, network state and topology and generation and load forecasts) between the different actors involved, also with human remote intervention.

IT – RPC: PERFORM REACTIVE POWER CAPABILITY CALCULATION FOR THE ITALIAN DEMO

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
IT - RPC	SGAM Domain	Perform reactive power capability calculation for the Italian Demo

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-08-03	Carla Marino (E-distribuzione) Daniele Clerici (RSE)		
2	2018-11-23	Alessio Pastore (E-distribuzione)	Review	
3	2018-12-19	Carla Marino (E-distribuzione)		

Scope and objectives of use case

Scope and objectives of use case	
Scope	Collect the reactive power capability curves from the resources connected to the distribution network. Optimize the reactive power capability exploitation between resources, including also the DS_O assets, avoiding/solving constraints violations and congestions in the distribution network. Calculate the resulting aggregated capability at the Primary Substation interface.
Objective(s)	Provide a total reactive power capability curve at the PS interface
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
This System Use Case describes the system process behind the calculation of the total reactive power capability of the network connected to the primary substation (DS_O/TS_O interconnection point). The total capability at the interconnection point is the result of the aggregation of the reactive power capabilities from the participating DERs (voluntary basis) and from the DS_O assets (BESS, STATCOM). This process is performed on an intra-day basis (every 6 hours) and its outcome is shared with the TS_O to define an agreed reactive power exchange profile for the following 6 hours slot; this profile is then managed in real-time,

every 15 minutes (see SUC IT – OP RP).
Complete description

The results of this System Use Case consist of the calculation of the reactive power capability at the interconnection point between the DS_O and the TS_O, given by the aggregation of the reactive power capabilities of the participating DERs and the DS_O asset.

At first the Network State Analysis process, described within System Use Case IT – NT SE, provides measurements, breakers status and load/generation forecast.

The info of Q capability of the single DER or DS_O regulation asset is necessary to obtain an accurate information about the available amount of the particular Q flexibility.

By aggregating the amount of all the flexibilities at the interconnection point of the Primary Substation, the DS_O can potentially provide to the TS_O a clear information of the reactive power capability of the distribution network area fed by the Primary Substation.

This info has to be updated on an intra-day basis (every 6 hours).

<u>Summary of use case</u>

- **<u>Reactive power capability calculation</u>**
  <u>Description</u>: This scenario includes a system process behind the calculation of the total reactive power capability of the network connected to the primary substation (DS_O/TS_O interconnection point).

  - Provide network updated information
    <u>Description</u>: The Central SCADA provides the updated network information and the capability curves of the participating resources to the Local SCADA.
    The network information updating process is described in the System Use Case 1.

  - Collect network information
    <u>Description</u>: The Local SCADA collect from the Central SCADA all the info related to:

    - Static Data of the network:

    position, the graphic symbol and the connection mode of each grid component, electrical characteristic of each grid component;

    - Dynamic Data of the network:

    measurements and events from field devices, load curves of customers, forecast of PV plants.

  - Calculate the total reactive power capability
    <u>Description</u>: Starting a loop control operation, the Reactive Power capability at the interconnection point is calculated.

  - Store total capability curve

Description: The Reactive Power capability value is available and stored in a database.

Key performance indicators (KPI)

Use case conditions

Use case conditions	
Assumptions	
1	Assumption
Prerequisites	
1	PreCondition: It is necessary that the Central SCADA provides all the updated network information to the Local SCADA, before the calculation process begins; so it is assumed that the process described in IT - NT SE is performed just before the total capability calculation process.

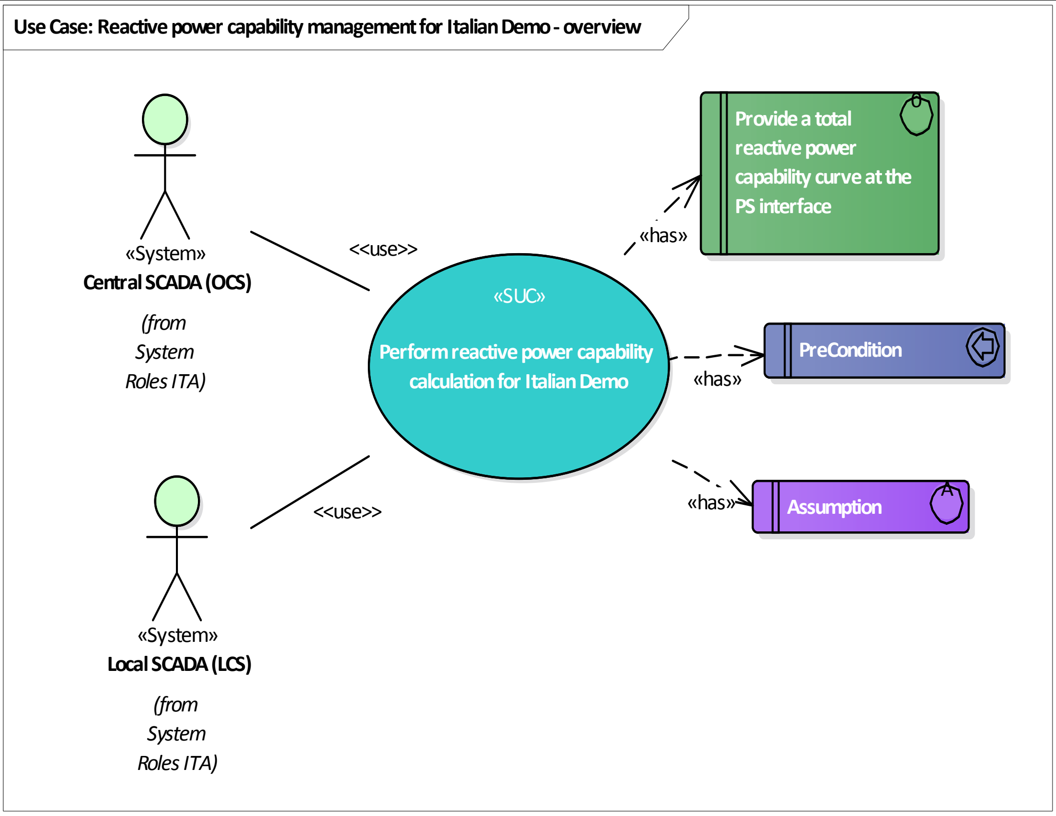
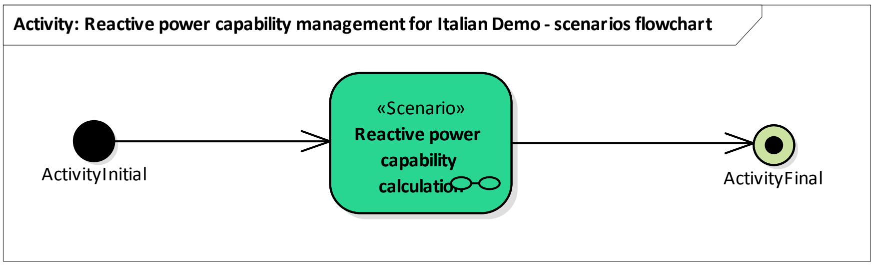
Further information to the use case for classification/mapping

Classification information
Relation to other use cases
<<BUC>> [IT-RP] Manage reactive power flexibility to support voltage control and congestion management in the Italian demo
Level of depth
White Box
Prioritisation
Generic, regional or national relation
National
Nature of the use case
SUC
Further keywords for classification

General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case
 

Technical details

Actors

Actors			
Grouping (e.g. domains, zones)	*Group description*		
Actor name	*Actor type*	*Actor description*	*Further information specific to this use case*
Central SCADA (OCS)	System	The Central SCADA is the monitoring and remote control system. It includes the database of the electrical network. The Central SCADA: • acquires events both from the Primary and Secondary Substations RTUs; • acquires measurements from the Primary Substations RTUs; • sends commands to the devices in the Primary Substations; • sends commands to the remote controlled Secondary Substations; • records manual updates.	
Local SCADA (LCS)	System	The Local SCADA is located in the Primary Substation and acquires the database and the recorded events from the Central SCADA. It's divided in: • a monitoring section; • a state estimation section; • a voltage regulation section.	

References

Step by step analysis of use case

Overview of scenarios

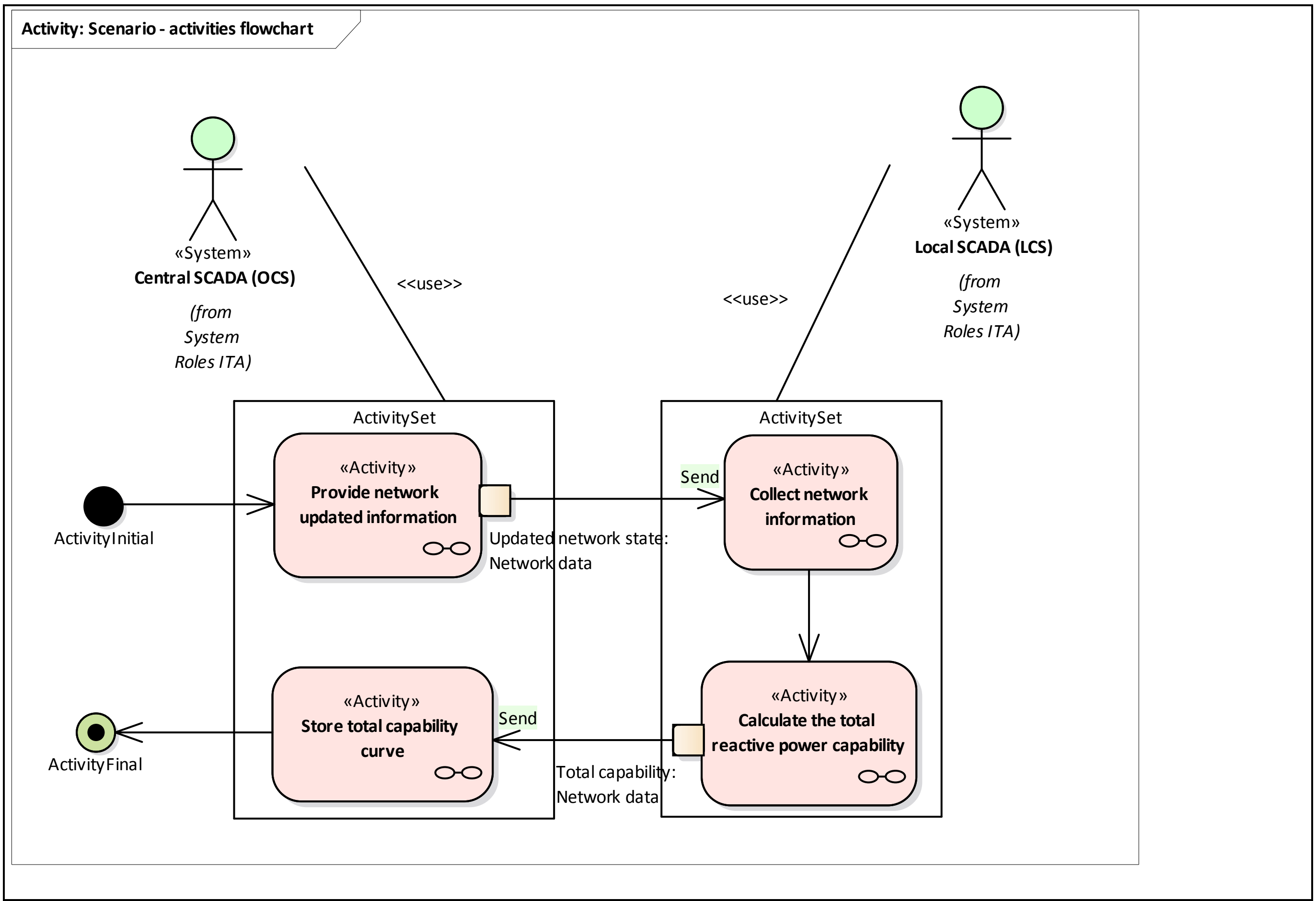
Scenario conditions							
No.	*Scenario name*	*Scenario description*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post-condition*
1	Reactive power capability	This scenario includes a system process behind the calculation of the total reactive power capability of the network connected to the				

	calculation	primary substation (DS_O/TS_O interconnection point).				

Steps - Scenarios

Reactive power capability calculation

This scenario includes a system process behind the calculation of the total reactive power capability of the network connected to the primary substation (DS_O/TS_O interconnection point).



Scenario step by step analysis

Scenario								
Scenario name	Reactive power capability calculation							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.1		Provide network	The Central SCADA provides the updated	Send	Central	Local SCADA	Info1-	

		updated information	network information and the capability curves of the participating resources to the Local SCADA. The network information updating process is described in the System Use Case 1.		SCADA (OCS)	(LCS)	Network data	
1.2		Collect network information	The Local SCADA collect from the Central SCADA all the info related to: • Static Data of the network: position, the graphic symbol and the connection mode of each grid component, electrical characteristic of each grid component; • Dynamic Data of the network: measurements and events from field devices, load curves of customers, forecast of PV plants.		Local SCADA (LCS)			
1.3		Calculate the total reactive power capability	Starting a loop control operation, the Reactive Power capability at the interconnection point is calculated.	Send	Local SCADA (LCS)	Central SCADA (OCS)	Info1-Network data	
1.4		Store total capability curve	The Reactive Power capability value is available and stored in a database.		Central SCADA (OCS)			

- Provide network updated information

Business section: Reactive power capability calculation/Provide network updated information

The Central SCADA provides the updated network information and the capability curves of the participating resources to the Local SCADA.

The network information updating process is described in the System Use Case 1.

Information sent:

Business object	*Instance name*	*Instance description*
Network data	Updated network state	

- Collect network information

Business section: Reactive power capability calculation/Collect network information

The Local SCADA collect from the Central SCADA all the info related to:

  - Static Data of the network:

position, the graphic symbol and the connection mode of each grid component, electrical characteristic of each grid component;

  - Dynamic Data of the network:

measurements and events from field devices, load curves of customers, forecast of PV plants.

- Calculate the total reactive power capability

Business section: Reactive power capability calculation/Calculate the total reactive power capability

Starting a loop control operation, the Reactive Power capability at the interconnection point is calculated.

Information sent:

Business object	*Instance name*	*Instance description*
Network data	Total capability	

- Store total capability curve

Business section: Reactive power capability calculation/Store total capability curve

The Reactive Power capability value is available and stored in a database.

Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information exchanged*	*Requirement, R-IDs*
Info1	Network data	It contains: • the primary substation network topology (x,y coordinates and the coupling of each elements: switches, busbars, feeders, HV/MV transformers, coils, static compensators, words etc…); • the secondary substation network topology (x,y coordinates and the coupling of each elements: switches, MV/LV transformers, generators, words, substation codes etc…); • the medium voltage distribution network topology (x,y coordinates and the coupling of each elements: the primary substation, feeders, switches, secondary substations etc…); • the electrical characteristics of network components to each element, specified in previous points several electrical parameters are associated: cables, transformers, line length, resistance etc…); • the real time measurements; • the current state of the breakers; • the information about each class of customers; • the generation forecast; • Power Capability values.	

IT – AP OP: PERFORM NETWORK OPTIMIZATION AFTER LOCAL MARKET CLOSURE FOR THE ITALIAN DEMO

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
IT - AP OP	SGAM Domain	Perform network optimization after local market closure for the Italian Demo

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-08-03	Carla Marino (E-distribuzione) Daniele Clerici (RSE)		
2	2018-11-23	Alessio Pastore (E-distribuzione)	Review	
3	2018-12-19	Carla Marino (E-distribuzione)		

Scope and objectives of use case

Scope and objectives of use case	
Scope	Optimize the distribution network, avoiding/solving congestions, imbalances and constraints violations, in order to guarantee the maximum exploitation of private resources for services to the transmission network (maximization of aggregated flexibility curve at PS interface). Based on the network state provided by the DS_O Central SCADA, the MO (through its own SCADA) may use DS_O assets to solve congestions or, alternatively, exploit some flexibility bids from local market. The DS_O own assets may be used also for solving imbalances created by flexibility activations.
Objective(s)	Calculate optimal set-points for the distribution network assets Create an active power vs cost curve, aggregating the flexibilities collected from local market
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
This Use Case describes the system process behind the optimization of the distribution network after the local flexibility market closure including the aggregation of active power flexibility bids in a single parametric curve (power vs cost). The process is based on an Optimal Power Flow aimed to achieve optimized network operations (avoiding/solving

constraints violations and congestions); the optimization process is tuned:

1. To determine the active power flexibilities which may be exploited for distribution network congestion management;
2. To maximize the active power capability at the primary substation, using the DS_O assets (BESS) for pursuing the highest (private) DERs flexibilities exploitation achievable;

This process is performed on real-time basis (every 15 minutes) and returns the set-points for all the resources/assets connected to the distribution network, as well as a total active power capability curve build from bids aggregation.

Complete description

The goal of this System Use Cases consists of:

- determining the active power flexibilities which may be exploited for distribution network congestion management
- maximizing the active power capability at the primary substation.

DS_O assets (BESS) are used to facilitate participation to DERs which joined the local market, whose characteristics are explained in Business Use Case IT AP - Manage active power flexibility to support mFRR/RR and congestion management in the Italian demo.

Summary of use case

- **Active power flexibilities management**
  Description: This Use Case describes the system process behind the optimization of the distribution network after the local flexibility market closure including the aggregation of active power flexibility bids in a single parametric curve (power vs cost).
  - Provide network updated information
    Description: At the end of the local flexibilities market the DS_O analyze the distribution network for retrieving the updated network state.
    Then DS_O provides it to the MO_D, including the info about congestions and constraints.
  - Collect network information
    Description: The Market Operator SCADA acquires all the network information in order to optimize the resources.
  - Optimize the network
    Description: The updated information is run into a cost function, guaranteeing all the fixed technical constraints.

    Taking into account of the network state, violations and congestions, the Market Operator SCADA optimizes the network:
    - exploiting the acquired resource during the market phase;

○ calculating the set-point for each asset of the DS_O in order to satisfy the request of the TSO. ▪ Aggregate bids in a parametric curve Description: After the optimization phase, the Market Operator SCADA produces a cost curve related to the power. The bids are classified on the requested power, the costs and the availability. A parametric cost curve is then created. The total flexibility at the interconnection point is available in order to establish the set-points for each resource.

Key performance indicators (KPI)

Use case conditions

	Use case conditions
	Assumptions
1	Assumption: DSO Assets take part to regulation process in order to allow the participation of private generators.
	Prerequisites
1	PreCondition1: Local Market has been performed.
2	PreCondition2: It is necessary that the Central SCADA can provide all the updated network information to the Local SCADA, before the calculation process begins; so it is assumed that the process described in IT - NT SE is performed just before the process described in this SUC.

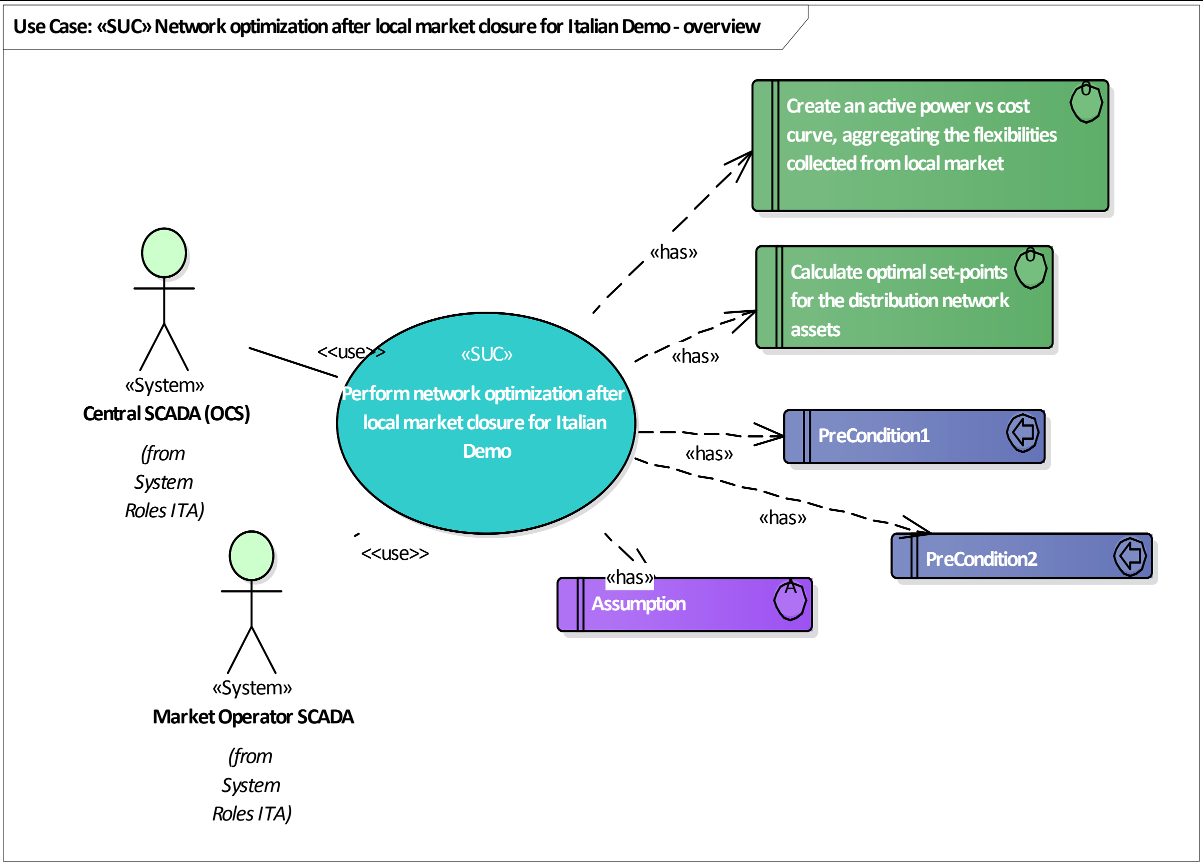
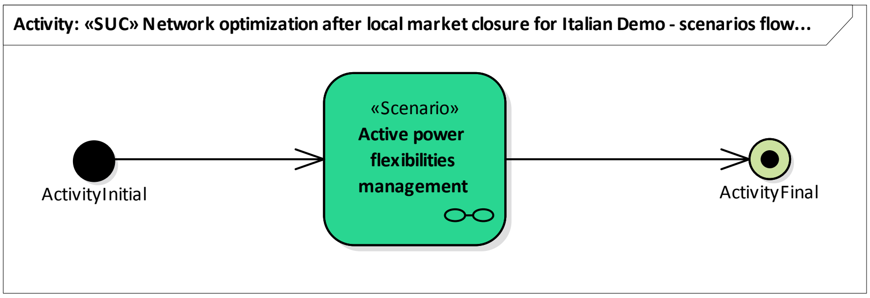
Further information to the use case for classification/mapping

Classification information
Relation to other use cases
<<BUC>> [IT-AP] Manage active power flexibility to support mFRR/RR and congestion management in the Italian demo
Level of depth
White Box
Prioritisation
Generic, regional or national relation
National
Nature of the use case
SUC
Further keywords for classification

General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case
 

Technical details

Actors

Actors			
Grouping (e.g. domains, zones)		*Group description*	
Actor name	*Actor type*	*Actor description*	*Further information specific to this use case*
Central SCADA (OCS)	System	The Central SCADA is the monitoring and remote control system. It includes the database of the electrical network. The Central SCADA: • acquires events both from the Primary and Secondary Substations RTUs; • acquires measurements from the Primary Substations RTUs; • sends commands to the devices in the Primary Substations; • sends commands to the remote controlled Secondary Substations; • records manual updates.	
Market Operator SCADA	System	The Market Operator SCADA is located in the Primary Substation and acquires the database and the recorded events from the Central SCADA. It's divided in: • a monitoring section; • a state estimation section; • an aggregation platform of the bids.	

References

Step by step analysis of use case

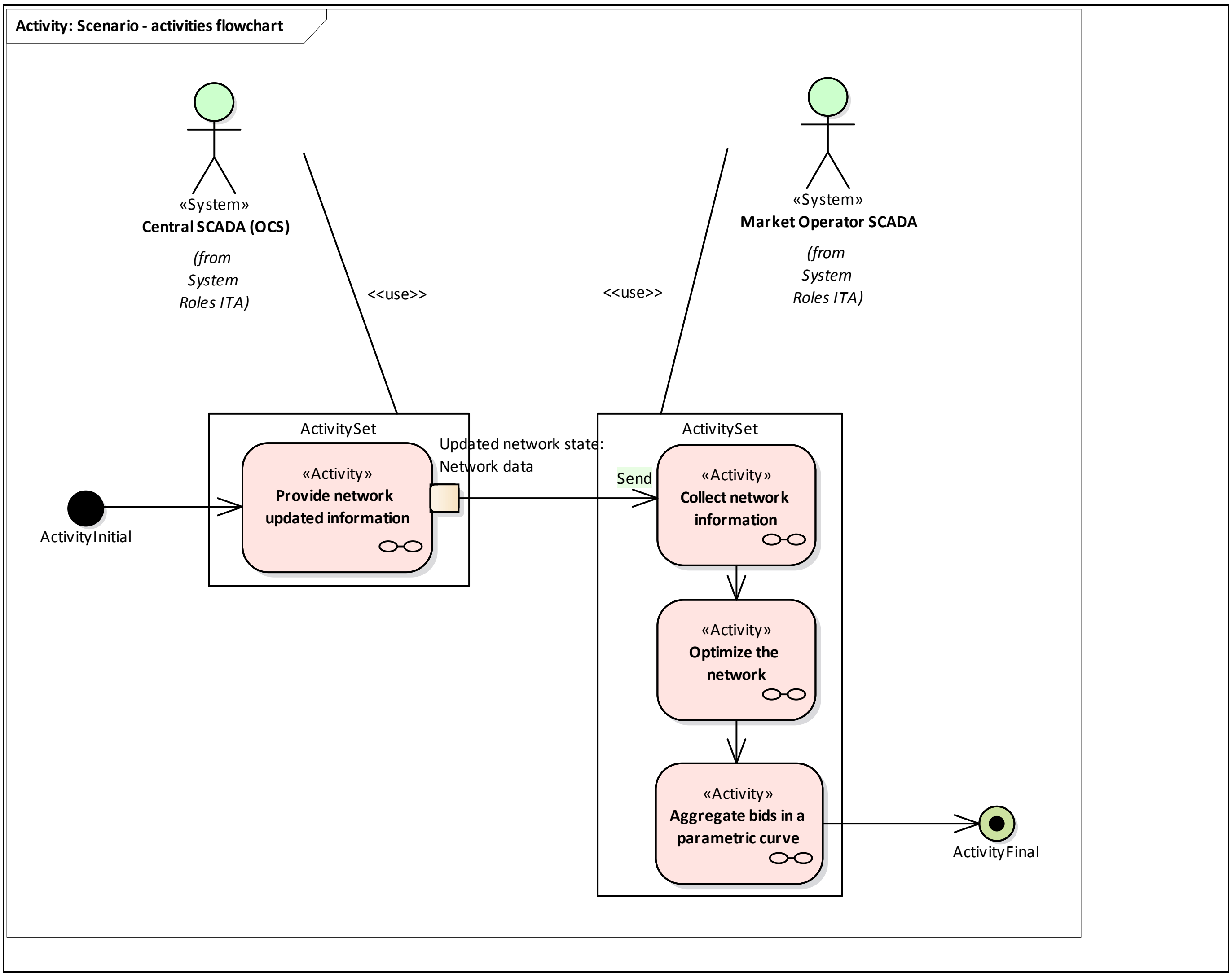
Overview of scenarios

Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	Active power flexibilities management	This Use Case describes the system process behind the optimization of the distribution network after the local flexibility market closure including the aggregation of active power flexibility bids in a single parametric curve (power vs cost).				

Steps – Scenarios

Active power flexibilities management

This Use Case describes the system process behind the optimization of the distribution network after the local flexibility market closure including the aggregation of active power flexibility bids in a single parametric curve (power vs cost).



Scenario step by step analysis

Scenario								
Scenario name	Active power flexibilities management							
Step No	**Event**	**Name of process/activity**	**Description of process/activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information exchanged (IDs)**	**Requirement, R-IDs**
1.1		Provide network updated information	At the end of the local flexibilities market the DS_O analyze the distribution network for retrieving the updated network state. Then DS_O provides it to the MO_D, including the info about congestions and constraints.	Send	Central SCADA (OCS)	Market Operator SCADA	Info1-Network data	Cat1.Req1
1.2		Collect network information	The Market Operator SCADA acquires all the network information in order to optimize the resources.		Market Operator SCADA			Cat1.Req2
1.3		Optimize the network	The updated information is run into a cost function, guaranteeing all the fixed technical constraints. Taking into account of the network state, violations and congestions, the Market Operator SCADA optimizes the network: • exploiting the acquired resource during the market phase; • calculating the set-point for each asset of the DS_O in order to satisfy the request of the TSO.		Market Operator SCADA			
1.4		Aggregate bids in a parametric	After the optimization phase, the Market Operator SCADA		Market Operator			

		curve	produces a cost curve related to the power. The bids are classified on the requested power, the costs and the availability. A parametric cost curve is then created. The total flexibility at the interconnection point is available in order to establish the set-points for each resource.		SCADA			

- Provide network updated information

Business section: Active power flexibilities management /Provide network updated information

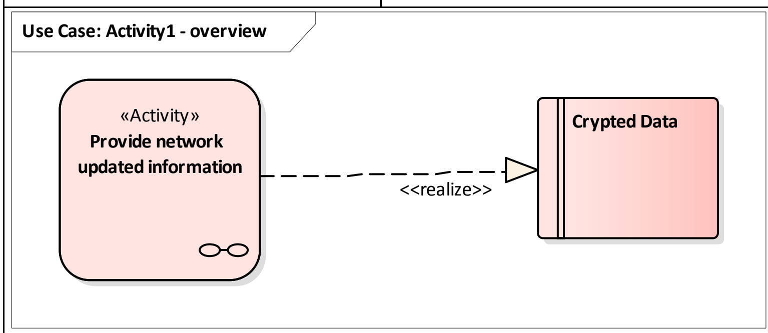
At the end of the local flexibilities market the DS_O analyze the distribution network for retrieving the updated network state.

Then DS_O provides it to the MO_D, including the info about congestions and constraints.

Requirement list (refer to "Requirement" section for more information)	
Requirement R-ID	***Requirement name***
Cat1.Req1	Crypted Data

Information sent:

Business object	*Instance name*	*Instance description*
Network data	Updated network state	

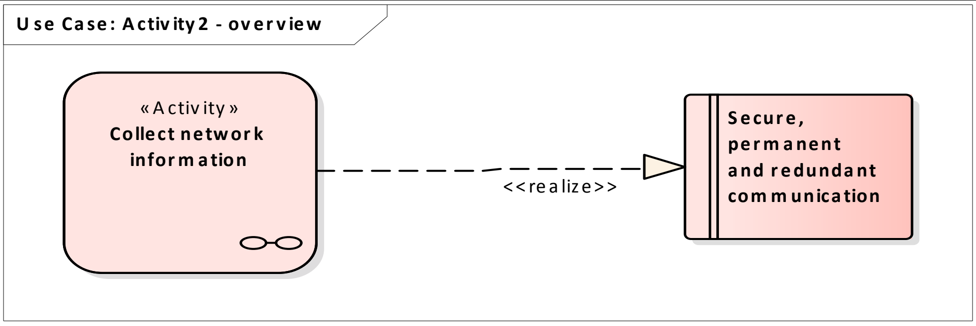


- Collect network information

Business section: Active power flexibilities management /Collect network information

The Market Operator SCADA acquires all the network information in order to optimize the resources.

Requirement list (refer to "Requirement" section for more information)	
Requirement R-ID	***Requirement name***
Cat1.Req2	Secure, permanent and redundant communication



- Optimize the network

Business section: Active power flexibilities management /Optimize the network

The updated information is run into a cost function, guaranteeing all the fixed technical constraints.

Taking into account of the network state, violations and congestions, the Market Operator SCADA optimizes the network:

- exploiting the acquired resource during the market phase;
- calculating the set-point for each asset of the DS_O

in order to satisfy the request of the TSO.

- Aggregate bids in a parametric curve

Business section: Active power flexibilities management /Aggregate bids in a parametric curve

After the optimization phase, the Market Operator SCADA produces a cost curve related to the power. The bids are classified on the requested power, the costs and the availability. A parametric cost curve is then created. The total flexibility at the interconnection point is available in order to establish the set-points for each resource.

Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
Info1	Network data	It contains: • the primary substation network topology (x,y coordinates and the coupling of each elements: switches, busbars, feeders, HV/MV transformers, coils, static compensators, words etc…); • the secondary substation network topology (x,y coordinates and the coupling of each elements: switches, MV/LV transformers, generators, words, substation codes etc…); • the medium voltage distribution network topology (x,y coordinates and the coupling of each elements: the primary substation, feeders, switches, secondary substations etc…); • the electrical characteristics of network components to each element, specified in previous points several electrical parameters are associated: cables, transformers, line length, resistance etc…); • the real time measurements; • the current state of the breakers; • the information about each class of customers; • the generation forecast; • Power Capability values.	

Requirements (optional)

Requirements (optional)		
Categories ID	***Category name for requirements***	***Category description***
Cat1	Security	
Requirement R-ID	***Requirement name***	***Requirement description***
Req1	Crypted Data	Data exchange should be encrypted due to the need to ensure the security of business processes
Req2	Secure, permanent and redundant communication	Secure, permanent and redundant communication channels between Market Operator SCADA and Central Operator SCADA

IT – RP OP: PERFORM NETWORK MANAGEMENT AND OPTIMIZATION FUNCTIONS FOR THE ITALIAN DEMO

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
IT - RP OP	SGAM Domain	Perform network management and optimization functions for the Italian Demo

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-08-03	Carla Marino (E-distribuzione) Daniele Clerici (RSE)		
2	2018-11-23	Alessio Pastore (E-distribuzione)	Review	
3	2018-12-19	Carla Marino (E-distribuzione)		

Scope and objectives of use case

Scope and objectives of use case	
Scope	Optimize the distribution network, avoiding/solving congestions and constraints violations, to guarantee the agreed reactive power capability at the PS interface and to follow the reactive power set-points send by the TS_O The DS_O Local SCADA manage both private resources and its own assets in order to follow the agreed exchange profile at PS, taking in to account the actual operating conditions.
Objective(s)	Provide optimal set-points for the assets connected to the distribution network Provide the agreed reactive power exchange at Primary Substation interface
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
This Use Case describes the system process behind the optimization and management of the distribution network including reactive power constraints at the primary substation. The process is based on an Optimal Power Flow aimed to achieve optimized network operations (avoiding/solving constraints violations and congestions) in presence of a constrained power exchange at the primary substation; the optimization process is tuned to pursue a balanced exploitation of all the participating DERs. This process is performed on real-time basis (every 15 minutes) and returns the set-points for all the resources/assets connected to the distribution network.

Complete description
This System Use Case is aimed to provide set point values to regulation assets in order to solve voltage violations taking into account of network constraints.

Summary of use case

- **Network management**
  Description: The process is based on an Optimal Power Flow aimed to achieve optimized network operations (avoiding/solving constraints violations and congestions) in presence of a constrained power exchange at the primary substation.
  - Provide network updated information
    Description: The Central SCADA provides the updated network information and the power capability profile (request by the TSO) of the participating resources to the Local SCADA.
    The network information updating process is described in the System Use Case 1.
  - Collect network information
    Description: The Local SCADA acquires all the network information in order to optimize the resources.
  - Optimize the network
    Description: Taking into account of the network state, violations and congestions, the Local SCADA optimizes the network:
    - exploiting the acquired resource during the market phase;
    - calculating the set-point for each asset

    in order to satisfy the request of the TSO.
  - Prepare set-points for delivery
    Description: The Local SCADA allocates all the resources in order to satisfy the capability request from the TSO and fixing the set-points for each resource.
  - Acquire set-points
    Description: RTUs take charge of the set points request from Local SCADA.
  - Address received set points to asset controllers
    Description: Field devices receive from RTUs set points ready to be addressed to asset controllers/regulators.

Key performance indicators (KPI)

Use case conditions

Use case conditions	
	Assumptions
1	Assumption
	Prerequisites

1	PreCondition: It is necessary that the Central SCADA can provide all the updated network information to the Local SCADA, before the calculation process begins; so it is assumed that the process described in IT - NT SE is performed just before the process described in this SUC.

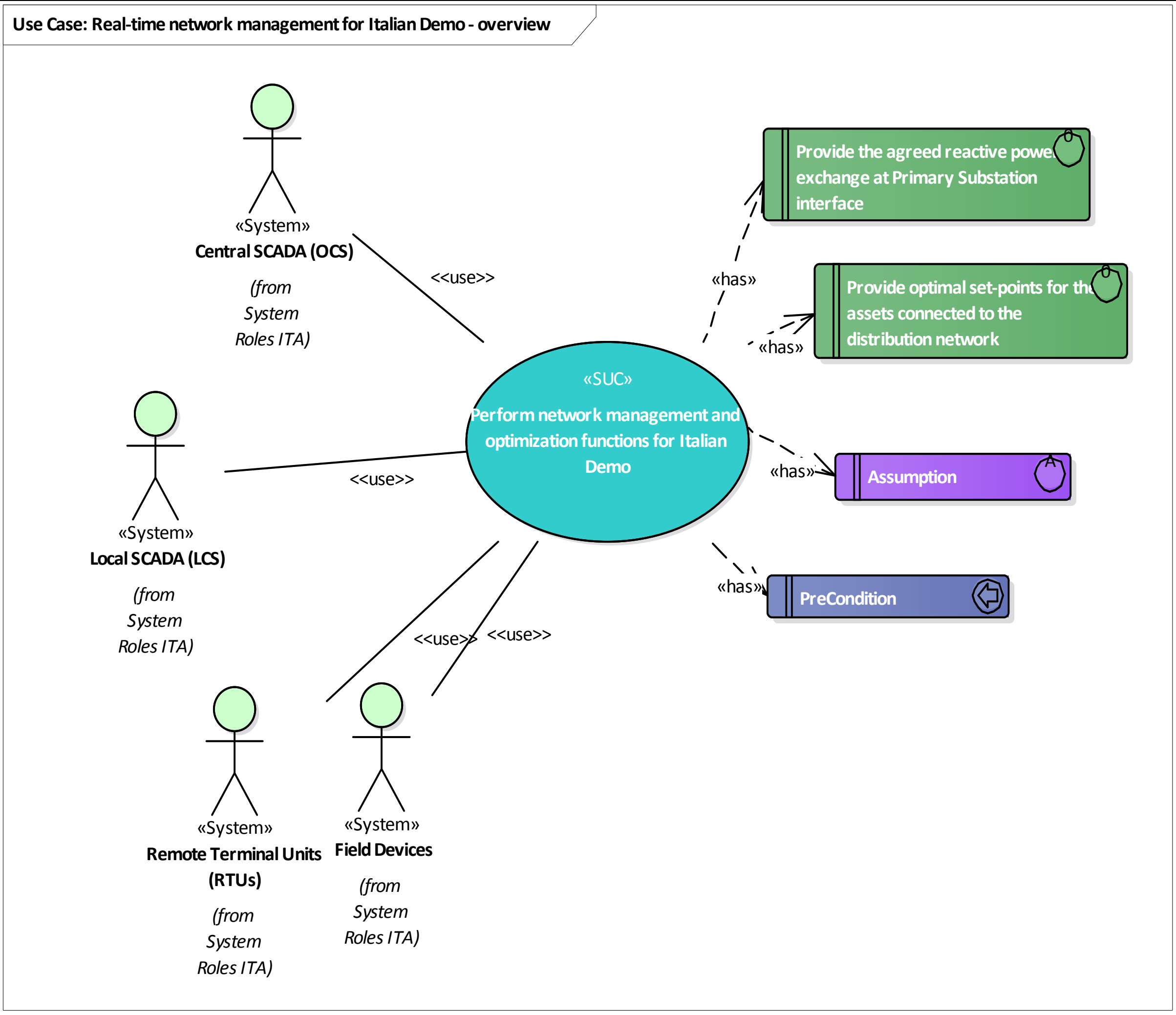
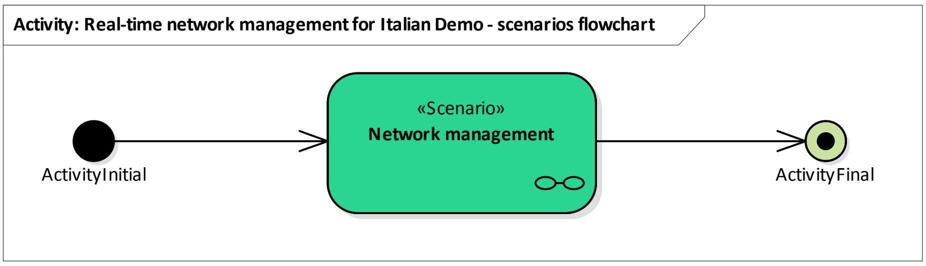
Further information to the use case for classification/mapping

Classification information
Relation to other use cases
<<BUC>> [IT-RP] Manage reactive power flexibility to support voltage control and congestion management in the Italian demo
Level of depth
White Box
Prioritisation
Generic, regional or national relation
National
Nature of the use case
SUC
Further keywords for classification

General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case
 

Technical details

Actors

Actors			
Grouping (e.g. domains, zones)		*Group description*	
Actor name	*Actor type*	*Actor description*	*Further information specific to this use case*
Central SCADA (OCS)	System	The Central SCADA is the monitoring and remote control system. It includes the database of the electrical network. The Central SCADA: • acquires events both from the Primary and Secondary Substations RTUs; • acquires measurements from the Primary Substations RTUs; • sends commands to the devices in the Primary Substations; • sends commands to the remote controlled Secondary Substations; • records manual updates.	
Local SCADA (LCS)	System	The Local SCADA is located in the Primary Substation and acquires the database and the recorded events from the Central SCADA. It's divided in: • a monitoring section; • a state estimation section; • a voltage regulation section.	
Field Devices	System	The Field devices include: • Transformer Integrated Protections; • Feeders' protections; • Secondary substation Fault Detectors; • Energy regulation Interfaces; • Storage interface; • Statcom interface.	

Remote Terminal Units (RTUs)	System	They are the Remote Terminal Units (RTUs) of Primary and Secondary Substations. They: • collect all the events happening in the medium voltage network send them to the connected SCADA. • collect measurements and breaker status from devices in field; • make correlation of events; • perform automation cycles; • send activation signals, commands to asset;	

References

Step by step analysis of use case

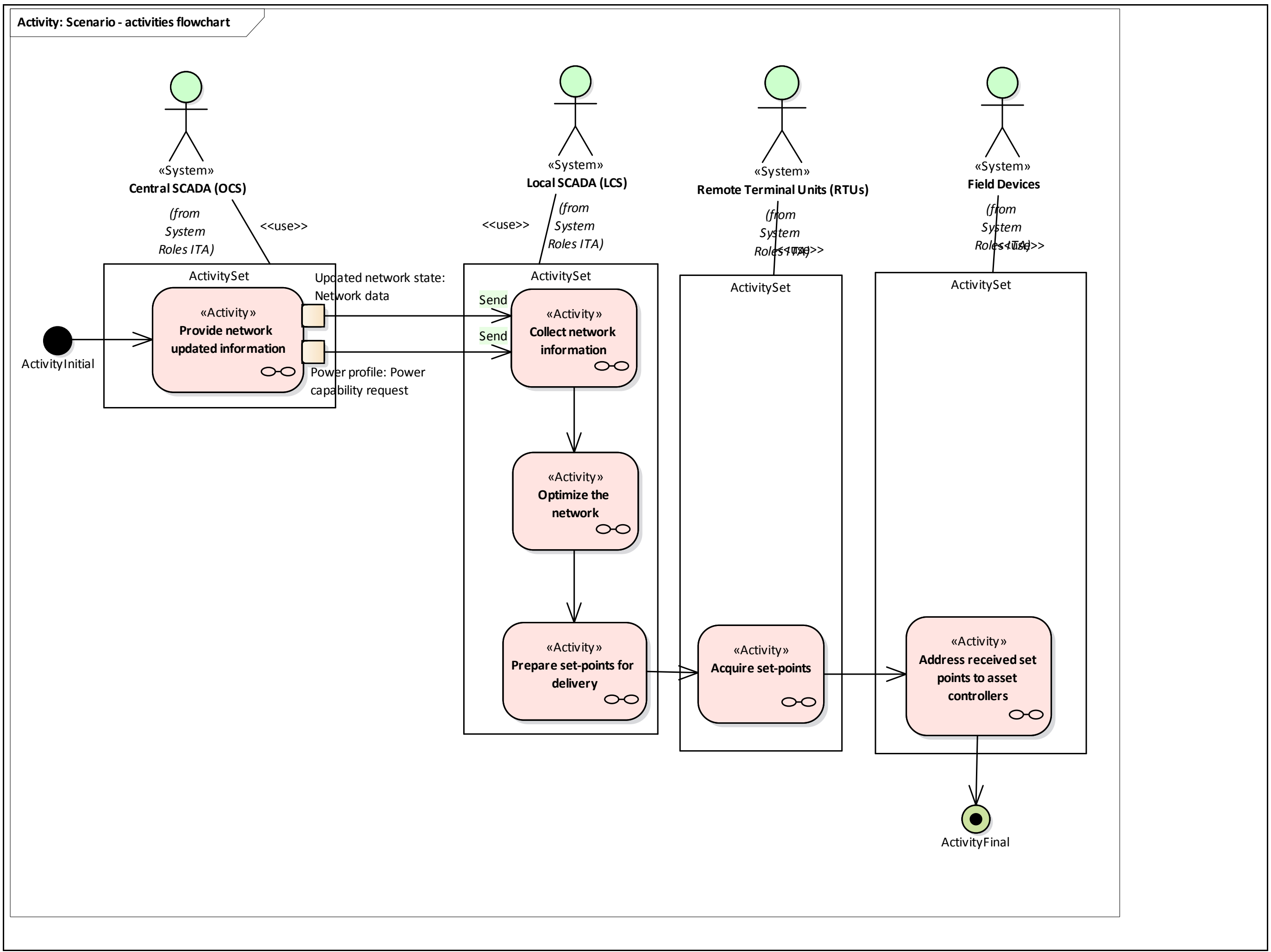
Overview of scenarios

Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	Network management	The process is based on an Optimal Power Flow aimed to achieve optimized network operations (avoiding/solving constraints violations and congestions) in presence of a constrained power exchange at the primary substation.				

Steps – Scenarios

Network management

The process is based on an Optimal Power Flow aimed to achieve optimized network operations (avoiding/solving constraints violations and congestions) in presence of a constrained power exchange at the primary substation.



Scenario step by step analysis

Scenario								
Scenario name	Network management							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.1		Provide network updated information	The Central SCADA provides the updated network information and the power capability profile (request by the	Send	Central SCADA (OCS)	Local SCADA (LCS)	Info1-Power capability request, Info2-	

			TSO) of the participating resources to the Local SCADA. The network information updating process is described in the System Use Case 1.				Network data	
1.2		Collect network information	The Local SCADA acquires all the network information in order to optimize the resources.		Local SCADA (LCS)			
1.3		Optimize the network	Taking into account of the network state, violations and congestions, the Local SCADA optimizes the network: • exploiting the acquired resource during the market phase; • calculating the set-point for each asset in order to satisfy the request of the TSO.		Local SCADA (LCS)			
1.4		Prepare set-points for delivery	The Local SCADA allocates all the resources in order to satisfy the capability request from the TSO and fixing the set-points for each resource.		Local SCADA (LCS)			
1.5		Acquire set-points	RTUs take charge of the set points request from Local SCADA.		Remote Terminal Units (RTUs)			
1.6		Address received set points to asset controllers	Field devices receive from RTUs set points ready to be addressed to asset controllers/regulators.		Field Devices			

- Provide network updated information

Business section: Network management/Provide network updated information

The Central SCADA provides the updated network information and the power capability profile (request by the TSO) of the participating resources to the Local SCADA.

The network information updating process is described in the System Use Case 1.

Information sent:

Business object	***Instance name***	***Instance description***
Power capability request	Power profile	
Network data	Updated network state	

- Collect network information

Business section: Network management/Collect network information

The Local SCADA acquires all the network information in order to optimize the resources.

- Optimize the network

Business section: Network management/Optimize the network

Taking into account of the network state, violations and congestions, the Local SCADA optimizes the network:

  - exploiting the acquired resource during the market phase;
  - calculating the set-point for each asset

in order to satisfy the request of the TSO.

- Prepare set-points for delivery

Business section: Network management/Prepare set-points for delivery

The Local SCADA allocates all the resources in order to satisfy the capability request from the TSO and fixing the set-points for each resource.

- Acquire set-points

Business section: Network management/Acquire set-points

RTUs take charge of the set points request from Local SCADA.

- <u>Address received set points to asset controllers</u>

Business section: Network management/Address received set points to asset controllers

Field devices receive from RTUs set points ready to be addressed to asset controllers/regulators.

Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
Info1	Power capability request	It consists on the power profile requested by the TSO.	
Info2	Network data	It contains: • the primary substation network topology (x,y coordinates and the coupling of each elements: switches, busbars, feeders, HV/MV transformers, coils, static compensators, words etc…); • the secondary substation network topology (x,y coordinates and the coupling of each elements: switches, MV/LV transformers, generators, words, substation codes etc…); • the medium voltage distribution network topology (x,y coordinates and the coupling of each elements: the primary substation, feeders, switches, secondary substations etc…); • the electrical characteristics of network components to each element, specified in previous points several electrical parameters are associated: cables, transformers, line length, resistance etc…); • the real time measurements; • the current state of the breakers; • the information about each class of customers; • the generation forecast; • Power Capability values.	

ANNEX IV. FINNISH SYSTEM USE CASES COMPLIANT WITH THE IEC62559-2 TEMPLATE

FIN – FC: FORECAST AVAILABLE RESOURCES FOR THE FINNISH DEMO

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
FIN - FC	SGAM Domain	Forecast available resources for the Finnish Demo

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-09-06	Corentin Evens, Kristiina Siilin, Johannes Einolander		Draft
2	2018-10-26	Corentin Evens, Kristiina Siilin, Antti Hyttinen		Final Version
3	2019-01-17	Corentin Evens		Harmonized version

Scope and objectives of use case

Scope and objectives of use case	
Scope	The aggregator forecasts the assets it has access to in order to be able to, in FIN SUC - FL AG, aggregate them and offer them to the markets.
Objective(s)	Accurate Forecasts: The forecasting tool should be designed so that it can produce accurate forecasts in a timely manner. The goal is to increase the forecasting accuracy and through this increase the performance of ancillary services for TSO and DSO, increase the revenue for retailer as well as increase the reliability of services. Robustness: the system should be designed so that if one of the forecasting tools does not update its data in time, the whole system is not stopped or stuck.
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
The asset forecasting tool uses the latest data about the assets in order to compute a forecast of the assets' flexibility which can be later used by the aggregation platform in order to form bids on various electricity and reserves markets.
Complete description

The Asset Forecasting Tool receives an instruction from the Aggregation Platform to update its forecasts. this can be initiated manually, at a fixed time related to market closure schedules or when a major change in the input data is noticed (e.g. new weather forecasts or acceptance of previous bids are received). The Asset Forecasting Tool requests updated data from the Assets Data Management Systems (see below) and uses them to compute a more accurate forecast of the flexibilities for the following 48h. The updated forecast is then uploaded to the Aggregation Database.

Each asset has a different data management system. Some of them have their data available in a cloud managed by a third party company (Virta, Optiwatti, DSO), and the BESS is managed directly by its own interface:

- EV: Virta cloud
- BESS: Unit internal system
- Distributed batteries: Virta cloud
- HEMS controlled homes: Optiwatti cloud
- AMR controlled loads: DSO interface

Summary of use case

- **Forecast available resources for the Finnish Demo**
  Description:
  - Start forecast update
    Description: The aggregation platform asks its assets forecasting system to make sure that the available data and forecasts are up-to-date in order to run a new round of bid creation.

    This process will be automatically started by significant changes in the input data, manually or at a fixed time of the day (based on markets gate closures or other factors).
  - Request updated historical data
    Description: The forecasting tool asks the assets data management system to check if the stored data is up-to-date and to update it if necessary.
  - Update asset data
    Description: The asset's data management system sends the newest available data to the forecasting tool.
  - Forecast asset availability
    Description: The asset forecasting tool runs its forecasting algorithms and updates its prediction.
  - Update asset forecast
    Description: The database receives the updated forecast from the asset forecasting tool and stores it.

Key performance indicators (KPI)

Use case conditions

Use case conditions	
Assumptions	
1	Limitations due to the regulatory and market environment: - The results from the forecasting tools should not permit the identification of specific individuals.
2	Rules relevant for the service (market & regulation): - This SUC is run every time the system is notified of significant changes in the input data, manually or at fixed times of the day. It can also be started by an update request from the aggregation platform in SUC FIN - FL AG.
Prerequisites	
1	Choices regarding the level of detail, the scope for the description of the SUC : - The communication with the specific assets has been previously established. Some are accessed directly through their interface and others through a third-party data cloud. - The forecast of small distributed resources is made at an aggregated level. The behaviour of individual units is too complex and unreliable to be of any use.
2	Choices for the delivery of the service: - The forecasts will be made for a period of 2 to 3 days (further analyzes will help determine which) so that the boundary conditions on the state of the devices at the end of the forecasting period do not impact the results too much for the first day (for which the forecasting is actually required).

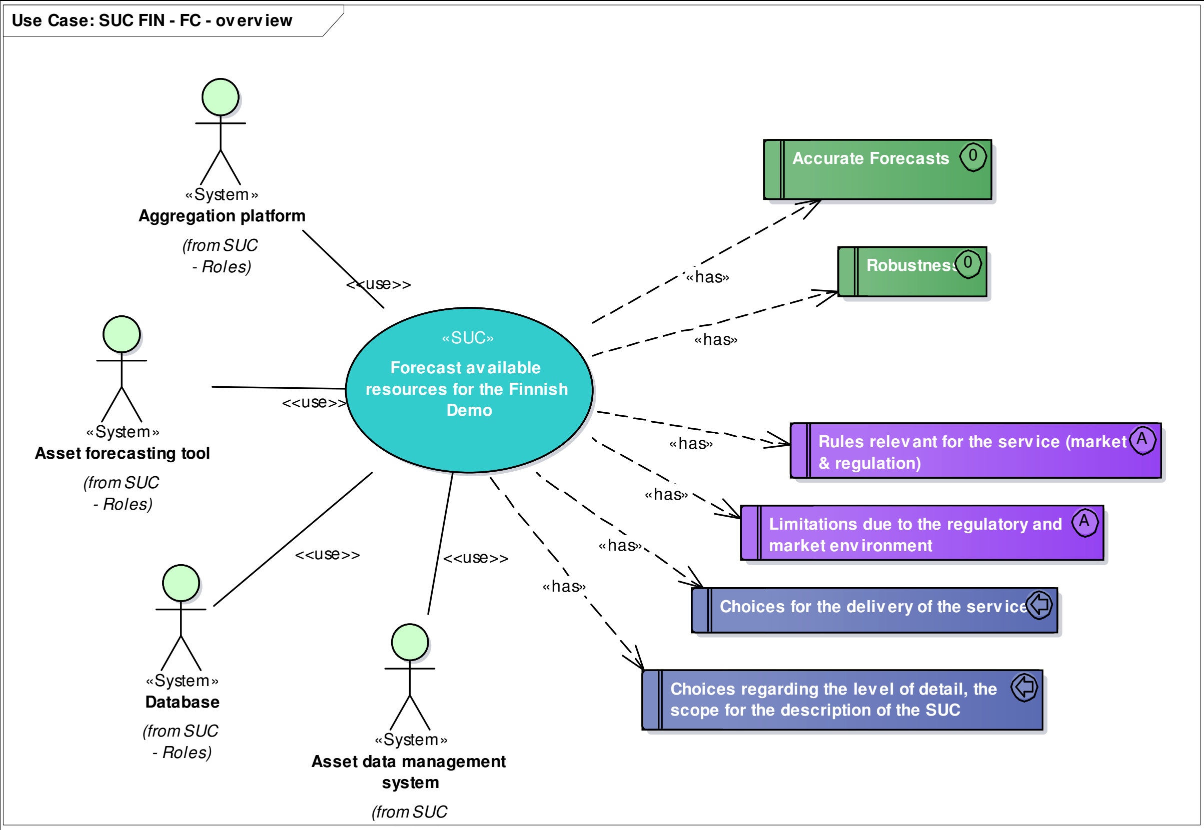
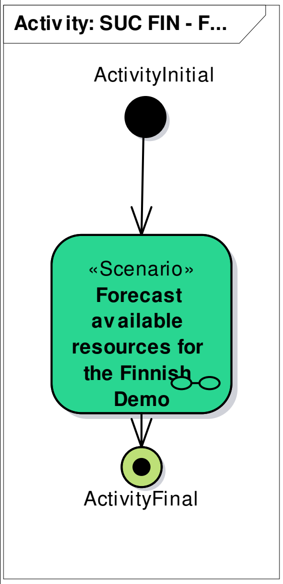
Further information to the use case for classification/mapping

Classification information
Relation to other use cases
<<BUC>> FI - FCR-N in Finland Demo <<BUC>> FI - mFRR in Finland Demo <<BUC>> FI - RPM in Finland Demo
Level of depth
White box
Prioritisation
Generic, regional or national relation
Existing Finnish market environment
Nature of the use case
SUC
Further keywords for classification

General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case
 

Technical details

Actors

Actors			
Grouping (e.g. domains, zones)		*Group description*	
Actor name	*Actor type*	*Actor description*	*Further information specific to this use case*
Asset forecasting tool	System	Piece of software in charge of forecasting the availability of an asset type.	
Database	System	The system in charge of keeping the inputs and outputs related to the different forecasting operations.	
Aggregation platform	System	The SysFlex aggregation platform manages the portfolio of resources that the aggregator wishes to use in the scope of the SysFlex project. Its role is to coordinate the forecasts of the different resources and to form the bids requested by the trading system in a timely fashion. For the time being, this will consist of a "main" aggregation platform (DEMS), which aggregates larger units, and of a "secondary" system that will aggregate the smaller units as inputs for the "main" platform.	
Asset data management system	System	System that collects and/or stores the asset data. Its structure depends on the considered asset. Refer to the use case's description.	

References

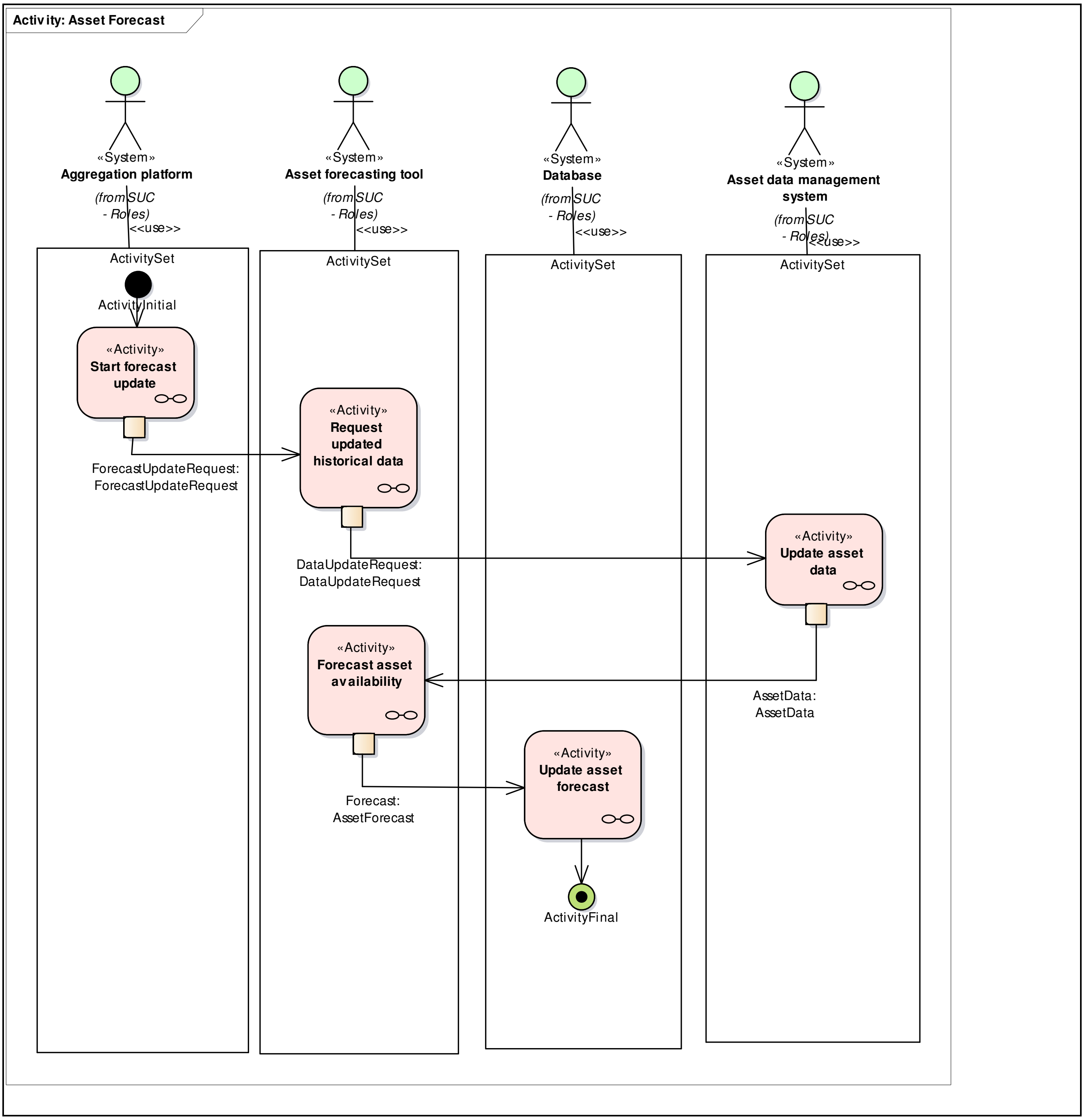
Step by step analysis of use case

Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario description*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post-condition*
1	Forecast available resources for the Finnish Demo					

Steps – Scenarios

Forecast available resources for the Finnish Demo



Scenario step by step analysis

Scenario	
Scenario	Forecast available resources for the Finnish Demo

name								
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.1		Start forecast update	The aggregation platform asks its assets forecasting system to make sure that the available data and forecasts are up-to-date in order to run a new round of bid creation. This process will be automatically started by significant changes in the input data, manually or at a fixed time of the day (based on markets gate closures or other factors).		Aggregation platform	Asset forecasting tool	Info1-ForecastUpdateRequest	
1.2		Request updated historical data	The forecasting tool asks the assets data management system to check if the stored data is up-to-date and to update it if necessary.		Asset forecasting tool	Asset data management system	Info2-DataUpdateRequest	
1.3		Update asset data	The asset's data management system sends the newest available data to the forecasting tool.		Asset data management system	Asset forecasting tool	Info3-AssetData, Info4-DataUpdated	
1.4		Forecast asset availability	The asset forecasting tool runs its		Asset forecasting	Database	Info5-AssetForecast	

			forecasting algorithms and updates its prediction.		tool			
1.5		Update asset forecast	The database receives the updated forecast from the asset forecasting tool and stores it.		Database	Database	Info4-DataUpdated	

- Start forecast update

Business section: Forecast available resources for the Finnish Demo/Start forecast update

The aggregation platform asks its assets forecasting system to make sure that the available data and forecasts are up-to-date in order to run a new round of bid creation.

This process will be automatically started by significant changes in the input data, manually or at a fixed time of the day (based on markets gate closures or other factors).

Information sent:

Business object	***Instance name***	***Instance description***
ForecastUpdateRequest	ForecastUpdateRequest	

- Request updated historical data

Business section: Forecast available resources for the Finnish Demo/Request updated historical data

The forecasting tool asks the assets data management system to check if the stored data is up-to-date and to update it if necessary.

Information sent:

Business object	***Instance name***	***Instance description***
DataUpdateRequest	DataUpdateRequest	

- Update asset data

Business section: Forecast available resources for the Finnish Demo/Update asset data

The asset's data management system sends the newest available data to the forecasting tool.

Information sent:

Business object	*Instance name*	*Instance description*
AssetData	AssetData	
DataUpdated	DataUpdated	

- Forecast asset availability

Business section: Forecast available resources for the Finnish Demo/Forecast asset availability

The asset forecasting tool runs its forecasting algorithms and updates its prediction.

Information sent:

Business object	*Instance name*	*Instance description*
AssetForecast	Forecast	- Asset ID - Times - Expected consumption for each time (MW) - Expected flexibility for each time (MW) - Maximum expected duration for each flexibility bracket (h) - Expected standard deviation from expected flexibility (or some to be determined percentile value) - List of market IDs to which the flexibility can be offered

- Update asset forecast

Business section: Forecast available resources for the Finnish Demo/Update asset forecast

The database receives the updated forecast from the asset forecasting tool and stores it.

Information sent:

Business object	*Instance name*	*Instance description*
DataUpdated	EVForecastUpdated	

Information exchanged

Information exchanged			
Information	*Name of information*	*Description of information exchanged*	*Requirement,*

exchanged, ID			***R-IDs***
Info1	ForecastUpdateRequest	The aggregation platform requests the different forecasting tools to update their forecasting. It includes: - ID of the resources to forecast - Time period to forecast	
Info2	DataUpdateRequest	Request from the forecasting tools to update the data related to a specific type of resources or market. It includes: - type of resource ID - time period to forecast	
Info3	AssetData	This includes historical and status data for a specific asset or group of aggregated assets. It may include: - Historical data - Status - Planned operations (e.g. planned maintenance, advance booking, etc)	
Info4	DataUpdated	Notification that the data related to a specific asset has been updated.	
Info5	AssetForecast	Forecast information about a specific resource. It may include: - Resource ID - Times - Production/Consumption - Available flexibility	

FIN – FLAG: AGGREGATE FLEXIBILITIES FOR THE FINNISH DEMO

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
FIN - FL AG	SGAM Domain	Aggregate flexibilities for the Finnish Demo

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-09-06	Corentin Evens, Kristiina Siilin, Johannes Einolander		Draft
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Scope and objectives of use case

Scope and objectives of use case	
Scope	This SUC aggregates the flexibilities from different assets by creating bids from their forecasted behaviour. The bids are submitted to the TSO or DSO and later dispatched to the specific resources if they are activated.
Objective(s)	Increase market liquidity: Increase the liquidity on the different markets, and the reliability of the services, by introducing resources that wouldn't otherwise be available. Increase aggregator revenue: The aggregator wishes to maximize the income it can obtain from operating its resources on the different markets.
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
The goal is to demonstrate how flexibility resources, i.e. small, distributed resources that are connected to the distribution network can be aggregated to be traded on TSO's existing market places and for DSO's balancing needs (demonstrated in SUC FIN - RP MK and RP MN).
Complete description

In this use case, the Aggregation Platform gathers the information about the forecast of the various Assets it is responsible for and transmits what is necessary for the Trading Platform to create and submit bids on the different markets. It is also responsible for receiving the accepted bids and communicating with the Assets for them to adjust their set points or activate accordingly.

In a first stage, it asks for up-to-date forecasts from the aggregation database. If necessary, and if time allows, it waits until the forecasting tool is done with its update and then optimizes the allocation of the assets' flexibilities to the different possible markets.

The Aggregation platform continues with sending the allocation of the assets' flexibilities to the trading system, which uses the information in order to create and submit bids to the market operator (in our case through the TSO interface).

The market is run and operated by the TSO/market operator and the accepted bids are communicated to the trading system. The trading system activates the large assets connected to it directly and also forwards its share of the accepted bids to the aggregation platform so that it can itself activate its assets or adjust their operating mode or set points.

Summary of use case

- **Aggregate flexibilities for the Finnish Demo**
  Description:
  - Activate Assets
    Description: - The aggregation platform communicates to the assets that they need to adjust their operating mode or set points. Based on the assets and the developments during the project, the platform will send direct orders or schedules to the assets interfaces.
    - Depending on the assets, the activation will be performed either by sending direct set points to the individual assets or by sending requests to a third-party data cloud that in turn will operate the assets.
  - Handle Accepted Bids
    Description: The trading platform receives the accepted bids from the TSO interface/market operator and communicates it to the aggregation platform in the form of market ID and accepted times and volumes.
  - Run Markets
    Description: The TSO or DSO receives the bids and runs its market places. It computes the accepted bids and sends the results to the different market participants.
  - Start bid creation
    Description: The optimization tool launches the creation or update of the forecasts in order to ensure that it will have appropriate data to run its optimization and create the bids required by the trading platform.

    This process can be started manually, at fixed times of the day suitable to create bids for the appropriate markets or upon notification by the database that the historical data and current status have been updated.
  - Send Asset Forecasts

Description: The database provides the aggregation platform with the list of assets forecasts relevant for the bids being calculated. ▪ Send markets forecast Description: The database provides the aggregation platform with the list of market forecasts relevant for the bids being calculated. ▪ Allocate assets to markets Description: The aggregation platform assigns the assets to the markets in which they are expected to create the largest profit. ▪ Store asset allocation Description: - The trading platform stores the aggregated allocation of the assets it controls. ▪ Submit bids Description: The trading system interfaces with the market operator and submits the bids in the appropriate form.

Key performance indicators (KPI)

Use case conditions

Use case conditions	
Assumptions	
1	Rules relevant for the service (market & regulation): - The SUC is run every time a market closure is scheduled. It could also be started manually or for example automatically once a day in order to have some values available in case of an emergency. - Depending on the market the bids are made for, the specifications in terms of timing and limitation will vary.
2	Limitations due to the regulatory and market environment: - The aggregator has to report to its balance responsible party as normal, taking into account the markets it is active on. - The aggregator has clear contracts with all of its customers detailing what can and can not be done and how the remuneration is calculated and performed.
Prerequisites	
1	Choices for the delivery of the service: - The architecture is based on existing communication channels of the aggregator.
2	Choices regarding the level of detail, the scope for the description of the SUC : - The aggregator's trading platform is an existing software in Helen's system. It will be used, but not modified during this demonstrator. - The TSO and DSO interface are merged into a single role for clarity in the diagrams. In practice, active power bids will be sent only to the TSO and reactive power bids only to the DSO.

Further information to the use case for classification/mapping

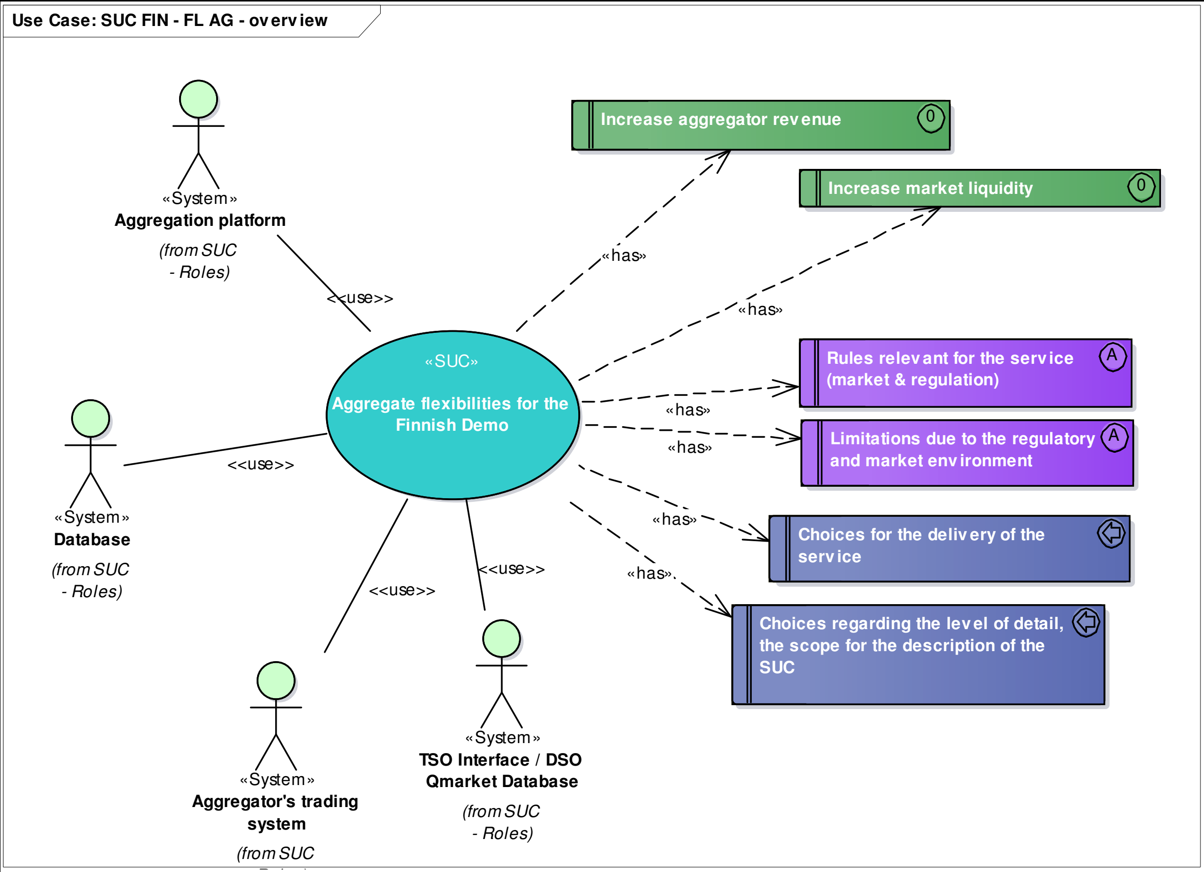
Classification information
Relation to other use cases

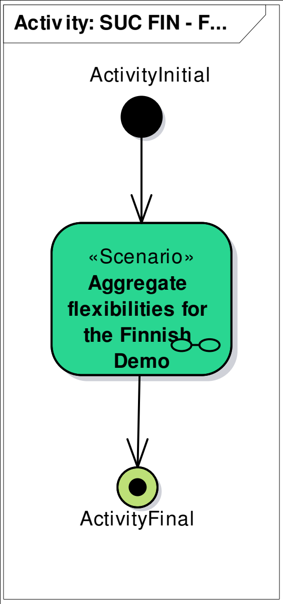
<<BUC>> FI - FCR-N in Finland Demo <<BUC>> FI - mFRR in Finland Demo <<BUC>> FI - RPM in Finland Demo
Level of depth
White box
Prioritisation
Generic, regional or national relation
National Finland market environment
Nature of the use case
SUC
Further keywords for classification

General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case




Technical details

Actors

Actors			
Grouping (e.g. domains, zones)	*Group description*		
Actor name	*Actor type*	*Actor description*	*Further information specific to this use case*
Database	System	The system in charge of keeping the inputs and outputs related to the different forecasting operations.	
Aggregation platform	System	The SysFlex aggregation platform manages the portfolio of resources that the aggregator wishes to use in the scope of the SysFlex project. Its role is to coordinate the forecasts of the different resources and to form the bids requested by the trading system in a timely fashion. For the time being, this will consist of a "main" aggregation platform (DEMS), which aggregates larger units, and of a "secondary" system that will aggregate the smaller units as inputs	

		for the "main" platform.	
Aggregator's trading system	System	The platform, in the aggregator's system, that is responsible for coordinating the resources and interacting with the various markets.	
TSO Interface / DSO Qmarket Database	System	Interface of the TSO (active power) or DSO (reactive power) that receives market bids. It also sends bid acceptance and activations signals.	

References

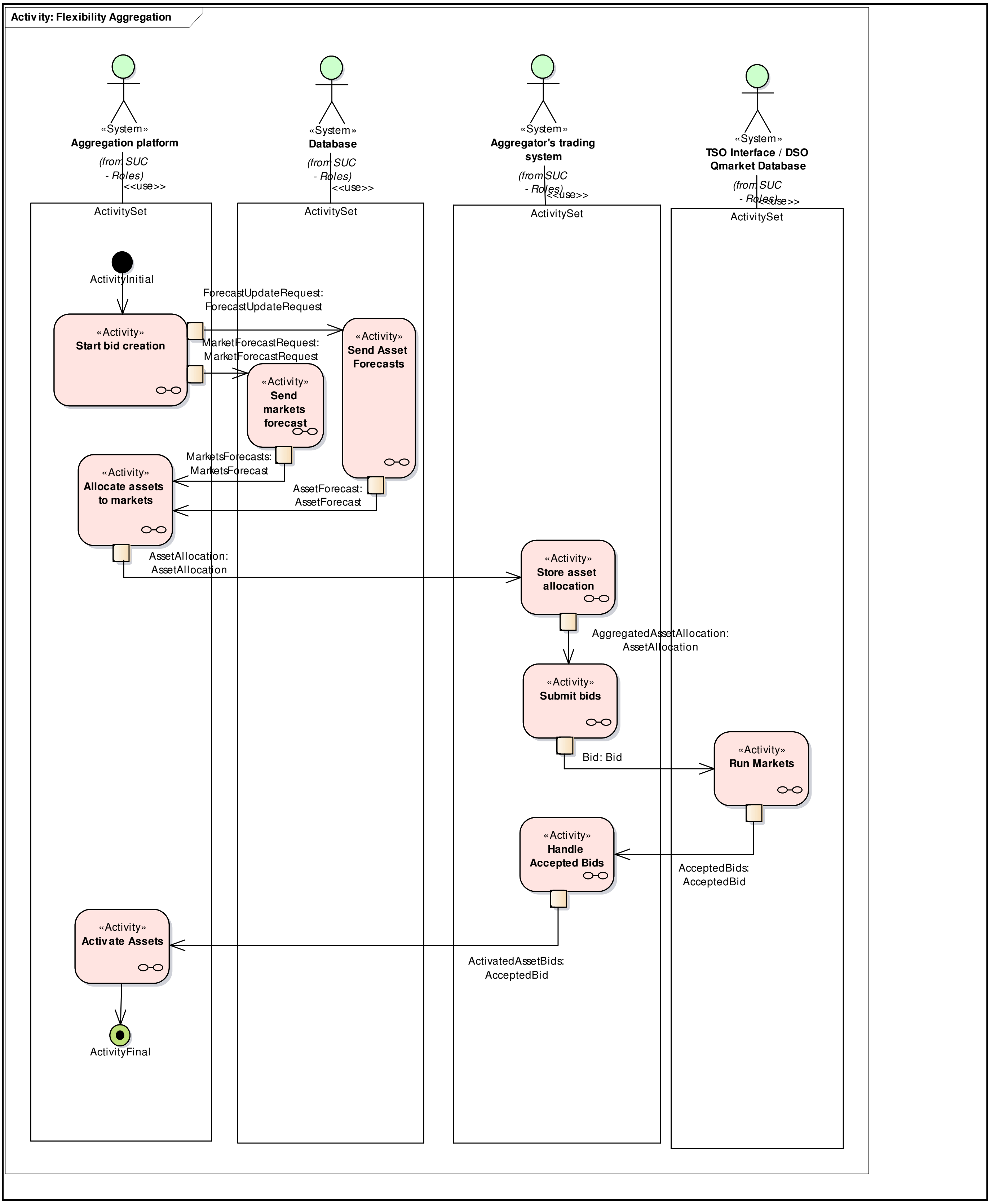
Step by step analysis of use case

Overview of scenarios

Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	Aggregate flexibilities for the Finnish Demo					

Steps - Scenarios

Aggregate flexibilities for the Finnish Demo



Scenario step by step analysis

Scenario

Scenario name	Aggregate flexibilities for the Finnish Demo							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.1		Activate Assets	- The aggregation platform communicates to the assets that they need to adjust their operating mode or set points. Based on the assets and the developments during the project, the platform will send direct orders or schedules to the assets interfaces. - Depending on the assets, the activation will be performed either by sending direct set points to the individual assets or by sending requests to a third-party data cloud that in turn will operate the assets.		Aggregation platform			
1.2		Handle Accepted Bids	The trading platform receives the accepted bids from the TSO interface/market operator and communicates it to the aggregation platform in the form of market ID and accepted times and volumes.		Aggregator's trading system	Aggregation platform	Info1-AcceptedBid	
1.3		Run Markets	The TSO or DSO receives the bids and runs its market places. It computes the accepted bids and		TSO Interface / DSO Qmarket	Aggregator's trading system	Info1-AcceptedBid	

			sends the results to the different market participants.		Database			
1.4		Start bid creation	The optimization tool launches the creation or update of the forecasts in order to ensure that it will have appropriate data to run its optimization and create the bids required by the trading platform. This process can be started manually, at fixed times of the day suitable to create bids for the appropriate markets or upon notification by the database that the historical data and current status have been updated.		Aggregation platform	Database	Info2-ForecastUpdateRequest, Info3-MarketForecastRequest	
1.5		Send Asset Forecasts	The database provides the aggregation platform with the list of assets forecasts relevant for the bids being calculated.		Database	Aggregation platform	Info4-AssetForecast	
1.6		Send markets forecast	The database provides the aggregation platform with the list of market forecasts relevant for the bids being calculated.		Database	Aggregation platform	Info5-MarketsForecast	
1.7		Allocate assets to markets	The aggregation platform assigns the assets to the markets in which they are expected to create the largest profit.		Aggregation platform	Aggregator's trading system	Info6-AssetAllocation	
1.8		Store asset	- The trading platform stores		Aggregator'	Aggregator'	Info6-AssetAllocation	

		allocation	the aggregated allocation of the assets it controls.		s trading system	s trading system		
1.9		Submit bids	The trading system interfaces with the market operator and submits the bids in the appropriate form.		Aggregator's trading system	TSO Interface / DSO Qmarket Database	Info7-Bid	

- Activate Assets

Business section: Aggregate flexibilities for the Finnish Demo/Activate Assets

- The aggregation platform communicates to the assets that they need to adjust their operating mode or set points. Based on the assets and the developments during the project, the platform will send direct orders or schedules to the assets interfaces.

- Depending on the assets, the activation will be performed either by sending direct set points to the individual assets or by sending requests to a third-party data cloud that in turn will operate the assets.

- Handle Accepted Bids

Business section: Aggregate flexibilities for the Finnish Demo/Handle Accepted Bids

The trading platform receives the accepted bids from the TSO interface/market operator and communicates it to the aggregation platform in the form of market ID and accepted times and volumes.

Information sent:

Business object	***Instance name***	***Instance description***
AcceptedBid	ActivatedAssetBids	

- Run Markets

Business section: Aggregate flexibilities for the Finnish Demo/Run Markets

The TSO or DSO receives the bids and runs its market places. It computes the accepted bids and sends the results to the different market participants.

Information sent:

Business object	***Instance name***	***Instance description***
AcceptedBid	AcceptedBids	

- Start bid creation

Business section: Aggregate flexibilities for the Finnish Demo/Start bid creation

The optimization tool launches the creation or update of the forecasts in order to ensure that it will have appropriate data to run its optimization and create the bids required by the trading platform.

This process can be started manually, at fixed times of the day suitable to create bids for the appropriate markets or upon notification by the database that the historical data and current status have been updated.

Information sent:

Business object	***Instance name***	***Instance description***
ForecastUpdateRequest	ForecastUpdateRequest	
MarketForecastRequest	MarketForecastRequest	

- Send Asset Forecasts

Business section: Aggregate flexibilities for the Finnish Demo/Send Asset Forecasts

The database provides the aggregation platform with the list of assets forecasts relevant for the bids being calculated.

Information sent:

Business object	***Instance name***	***Instance description***
AssetForecast	AssetForecast	

- Send markets forecast

Business section: Aggregate flexibilities for the Finnish Demo/Send markets forecast

The database provides the aggregation platform with the list of market forecasts relevant for the bids being calculated.

Information sent:

Business object	***Instance name***	***Instance description***
MarketsForecast	MarketsForecasts	

- Allocate assets to markets

Business section: Aggregate flexibilities for the Finnish Demo/Allocate assets to markets

The aggregation platform assigns the assets to the markets in which they are expected to create the largest profit.

Information sent:

Business object	***Instance name***	***Instance description***
AssetAllocation	AssetAllocation	

- Store asset allocation

Business section: Aggregate flexibilities for the Finnish Demo/Store asset allocation

- The trading platform stores the aggregated allocation of the assets it controls.

Information sent:

Business object	***Instance name***	***Instance description***
AssetAllocation	AggregatedAssetAllocation	

- Submit bids

Business section: Aggregate flexibilities for the Finnish Demo/Submit bids

The trading system interfaces with the market operator and submits the bids in the appropriate form.

Information sent:

Business object	***Instance name***	***Instance description***
Bid	Bid	

Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
Info1	AcceptedBid	- Bid ID - Times	

		- Prices - Volume	
Info2	ForecastUpdateRequest	The aggregation platform requests the different forecasting tools to update their forecasting. It includes: - ID of the resources to forecast - Time period to forecast	
Info3	MarketForecastRequest	Request for an update of the markets forecasts. It includes ID of the markets to forecast.	
Info4	AssetForecast	Forecast information about a specific resource. It may include: - Resource ID - Times - Production/Consumption - Available flexibility	
Info5	MarketsForecast	Forecasts for a list of markets. It includes: - Market ID - Price - Expected deviation / forecasting error - Probability of activation (if relevant)	
Info6	AssetAllocation	- Array of markets ID - Array of times - Array of volumes - Array of prices - ID of the assets assigned to the bid	
Info7	Bid	Bid for active or reactive power market. It may include: - Market ID - Aggregator's ID - Times - Volumes - Prices	

FIN – RP MK: PERFORM DSO REACTIVE POWER MARKET FOR THE FINNISH DEMO

Description of the use case

Name of use case

Use case identification

ID	Area(s)/Domain(s)/Zone(s)	Name of use case
FIN - RP MK	SGAM Domain	Perform DSO reactive power market for the Finnish Demo

Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
1	2018-09-06	Corentin Evens, Pirjo Heine, Suvi Takala		Draft
2	2018-10-26	Corentin Evens, Pirjo Heine, Suvi Takala		Final version
3	2019-01-17	Corentin Evens		Harmonized version

Scope and objectives of use case

Scope and objectives of use case	
Scope	Operate the reactive power market and the market mechanism. Send activation requests to the asset operators of accepted bids.
Objective(s)	Minimize tariff payments: The DSO wants to minimize the fees it may face for being outside the required PQ-window. Increase revenue: - The aggregator uses resources to provide reactive power compensation to the DSO market place and receive a remuneration for it.
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
In order to reduce its PQ deviation fee costs, the DSO sets up a market and calls for bids from aggregators. After the results of market clearing are available, the DSO market place sends the activation requests to aggregators or asset operators.
Complete description
Upon receiving a notification from the "SUC FIN – RP MN" use case, the DSO's market platform starts a clearing market procedure. Prior to clearing the market the platform has received and compiled the reactive power bids from the different certified resources. Once the market is cleared the results and the activation requests to compensate reactive power are sent to the relevant asset operators. Summary of use case • **Perform DSO reactive power market for the Finnish Demo** Description: The DSO operates the reactive power market. ▪ Initiate market process Description: Request to start the reactive power market process received from SUC FIN - RP MN.

This activity sends a request for bids from the aggregators and, later, launches the market clearing process. ▪ Send reactive power bid Description: The aggregator sends its reactive power capabilities as well as the price at which it can be activated. ▪ Compile reactive power offers Description: Collects and save the reactive power offers made to the market. ▪ Clear Market Description: Dispatches the reactive power operation among the different providers based on their availability, price and on the network needs. ▪ Log in and dispatch market results Description: - Notifies accepted and rejected bids - Log the information in the database ▪ Activate bid assets Description: The aggregator receives the information about how much reactive power they should provide during the given time periods. Their internal processes will further dispatch it to their own assets.

Key performance indicators (KPI)

Use case conditions

Use case conditions	
Assumptions	
1	limitations due to the regulatory and market environment: - The market should be open to all the aggregators active in the network area (in practice for the demonstrator, we will have only one aggregator). - The market clearing process should be clear, transparent and non-biased.
2	rules relevant for the service (market & regulation): - The timing of the different steps still needs to be determined as the development goes on.
Prerequisites	
1	Choices regarding the level of detail, the scope for the description of the SUC : - "Aggregators" also include retailers, operators of a single asset and even active consumers that would have enough capacity to act as their own party.
2	choices for the delivery of the service: - The location of the assets participating to the reactive power regulation needs to be validated in order to check that they do not cause more problems than they solve. - This SUC is related to the Reactive Power Management BUC from WP3.

Further information to the use case for classification/mapping

Classification information
Relation to other use cases

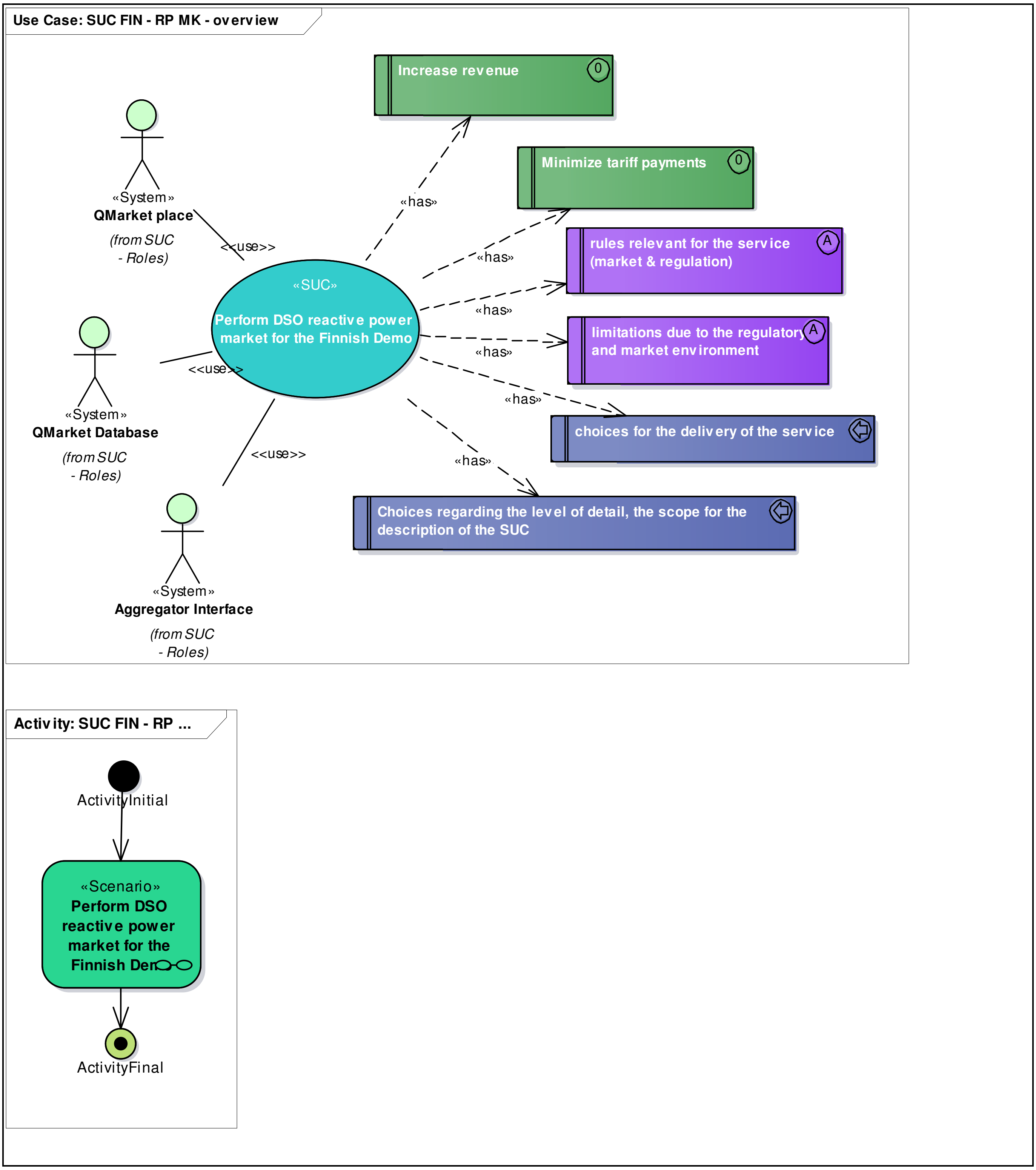
<<BUC>> FI - RPM in Finland Demo
Level of depth
White box
Prioritisation
Generic, regional or national relation
Regional distribution network in Helsinki
Nature of the use case
SUC
Further keywords for classification

General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case



Technical details

Actors

Actors			
Grouping (e.g. domains, zones)	***Group description***		
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
QMarket place	System	Market place operates the market mechanism for the requested reactive power. • Sends the result of market mechanism to the aggregators • Receives the data of fulfilled activation from aggregators agreements	
QMarket Database	System	Contains the information about accepted resources in the market place.	
Aggregator Interface	System	Provides the compensation asked by the DSO market place. Gets the result of market mechanism and sends the data of fulfilled activation to market place.	

References

Step by step analysis of use case

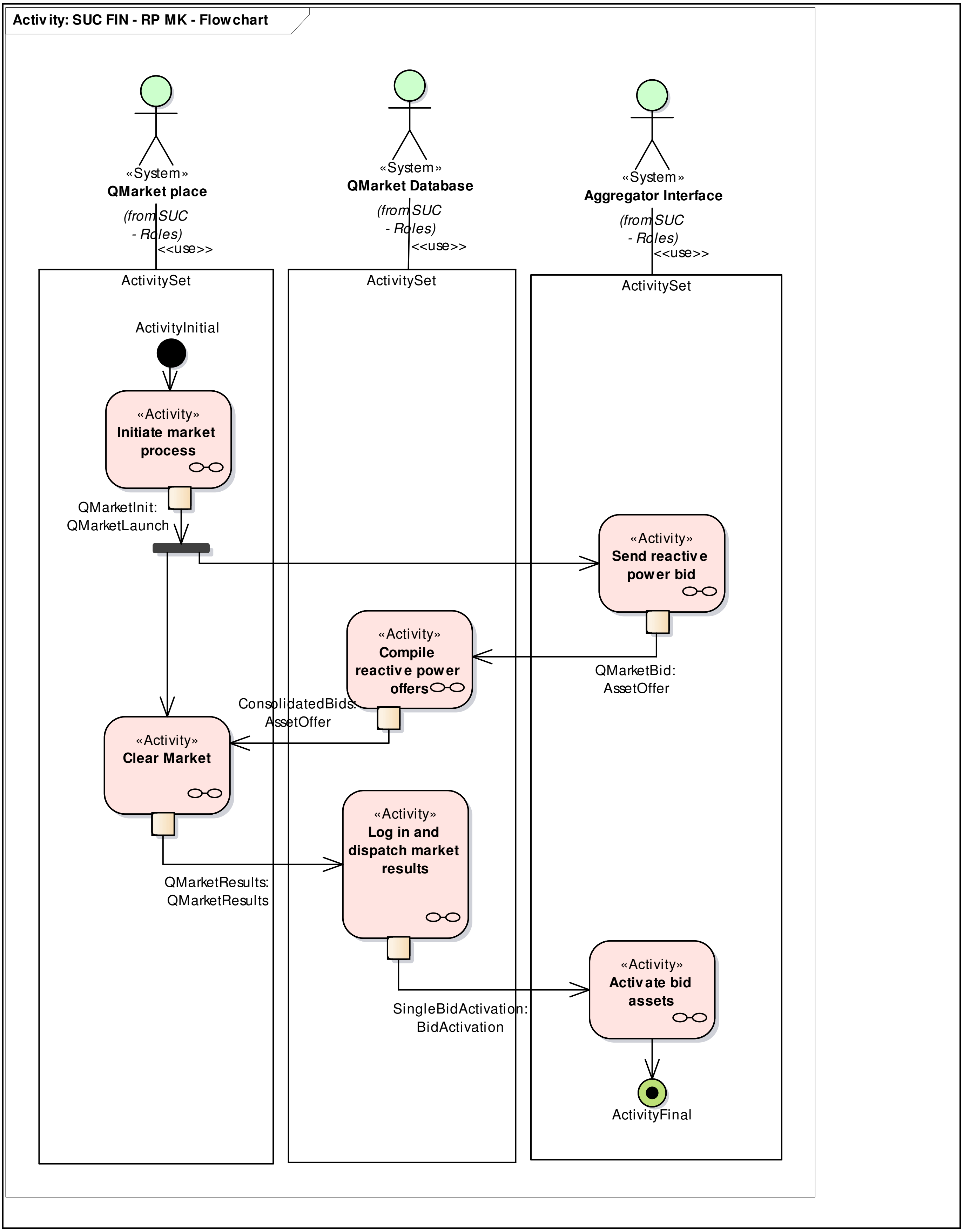
Overview of scenarios

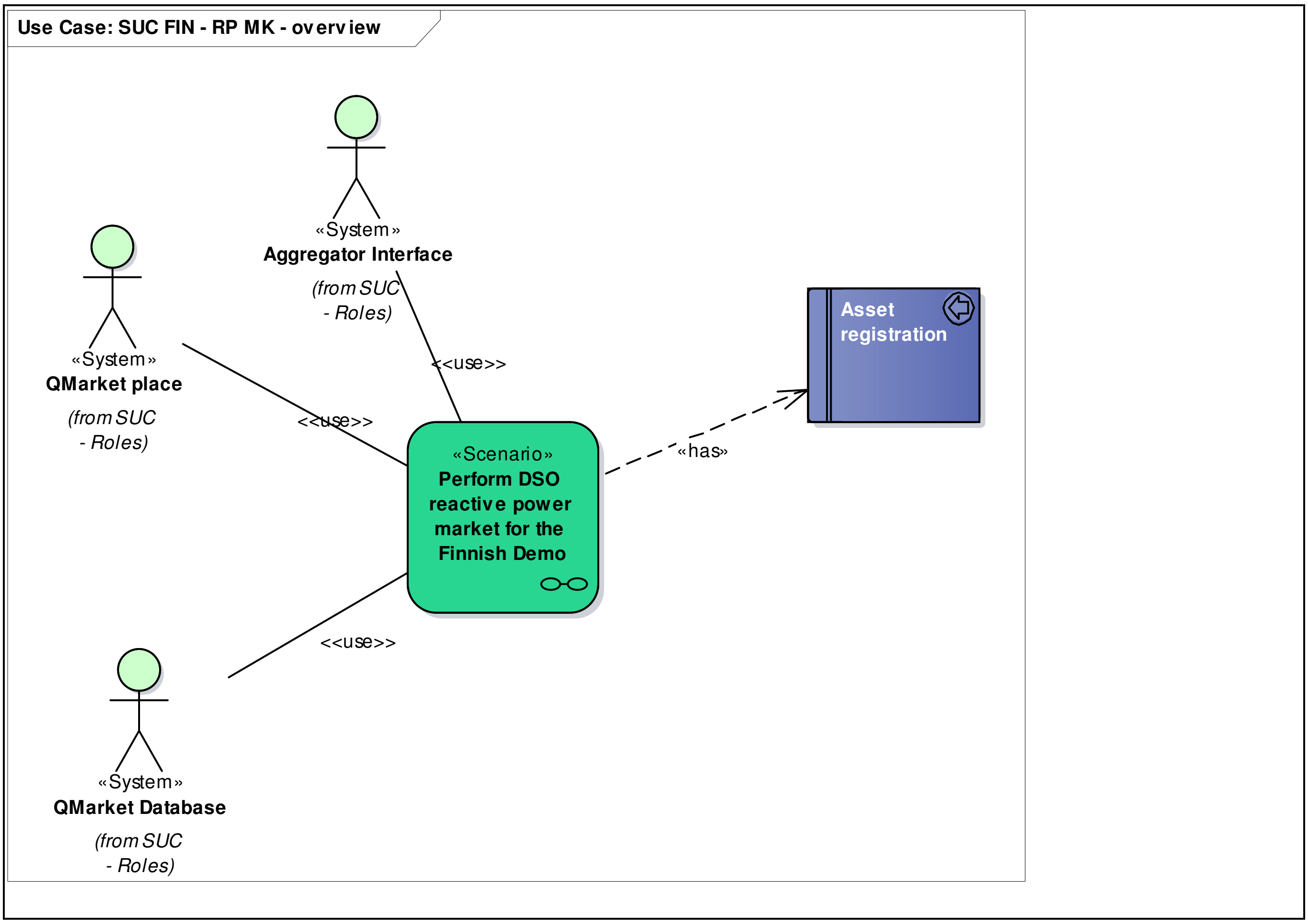
Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	Perform DSO reactive power market for the Finnish Demo	The DSO operates the reactive power market.			Asset registration: The assets wishing to participate to the reactive power market have previously registered their capacity and have demonstrated their ability to provide the required services as well as to measure them accurately.	

Steps - Scenarios

Perform DSO reactive power market for the Finnish Demo

The DSO operates the reactive power market.


Activity: SUC FIN - RP MK - Flowchart
«System»
QMarket place
(from SUC - Roles)
<<use>>
«System»
QMarket Database
(from SUC - Roles)
<<use>>
«System»
Aggregator Interface
(from SUC - Roles)
<<use>>
ActivitySet
ActivitySet
ActivitySet
ActivityInitial
«Activity»
Initiate market process
QMarketInit:
QMarketLaunch
«Activity»
Send reactive power bid
QMarketBid:
AssetOffer
«Activity»
Compile reactive power offers
ConsolidatedBids:
AssetOffer
«Activity»
Clear Market
«Activity»
Log in and dispatch market results
QMarketResults:
QMarketResults
«Activity»
Activate bid assets
SingleBidActivation:
BidActivation
ActivityFinal



Scenario step by step analysis

Scenario								
Scenario name	Perform DSO reactive power market for the Finnish Demo							
Step No	***Event***	***Name of process/activity***	***Description of process/activity***	***Service***	***Information producer (actor)***	***Information receiver (actor)***	***Information exchanged (IDs)***	***Requirement, R-IDs***
1.1		Initiate market process	Request to start the reactive power market process received from SUC FIN - RP MN. This activity sends a request for bids from the aggregators and, later, launches the market clearing process.		QMarket place	Aggregator Interface, QMarket place	Info1-QMarketLaunch	
1.2		Send reactive	The aggregator sends its reactive		Aggregator	QMarket	Info2-	

		power bid	power capabilities as well as the price at which it can be activated.		Interface	Database	AssetOffer	
1.3		Compile reactive power offers	Collects and save the reactive power offers made to the market.		QMarket Database	QMarket place	Info2-AssetOffer	
1.4		Clear Market	Dispatches the reactive power operation among the different providers based on their availability, price and on the network needs.		QMarket place	QMarket Database	Info3-QMarketResults	
1.5		Log in and dispatch market results	- Notifies accepted and rejected bids - Log the information in the database		QMarket Database	Aggregator Interface	Info4-BidActivation	
1.6		Activate bid assets	The aggregator receives the information about how much reactive power they should provide during the given time periods. Their internal processes will further dispatch it to their own assets.		Aggregator Interface			

- Initiate market process

Business section: Perform DSO reactive power market for the Finnish Demo/Initiate market process

Request to start the reactive power market process received from SUC FIN - RP MN. This activity sends a request for bids from the aggregators and, later, launches the market clearing process.

Information sent:

Business object	*Instance name*	*Instance description*
QMarketLaunch	QMarketInit	

- Send reactive power bid

Business section: Perform DSO reactive power market for the Finnish Demo/Send reactive power bid

The aggregator sends its reactive power capabilities as well as the price at which it can be activated.

Information sent:

Business object	*Instance name*	*Instance description*
AssetOffer	QMarketBid	

- Compile reactive power offers

Business section: Perform DSO reactive power market for the Finnish Demo/Compile reactive power offers

Collects and save the reactive power offers made to the market.

Information sent:

Business object	*Instance name*	*Instance description*
AssetOffer	ConsolidatedBids	

- Clear Market

Business section: Perform DSO reactive power market for the Finnish Demo/Clear Market

Dispatches the reactive power operation among the different providers based on their availability, price and on the network needs.

Information sent:

Business object	*Instance name*	*Instance description*
QMarketResults	QMarketResults	

- Log in and dispatch market results

Business section: Perform DSO reactive power market for the Finnish Demo/Log in and dispatch market results

- Notifies accepted and rejected bids
- Log the information in the database

Information sent:

Business object	*Instance name*	*Instance description*
BidActivation	SingleBidActivation	

- Activate bid assets

Business section: Perform DSO reactive power market for the Finnish Demo/Activate bid assets

The aggregator receives the information about how much reactive power they should provide during the given time periods. Their internal processes will further dispatch it to their own assets.

Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
Info1	QMarketLaunch	Initiation of a reactive power market. - Market ID - Time periods - Network part ID - Reactive power needs	
Info2	AssetOffer	Information about the assets and their willingness to provide reactive power for the upcoming time period. - Asset ID - Reactive power that can be provided during the next time period (kvar) - Price (€/kvar)	
Info3	QMarketResults	- Bid ID - Acceptance (full or partial) or rejection of the bid	
Info4	BidActivation	- Bid ID - Time period - Activation (total, partial or not at all)	

FIN – RP MN: MANAGE REACTIVE POWER FOR THE FINNISH DEMO

Description of the use case

Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
FIN - RP MN	SGAM Domain	Manage reactive power for the Finnish Demo

Version management

Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-09-06	Corentin Evens, Pirjo Heine, Suvi Takala		Draft
2	2018-10-26	Corentin Evens, Pirjo Heine, Suvi Takala		Final version
3	2019-01-17	Corentin Evens		Harmonized version

Scope and objectives of use case

Scope and objectives of use case	
Scope	Calculate the demand of reactive power from DSO market place and send it to the DSO market place (to SUC FIN - RP MK).
Objective(s)	Minimize tariff payments: The DSO wants to minimize the fees it may face for being outside the required PQ-window. Increase revenue: The aggregator uses resources to provide reactive power compensation to the DSO market place and receive a remuneration for it. Decision about market use: Decide if the DSO reactive power market is used for the considered time periods.
Related business case(s)	

Narrative of Use Case

Narrative of use case
Short description
In this SUC the SCADA requests, receives and collects information about the status of the network and determines how much reactive power will be asked from the 110kV compensation devices and how much will be needed from the DSO market place for the considered time period. The SCADA then sends the reactive power activation commands to the 110kV resources and initiates the DSO market place process.
Complete description
The task of this SUC is to decide whether reactive power will be asked from the DSO reactive power market place (SUC FIN - RP MK) or not. For this decision, this SUC needs to calculate the demand of additional reactive power

compensation to be asked from the DSO reactive power market. The demand consists of hourly values and amounts and is mainly based on historical data. The historical data includes hourly TSO/DSO connection point measurements and the limits of the PQ-window. The demand for the considered time period will be sent to DSO market place (to SUC FIN - RP MK), which utilizes the assets connected to the distribution network of the DSO.

In addition, this SUC describes the current reactive power control provided by 110 kV reactor and capacitors that constantly occurs on the background. Currently, the reactive power control is mainly based on the DSO's 110 kV reactors and capacitors. The control of 110 kV devices is automated and based on the reactive power measurements in the TSO/DSO connection points and the limits of PQ window. This automated control of 110 kV devices will continue as it is regardless of the ancillary reactive power market that is examined in the EU-SysFlex Finnish Demonstrator.

Background information: In Finland, a reactive power tariff structure exists between the TSO and DSOs. The PQ window between the TSO and DSO sets the limits for the input of reactive power to the transmission network and for the output of reactive power from the transmission network. If the DSO's reactive power exceeds the PQ window limits, a reactive power tariff payment (like a penalty payment) becomes into force. DSO's aim is to stay within the PQ window by controlling the reactive power.

Summary of use case

- **Manage reactive power for the Finnish Demo**
  Description: Decides if reactive power will be asked from the DSO market place and calculates the needed amounts.

  - Request measurement data
    Description: The SCADA requests the data about the status of the control step position of the 110 kV reactor and the on/off status of the 110 kV capacitors, as well as:
    - Static Data of the network: position, the graphic symbol and the connection mode of each grid component, electrical characteristic of each grid component;
    - Dynamic Data of the network: measurements and events from PQ window and 110 kV reactor/capacitors.

  - Transmit data
    Description: The network devices as well as the distributed assets transmit the requested data to the SCADA.

  - Collect network information
    Description: Estimates the total needs for reactive power in order to satisfy the PQ window requirements. This calculation already factors in the result of the bilateral contracts activation that currently takes place once a month.

  - Calculate 110 kV devices compensation demand
    Description: The SCADA system determines automatically the control of the 110 kV compensators during the operating hour.
    This process was in place before the SysFlex project and is not going to be modified during the project.

  - Calculate need for reactive power
    Description: The reactive power dispatch calculates the needs for reactive power for the following

time period in the different parts of the network. This process takes into account the reactive power that has already been contracted through the bilateral contracts and requested from the 110kV reactors and capacitors.

- Provide reactive power
  Description: Operate the DN_O operated reactors and capacitors and measure their reactive power provision.

- Log in reactive power provision
  Description: The SCADA system records the results of the operation of the reactors and capacitors in its database.

- Update historical data
  Description: The DSO updates its database with the new network information and prepares the historical data needed for the reactive power dispatch to the new market.

- Initiate market process
  Description: Launches the market process defined in the System Use Case SUC FIN - RP MK.

Key performance indicators (KPI)

Use case conditions

	Use case conditions
	Assumptions
1	Rules relevant for the service (market & regulation): - The timing of the different steps still needs to be determined as the development goes on.
2	Limitations due to the regulatory and market environment: - The choice to activate the bilateral contracts prior to this SUC should have been made in a clear and neutral way. In the demonstrator, there is only one bilateral agreement taken into consideration.
	Prerequisites
1	Choices for the delivery of the service: - The location of the assets participating to the reactive power regulation needs to be validated in order to check that they do not cause more problems than they solve. - This SUC is related to the Reactive Power Management BUC from WP3.
2	Choices regarding the level of detail, the scope for the description of the SUC : - The SCADA has access to real time measurements of the devices connected to the network. - "Devices" include both the measuring devices and the controllable 110 kV reactors/capacitors. This is done only in order to simplify the figures as both of those are already existing and implemented. They will not be modified during the project.

Further information to the use case for classification/mapping

Classification information
Relation to other use cases
<<BUC>> FI - RPM in Finland Demo

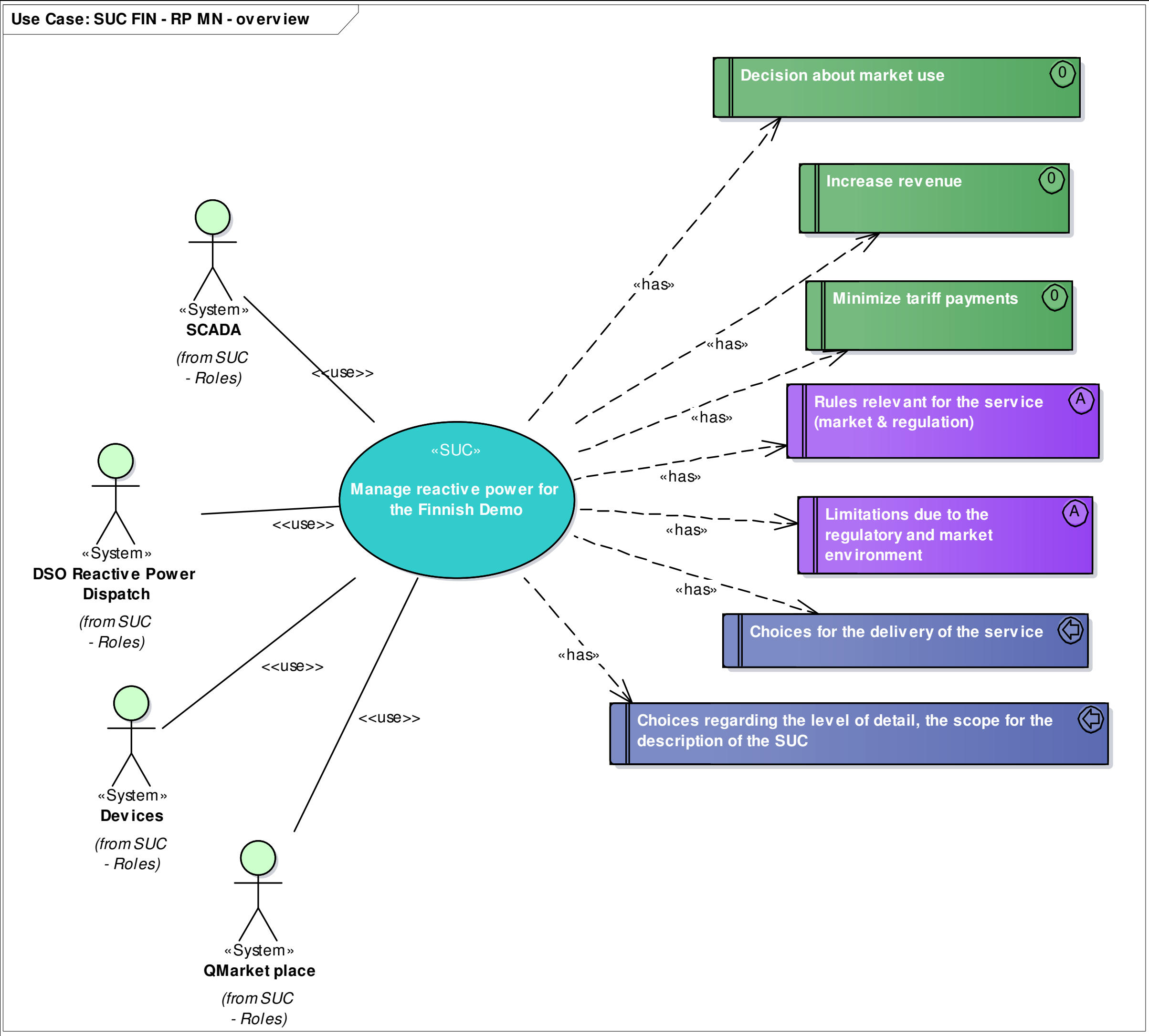
Level of depth
White box
Prioritisation
Generic, regional or national relation
Regional distribution network in Helsinki
Nature of the use case
SUC
Further keywords for classification

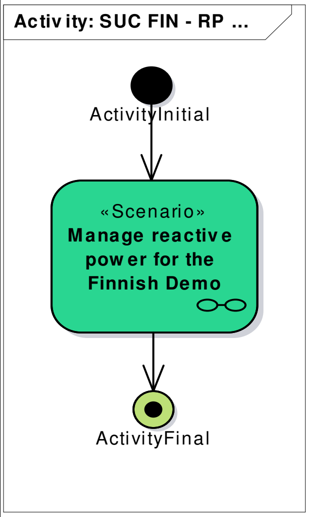
General remarks

General remarks
GeneralRemarks:

Diagrams of use case

Diagram(s) of use case





Technical details

Actors

Actors			
Grouping (e.g. domains, zones)		***Group description***	
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
QMarket place	System	Market place operates the market mechanism for the requested reactive power: • Sends the result of market mechanism to the aggregators • Receives the data of fulfilled activation from aggregators agreements	
Devices	System	All the measurement devices and the 110 kV reactors and capacitors used in monitoring and controlling the reactive power balance within the PQ window.	
DSO Reactive Power Dispatch	System	The DSO database transmits the historical measurement data and calculates the need for reactive power from the DSO market place.	
SCADA	System	SCADA is the monitoring and remote control system. It includes the database of the electrical network. The SCADA can: • acquire events both from the 110 kV reactor/capacitors, Primary and Secondary Substations RTUs; • acquire measurements from the 110 kV reactors/capacitors, Primary and Secondary Substations RTUs; • send commands to 110 kV reactor/capacitors; • send commands to the devices in the Primary Substations; • send commands to the remote controlled Secondary Substations.	

References

Step by step analysis of use case

Overview of scenarios

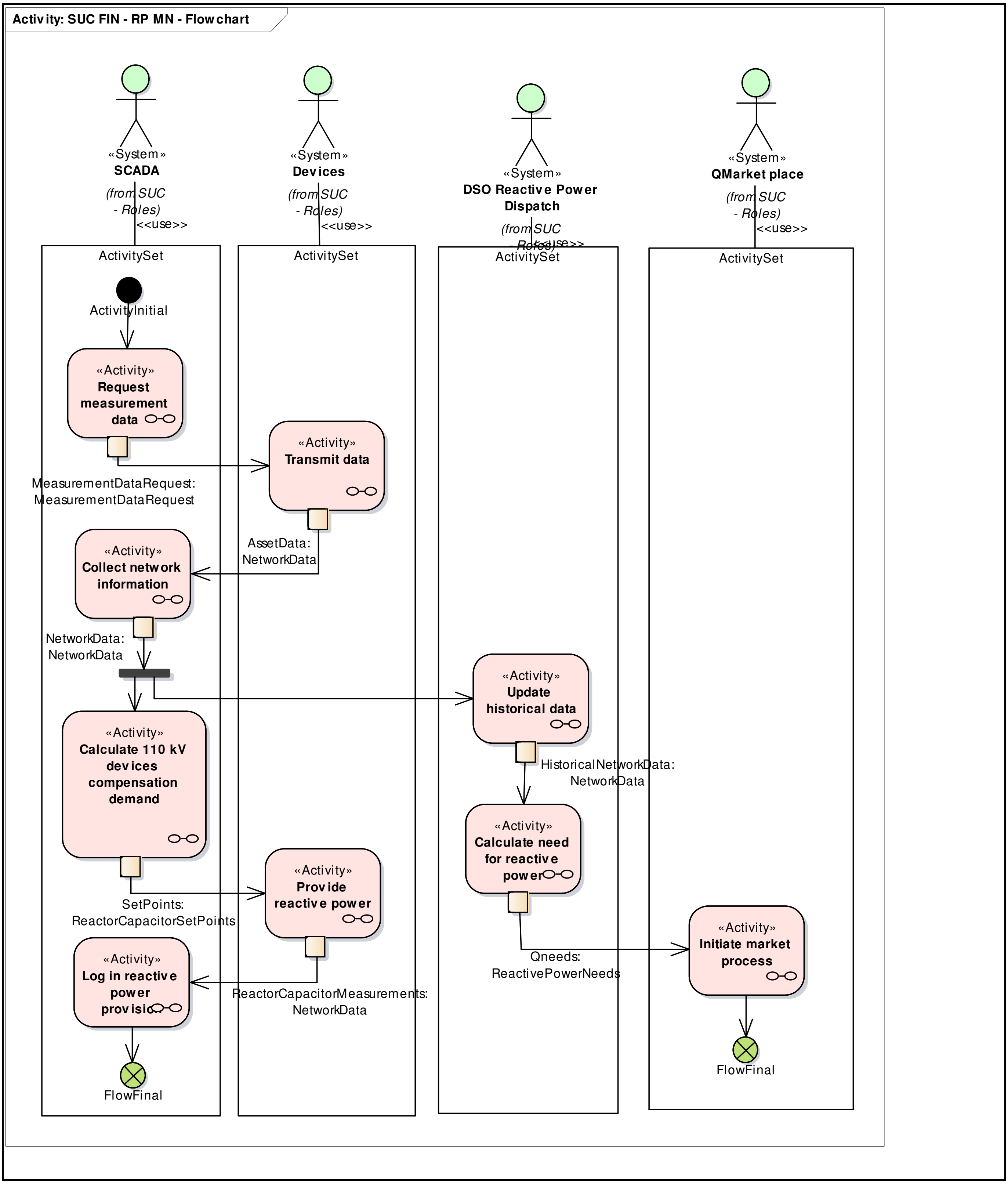
Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	Manage reactive power for the Finnish Demo	Decides if reactive power will be asked from the DSO market place and calculates the needed amounts.				

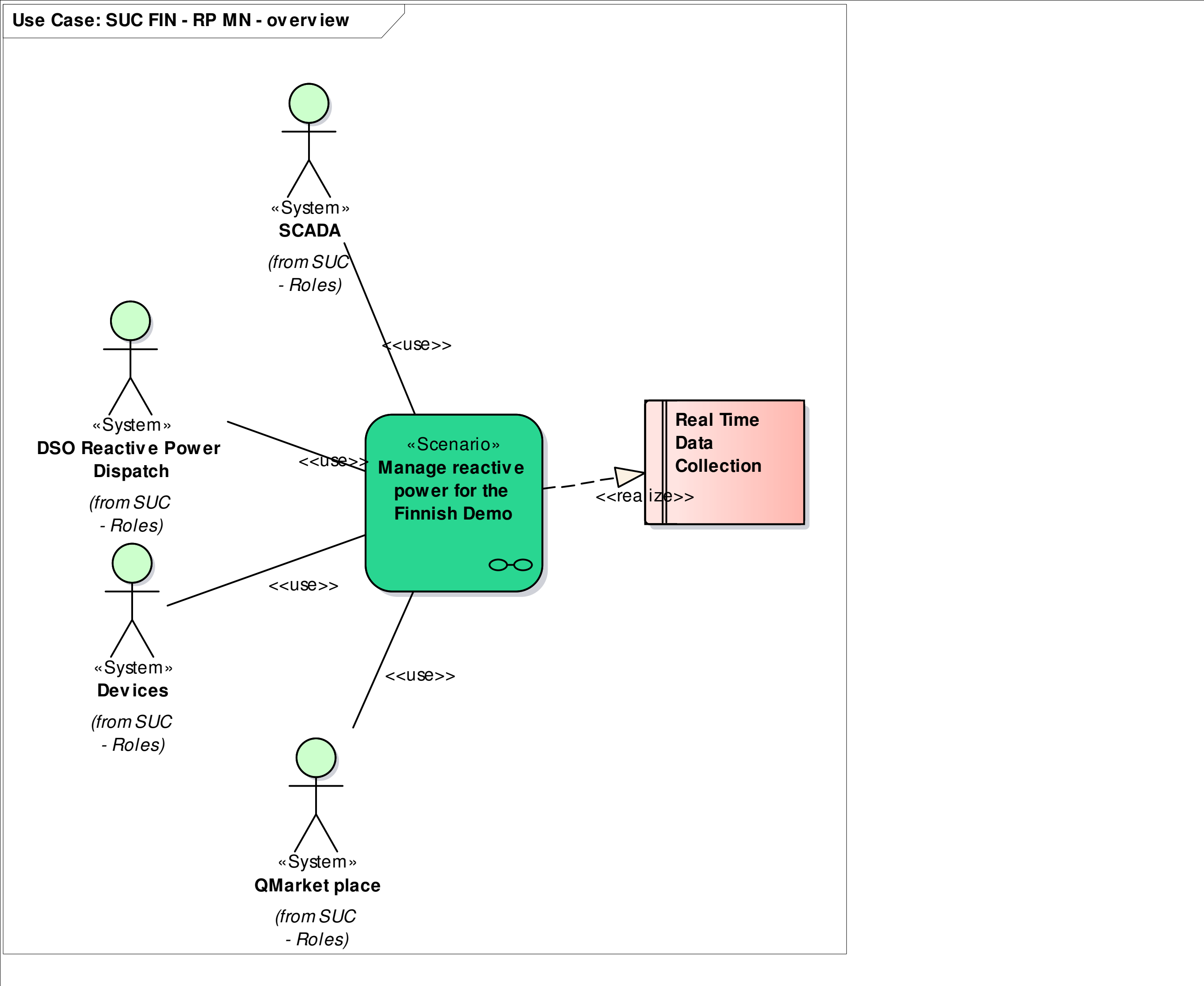
Steps - Scenarios

Manage reactive power for the Finnish Demo

Decides if reactive power will be asked from the DSO market place and calculates the needed amounts.

Requirement list (refer to "Requirement" section for more information)	
Requirement R-ID	***Requirement name***
Req1	Real Time Data Collection


Activity: SUC FIN - RP MN - Flowchart
«System»
SCADA
(from SUC - Roles)
<<use>>
«System»
Devices
(from SUC - Roles)
<<use>>
«System»
DSO Reactive Power Dispatch
(from SUC - Roles)
<<use>>
«System»
QMarket place
(from SUC - Roles)
<<use>>
ActivitySet
ActivityInitial
«Activity»
Request measurement data
MeasurementDataRequest: MeasurementDataRequest
«Activity»
Transmit data
AssetData: NetworkData
«Activity»
Collect network information
NetworkData: NetworkData
«Activity»
Update historical data
HistoricalNetworkData: NetworkData
«Activity»
Calculate 110 kV devices compensation demand
«Activity»
Calculate need for reactive power
SetPoints: ReactorCapacitorSetPoints
«Activity»
Provide reactive power
«Activity»
Initiate market process
Qneeds: ReactivePowerNeeds
«Activity»
Log in reactive power provision
ReactorCapacitorMeasurements: NetworkData
FlowFinal



Scenario step by step analysis

Scenario								
Scenario name	Manage reactive power for the Finnish Demo							
Step No	*Event*	*Name of process/activity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information exchanged (IDs)*	*Requirement, R-IDs*
1.1		Request measurement data	The SCADA requests the data about the status of the control step position of the 110 kV reactor and the on/off status of the 110 kV		SCADA	Devices	Info1-MeasurementDataRequest	

			capacitors, as well as: - Static Data of the network: position, the graphic symbol and the connection mode of each grid component, electrical characteristic of each grid component; - Dynamic Data of the network: measurements and events from PQ window and 110 kV reactor/capacitors.					
1.2		Transmit data	The network devices as well as the distributed assets transmit the requested data to the SCADA.		Devices	SCADA	Info2-NetworkData	
1.3		Collect network information	Estimates the total needs for reactive power in order to satisfy the PQ window requirements. This calculation already factors in the result of the bilateral contracts activation that currently takes place once a month.		SCADA	SCADA, DSO Reactive Power Dispatch	Info2-NetworkData	
1.4		Calculate 110 kV devices compensation demand	The SCADA system determines automatically the control of the 110 kV compensators during the operating hour. This process was in place before the SysFlex project and is not going to be		SCADA	Devices	Info3-ReactorCapacitorSetPoints	

			modified during the project.					
1.5		Calculate need for reactive power	The reactive power dispatch calculates the needs for reactive power for the following time period in the different parts of the network. This process takes into account the reactive power that has already been contracted through the bilateral contracts and requested from the 110kV reactors and capacitors.		DSO Reactive Power Dispatch	QMarket place	Info4-ReactivePowerNeeds	
1.6		Provide reactive power	Operate the DN_O operated reactors and capacitors and measure their reactive power provision.		Devices	SCADA	Info2-NetworkData	
1.7		Log in reactive power provision	The SCADA system records the results of the operation of the reactors and capacitors in its database.		SCADA			
1.8		Update historical data	The DSO updates its database with the new network information and prepares the historical data needed for the reactive power dispatch to the new market.		DSO Reactive Power Dispatch	DSO Reactive Power Dispatch	Info2-NetworkData	
1.9		Initiate market process	Launches the market process defined in the System Use Case SUC FIN - RP MK.		QMarket place			

- Request measurement data

Business section: Manage reactive power for the Finnish Demo/Request measurement data

The SCADA requests the data about the status of the control step position of the 110 kV reactor and the on/off status of the 110 kV capacitors, as well as:

- Static Data of the network: position, the graphic symbol and the connection mode of each grid component, electrical characteristic of each grid component;

- Dynamic Data of the network: measurements and events from PQ window and 110 kV reactor/capacitors.

Information sent:

Business object	*Instance name*	*Instance description*
MeasurementDataRequest	MeasurementDataRequest	

- Transmit data

Business section: Manage reactive power for the Finnish Demo/Transmit data

The network devices as well as the distributed assets transmit the requested data to the SCADA.

Information sent:

Business object	*Instance name*	*Instance description*
NetworkData	AssetData	

- Collect network information

Business section: Manage reactive power for the Finnish Demo/Collect network information

Estimates the total needs for reactive power in order to satisfy the PQ window requirements. This calculation already factors in the result of the bilateral contracts activation that currently takes place once a month.

Information sent:

Business object	*Instance name*	*Instance description*
NetworkData	NetworkData	

- Calculate 110 kV devices compensation demand

Business section: Manage reactive power for the Finnish Demo/Calculate 110 kV devices compensation demand

The SCADA system determines automatically the control of the 110 kV compensators during the operating hour. This process was in place before the SysFlex project and is not going to be modified during the project.

Information sent:

Business object	***Instance name***	***Instance description***
ReactorCapacitorSetPoints	SetPoints	

- Calculate need for reactive power

Business section: Manage reactive power for the Finnish Demo/Calculate need for reactive power

The reactive power dispatch calculates the needs for reactive power for the following time period in the different parts of the network. This process takes into account the reactive power that has already been contracted through the bilateral contracts and requested from the 110kV reactors and capacitors.

Information sent:

Business object	***Instance name***	***Instance description***
ReactivePowerNeeds	Qneeds	

- Provide reactive power

Business section: Manage reactive power for the Finnish Demo/Provide reactive power

Operate the DN_O operated reactors and capacitors and measure their reactive power provision.

Information sent:

Business object	***Instance name***	***Instance description***
NetworkData	ReactorCapacitorMeasurements	

- Log in reactive power provision

Business section: Manage reactive power for the Finnish Demo/Log in reactive power provision

The SCADA system records the results of the operation of the reactors and capacitors in its database.

- Update historical data

Business section: Manage reactive power for the Finnish Demo/Update historical data

The DSO updates its database with the new network information and prepares the historical data needed for the reactive power dispatch to the new market.

Information sent:

Business object	***Instance name***	***Instance description***
NetworkData	HistoricalNetworkData	

- Initiate market process

Business section: Manage reactive power for the Finnish Demo/Initiate market process

Launches the market process defined in the System Use Case SUC FIN - RP MK.

Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
Info1	MeasurementDataRequest	Request for measurement data, including: - Assets ID or network component ID - Time periods - Data to be sent (eg. active power, reactive power, capacity...)	
Info2	NetworkData	Data about the static and dynamic state of the DSO network, including: - position, the graphic symbol and the connection mode of each grid component - electrical characteristic of each grid component - measurements and events from PQ window - control step position and on/off status of the 110 kV reactor/capacitors.	
Info3	ReactorCapacitorSetPoints	- Network asset ID - Set Point	
Info4	ReactivePowerNeeds	Needs for reactive power. - ID of a part of the network - time periods - reactive power needed (in kvar) for each	

		time period	

Requirements (optional)

Requirements (optional)		
Categories ID	***Category name for requirements***	***Category description***
Cat1		
Requirement R-ID	***Requirement name***	***Requirement description***
Req1	Real Time Data Collection	The SCADA receives network status data in real time.