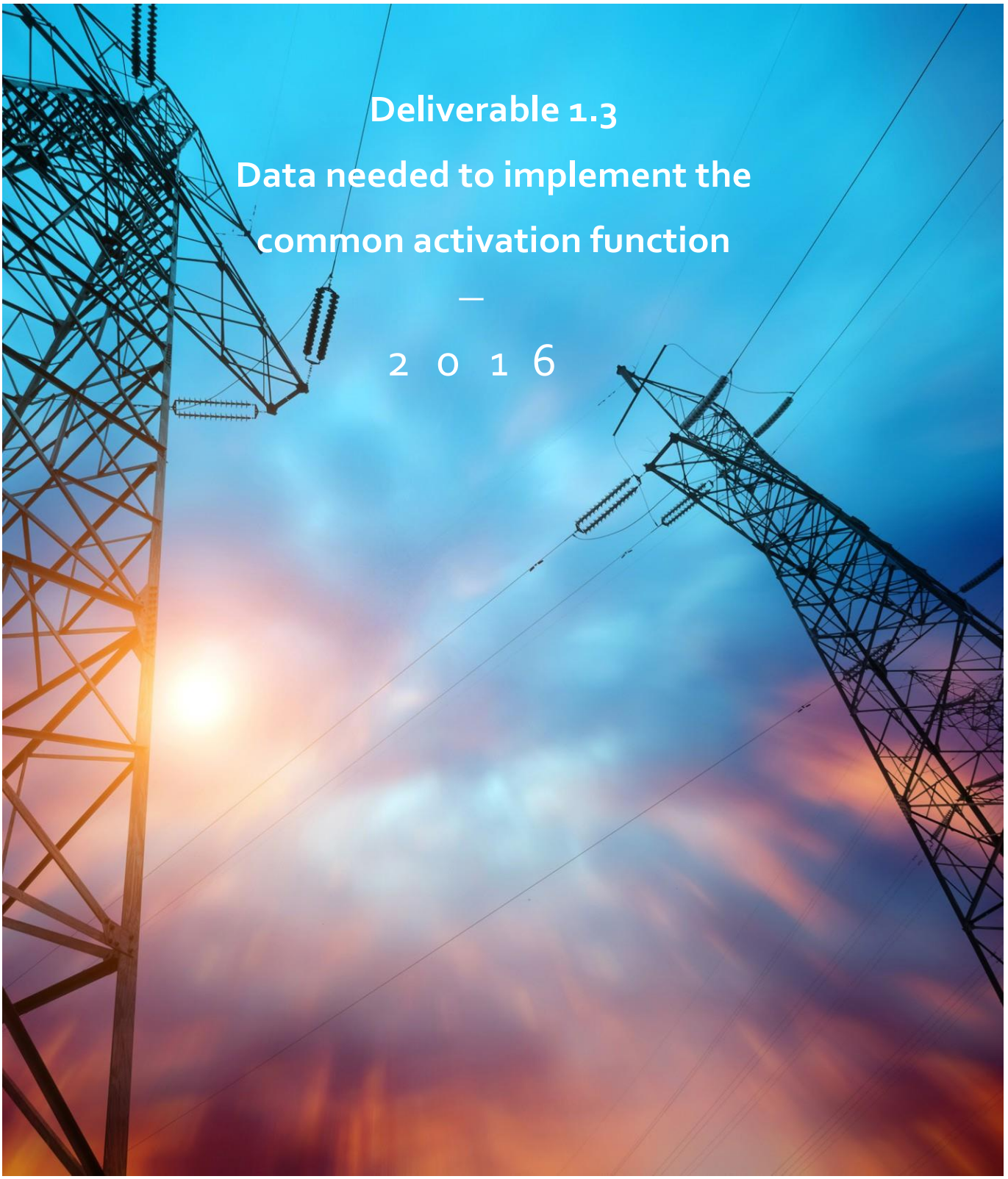
FutureFlow



Deliverable 1.3

Data needed to implement the common activation function

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2016

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 691777

FutureFlow

Document Information

Programme	Horizon 2020 – Cooperation / Energy
Project acronym	FutureFlow
GA number	691777
Deliverable	D1.3
WP/Task related	W1 / T1.4
Type	Report
Confidential:	Members of consortium
Date of delivery	4.1.2017
Status and Version	Version 1.3
Number of pages	81 pages
Document Responsible	EIMV
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Version	Date	Author(s)	Notes	Status
1.3	4.1.2017	EIMV	Layout minor edits.	
1.2	3.1.2017	EIMV	Included MAVIR comments.	
1.1	30.12.2016	EIMV	Included EKC comments.	
1	13.12.2016	EIMV	Final. For GA confirmation.	
0.9	12.12.2016	MAVIR	Review and content comments.	
0.8	9.12.2016	CG, GEMALTO	Review comments. Security update.	
0.5	30.11.2016	EIMV	For review.	
0.2	13.9.2016	EIMV	Demo arch and Data exchange chapters in Appendix.	
0.1	31.8.2016	EIMV	Initial version.	

FutureFlow

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Table of acronyms

Acronym	Meaning
ACE	Area Control Error
aFRR	Automatic Frequency Restoration Reserve
API	Application program interface
ATC	Available transfer (transmission, transport) capability (capacity)
BSID	BSP identification ID
BSP	Balancing service provider
CAF	Common activation function
CZC	Cross zonal capacity
DG	Distributed generation
DR	Demand response
EMS	Energy Management System
FCR	Frequency Containment Reserve
FF	FutureFlow
GW	Gateway
HMI	Human machine interface
HTTPS	Hypertext Transfer Protocol Secure
ICCP	Inter-Control Center Communications Protocol (TASE.2)
ICT	Information and Communication technology
LFC	Load Frequency Control
mFRR	Manual Frequency Restoration Reserves
MQTT	MQ telemetry protocol
OPC	OLE for process control
REST	Representational State Transfer
TSID	TSO identification ID
TSO	Transmission system operator

UI	User Interface
UML	Unified modeling language
VPN	Virtual Private Network
VPP	Virtual Power Plant

Glossary

Refer to ENTSO-E glossary, https://www.entsoe.eu/data/data-portal/glossary/Pages/home.aspx.

The aim of the FutureFlow Project

Four European TSOs of Central-Eastern Europe (Austria, Hungary, Romania, Slovenia), associated with power system experts, electricity retailers, IT providers and renewable electricity providers, propose to design a unique regional cooperation scheme: it aims at opening Balancing and Redispatching markets to new sources of flexibility and supporting such sources to act on such markets competitively. By means of a prototype aggregation solution and renewable generation forecasting techniques, flexibility providers – distributed generators (DG) and commercial and industrial (C&I) consumers providing demand response (DR) – are enabled, to provide competitive offers for Frequency Restoration Reserve (including secondary control activated with a response time of 30 seconds and full activation time of 15 minutes). Retailers act as flexibility aggregators and pool the resource in order to provide the products required by the TSO. A comprehensive techno-economic model for the cross border integration of such services involves a common activation function (CAF) tailored to deal with congested borders and optimized to overcome critical intra-regional barriers. The resulting CAF is implemented as a cloud solution of a prototype Regional Balancing and Redispatching Platform, which makes research activities about cross-border integration flexible while linking with the aggregation solution. Use cases of growing complexity are pilot-tested, going from the involvement of DR and DG into national balancing markets to cross border competition between flexibility providers. Based on past experience with tertiary reserve, participating C&I consumers and DG are expected to provide close to 40 MW of secondary reserve. Impact analyses of the pilot tests together with dissemination activities towards all the stakeholders of the electricity value chain will recommend business models and deployment roadmaps for the most promising use cases, which, in turn, contribute to the practical implementation of the European Balancing Target Model by 2020.

Project Partners

No	Name	Short name	Country
1	ELES DOO SISTEMSKI OPERATOR PRENOSNEGA ELEKTROENERGETSKEGA OMREZJA	ELES, d.o.o.	Slovenia
2	AUSTRIAN POWER GRID AG	APG	Austria
3	MAVIR MAGYAR VILLAMOSENERGIA-IPARI ATVITELI RENDSZERIRANYITO ZARTKORUEN MUKODO RESZVENYTARSASAG	MAVIR ZRT	Hungary
4	COMPANIA NATIONALA DE TRANSPORT ALENERGIEI ELECTRICE TRANSELECTRICA SA	TRANS	Romania
5	ELEKTROINSTITUT MILAN VIDMAR	EIMV	Slovenia
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7	ELEKTRO ENERGIJA, PODJETJE ZA PRODAJO ELEKTRIKE IN DRUGIH ENERGENTOV, SVETOVANJE IN STORITVE, D.O.O.	EE	Slovenia
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Executive summary

Cloud platform approach to implement common activation function requires interoperability between main stakeholders on marketplace, in particular on BSP-TSO-cloud platform chain.

The main constraints to consider during solutions definitions are:

1. Existing IT infrastructure (protocols, models) for TSO-TSO communication.
2. TSO-genset control mechanism for aFRR control
3. Existing TSO-BSP IT infrastructure, if it is implemented at all
4. TSO-TSO model

This document serves as a requirement specification document, describing architecture as visible to main stakeholders. It is further used as input for functional specification for crucial systems, designed later in WP3.

Description of system behavior is largely based on use case specification model defined by IEC 62559-2 standard notation [IEC559 2015]. It defines actors, their interrelations and actions, including required data exchanges.

We are dealing with transmission grid, live operational systems, and as such we cannot compromise their operations or stability. Therefore, we decided for a special implementation of a demo architecture, designed for minimum impact to other control regions, and implemented only in single hosting TSO with remote data exchanges to other TSOs in region. This is defined as the first use case.

The second use case presents cross zonal balancing mechanism, i.e. aFRR activation, based on target architecture. The proposed target architecture is scalable and can be implemented EU wide.

The third use case is redispatching. It is based on the same target architecture that realises different data flows data exchanges.

The description is not bound to a particular communication protocol implementation, but rather supports existing communication solutions, as well as encourages gradual transition to modern, scalable, secure communication solutions. The list of possibilities is based on review of present state implementations within TSO and recently ISO/IEC/OASIS standardized new protocols (e.g. MQTT [MQTT 2014], [ISO922 2016]).

Data exchange profiles among actors are based on key information (source, destination, value ranges, update periods, storage, identification) that needs to be conveyed that other party can realize particular action. Any further data encapsulation into higher level protocols or formats (e.g. XML, JSON [JSON 2013], SOAP [SOAP 2007]) and serialization mechanism is not part of this document.

1 Introduction

1.1 Outline

Implementation of common activation function as a cloud platform requires seamless interoperability between stakeholders of TSO-TSO model (TSO) and their systems (SCADA/EMS).

We propose a use case approach, based on IEC 62559 methodology, to describe problem in detail, propose IT solution and define all systems (actors) comprising implementation. To guarantee gradual system testing of building blocks and interfacing with existing IT infrastructures at TSO and BSP we define a demonstration architecture that is hosted on single TSO (ELES). This demonstration architecture is going to be the only one implemented on the FutureFlow project. Demonstration architecture will be capable of implementing aFRR and redispatch. Target architecture is also proposed as a scalable solution for production environments, where all TSO from different control zones are connected to cloud platform. We propose the use case modeling of aFRR and redispatch also on the target architecture.[1]

Interfacing with SCADA/EMS systems with load frequency controller (LFC control) towards cloud platform and BSP must follow security first concerns and protocol conversion, as second. User interaction via HMI on TSO and BSP sides also enables view into cross border bidding process, and balancing actions.

1.2 Relation to other work packages

Deliverable 1.3 (D1.3) is closely related to WP2, Task 2.1 "Specification of the DR & DG flexibility aggregation platform" that specifies aFRR aggregation platform residing within BSP and its communication with flexibility provider. Detailed API view of CAF interfacing is defined in WP3, Task 3.1 "Specifications of the prototype regional balancing and redispatching platform with common activation function for FRR". Use cases from the perspective of pilot tests are defined in WP4, Task 4.1 "Definition and implementation process of the four use cases" and are a superset of our use cases that focus on CAF interfaces.

[1] Solutions described or planned in this document shall not construe a legally bind for use or apply by any member party; therefore, these solutions are only for R&D purposes.

2 FutureFlow system architecture

Architecture definition depends also on market stakeholders or actors, their main responsibilities, envisaged hierarchical communication topology among them. A brief outline of marketplace is followed by architectural proposal that supports TSO-TSO model.

2.1 Actor and process interactions on cross border marketplace

Marketplace comprises actors with processes and their interactions. Several actors may be part of the same business entity (stakeholder) and only run as a distinct process there. We adopted this based on a simplified view of harmonized electricity role model [ENTSO 2015]. The overview of market place actors and their interactions is in Figure 1, with dashed lines depicting stakeholders themselves. There is a Cloud platform with basic functions directly connected to TSO, and BSP communicates with TSO only, to realize TSO-TSO model. Our use case approach focuses on relations and processes between BSP-TSO, TSO-cloud platform. Process functions within cloud platform are placed into state diagrams (Chapter 5.2) for explanation of their dynamic interactions.

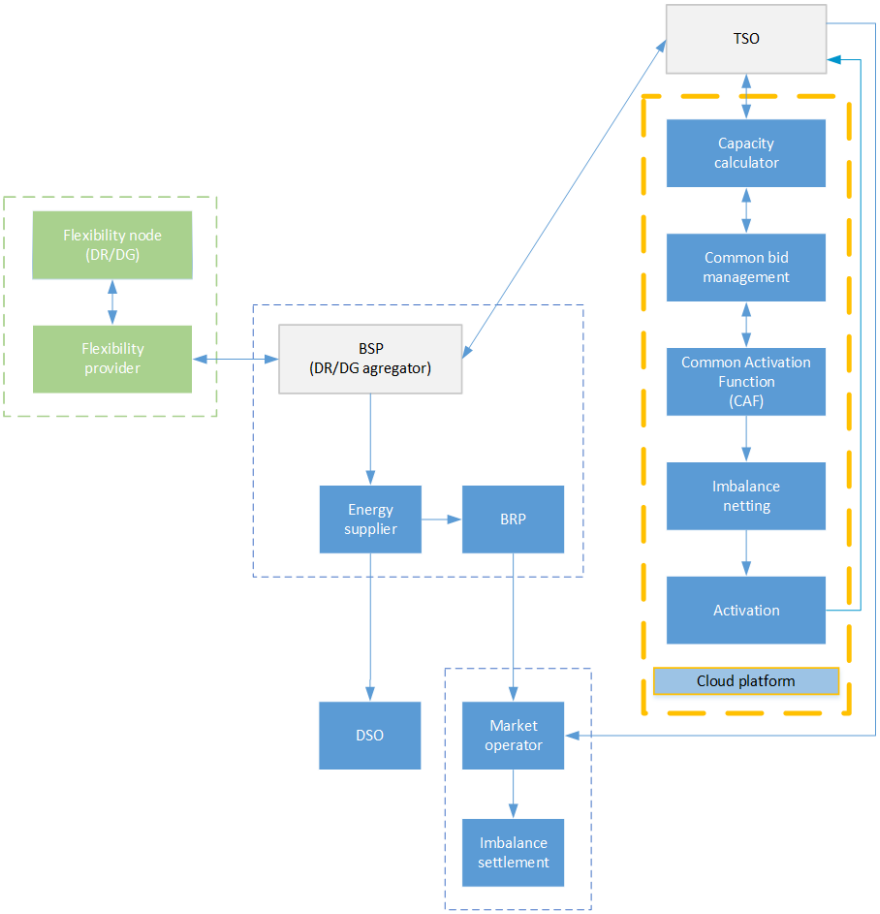

Figure 1: Overview of actor relations on electricity market.

2.2 Architecture definition for TSO-TSO model

FutureFlow system architecture is realised as a roadmap in two stages:

1. Demo site system architecture (Figure 2). It is implemented within a secure TSO environment as a hosting site. In FutureFlow we have demo site implemented in ELES that acts as hosting TSO for all other guest TSOs (APG, MAVIR, TRANS). It also functions to interconnect with all BSPs. ELES Demo Site is the sole connection to FutureFlow Cloud for all participating TSOs.
2. Target system architecture (Figure 3). This is the real life architecture solution for a TSO-TSO model, whereby each TSO is connected to regional BSPs and inter TSO FutureFlow cloud platform.

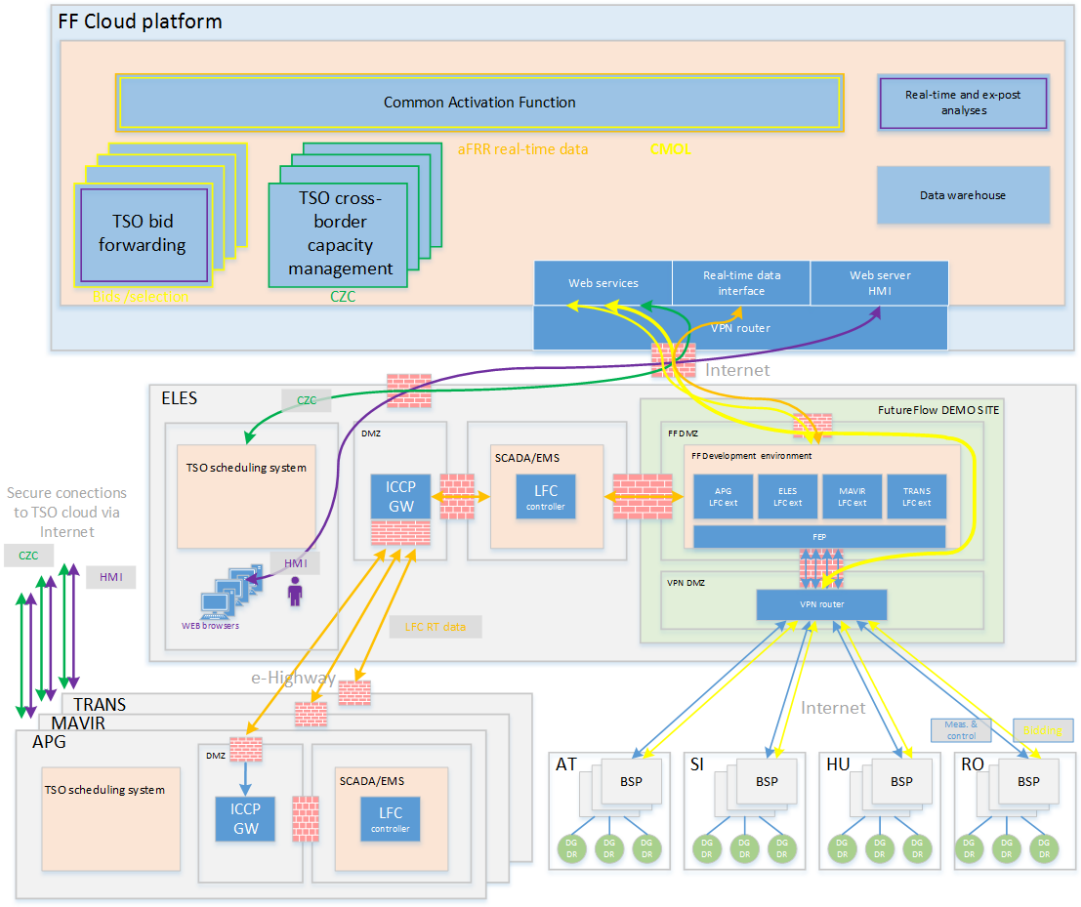

Figure 2: FutureFlow demo site architecture.

We describe use cases for both architectural stages, since demonstration stage acts as a test preliminary deployment "how-to" guide for any TSO. (Note, that both architecture representations are evolved versions of those depicted in D2.1.).

2.2.1 Architecture building blocks

The system architecture consists of three major system building blocks:

1. TSO (ELES, APG, MAVIR, TRANS) SCADA/EMS and e-Highway communication paths or any other TSO-TSO existing communication means. Information

sources can be TSO scheduling system (or any other equivalent solution, which provides the information about the available transmission capacity for balancing or redispatch purposes) and the LFC (AGC) realized within SCADA/EMS and presenting measurements/variables and control within EMS. Systems reside within TSO's DMZ secured information environment. External communication path is the existing e-Highway (or any other TSO-TSO existing communication means), a pan EU inter TSO network built over dedicated lines. The Area Control Error (ACE) and other variables needed by development environment (LFC extension in particular) is exchanged through this e-Highway network using the ICCP - IEC 60870-6-503 [IEC870 2014] protocol (orange line), that is predominantly used in TSO environments (Note that some present communication protocols cannot be directly terminated within cloud environments, thus a form of protocol translation gateway or use of other protocols is required.). The web human Interface enabling the management of the FutureFlow cloud platform applications (e.g. managing cross-border capacity or managing bids, which can be eligible to be forwarded to CAF) can be accessed via secured Internet link (purple line). Moreover, the cross-border capacity management information (CZC, ATC) can also be exchanged between a TSO and the FutureFlow cloud platform via a secure Internet link (green line).

2. Balancing Service providers (BSP), located in each TSO country (SI, AT, HU, RO) are managing DR/DG flexibilities pools with the FutureFlow Demo site environment using data communication channels transiting over public Internet paths. BSPs in each control zone communicate to TSO within the same control zone. In Demo architecture, this link is established to ELES over Internet secured link (e.g. IPSec). Each BSP is connected with a single secure link, either telecom provided VPN or Internet, but with two types of data flows and separate tunnels (VLAN): measurement and control (blue line) – TSO EMS (2 s packet average rate) and bidding (yellow line) - TSO bid forwarding function (minutes packet rate).

3. The FutureFlow cloud platform system (based on SAP HANA platform) implements several functionalities. It is connected to hosing TSO (ELES) in demo system architecture, whereas it is connected to all TSOs in target system architecture. The cloud platform has three main interfaces: real-time data interface, web services interface and human web interface. Its communication interface is configured only for designated types of protocols (with only their ports opened) and access control lists of all nodes (MAC, IP).

2.2.2 Communication protocols

These communication protocol types can be used within implemented system:

- IEC 60870-6-503 (ICCP) (orange line); SCADA/EMS information; e-Highway or any other TSO-TSO existing communication means
- HTTPS, RESTful [RAML 2016] (Web services) architectural style (yellow line);

bidding information, ATC/CZC; VPN telecom operator or VPN over Internet (IPsec)

- IEC 60870-5-104 (blue line); measurement and control information; VPN telecom operator or VPN over Internet (IPsec)
- HTTPS, RESTful architectural style (green line); Web services; Internet
- HTTPS (purple line), Web application for user application; Internet
- ISO/IEC 20922, Message Queueing Telemetry Protocol (MQTT), hosting TSO (ELES) Demo site (Development environment) – FutureFlow Cloud platform (orange line).

We also demonstrate during the project, within controlled environment, the communication with a single type of protocol: message queue protocol - MQTT.

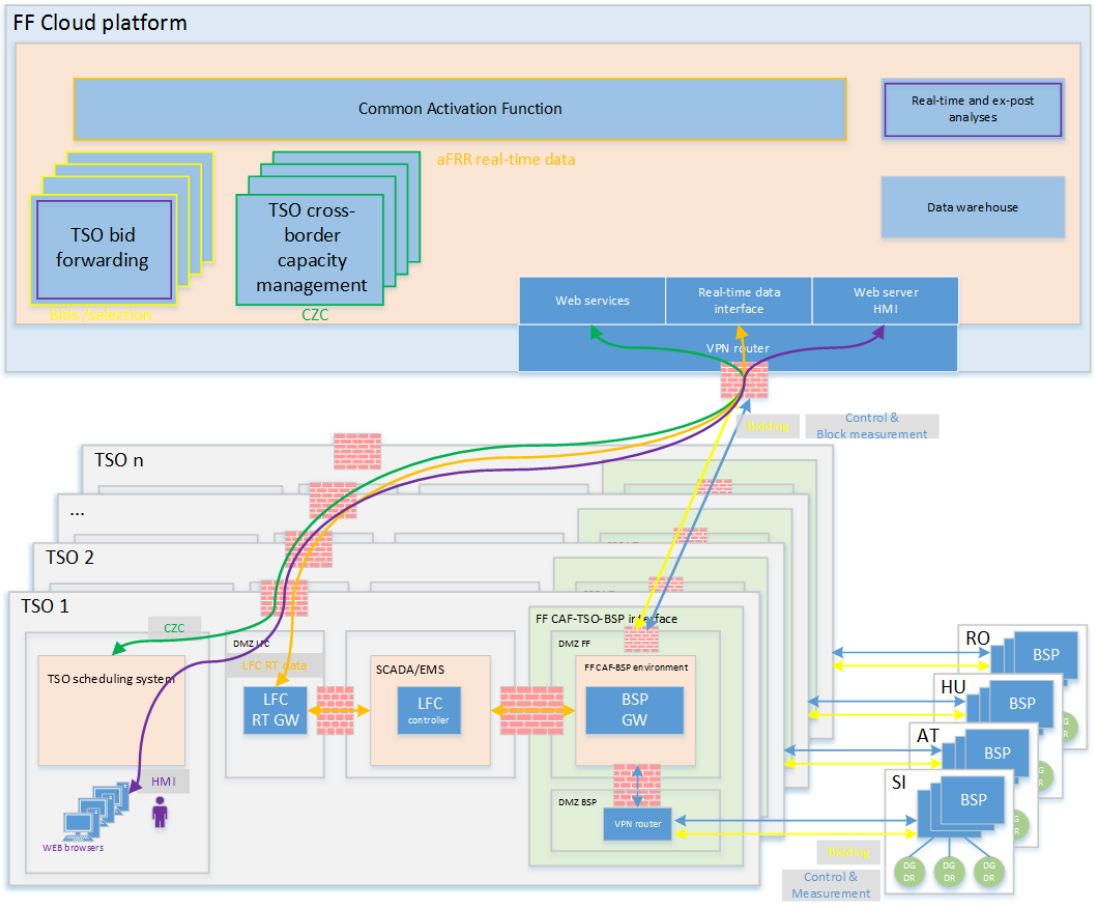

Figure 3: FutureFlow target architecture.

3 Smart grid architecture model according to M/490

European Smart Grids Reference Architecture and corresponding standardization framework was developed upon the European Commissions' Mandate M/490 – a standardization mandate to European Standardization Organizations (CEN, CENELEC and ETSI) to support European Smart Grid [M490 2011]. The following deliverables have been made available by the CEN-CENELC-ETSI Smart Grid Coordination Group:

- Reference Architecture,
- Smart Grid Set of Standards,
- Sustainable Standardization Processes,
- Smart Grid Information Security.

Smart Grid Reference Architecture (SGRA) is a technical reference architecture, which represent the functional information data flows between the main domains and integrate many systems and subsystem architectures [SGRA 2012].

Smart Grid Set of Standards (SGSS) is a set of consistent standards for communication protocols and data models, which support the information exchange and the integration of all users into the electric system operation [FSS 2012, SGSS 2014].

The most important elements of the SGRA are:

- European Conceptual Model - a top layer model.
- Smart Grids Architecture Model (SGAM) Framework – a framework supporting the design of smart grids use cases with an architectural approach allowing for a representation of interoperability viewpoints in a technology neutral manner.
- SGAM Methodology – a methodology for assessing smart grid use cases and how they are supported by standards.

Figure 4 shows the Smart Grids Architecture Model (SGAM) framework. Upon the Cartesian plane consisting of five domains from the European Conceptual Model (Generation, Transmission, Distribution, DER, Customer premises) and six zones (Process, Field, Station, Operation, Enterprise, Market) the interoperability stack is applied.

After having analysed the SGSS no use case related to the FutureFlow topics were identified. FutureFlow use cases should thus be described and contributed to the IEC TC8 WG6 (Generic Smart Grid Requirements) and to the CEN-CENELC-ETSI Smart Grid Coordination Group.

3.1 Information layer in context of FutureFlow architecture

Information layer is concerned with semantics of transported data over communication layer. The information layer semantics covers systems and process operations. During analysis, it has been identified that the following are interesting to consider in later stages

of project:

- Common Grid Model Exchange Standard (CGMES) [CGM 2014].
- Common information model (CIM) [IEC301 2013]
- Scheduling system (ESS) [ESS 2012]
- Reserve Resource Process (ERRP) [ERR 2013]
- Capacity Allocation and Nomination System (ECAN) [ECA 2011]
- Balancing services [BAL 2015]

Simple semantics description for essential functions to support aFRR and redispatching, is outlined in Chapter 11.

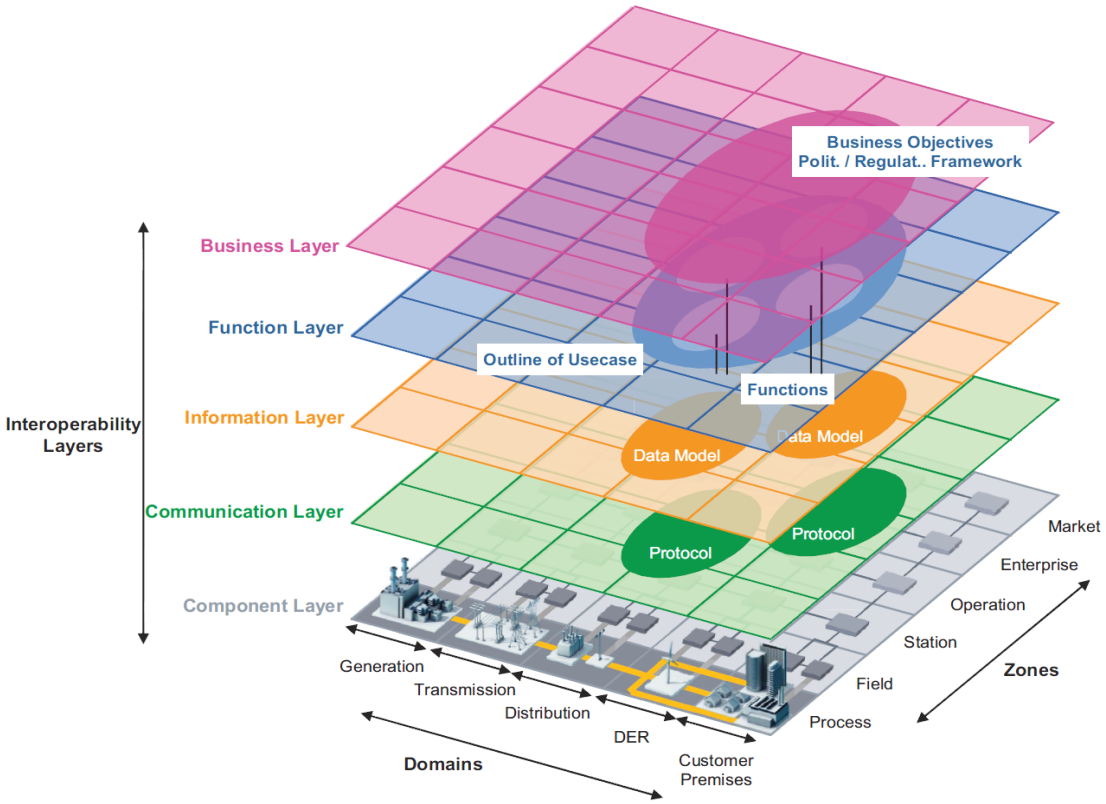

Figure 4: Smart Grids Architecture Model (SGAM) framework.

Protocols that we foresee in project are covered in Chapter 2.2.2 and summarised in Table 1. The main goal is to use protocols that can convey semantics from existing systems used in TSOs and other stakeholders, i.e. semantics is at the top Layer 7 of ISO/OSI protocol stack. We can use MQTT protocol to convey semantics of FutureFlow inter stakeholder communication and of existing systems (e.g. CIM, ESS) and it can be considered in the cloud platform to TSO communication demonstration.

4 Alignment with operational cases on field pilots

In the FutureFlow outline document we defined several operational cases (OC) how complete system will be tested under different operational and configuration conditions on field pilot demonstrations. Operational cases defined for study of the field demonstrations and are described in WP4, however we present them also here to align our use cases with them.

4.1 Operational case 1 - DR/DG local operation

OC1 defines local operations of DR/DG via BSP within each control zone, for aFRR and redispatching (Figure 5). BSP (DR/DG aggregator) connects (1) to a pool of independent flexibility providers. TSO acquires (2) aggregated flexibility products from BSPs. The whole process is run within a single control zone.

OC1 serves two scenarios:

1. Local operation.
2. Fall back from cross zonal operation in cases without available transmission capacity or force majeure where only local operation is possible (e.g. communication connection with FutureFlow cloud platform is lost).

Figure 5: Operational case 1.

4.2 Operational case 2 - DR/DG cross border operation

OC2 defines operations of DR/DG via BSP within coupled balancing markets of control zones, for aFRR and redispatching (Figure 6). BSP (DR/DG aggregator) connects (1) to a pool of independent flexibility providers, within the same control zone. TSO acquires (2) aggregated flexibility products from BSPs within each control zone. Each TSO informs (3) FutureFlow cloud platform about confirmed and validated bids that are eligible for bidding process on cross border aFRR market or for redispatching and about scheduled transmission capacities on cross border links. The whole process is run in all control zones, coordinated through CMOL from FutureFlow cloud platform.

For time periods without available transmission capacity or force majeure this OC2 falls back to OC1 operation. Only local MOL is used for aFRR activation by local TSO.

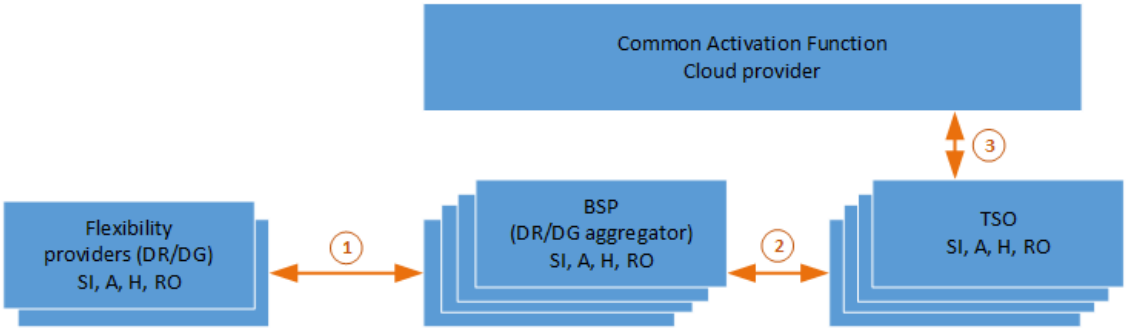

Figure 6: Operational case 2.

4.3 Operational case 3 - TSO switching BSPs cross border operation

OC3 defines operations of DR/DG via BSP within coupled balancing markets of control zones, for aFRR and redispatching (Figure 7). BSP (DR/DG aggregator) connects (11) to a pool of independent flexibility providers, independently for each control zone. We propose here that flexibility providers are allowed to offer flexibilities (11 or 12) to different BSP operators (BSP_1 or BSP_2), within the same control zone, but at different, non-overlapping time horizons. However, changing between BSPs has long time periods, at least on the order of days due to current process practices (e.g. long term paper based prequalification process). TSO acquires (2) aggregated flexibility products from BSPs within each control zone. Each TSO informs (3) FutureFlow cloud platform about confirmed and validated bids that are eligible for bidding process on cross border aFRR market or for redispatching and about scheduled transmission capacities on cross border links. The whole process is run in all control zones, coordinated through CMOL from FutureFlow cloud platform.

We demonstrate this operational case within controlled laboratory environment, only. Regulatory environment and provisions of guarantees from BSP to TSOs regarding must be amended to enable tests of this operational case in real environments.

For time periods without available transmission capacity or force majeure this OC3 falls back to OC1 operation. Only local MOL is used for aFRR operation by local TSO.

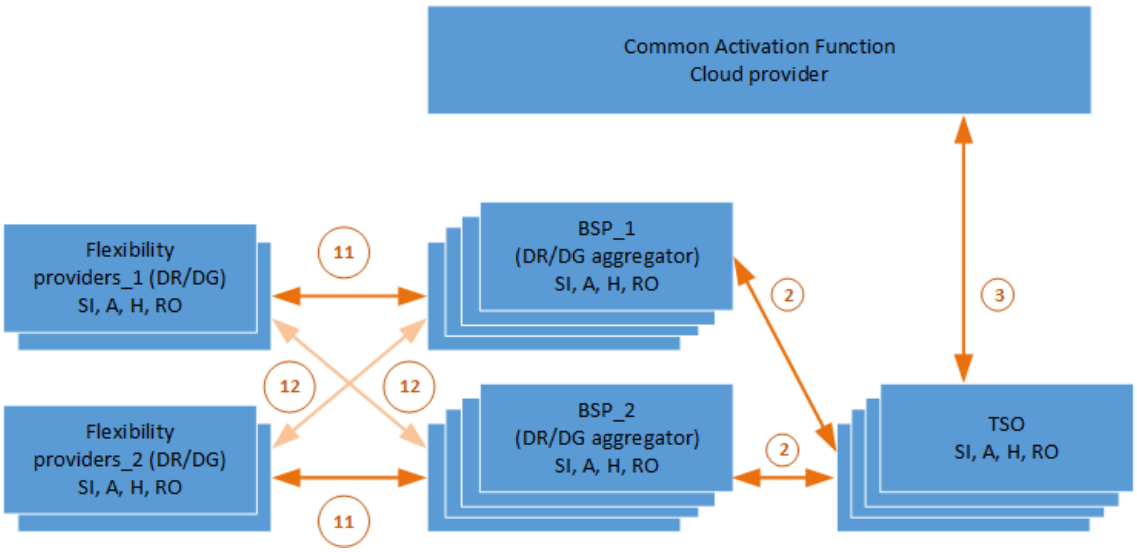

Figure 7: Operational case 3.

5 Use case description for aFRR

This use case describes the BSP participation in aFRR balancing TSO-TSO model. Use case aFRR is defined for FutureFlow target architecture. Note, that UC1, use case for demonstration site is described in Appendix Chapter 10. UC1 on demonstration site also implements aFRR on FutureFlow project.

5.1 Section 1 - Description of the use case

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
UC2	cross border	BSP participation in aFRR balancing TSO-TSO cross border market model

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
0.1	13/09/2016		Initial version	
0.2	2/11/2016		Architecture diagrams, actors.	

Scope and Objectives of Use Case	
Scope	This use case describes BSP participation in aFRR balancing services cross border market. Market is organized as TSO-TSO model. BSP acts as aggregator of DR and DG flexibilities offered as products to TSO.
Objective(s)	The objective is to define information exchanges between the actors of this use case.
Related business case(s)	UC3 (redispatch), deliverable D2.1 (BSP - flexibility node)

Narrative of Use Case
Short description
BSP participates as aggregator of DR and DG flexibilities on TSO-TSO model for cross border aFRR activation. TSO collects BSP products as bids and forwards all eligible products to cloud CAF platform. CAF platform acts as central information exchange between TSOs of the region. CAF accepts products from all TSOs of the region and forms CMOL type bid list. Bids (products) are activated on any TSO's demand according to calculated ACE within its control zone. Cycle repeats on 1 hour period. Respective TSO is receiving the measurement signal from BSP to monitor the quality of procured power for aFRR. After the activation, the TSO, or any other responsible entity (i.e. market operator), perform the imbalance settlement and financially compensate the procured power for aFRR.
Complete description
Use case BSP participation in aFRR balancing TSO-TSO cross border market model relies on cloud platform that acts as information exchange, optimization and aFRR balancing solution for multiple control zones. The main business actors participating in the use case are: one cloud provider and several TSOs (1-10), BSPs (1-100) and flexibility providers (1-1000s) in each control zone. Architectural and implementation scalability to support communications, data handling and security aspects must be addressed at each system entity within business actors. Limits on communication latencies (start of data send at source node to data receive at destination node) between different actors, e.g. TSO-BSP, TSO-cloud platform are proposed such that the processes operate within time constraints of TSO LFC control and envisaged proposed solutions. There are two HMI platforms that allow user influence: • TSO bidding platform. TSO operator has complete view of bid collection process, participating BSP, types of bid products, generated CMOL, local MOL. Furthermore, it has the credentials to cancel bid. • Flexibility aggregation platform. BSP operator has complete view of flexibility provider and their DR/DG flexibility nodes operations and controls the product bidding towards TSO. Details of the platform can be found in D2.1.

Use case is composed of three separate scenarios, of which at least two run in series:

UC2, Scenario1: Bidding process of products for aFRR balancing and CMOL generation. Scenario1 always precedes Scenario2 or Scenario3. Scenario1 runs in time frame from Tweekahead to Trealtimestart.

UC2, Scenario2: aFRR real time balancing operation with cross zone capacity exchange, transmission capacity is available. Scenario2 runs in time frame from Trealtimestart to Trealtimeend. Scenario2 starts after Scenario1 finishes.

UC2, Scenario3: aFRR real time balancing operation without cross zone capacity exchange, only local control zone operation. The same Scenario3 applies when TSO cannot establish communication with cloud platform or there is no transmission capacity available. Scenario3 starts after Scenario1 finishes.

The use case, a series of Scenario1 and Scenario2, or Scenario1 and Scenario3, consists of these processes or Phases (Figure 8):

1. Collection of bids (Phase I). Bids are collected on at least day ahead basis until specified gate closure time. This closes the bid collection and bid updating process of bids to be accepted for possible activation in the next 30 min. No changes or cancellation of existing bids after that time is possible (for the same activation period). This is the slowest process with non-time critical asynchronous communication (> 30 s latencies are tolerated), triggered by BSP to TSO.
2. TSO bid forwarding and capacity management (Phase II). TSO checks the bids for compliance and decides on their acceptance on positive compliance. Available transfer capability is evaluated for all cross border transmission paths taking into account all accepted bids. This is slow process with non-time critical asynchronous communication (< 10 s latencies are tolerated), triggered by TSO to cloud platform.
3. CMOL list creation (Phase II). A global, multi zone common merit order list of accepted bids from all control zones is generated in CAF. This is fast process with cloud platform internal processing only, followed by cloud CMOL list notification of TSOs which is fast process with time critical asynchronous communication (< 5 s latencies are tolerated), triggered by cloud platform to TSO.
4. CMOL bid activations from CAF, also called real time operation (Phase III). Activation period of CMOL bids starts control signal exchange between CAF and all TSOs to manage ACE in each control zone by activation of bids from CMOL. Imbalance netting is performed either as a separate process or is integrated within the optimization function loop. Phase III can start with eligible bids that entered gate 30 min before or another cycle before that, i.e. 1.5 h in past, depending on TSO agreed minimum process reaction times from BSP and flexibility providers. This is the fastest process with hard real time critical asynchronous communication (< 0.5 s latencies are tolerated), triggered by cloud platform to TSO and subsequently by TSO to BSPs.
5. Forwarding BSP measurement data to TSO (Phase III). TSO monitors the activation and evaluates the response of BSP. This is fast process with real time asynchronous communication (order of seconds (5 s) latencies are tolerated), triggered by BSPs to TSO and TSO to cloud platform.

Settlement of the procured power is not part of use case and is done off line. TSO or market operator gather measurement data from activations and perform the financial and imbalance settlement. This off line process is not shown on Figure 8.

All described processes or Phases run concurrently by overlapping different time horizons, i.e. each action starts in Phase I and proceeds to Phase III, but all are active for different bid timeframes.

Phases I, II, III are described in separate step tables for each scenario in this use case. It is mandatory that each event activity (defined in tables) generates an acknowledge signal or message from receiving actor back to originating actor with message receipt confirmation, optional parameters and time stamp.

Details of BSP to flexibility node control are described in document D2.1.

The implementation of cloud platform and connecting actor systems must also consider special situations. Special situations must be handled such to preserve control zone stability as priority. The critical is real time operation within Phase III. Functional specifications of each actor system must take these into consideration and include proper remedy actions in design itself:

- Cloud platform is not responsive within 2 s periods or communication link to cloud platform is lost.

- BSP is not delivering bid product or is delivering underspecified or is not responsive or communication link to TSO is lost.
- Flexibility node (DR/DG) stops delivering flexibility or is delivering underspecified or is not responsive or communication link to BSP is lost.

Key performance indicators of data transport actor types can be measured with packet analyser software (e.g. Wireshark [WS 2016]).

General Remarks
Actor types acronyms: SY = System; BI = Business; DT = Data; CS = Cloud System; HI = Human Interface Times definitions: • Tweekahead = time frame up to 1 week ahead before Tgateclosure time • Tdayahead = time frame up to 24 hours ahead before Tgateclosure time • Tpricechange = time frame up to Tgateclosure time; price of bid can change • Tbidcancel = time frame before Tgateclosure time; bid can be cancelled • Tgateclosure = time ending acceptance of bids (e.g. 30 min before real time operation) • Tcritical = time before Trealtimestart operation, usually minimum time that allows TSO operator to change bids (e.g. 5 min). Note, that bid change must still be confirmed by BSP. • Tcriticalbidcancel = time frame up to Tcritical before Trealtimestart operation (e.g. 3-5 min); bid can be cancelled only in critical special situation and TSO may apply penalties to BSP. This is the last time frame where TSO has control within its environment. • Tcmol = time after Tcriticalbidcancel before real time operation (e.g. 3 min) allotted for CMOL creation process within cloud platform • Trealtimestart = start of real time operation, usually done on whole hour, defined as time = 0 • Trealtimebidcancel = time during real time operation; bid can be cancelled only in critical special situations (e.g. product fail) and TSO may apply penalties • Trealtimeend = end of real time operation, usually 1 h after Trealtimestart

5.2 Section 2 – Diagrams of the use case

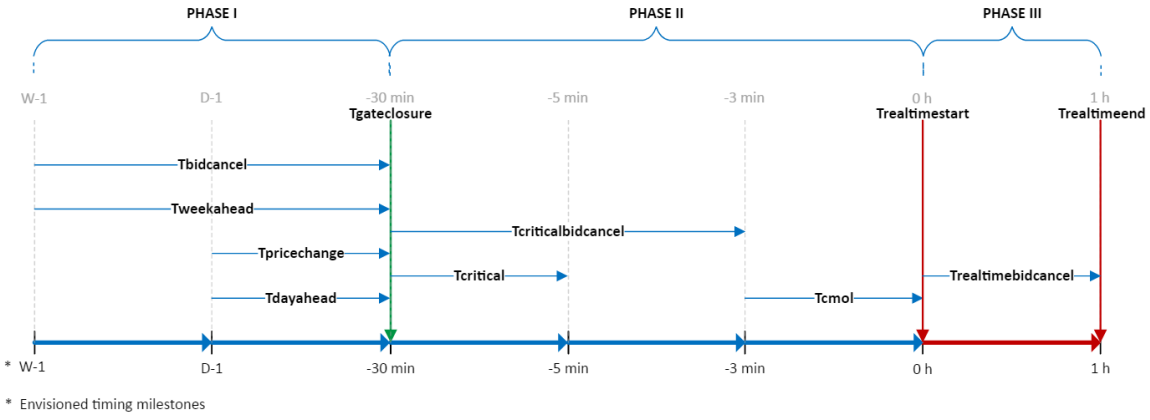

Figure 8: Timing diagram of aFRR process phases.

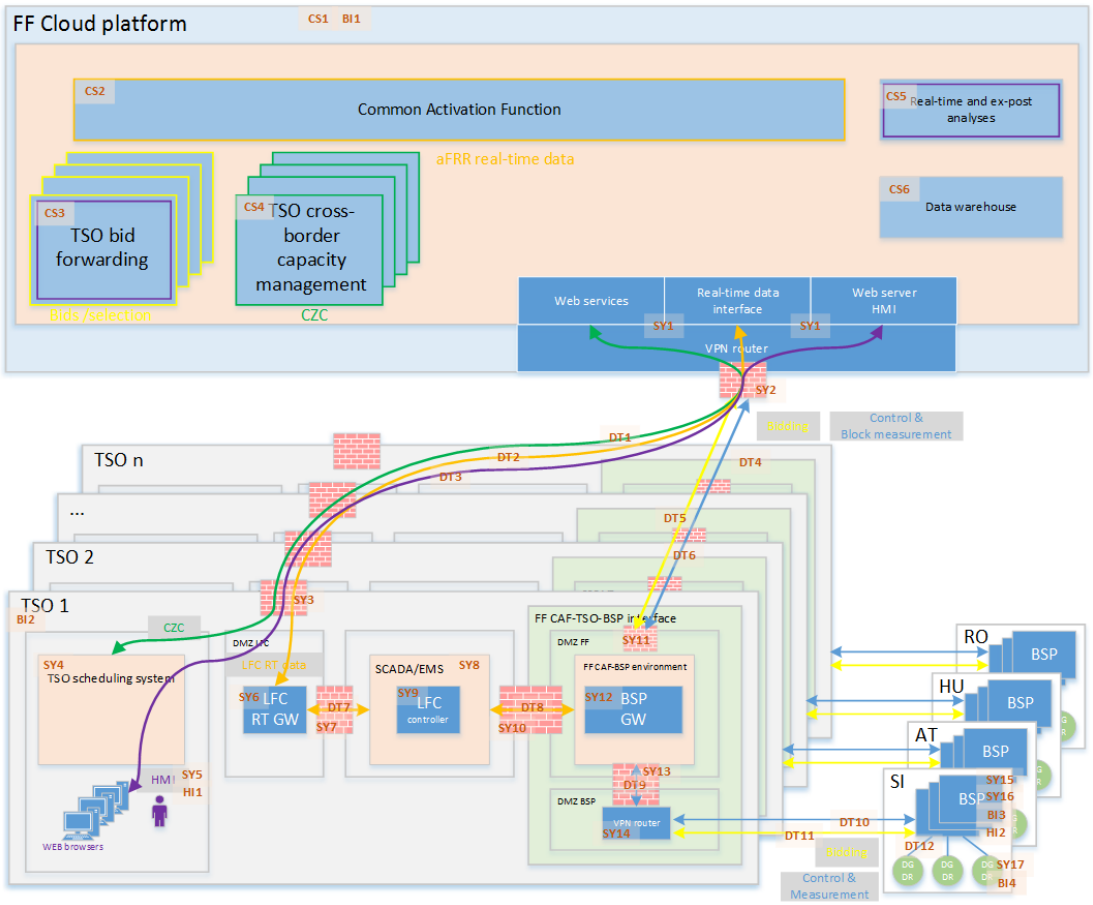

Figure 9: Target FutureFlow architecture for aFRR and redispatch with actor types.

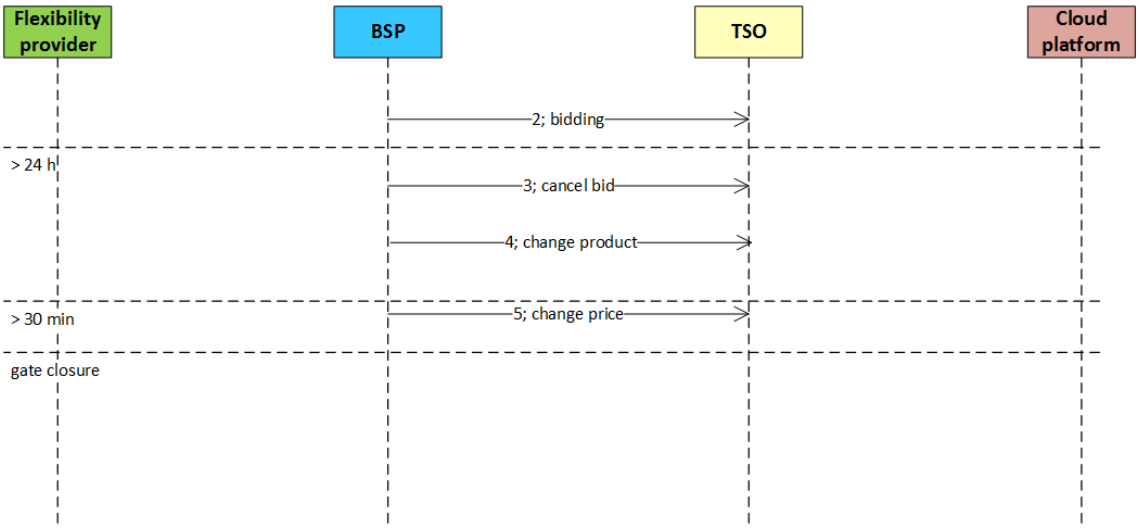

Figure 10: Sequence diagram for Phase I of aFRR use case.

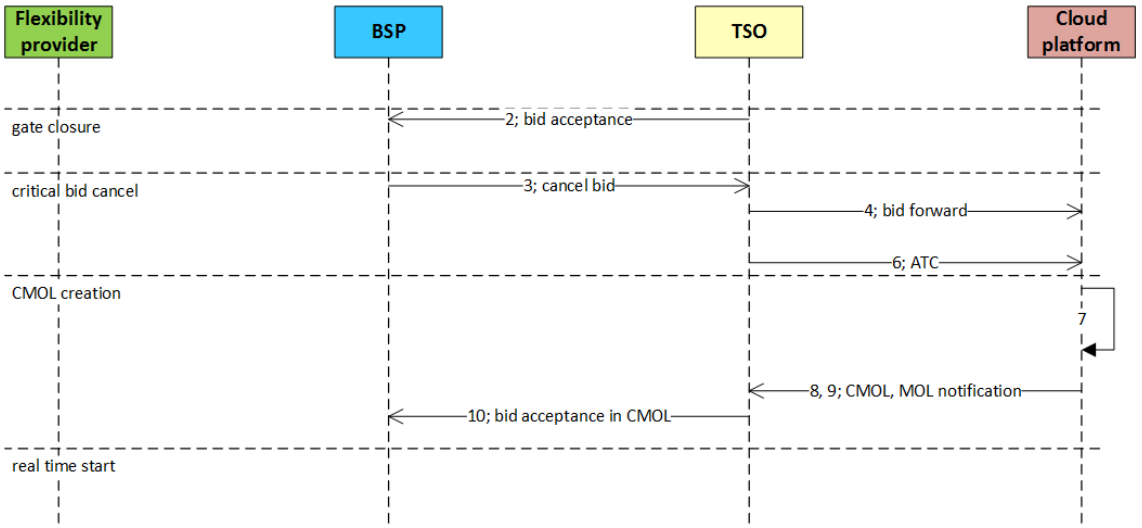

Figure 11: Sequence diagram for Phase II of aFRR use case.

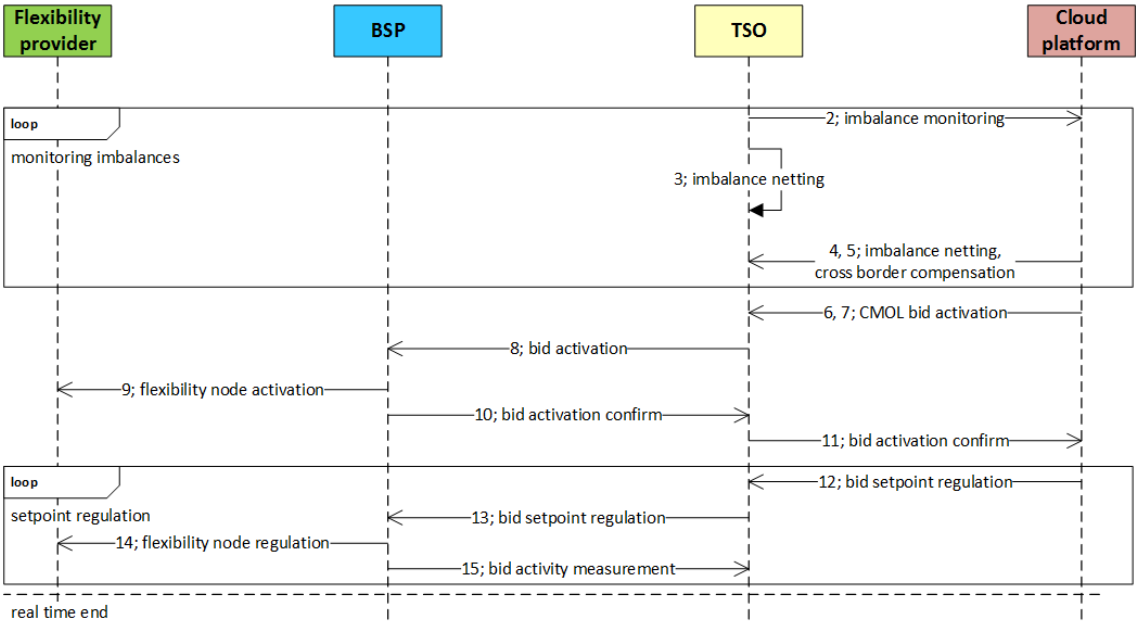

Figure 12: Sequence diagram for Phase III of aFRR use case.

5.3 Section 3 – Technical details

Actors (Refer to Figure 9.)			
Grouping (e.g. domains, zones)		Group Description	
/		/	
Actor Name	Actor Type	Actor Description	Further information specific to this Use Case
FutureFlow cloud platform	cloud system CS1	System, based as a cloud platform (e.g. SAP HANA), acting as an information exchange mechanism for cross border aFRR market operation between different TSOs from multiple control zones.	
FutureFlow cloud provider	business BI1	Business entity providing cloud platform aFRR services to TSOs in TSO-TSO model from multiple control zone regions.	
Common activation function	cloud system CS2	Program installed within cloud platform responsible for CMOL formation, communication with TSOs and optimally directing aFRR activations in all control zones.	
TSO bid forwarding	cloud system CS3	Program installed within cloud platform responsible for bid confirmation and validation before they enter CAF and is assigned for each TSO.	
TSO cross border capacity management	cloud system CS4	Program installed within cloud platform calculating available transmission capability on all cross zone borders and is assigned for each TSO.	
Real time and ex-post analyses	cloud system CS5	Program installed within cloud platform used for calculation of KPI and other interesting information from all data in DWH.	
Data warehouse	cloud system CS6	Large database installed within cloud platform used as a long-term storage (historian) of measurement and control data exchanges with TSO, BSP.	
VPN router cloud platform	System SY1	Device or program installed in cloud platform and providing secure network connection for secured data transports protocols (Web services, real time data, Web server for human interfaces) and authenticating all TSOs participating in aFRR balancing. Data transports are tunnelled within VPN created from TSO or cloud provider (e.g. OpenVPN) or with telecom operator provided service.	
Security gateway cloud platform	System SY2	Device facing cloud platform and providing information security protection (firewall) acting as a demarcation point between cloud platform and TSO for different types of data transports.	
TSO	business BI2	TSO business entity interconnecting one or more BSP and cloud platform in TSO-TSO model.	

Actors (Refer to Figure 9.)			
Grouping (e.g. domains, zones)		Group Description	
/		/	
Actor Name	Actor Type	Actor Description	Further information specific to this Use Case
Security gateway TSO	system SY3	Device facing TSO and providing information security protection (firewall) acting as a demarcation point between TSO and cloud platform for different types of data transports.	
TSO scheduling system	system SY4	Program installed at TSO for scheduling transmission capacity (ESS) of electricity flows on cross border transmission lines.	
TSO bidding platform	system SY5	Information system installed at TSO that with user interface and TSO bid forwarding enables full insight of main systems operations (e.g. LFC, CAF, bids, CMOL).	
User interface at TSO	human interface HI1	Information system installed at TSO acting as user interface for real time observation and control of aFRR process. Presents crucial market information and allows TSO operator to interactively control the aFRR process (e.g. cancel bid).	
ATC/CZC	data transport DT1	Available transfer capability (capacity) information exchange with cloud platform for all transmission lines for each TSO's control zone.	
TSO user interface exchange	data transport DT3	Information exchange between Web browser interface installed in TSO on bidding platform and cloud platform.	
LFC real time gateway	System SY6	Gateway or program installed at TSO transferring LFC real time data (e.g. ACE, control demand) and acting as intermediary protocol translator between EMS/SCADA and cloud platform.	
Security gateway LFC real time gateway to LFC	system SY7	Device or program facing EMS/SCADA and providing information security protection acting as a demarcation point between TSO EMS/SCADA and other TSO systems (e.g. LFC real time gateway).	
EMS/SCADA	system SY8	Consists of energy management programs and SCADA control used for reliable operation of transmission system.	
LFC	system SY9	Program and/or system installed at TSO for load and frequency control within control zone using measurements from EMS/SCADA to automatically control transmission system stability and controls external generators, i.e. BSP provided flexibility products and classical gen sets.	

Actors (Refer to Figure 9.)			
Grouping (e.g. domains, zones)		Group Description	
/		/	
Actor Name	Actor Type	Actor Description	Further information specific to this Use Case
Security gateway BSP gateway to LFC	system SY10	Device or program facing LFC and providing information security protection acting as a demarcation point between TSO BSP gateway and EMS/SCADA effectively DMZ isolating CAF-BSP environment from EMS/SCADA.	
LFC real time data	data transport DT2	LFC real time data (e.g. ACE, control demand) exchange between LFC real time gateway towards cloud platform.	
LFC data to LFC real time gateway	data transport DT7	LFC data (e.g. ACE, control demand) exchange between EMS/SCADA and LFC real time gateway.	
LFC data to BSP gateway	data transport DT8	LFC data (e.g. ACE, control request) exchange between EMS/SCADA and BSP gateway.	
Security gateway CAF-BSP environment TSO	system SY11	Device facing TSO and providing information security protection (firewall) acting as a demarcation point between TSO and cloud platform for different types of data transports.	
BSP gateway	system SY12	Information system installed within TSO acting as an intermediary gateway between BSP and cloud platform environments. It transfers bid activation commands to BSP based on LFC and CAF status.	
Security gateway BSP	system SY13	Device facing BSP and providing information security protection (firewall) acting as a demarcation point between TSO and BSP for different types of data transports.	
VPN router DMZ BSP	system SY14	Device or program installed in TSO and connecting data transports and authenticating all BSP participating in aFRR services. Data transports are tunnelled within VPN created from TSO (e.g. OpenVPN) or with telecom operator provided service.	
BSP user interface exchange	data transport DT4	Information exchange between Web browser interface installed in BSP and cloud platform via TSO.	
TSO to cloud platform bidding exchange	data transport DT5	Confirmed bidding process between TSO and cloud platform, usually based on HTTPS (REST web services) or MQTT.	
TSO to cloud platform control and measurement exchange	data transport DT6	Information exchange of (product baseline, commands) between TSO and cloud platform, with tight time constraints (e.g. 1 sec), usually based on queuing protocols (e.g. MQTT).	

Actors (Refer to Figure 9.)			
Grouping (e.g. domains, zones)		Group Description	
/		/	
Actor Name	Actor Type	Actor Description	Further information specific to this Use Case
VPN router to BSP gateway exchange	data transport DT9	Information exchange of bidding, control and measurement, human interface within TSO environment towards BSP.	
BSP to TSO control and measurement exchange	data transport DT10	Information exchange (product baseline, commands) to TSO, usually based on IEC 60870-5-104 or MQTT.	
BSP to TSO bidding exchange	data transport DT11	Bidding offers of products to TSO, usually based on HTTPS (REST web services) or MQTT.	
BSP	business BI3	BSP acting as aggregator of flexibility capacities from many flexibility providers and producing flexibility products as bids to TSO.	
Flexibility aggregation platform towards TSO	system SY15	Information system installed at BSP for communication and control with TSO and user interface.	
Flexibility aggregation platform towards flexibility provider	system SY16	Information system installed at BSP for data exchange with flexibility provider including forecasting and control.	
User interface at BSP	human interface HI2	Information system installed at BSP acting as user interface for managing flexibility aggregation platform and BSP actions towards TSO and flexibility provider.	
BSP to flexibility provider exchange	data transport DT12	Information exchange (generation/consumption data, commands) with DR/DG units or PLC/SCADA at flexibility provider, usually based on IEC 60870-5-104 or MQTT.	
Flexibility provider	business BI4	Business C or I entity offering flexibility capacity to BSP. It may contain one or more flexibility nodes at single location.	
Flexibility node	system SY17	DG or DR type, installed at flexibility provider having its own measurement on power lines (power).	

Use Case Conditions			
Actor/System/ Information/Contract	Triggering Event	Pre-conditions	Assumption
Multilateral agreement between respective TSOs aiming for cross border exchange of aFRR balancing services. BSP has prequalified bid products, either as standard or specific at TSO of the region. Flexibility provider has contracted DR/DG flexibility supply with BSP. Each DR/DG flexibility node is equipped with measurements and control system (PLC, small SCADA) and real time communications link to BSP.	aFRR balancing energy bid procurement solicitation for cross zone operation on open bidding procedure available to any BSP and TSO in participating control zones.	ACE in any of control zones starts Phase III, real time operation.	Cloud platform communicating with TSOs in different control zones. Target system architecture including its constituent actor systems are implemented and operational.

References						
No.	References Type	Reference	Status	Impact on Use Case	Originator / Organisation	Link
/	/					

Classification Information
Relation to Other Use Cases
Use case BSP participation in aFRR based cross border balancing TSO-TSO model is a reference case for other two use cases: i) Demonstration site for BSP participation in aFRR balancing TSO-TSO model, ii) BSP participation for redispatch actions in TSO-TSO model.
Level of Depth
Suitable for functional requirements specification of building blocks.
Prioritization
/
Generic, Regional or National Relation
Generic for EU ENTSO-E region.
Viewpoint
/
Further Keywords for Classification
/

5.4 Section 4 – Step by step analysis of the use case

Scenario Conditions					
No.	Scenario Name	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
1	Bid collection, Phase I	TSOs	Bid collection start at week or day ahead before real time operation.	Opened market. Communication BSP-TSO.	A set of collected bids at gate closure time.
2	Transport (or transmission or transfer) capacity reservation and CMOL generation, Phase II	cloud platform	Gate closure.	Collected bid products from BSP, via TSO. Communication TSO-cloud platform.	Common merit order list (CMOL) of bid products.
3	aFRR real time balancing operation with cross-border balancing energy exchange, Phase III	cloud platform, TSOs, BSPs, flexibility providers	ACE imbalance in any of control zones. Start of real time operation for selected CMOL period (e.g. 1 h).	Communication TSO-cloud platform, BSP-TSO, flexibility node-BSP, DR/DG-flexibility node.	Minimum achievable ACE in control zones. End of real time operation for selected CMOL period (e.g. 1 h).

Scenario based on Target Architecture								
Scenario Name:		No. 1 – Bid collection, Phase I						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
1		Start	Start of bid collection, bidding		/	/	/	
2		Collection of aFRR bids	TSO collects aFRR bids from BSPs in the same control zone. Process length is up to one week ahead prior to gate closure. The last eligible product bid is 24 h ahead of gate closure. Bid is checked and formally verified by TSO and/or cloud platform. Confirmation or error reply is sent from TSO to BSP.		BSP	TSO	BSP bid to TSO	
3		Cancel aFRR bid	BSPs can cancel bid at least 24 h prior to gate closure. After that only product price change is allowed. Cancellation is mandatory if BSP wants to change product type, later. TSO checks that the bid is already in system, otherwise error reply is sent to BSP.		BSP	TSO	BSP bid cancel (must use the same bid ID as already used)	
4		Change aFRR bid	BSPs can change bid itself, can be only product type and/or price at least 24 h prior to real time. Products, BSP flexibility product data, with the same IDs must be presented. The same message is used as for bidding. TSO system and cloud platform must update all bids with the same IDs.		BSP	TSO	BSP bid to TSO (must use the same bid ID as already used)	

Scenario based on Target Architecture								
Scenario Name:		No. 1 – Bid collection, Phase I						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
5		Change price of aFRR bid	BSPs can change product price (up or down) of bid at least 30 min h prior to real time. This makes bid type and price final. Products, BSP flexibility product data, with the same IDs, but different price must be presented. TSO checks that the bid is already in system, otherwise error reply is sent to BSP.		BSP	TSO	BSP bid to TSO (must use the same bid ID as already used)	

Scenario based on Target Architecture								
Scenario Name:		No. 2 – Transport (or transmission or transfer) capacity reservation and CMOL generation, Phase II						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
1		Start	Start of gate closure		/	/	/	
2		Bid acceptance and confirm at gate closure	TSO notifies BSP about all accepted bids that were offered until Tgateclosure time. This is a confirmation that TSO accepted bid into further evaluation, i.e. it is eligible to be processed by CMOL in cloud platform. Each bid is confirmed separately. Only eligible bids meeting minimum requirements and any special requirements (set dynamically by TSO) are accepted by TSO. Bids are accepted until Tgateclosure time. Criteria for bid eligibility and minimum requirements are established in separate off line process and put forward to cloud platform.		TSO	BSP	TSO bid confirm	
3		Cancel bid until real time	Bids can be cancelled under special circumstances before real time operation and until Tcriticalbidcancel time by BSP.		BSP	TSO	BSP bid cancel	
4		Bid forwarding to cloud platform	Accepted eligible and validated bids are forwarded from all TSOs and all control zones to cloud platform after Tgateclosure and before Tcmol.		TSO	cloud CAF	TSO bid list to CAF	
5		Fixed bids at cloud platform	Collected bids from all TSOs and all control zones are fixed at cloud platform just prior to Tcmol time.		cloud CAF	cloud CAF	/	

Scenario based on Target Architecture								
Scenario Name:		No. 2 – Transport (or transmission or transfer) capacity reservation and CMOL generation, Phase II						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
6		Transport (or transmission or transfer) capacity availability	Each TSO submits available transport (or transmission or transfer) capacity (ATC/CZC, Flow-based) to cloud platform.		TSO	cloud CAF	ATC/CZC, Flow based list	
7		Creation of CMOL	Common merit order list is created within cloud platform. Only bids, that are listed in CMOL are used on aFRR market, but only when/if need arises, i.e. imbalance happens. Optimization must permit dynamic removal of bids to dynamically build CMOL, but only in special cases, when bid products are cancelled during real time operation.		cloud CAF	cloud CAF	/	
8		Complete CMOL notification to TSO	Complete CMOL accepted bids are transferred to each TSO. It is presented in HMI bidding platform.		cloud CAF	TSO HMI bidding platform	CAF CMOL bid list to TSO	
9		Local MOL notification to TSO	CMOL accepted bids are filtered so that each TSO receives only its own local bids. A list of bids belonging to each TSO is sent as a local MOL.		cloud CAF	TSO LFC	CAF local MOL list to TSO	

Scenario based on Target Architecture								
Scenario Name:		No. 2 – Transport (or transmission or transfer) capacity reservation and CMOL generation, Phase II						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
10		Bid acceptance after CMOL notification to BSPs	TSO notifies BSPs of all accepted bids that were used in final CMOL and copied to local MOL. This is the confirmation that CMOL was created with the particular bid on the list and as such that it can eventually be activated. Each bid is confirmed separately. BSP must receive the bid confirmation twice (Step 2 that it is accepted into process as eligible bid, Step 10 that it is listed on CMOL) during Phase II for each bid that can be activated during real time Phase III operation.		TSO	BSP	TSO bid confirm	

Scenario based on Target Architecture								
Scenario Name:		No. 3 - aFRR real time balancing operation with cross zone energy exchange, Phase III						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
1		Start	Start of real time operation. For designated bid products within CMOL period, e.g. 1 h.		/	/	/	
2		Monitoring imbalances	Monitoring for imbalances, ACE.		TSO LFC	cloud CAF	ACE open loop, TSO LFC control data real time measurements (2 s period)	
3		Imbalance netting TSO -OR-	TSO starts the imbalance netting on all control zone borders. All bordering TSO are notified of imbalance netting results.		TSO	TSO	/	
4		Imbalance netting cloud CAF	Cloud CAF starts the imbalance netting on all control zone borders. All TSOs are notified of imbalance netting results. This step is only used during two stage optimization process (netting, ACE minimization)		cloud CAF	TSOs	imbalance netting	
5		Cross border compensation cloud CAF	Cloud CAF triggers cross border compensation on all control zone borders. This step is only used in Option2 control strategy.		cloud CAF	TSO LFC	cross border compensation	
6		Cloud CAF bid activation on capacity -OR-	Cloud CAF activates bids only if imbalance still exists after netting. TSO receives MW activation request.		cloud CAF	TSO CAF-BSP environment	CAF bid control activation setpoint	
7		Cloud CAF bid activation on products	Cloud CAF activates bids only if imbalance still exists after netting. TSO gets MW activation request and products listed to fulfil the MW request.		cloud CAF	TSO CAF-BSP environment	CAF bid control activation list	

Scenario based on Target Architecture								
Scenario Name:		No. 3 - aFRR real time balancing operation with cross zone energy exchange, Phase III						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
8		TSO bid activation to BSP	TSO informs BSP to activate product bid, it will need to start delivering the product (MW).		TSO CAF-BSP environment (BSP GW)	BSP	TSO bid activation to BSP	
9		BSP activates product bid	BSP activates product bid.		BSP	flexibility providers	activation signal to flexibility providers	
10		BSP confirms bid activation to TSO	BSP confirms activation of product bid.		BSP	TSO CAF-BSP environment (BSP GW)	BSP bid activation confirm	
11		TSO confirms bid activation to cloud CAF	TSO confirms activation of product bid to cloud CAF.		TSO CAF-BSP environment (BSP GW)	cloud CAF	TSO bid activation confirm	
12		Control regulation of product setpoint to TSO	Cloud CAF continuously regulates, changes setpoint of product bid (MW).		cloud CAF	TSO LFC via LFC RT GW	CAF bid control activation setpoint	
13		Control regulation of product setpoint to BSP	TSO control, changes product bid setpoint (MW).		TSO LFC via CAF-BSP environment (BSP GW)	BSP	TSO flexibility activation and setpoint control	
14		Control regulation of product setpoint to flexibility node	BSP control, changes flexibility node setpoint (MW).		BSP	flexibility node	BSP flexibility setpoint control	

Scenario based on Target Architecture								
Scenario Name:		No. 3 - aFRR real time balancing operation with cross zone energy exchange, Phase III						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
15		Measurement of product activity	TSO receives measured data of products activation setpoints from BSP.		BSP	TSO LFC via CAF-BSP environment (BSP GW)	BSP product activity measurement	
16		End of real time	End of current 1h real time period. For designated bid products within CMOL period, e.g. 1 h.		/	/	/	
17		Settlement process	Settlement process begins off line, end of day. (Outside this process.).		/	/	/	

5.5 Section 5 – Information exchanged

Information Exchanged		
Name of Information (ID)	Description of Information Exchanged	Requirements to information data
	Refer to chapter Data exchange profiles and schemes proposal.	

5.6 Section 6 – Requirements

Requirements (optional)	
Categories for Requirements	Category Description
/	
Requirement ID	Requirement Description
/	

5.7 Section 7 – Common terms and definitions

Common Terms and Definitions	
Term	Definition
	Refer to Table of acronyms.

5.8 Section 8 – Custom information

Custom Information (optional)		
Key	Value	Refers to Section
/		

5.9 Section 9 – Key performance indicators

Key performance indicators		
Name of KPI	Description of KPI	Refers to Section
ML_CM_BT	Packet length per transaction control and measurement BSP - TSO	Section 3, data transport actor type
ML_B_BT	Packet length per transaction bidding BSP - TSO	
ML_CM_TC	Packet length per transaction control and block measurement TSO - cloud platform	
ML_B_TC	Packet length per transaction TSO that forwards bids - cloud platform	
ML_H_BC	Packet length per transaction HMI BSP - cloud platform	
ML_H_TC	Packet length per transaction HMI TSO bidding platform - cloud platform	
CD_FB	Communication delay flexibility node - BSP	
CD_BT	Communication delay BSP - TSO CAF-BSP environment (BSP GW)	
CD_TC	Communication delay TSO - cloud platform	
PL_FB	Packet loss on path flexibility node - BSP	
PL_BT	Packet loss on path BSP - TSO CAF-BSP environment (BSP GW)	
PL_TC	Packet loss on path TSO cloud platform	

6 Use cases description for redispatch

This use case describes the BSP participation for redispatch actions in TSO-TSO cross border market model. This use case can run on Target FutureFlow architecture (Figure 9) or Demo site architecture. For more information on redispatching refer to D3.3.

6.1 Section 1 - Description of the use case

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
UC3	cross border	BSP participation for redispatch actions in model

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
0.1	9/11/2016	EKC	Initial version	
0.2	28/11/2016	EIMV, EKC	State diagrams	

Scope and Objectives of Use Case	
Scope	This use case describes redispatch operations with BSP participation in cross border market.
Objective(s)	The objective is to define information exchanges between the actors of this use case.
Related business case(s)	UC2

Narrative of Use Case
Short description
BSP participates as aggregator of generators and loads (including DR and DGs) on TSO-TSO model for cross border redispatch services. TSO collects BSP products as redispatch bids and forwards all eligible redispatch products to cloud CAF platform. CAF platform acts as central information exchange between TSOs of the region. CAF accepts redispatch products from all TSOs of the region and forms redispatch bidding list (RBL). Redispatch bids use location of generator and load (incl. DR/DG flexibility) nodes as additional parameter. Redispatch bids (products), obtained as the optimal solution for solving congestion on a particular line can be activated. Cycle repeats on 1-hour period, or less in case of real-time redispatching. TSO is receiving measurement signal from BSP to monitor the quality of procured power for redispatching. After the redispatch action, the TSO, or any other responsible entity (i.e. market operator), perform cost-sharing settlement. Note that redispatching process is separate from aFRR and different bids are presented to cloud platform, from different sources (Refer to Appendix Chapter 11.1).
Complete description
Use case BSP participation for redispatch actions in TSO-TSO model relies on cloud platform that acts as information exchange, optimization and redispatching solution for multiple control zones. Redispatching concept involves actions to solve the grid network congestions on cross border transmission lines in economic way with some form of cost allocation and cost sharing among TSOs (connected generation and consumption). The main business actors participating in the use case are: one cloud provider and several TSOs (1-10), BSPs (1-100) and flexibility providers (1-1000s) in each control zone. Architectural and implementation scalability to support communications, data handling and security aspects must be addressed at each system entity within business actors. Redispatching action must produce congestion relief on critical branch, i.e. the current flow must decrease below or

to the level of the allowed branch loading limit and at the same time relieving congestion on branch should not cause overloading on other monitored branches. Optimization seeks coordinated cross border redispatching actions with cost minimization. In order to efficiently resolve congestion on a particular line, coordinated redispatching based on minimization of costs is based on optimal power flow, i.e. that gives the minimum of costs and at the same time satisfies all predefined constraints, e.g. no overload of cross border transmission lines. No units that are used for aFRR can be used for redispatching.

Generators and loads that are participating in redispatch bidding process must provide at least this information: i) Amount of power available for upward/downward redispatching [MW]; ii) Price for upward/downward redispatching [€/MWh]; Location of unit in the system.

There are different time-frames on which redispatching can be applied (day ahead, intraday and real time). Since redispatching represents costly remedial action it is often used only as the last resort. Each transmission line is able to stand the overloading of several percent's up to the limit defined by each responsible TSO. From the moment a line becomes overloaded till the relay protection activates and switches off the line, the TSO should perform redispatching. Since this time-frame is very limited, the optimization is performed upfront to derive a set of scenarios, e.g. TSO has the list of optimal redispatching actions for each critical branch and even for contingencies.

Bid price, for upward bids is always positive, while for the downward bids can be either negative (defines service provider request to receive the money for activated service) or positive (defines service provider willingness to pay for delivering the service).

Based on all the information from the bidding list, for each node in the system, the objective function considers upward/downward bids (with the amount and the price) located at that particular node, and finds the solution that provides minimum of redispatching costs.

There are two HMI platforms that allow user influence:

- TSO redispatch bidding platform. TSO operator has complete view of redispatch bid collection process, participating BSP, types of redispatch bid products, generated RBL, local RBL. Furthermore, it has the credentials to cancel redispatch bid.
- Flexibility aggregation platform. BSP operator has complete view of flexibility provider and their DR/DG redispatch flexibility nodes operations and controls the product bidding towards TSO. Details of the platform can be found in D2.1.

Use case is composed of two contiguous scenarios:

UC3, Scenario1: Bidding process of products for redispatch and RBL generation. Scenario1 always precedes Scenario2. Scenario1 runs in time frame from Tweekahead to Trealtimestart.

UC3, Scenario2: Redispatch real time operation with changed load flows. Scenario2 runs in time frame from Trealtimestart to Trealtimeend. Scenario2 starts after Scenario1 finishes.

The use case, a series of Scenario1 and Scenario2, consists of these processes or Phases (Figure 13):

1. Collection of redispatch bids (Phase I). Redispatch are collected on at least day ahead basis until specified gate closure time. This closes the bid collection and bid updating process of bids to be accepted for possible activation in the next 30 min. No changes or cancellation of existing redispatch bids after that time is possible (for the same activation period). This is the slowest process with non-time critical asynchronous communication (> 30 s latencies are tolerated), triggered by BSP to TSO.
2. TSO redispatch bid forwarding and capacity management (Phase II). TSO checks the redispatch bids for compliance and decides on the fly of their acceptance. Day ahead and intraday capacity forecasts and capabilities are evaluated. This is slow process with non-time critical asynchronous communication (< 10 s latencies are tolerated), triggered by TSO to cloud platform.
3. RBL list creation (Phase II). A global, multi zone redispatching bidding list of accepted redispatch bids from all control zones is generated in CAF. This is fast process with cloud platform internal processing only, followed by cloud RBL list notification of TSOs which is fast process with time critical asynchronous communication (< 5 s latencies are tolerated), triggered by cloud platform to TSO.
4. RBL bid activations from CAF, also called real time operation (Phase III). Activation of RBL redispatch bids in case of overload condition on transmission lines, starts control signal exchange between CAF and all

TSOs to overload by redispatching operation on particular cross border line by activation of bids from RBL. This is the fastest process with hard real time critical asynchronous communication (< 0.5 s latencies are tolerated), triggered by cloud platform to TSO and subsequently by TSO to BSPs.

5. Forwarding measurement data to TSO (Phase III). TSO monitors the activation and evaluates the response of BSP. This is the fastest process with hard real time critical asynchronous communication (< 0.5 s latencies are tolerated), triggered by BSPs to TSO and TSO to cloud platform.

Settlement and cost sharing of the procured power is not part of use case and is done off line (not shown on Figure 13).

All described processes or Phases run concurrently by overlapping different time horizons, i.e. each action starts in Phase I and proceeds to Phase III, but all are active for different redispatch bid timeframes.

Phases I, II, III are described in separate step tables for each scenario in this use case. It is mandatory that each event activity (defined in tables) generates an acknowledge signal or message from receiving actor back to originating actor with message receipt confirmation, optional parameters and time stamp.

Key performance indicators of data transport actor types can be measured with packet analyser software (e.g. Wireshark [WS 2016]). They are defined for BSP-TSO, TSO-cloud platform paths.

General Remarks
Times definitions: • Tweekahead = time frame up to 1 week ahead before Tgateclosure time • Tdayahead = time frame up to 24 hours ahead before Tgateclosure time • Tpricechange = time frame up to Tgateclosure time; price of bid can change • Tbidcancel = time frame before Tgateclosure time; redispatching bid can be cancelled • Tgateclosure = time ending acceptance of redispatching bids (e.g. 30 min before real time operation) • Trbl = time after Tgateclosure until real time operation (e.g. 25 min) allotted for redispatching bidding list (RBL) creation process within cloud platform • Trealtimestart = start of real time operation, usually done on whole hour, defined as time = 0 • Trealtimebidcancel = time during real time operation; redispatching bid can be cancelled only in critical special situations (e.g. product fail) and TSO may apply penalties • Trealtimeend = end of real time operation, usually 1 h after Trealtimestart

6.2 Section 2 – Diagrams of the use case

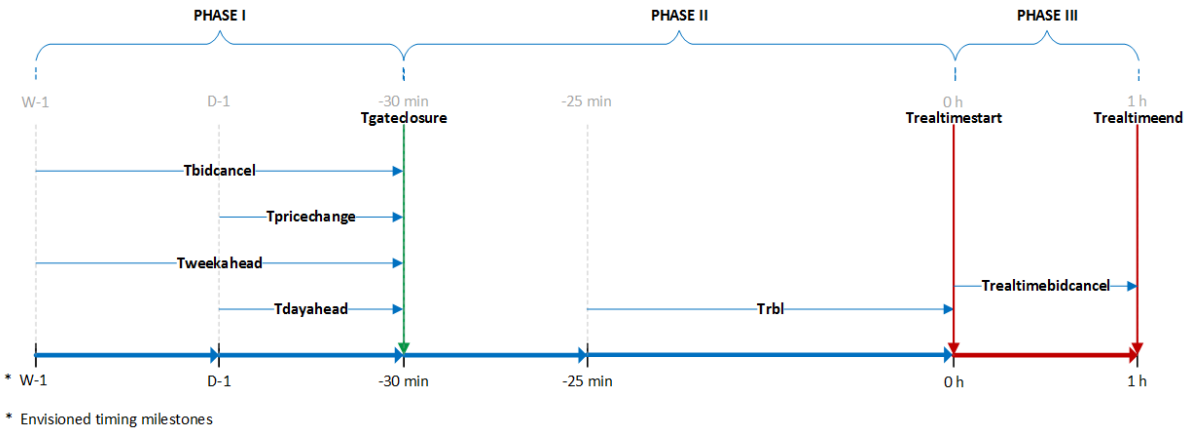

Figure 13: Timing diagram of redispatch process phases.

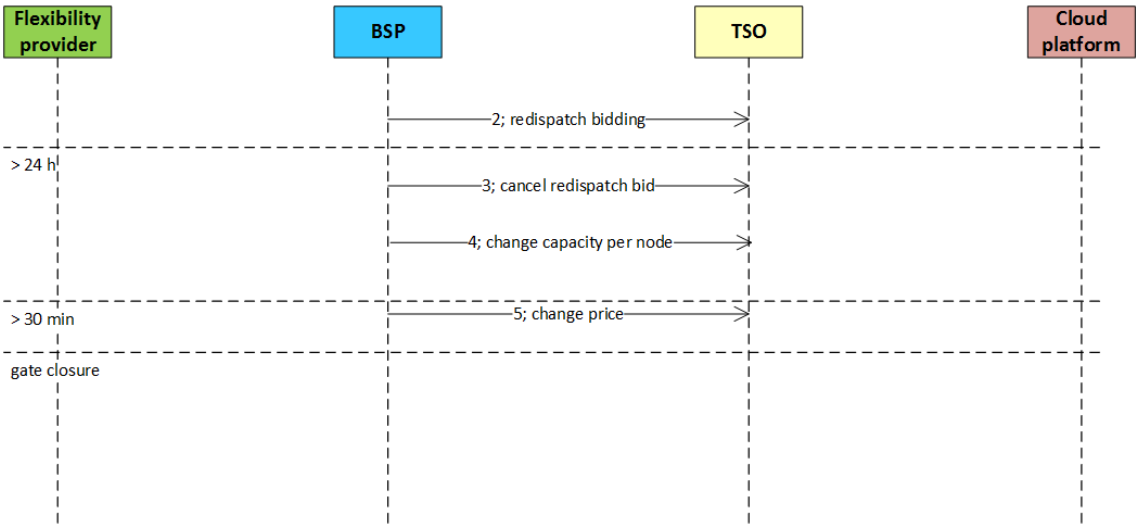

Figure 14: Sequence diagram for Phase I of redispatch use case.

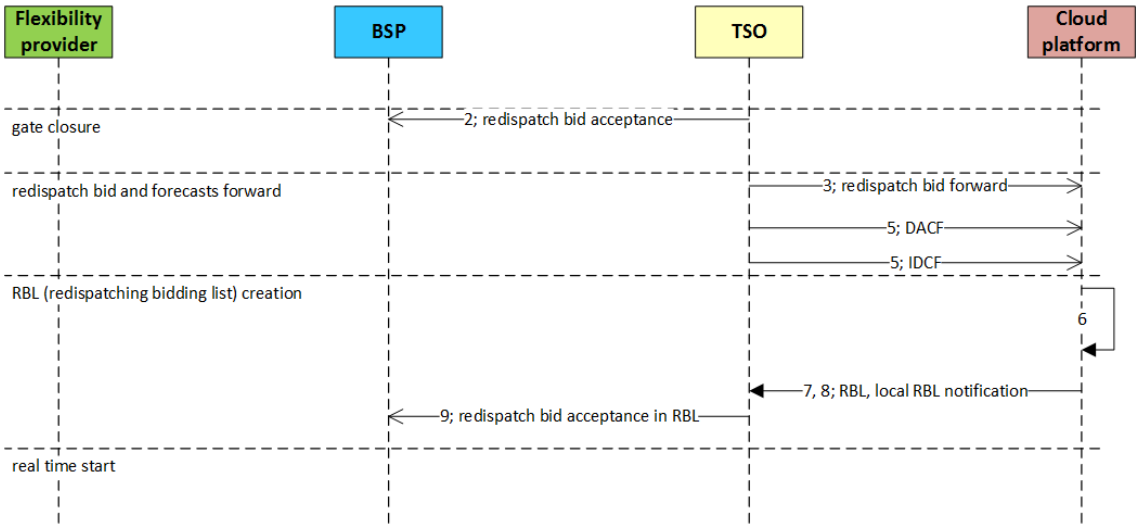

Figure 15: Sequence diagram for Phase II of redispatch use case.

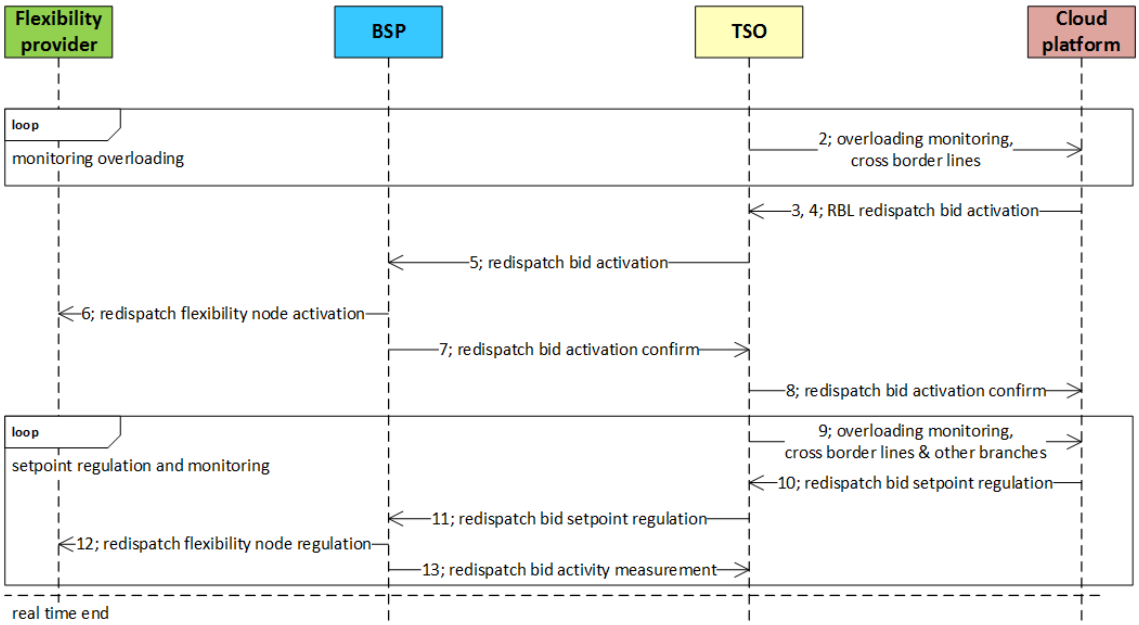

Figure 16: Sequence diagram for Phase III of redispatch use case.

6.3 Section 3 – Technical details

Actors			
Grouping (e.g. domains, zones)		Group Description	
/		/	
Actor Name	Actor Type	Actor Description	Further information specific to this Use Case
Refer to chapter Use case description for aFRR.			

Use Case Conditions			
Actor/System/ Information/Contract	Triggering Event	Pre-conditions	Assumption
Multilateral agreement between respective TSOs aiming for redispatching actions, including cost sharing (Refer to D3.3.). Flexibility provider has contracted DR/DG redispatch flexibility supply with BSP. Each DR/DG redispatch flexibility node is equipped with measurements and control system (PLC, small SCADA) and real time communications link to BSP.	Redispatching bid procurement solicitation for cross zone operation on open bidding procedure available to any BSP and TSO in participating control zones.	Overload on cross zone transmission lines starts Phase III, real time operation.	Cloud platform communicating with TSOs in different control zones. Target system architecture including its constituent actor systems are implemented and operational.

References						
No.	References Type	Reference	Status	Impact on Use Case	Originator / Organisation	Link
/	/					

Classification Information
Relation to Other Use Cases
Use case BSP participation for redispatch actions in TSO-TSO model is closely related to two other use cases: i) Demonstration site for BSP participation in aFRR balancing TSO-TSO model, ii) BSP participation in aFRR balancing TSO-TSO model.
Level of Depth
Suitable for functional requirements specification of building blocks.
Prioritization
/
Generic, Regional or National Relation
Generic for EU ENTSO-E region.
Viewpoint
/
Further Keywords for Classification
/

6.4 Section 4 – Step by step analysis of the use case

Scenario Conditions					
No.	Scenario Name	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
1	Bid collection for redispatch, Phase I	TSOs	Redispatch bid collection start at week or day ahead before real time operation.	Opened market. Communication BSP-TSO.	A set of collected redispatch bids at gate closure time.
2	RBL generation for redispatch, Phase II	cloud platform	Gate closure.	Collected bid products from BSP, via TSO. Communication TSO-cloud platform.	Redispatching bidding list (RBL) of redispatch bid products per node location.
3	Redispatch real time operation with changed load flows, Phase III	cloud platform, TSOs, BSPs, redispatch flexibility providers	Overload condition on transmission lines between cross border control zones. Start of real time redispatch operation for selected RBL period (e.g. 1 h).	Communication TSO-cloud platform, BSP-TSO, redispatch flexibility node-BSP, redispatch DR/DG-flexibility node.	Prevented overload protection activation. Lower load flows on transmission lines between cross border control zones. End of real time operation for selected RBL period (e.g. 1 h).

Scenario based on Target Architecture								
Scenario Name:		No. 1 – Bid collection for redispatch, Phase I						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
1		Start	Start of bid collection, bidding		/	/	/	
2		Collection of redispatch bids	TSO collects redispatch bids per node location from BSPs in the same control zone. Process length is up to one week ahead prior to gate closure. The last eligible product bid is 24 h ahead of gate closure. Bid is checked and formally verified by TSO and/or cloud platform. Confirmation or error reply is sent from TSO to BSP.		BSP	TSO	BSP redispatch bid to TSO	
3		Cancel redispatch bid	BSPs can cancel redispatch bid at least 24 h prior to gate closure. After that only product price change is allowed. Cancellation is mandatory if BSP wants to change product type, later. TSO checks that the redispatch bid is already in system, otherwise error reply is sent to BSP.		BSP	TSO	BSP redispatch bid cancel (must use the same bid ID as already used)	
4		Change redispatch bid	BSPs can change redispatch bid itself, can be only per node product capacity [MW] and/or price at least 24 h prior to real time. Products, BSP flexibility product data, with the same IDs must be presented. The same message is used as for bidding. TSO system and cloud platform must update all bids with the same IDs.		BSP	TSO	BSP redispatch bid to TSO (must use the same bid ID as already used)	

Scenario based on Target Architecture								
Scenario Name:		No. 1 – Bid collection for redispatch, Phase I						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
5		Change price of redispatch bid	BSPs can change product price of redispatch bid at least 30 min prior to real time. This makes redispatch bid per node capacity and price final. Products, BSP flexibility product data, with the same IDs, but different price must be presented. TSO checks that the redispatch bid is already in system, otherwise error reply is sent to BSP.		BSP	TSO	BSP redispatch bid to TSO (must use the same bid ID as already used)	

Scenario based on Target Architecture								
Scenario Name:		No. 2 – RBL generation for redispatch, Phase II						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
1		Start	Start of gate closure		/	/	/	
2		Redispatch bid acceptance and confirm at gate closure	TSO notifies BSP about all accepted redispatch bids that were offered until Tgateclosure time. Each redispatch bid is confirmed separately. Only eligible redispatch bids meeting minimum requirements and any special requirements (set dynamically by TSO) are accepted by TSO. Bids are accepted until Tgateclosure time. Criteria for redispatch bid eligibility and minimum requirements are established in separate off line process and put forward to cloud platform.		TSO	BSP	TSO redispatch bid confirm	
3		Redispatch bid forwarding to cloud platform	Accepted eligible and validated redispatch bids are forwarded from all TSOs and all control zones to cloud platform after Tgateclosure and before real time operation.		TSO	cloud CAF	TSO redispatch bid list to CAF	
4		Fixed redispatch bids at cloud platform	Collected redispatch bids from all TSOs and all control zones are fixed at cloud platform just prior to Trbl time.		cloud CAF	cloud CAF	/	
5		Congestion forecast	Each TSO presents DACF, IDCF to cloud platform.		TSO	cloud CAF	DACF list, IDCF list	

Scenario based on Target Architecture								
Scenario Name:		No. 2 – RBL generation for redispatch, Phase II						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
6		Creation of RBL	Redispatching bidding list (RBL) is created within cloud platform. Only redispatch bids, that are listed in RBL are used for possible redispatching, but only when/if need arises, i.e. cross zone transmission link overloading happens. A list of predefined, precalculated redispatch scenarios if available in CAF. Only single scenario is selected based on optimization result.		cloud CAF	cloud CAF	/	
7		Complete RBL notification to TSO	Complete RBL accepted bids are transferred to each TSO. It is presented in HMI bidding platform.		cloud CAF	TSO HMI bidding platform	CAF RBL bid list to TSO	
8		Local RBL notification to TSO	RBL accepted bids are filtered so that each TSO receives only its own local redispatch bids. A list of redispatch bids belonging to each node and TSO is sent as a local RBL.		cloud CAF	TSO LFC	CAF local RBL list to TSO	
9		Bid acceptance after RBL notification to BSPs	TSO notifies BSPs of all accepted redispatch bids that were used in final RBL and copied to local RBL. Each redispatch bid is confirmed separately. BSP must receive the redispatch bid confirmation twice (Step 2 that it is accepted into process as eligible bid, Step 9 that it is listed on RBL) during Phase II for each redispatch bid that is going to be activated during redispatch real time Phase III operation.		TSO	BSP	TSO redispatch bid confirm	

Scenario based on Target Architecture								
Scenario Name:		No. 3 - Redispatch real time operation, Phase III						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
1		Start	Start of real time operation. For designated redispatch bid products within RBL period, e.g. 1 h.		/	/	/	
2		Monitoring cross border transmission lines for overloading	Monitoring overloading of cross border transmission lines.		TSO LFC	cloud CAF	Transmission line overload status (all and each cross border transmission line separately), (2 s period)	
3		Cloud CAF redispatch bid scenario activation -OR-	Cloud CAF activates redispatch bids only when overloading is detected. TSO receives redispatch scenario SCx activation request. SCx is only a tag, that is synonymous with a list of all nodes and redispatch bids in local RBL to be activated to achieve optimization objectives. SCx to list table must be exchanged TSO-cloud prior to real time operation.		cloud CAF	TSO CAF-BSP environment (BSP GW)	CAF redispatch scenario SCx activation	
4		Cloud CAF redispatch bid activation on products	Cloud CAF activates redispatch bids only when overloading is detected. TSO gets a list of all nodes and redispatch bids in local RBL to be activated to achieve optimization objectives.		cloud CAF	TSO CAF-BSP environment (BSP GW)	CAF redispatch bid activation list	
5		TSO bid activation to BSP	TSO informs BSP to activate redispatch product bid.		TSO CAF-BSP environment (BSP GW)	BSP	TSO redispatch bid activation to BSP	

Scenario based on Target Architecture								
Scenario Name:		No. 3 - Redispatch real time operation, Phase III						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
6		BSP activates redispatch product bid	BSP activates redispatch product bid.		BSP	flexibility providers	activation signal to flexibility providers	
7		BSP confirms redispatch bid activation to TSO	BSP confirms activation of redispatch product bid.		BSP	TSO CAF-BSP environment (BSP GW)	BSP redispatch bid activation confirm	
8		TSO confirms redispatch bid activation to cloud CAF	TSO confirms activation of redispatch product bid to cloud CAF.		TSO CAF-BSP environment	cloud CAF	TSO redispatch bid activation confirm	
9		Monitoring cross border transmission lines and other branches for overloading	Monitoring overloading of cross border transmission lines and other branches.		TSO LFC	cloud CAF	Transmission line overload status, Other branches overload status (all and each cross border transmission line and other branch separately), (2 s period)	
10		Control regulation of redispatch product setpoint to TSO	Cloud CAF continuously regulates, changes setpoint of redispatch product bid (MW).		cloud CAF	TSO LFC via LFC RT GW	CAF redispatch bid control activation setpoint	
11		Control regulation of redispatch product setpoint to BSP	TSO control, changes redispatch product bid setpoint (MW).		TSO LFC via CAF-BSP environment (BSP GW)	BSP	TSO redispatch flexibility activation and setpoint control	
12		Control regulation of product setpoint to flexibility node	BSP control, changes redispatch flexibility node setpoint (MW).		BSP	redispatch flexibility node	BSP redispatch flexibility setpoint control	

Scenario based on Target Architecture								
Scenario Name:		No. 3 - Redispatch real time operation, Phase III						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
13		Measurement of redispatch product activity	TSO receives measured data of redispatch products activation setpoints from BSP.		BSP	TSO LFC via CAF-BSP environment (BSP GW)	BSP redispatch product activity measurement	
14		End of real time	End of current 1h real time period. For designated redispatch bid products within RBL period, e.g. 1 h.		/	/	/	
15		Redispatch cost sharing settlement process	Redispatch cost sharing settlement process begins off line, end of day. (Outside this process.).		/	/	/	

6.5 Section 5 – Information exchanged

Information Exchanged		
Name of Information (ID)	Description of Information Exchanged	Requirements to information data
	Refer to chapter Data exchange profiles and schemes proposal.	

6.6 Section 6 – Requirements

Requirements (optional)	
Categories for Requirements	Category Description
/	/
Requirement ID	Requirement Description
/	/

6.7 Section 7 – Common terms and definitions

Common Terms and Definitions	
Term	Definition
	Refer to Table of acronyms.

6.8 Section 8 – Custom information

Custom Information (optional)		
Key	Value	Refers to Section
/	/	/

6.9 Section 9 – Key performance indicators

Key performance indicators		
Name of KPI	Description of KPI	Refers to Section
ML_R_CM_BT	Message length per redispatch transaction control and measurement BSP - TSO	Section 3, data transport actor type
ML_R_B_BT	Message length per redispatch transaction bidding BSP - TSO	
ML_R_CM_TC	Message length per redispatch transaction control and block measurement TSO - cloud platform	
ML_R_B_TC	Message length per redispatch transaction TSO that forwards bids - cloud platform	
ML_R_H_BC	Message length per redispatch transaction HMI BSP - cloud platform	
ML_R_H_TC	Message length per redispatch transaction HMI TSO bidding platform - cloud platform	
CD_R_FB	Communication delay redispatch flexibility node - BSP	
CD_R_BT	Communication delay BSP - TSO CAF-BSP environment (BSP GW)	
CD_R_TC	Communication delay TSO - cloud platform	
PL_R_FB	Packet loss on path redispatch flexibility node - BSP	
PL_R_BT	Packet loss on path BSP - TSO CAF-BSP environment (BSP GW)	
PL_R_TC	Packet loss on path TSO cloud platform	

7 Proposal for standard improvements

In this chapter, we propose some possible improvements to standards, based on the FutureFlow target architecture and use case analysis of cross border aFRR and redispatching services.

7.1 IEC 62559 standard

IEC 62559 defines a standardised use case methodology for description of power system user requirements for automation systems, based on their utility business needs.

We proposed to extend the methodology with additional Section: Key performance Indicators. For both described use cases (aFRR, Redispatch) we specified communications KPI that can be used to track operational performance of architecture implementation.

7.2 IEC TC8 WG6 Generic smart grid requirements

After having analyzed the SGSS no use case equivalent to FutureFlow topics were identified. FutureFlow use cases are best described and contributed to the IEC TC8 WG6 (Generic Smart Grid Requirements), as well as to the CEN-CENELC-ETSI Smart Grid Coordination Group.

MQTT protocol implementation is planned on demo architecture implementation on selected systems (Table 1) and as interconnect with cloud platform. We plan to propose also MQTT use in communication and information (Chapter 3.1) layers of SGRA framework after successful tests on project.

8 Conclusions

Analysis and architecture of FutureFlow information solution that supports TSO-TSO model is based on use case analysis. We used IEC 62559 use case template to describe three different cases: Demo architecture, target architecture supporting both aFRR and redispatch operations. Descriptions provide requirements specification, that is used in WP3 to define functional detailed specification of cloud platform and demonstration solutions in WP2.

We propose to take a fresh look at design of real time interfaces (measurements, control) that link SCADA, LFC to BSP and cloud platform, utilising message queuing protocols (MQTT) to achieve unified implementation (Table 1) across systems and low latency, while guaranteeing delivery with built in QoS (MQTT level 2 or 3).

Table 1 : FutureFlow target architecture protocol summary.

Actor	Data interface (purpose)	Protocol
SY1 Cloud platform	Web services (non-time critical)	• HTTPS, JSON (RESTful) • HTTPS, XML • TLS, TCP, MQTT • HTTPS, SOAP
	Real time (measurements, control)	• TLS, TCP, MQTT • HTTPS, XML
	Web server (HMI)	• WebSocket Secure with TLS • HTTPS
SY4 TSO scheduling system	Web services (ATC/CZC, DACF, IACF)	• HTTPS, JSON (RESTful) • HTTPS, XML • TLS, TCP, MQTT
SY5 TSO bidding platform	Web server (HMI)	• WebSocket Secure with TLS • HTTPS
SY6 LFC real time GW towards SY1	Real time (measurements, control of SCADA/EMS, SY9 LFC)	• TLS, TCP, MQTT
SY12 BSP GW towards BSP	Real time (measurements, control of BSP)	• TLS, TCP, MQTT • IEC 60870-5-104
	Web server (HMI)	• WebSocket Secure with TLS • HTTPS
SY12 BSP GW towards SY9	Real time (measurements, control of SY9 LFC)	• IEC 60870-6 (TASE.2/ICCP)
SY12 BSP GW towards SY1	Real time (measurements, control of BSP)	• TLS, TCP, MQTT
	Web server (HMI)	• WebSocket Secure with TLS • HTTPS

9 References

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10 Appendix 1: Use case description for demonstration site

10.1 Section 1 – Description of the use case

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
UC1		Demonstration site for BSP participation in aFRR balancing TSO-TSO cross border market model

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
0.1	17/10/2016		Initial version	
0.2	3/11/2016		Actor descriptions	

Scope and Objectives of Use Case	
Scope	This use case describes demonstration site residing in single TSO to realize BSP participation in aFRR balancing services cross border market.
Objective(s)	The objective is to define information exchanges between the actors of this use case.
Related business case(s)	UC2

Narrative of Use Case
Short description
BSP participates as aggregator of DR and DG flexibilities on cross border balancing based on TSO-TSO model. Hosting TSO (ELES) is provider of demo site that exchanges measurement information with LFCs from other TSOs via e-Highway (or any other TSO-TSO existing communication means). TSO collects BSP products as bids and forwards all eligible products to cloud CAF platform. CAF platform is directly connected to hosting TSO that acts as information hub for data exchange with other TSOs via e-Highway. CAF accepts products from all control zones, but that were relayed only via hosting TSO, and forms CMOL type bid list. Bids (products) are activated on any TSO's demand according to calculated ACE and frequency deviations within its control zone, but this information was relayed via e-Highway to hosting TSO. Cycle repeats on 1 hour period. Respective TSO is receiving the measurement signal from BSP only indirectly via hosting TSO.
Complete description
For a reference description refer to use case for aFRR. Here are described specifics of demonstration setup. FutureFlow demo site is installed only in hosting TSO (ELES). All other participating TSOs require no changes within their EMS/SCADA systems. Demo site is composed of development environment that consists of multiples LFC extension instances, one for each TSO or each control zone. A central VPN router in the same demo site collects measurement and control data from all BSPs, in all control zones, via secured Internet. LFC data that includes all ACE and control signals (Refer to chapter Data exchange profiles and schemes proposal) is transported via e-Highway (or any other TSO-TSO existing communication means) from other TSOs to hosting TSO (ELES) ICCP gateway. LFC data for particular control zone is linked with LFC extension instance of the same control zone within development environment. Interaction from development environment and each LFC extension with cloud platform is logically separated (e.g. different IP addresses). This principle enables apparently direct communication from each TSO to cloud platform. HMI in hosting TSO acts as bidding platform and is augmented with further controls of development environment. Other HMI bidding platforms are identical to aFRR use case in target architecture and directly interact their ATC/CZC and HMI information with cloud platform via secure Internet.

General Remarks
Refer to UC2.

10.2 Section 2 – Diagrams of the use case

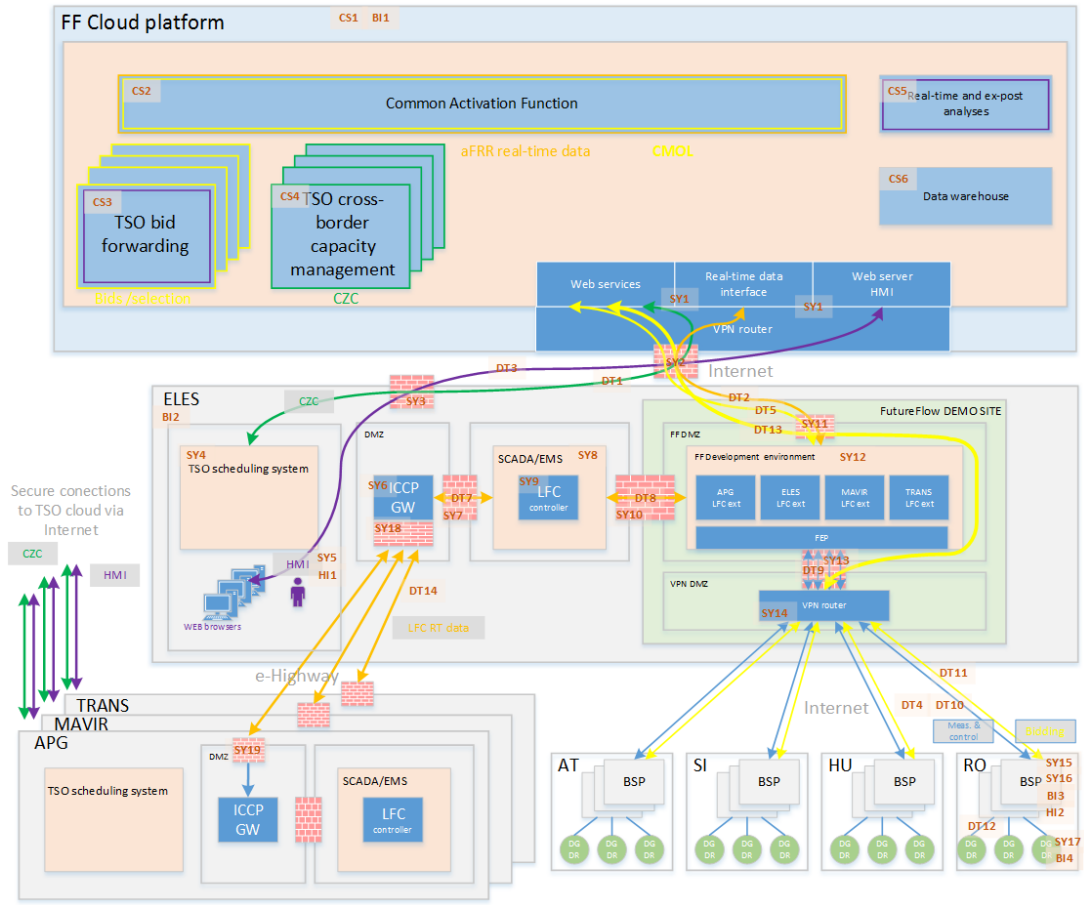

Figure 17: Demo FutureFlow architecture with actor types.

10.3 Section 3 – Technical details

Actors (Refer to Figure 17.)			
Grouping (e.g. domains, zones)		Group Description	
Actor Name	Actor Type	Actor Description	Further information specific to this Use Case
FutureFlow cloud platform	cloud system CS1	System, based as a cloud platform (e.g. SAP HANA), acting as an information exchange mechanism for cross border aFRR market operation between different TSOs from multiple control zones.	
FutureFlow cloud provider	business BI1	Business entity providing cloud platform aFRR services to TSOs and BSPs from multiple regions.	
Common activation function	cloud system CS2	Program installed within cloud platform responsible for CMOL formation, communication with TSOs and optimal scheduling of aFRR in all control zones.	

Actors (Refer to Figure 17.)			
Grouping (e.g. domains, zones)		Group Description	
Actor Name	Actor Type	Actor Description	Further information specific to this Use Case
TSO bid forwarding	cloud system CS3	Program installed within cloud platform responsible for bid confirmation and validation before they enter CAF and is assigned for each TSO.	
TSO cross border capacity management	cloud system CS4	Program installed within cloud platform calculating available transmission capability on all cross zone borders and is assigned for each TSO.	
Real time and ex-post analyses	cloud system CS5	Program installed within cloud platform used for calculation of KPI and other interesting information from all data in DWH.	
Data warehouse	cloud system CS6	Large database installed within cloud platform used as a long-term storage (historian) of measurement and control data exchanges with TSO, BSP.	
VPN router cloud platform	system SY1	Device or program installed in cloud platform and providing secure network connection to tunnel data transports (Web services, real time data, Web server for human interfaces) and authenticating development environment communication from hosting TSO (ELES), comprising also instances of LFC extensions of all other TSOs. Data transport protocols are tunnelled within VPN created from TSO or cloud provider (e.g. OpenVPN) or with telecom operator provided service.	
Security gateway cloud platform	system SY2	Device facing cloud platform and providing information security protection (firewall) acting as a demarcation point between cloud platform and hosting TSO (ELES) for different types of data transports.	
TSO	business Bl2	Hosting TSO (ELES) business entity interconnecting one or more BSP and cloud platform with development environment and constituent LFC extensions of each TSO.	

Actors (Refer to Figure 17.)			
Grouping (e.g. domains, zones)		Group Description	
Actor Name	Actor Type	Actor Description	Further information specific to this Use Case
Security gateway TSO	system SY3	Device facing hosting TSO (ELES) and providing information security protection (firewall) acting as a demarcation point between hosting TSO and cloud platform for different types of data transports.	
TSO scheduling system	system SY4	Program installed at hosting TSO for scheduling transmission capacity (ESS) of electricity flows on cross border transmission lines between control zones. It uses also historical data for control zones of other TSOs (testing phase).	
TSO bidding platform	system SY5	Information system installed at TSO that with user interface and TSO bid forwarding enables full insight of main systems operations (e.g. LFC, CAF, bids, CMOL).	
User interface at TSO	human interface HI1	Information system installed at TSO acting as user interface for real time observation and control of aFRR process. Presents crucial market information and allows TSO operator to interactively control the aFRR process (e.g. cancel bid).	
ATC/CZC	data transport DT1	Available transfer capability (capacity) information exchange with cloud platform for all transmission lines for each TSO's control zone. ATC/CZC of other TSO are exchanged off line (testing phase) or real time.	
TSO user interface exchange	data transport DT3	Information exchange between Web browser interface installed in TSO on bidding platform and cloud platform.	
ICCP gateway	system SY6	Gateway or program installed at TSO transferring LFC real time data (e.g. ACE, control demand) and acting as as intermediary protocol translator between EMS/SCADA (IEC 60870-6-503 ICCP/TASE.2) and cloud platform.	
Security gateway ICCP to e-Highway	system SY18	Device facing e-Highway and providing information security protection (firewall) to ICCP gateway within hosting TSO (ELES).	
LFC data from TSOs to hosting TSO ICCP gateway	data transport DT14	LFC data (e.g. ACE, control demand) exchange from other TSO to hosting TSO (ELES) via e-Highway.	

Actors (Refer to Figure 17.)			
Grouping (e.g. domains, zones)		Group Description	
Actor Name	Actor Type	Actor Description	Further information specific to this Use Case
Security gateway from TSO ICCP to e-Highway	system SY19	Device facing ICCP gateway in each TSO and providing information security protection (firewall) towards e-Highway.	
Security gateway LFC real time gateway to LFC	system SY7	Device or program facing EMS/SCADA and providing information security protection acting as a demarcation point between TSO EMS/SCADA and other TSO systems (e.g. LFC real time gateway).	
EMS/SCADA	system SY8	Consists of energy management programs and SCADA control used for reliable operation of multi control zone interconnected transmission systems.	
LFC	system SY9	Program and/or system installed at TSO for load and frequency control within control zone using measurements from EMS/SCADA to automatically control transmission system stability and controls external generators, i.e. BSP provided flexibility products and classical gen sets.	
Security gateway Demo site to LFC	system SY10	Device or program facing LFC and providing information security protection acting as a demarcation point between hosting TSO (ELES) demo site (development environment) and EMS/SCADA effectively DMZ isolating demo site environment from EMS/SCADA.	
LFC data to ICCP gateway	data transport DT7	LFC data (e.g. ACE) exchange between EMS/SCADA and ICCP gateway.	
LFC data to demo site gateway	data transport DT8	LFC data (e.g. ACE) exchange between EMS/SCADA and demo site (development environment) gateway, carrying LFC data from each TSO.	
Security gateway demo site environment TSO	system SY11	Device facing hosting TSO (ELES) and providing information security protection (firewall) acting as a demarcation point between hosting TSO demo site (development environment) and cloud platform for different types of data transports.	
Development environment	system SY12	Information system installed within hosting TSO (ELES) implementing key LFC extension functionalities of each TSO.	

Actors (Refer to Figure 17.)			
Grouping (e.g. domains, zones)		Group Description	
Actor Name	Actor Type	Actor Description	Further information specific to this Use Case
Security gateway BSP	system SY13	Device facing BSP and providing information security protection (firewall) acting as a demarcation point between hosting TSO (ELES) and BSP for different types of data transports.	
VPN router DMZ BSP	system SY14	Device or program installed in hosting TSO (ELES) and providing secure network connection to tunnel data transports and authenticating all BSP participating in aFRR services. Data transports are tunnelled within VPN created from hosting TSO (ELES) (e.g. OpenVPN) or with telecom operator provided service.	
BSP user interface exchange	data transport DT4	Information exchange between Web browser interface installed in BSP and cloud platform via hosting TSO (ELES).	
LFC extension real time data	data transport DT2	LFC extension real time data (e.g. ACE, control demand) exchange from hosting TSO (ELES) and each instance of LFC extension belonging to other TSOs and loud system platform.	
TSO to cloud platform bidding exchange	data transport DT5	Confirmed bidding process between hosting TSO (ELES) and instances belonging to other TSOs and cloud platform, usually based on HTTPS (REST web services) or MQTT.	
VPN router to BSP gateway exchange	data transport DT9	Information exchange of control and measurement data within hosting TSO (ELES) environment towards BSPs.	
BSP to hosting TSO control and measurement exchange	data transport DT10	Information exchange (product baseline, commands) to hosting TSO (ELES), usually based on IEC 60870-5-104 or MQTT.	
BSP to hosting TSO bidding exchange	data transport DT11	Bidding offers of products to hosting TSO (ELES), usually based on HTTPS (REST web services) or MQTT.	
BSP to hosting TSO bidding forwarding	data transport DT13	Bidding offers of products from all BSPs forwarded to cloud platform via hosting TSO (ELES).	
BSP	business BI3	BSP acting as aggregator of flexibility capacities from many flexibility providers and producing flexibility products as bids to hosting TSO (ELES).	
Flexibility aggregation platform towards hosting TSO	system SY15	Information system installed at BSP for communication and control with hosting TSO (ELES) and user interface.	

Actors (Refer to Figure 17.)			
Grouping (e.g. domains, zones)		Group Description	
Actor Name	Actor Type	Actor Description	Further information specific to this Use Case
Flexibility aggregation platform towards flexibility provider	system SY16	Information system installed at BSP for data exchange with flexibility provider including forecasting and control.	
User interface at BSP	human interface HI2	Information system installed at BSP acting as user interface for managing flexibility aggregation platform and BSP actions towards hosting TSO (ELES) and flexibility provider.	
BSP to flexibility provider exchange	data transport DT12	Information exchange (generation/consumption data, commands) with DR/DG units or PLC/SCADA at flexibility provider, usually based on IEC 60870-5-104 or MQTT.	
Flexibility provider	business BI4	Business C or I entity offering flexibility capacity to BSP. It may contain one or more flexibility nodes at single location.	
Flexibility node	system SY17	DG or DR type, installed at flexibility provider having its own measurement on power lines (power).	

Use Case Conditions			
Actor/System/ Information/Contract	Triggering Event	Pre-conditions	Assumption
BSPs have notified TSO of their bid product capacities that are used in control zones during demonstration. Flexibility provider has contracted DR/DG flexibility supply with BSP for demonstration purposes. Each DR/DG flexibility node is equipped with measurements and control system (PLC, small SCADA) and real time communications link to BSP.	aFRR test operational cases from WP4.	ACE in any of control zones starts Phase III, real time operation, during demonstration.	Cloud platform communicating with hosting TSO (ELES) and other TSOs. Demo site system and other constituent actor systems are implemented and operational.

References						
No.	References Type	Reference	Status	Impact on Use Case	Originator / Organisation	Link
/	/					

Classification Information
Relation to Other Use Cases
UC2, as a target architecture realization.
Level of Depth
Suitable for functional requirements specification of building blocks in demo site.
Prioritization
/
Generic, Regional or National Relation
National, suitable for testing.
Viewpoint
/
Further Keywords for Classification
/

10.4 Section 4 – Step by step analysis of the use case

Scenario Conditions					
No.	Scenario Name	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
1	Refer to UC2.				

Scenario								
Scenario Name:		Refer to UC2 with modifications.						
Step No.	Event	Name of Process/ Activity	Description of Process/ Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirement ID
/								

10.5 Section 5 – Information exchanged

Information Exchanged		
Name of Information (ID)	Description of Information Exchanged	Requirements to information data
	Refer to UC2.	

10.6 Section 6 – Requirements

Requirements (optional)	
Categories for Requirements	Category Description
/	
Requirement ID	Requirement Description
/	

10.7 Section 7 – Common terms and definitions

Common Terms and Definitions	
Term	Definition
/	

10.8 Section 8 – Custom information

Custom Information (optional)		
Key	Value	Refers to Section
/		

10.9 Section 9 – Key performance indicators

Key performance indicators (optional)		
Name of KPI	Description of KPI	Refers to Section
	Refer to UC2.	

11 Appendix 2: Data exchange profiles and schemes

This chapter outlines the preliminary information of data exchange packets between actors. Goal is to put forward requirements for data exchange packets as will be later defined in software solutions on development environment and cloud platform. Many of functions are proposed as variables with a defined range, rather than constants, to suit development purposes for later exploration of alternatives. More evolved description can be found in D3.3. General information is as follows:

- TSO-TSO model.
- aFRR: CMOL BSP bid selection mechanism.
- aFRR: CMOL creation at least 5 min before real time operation and updated every 1 hour.
- Redispatch: RBL BSP bid selection mechanism.
- Redispatch: RBL creation before real time operation and updated every 1 hour.
- Local MOL BSP bid selection mechanism local control zone when no cross zone transmission capacity is available.
- Bid products have harmonised FAT across control zones.
- TSO is uniquely identified by TSID.
- BSP is uniquely identified by BSID.
- Flexibility node DR/DG location is uniquely identified, for redispatch actions.
- Transmission link between two control zones is uniquely identified by TLID.

aFRR bids are conditionally activated according to the following rule: CMOL bid activation, iff (if and only if) transmission capacity on transmission link (TLID) is available, for each control zone pair of countries, otherwise only local bids within control zone proceed with activation.

Redispatch bids are conditionally activated according to the following rule: RBL bid activation, iff (if and only if) overloading on transmission link (TLID) is detected, for each control zone pair of countries.

Data exchange is described with a set:

- Source - Destination. Data transmitting and receiving actor.
- Functions. Information content: aFRR/redispatch type of action, format, ranges and resolution.
- Update period. Frequency of data packet exchange between two actors.
- Acknowledgement. Confirmation of reception sent from receiving to transmitting actor.
- DWH save transaction with time stamp. Some transactions can optionally be

saved to cloud platform DWH for post analysis.

- Time stamp. Each message is time stamped with second resolution. This requirement is by default and not shown in descriptions below.

Details of data exchange flexibility provider - BSP are covered in Deliverable 2.1.

11.1 BSP - TSO data exchange

11.1.1 BSP flexibility product

BSP flexibility product data (BFPD) specifies technical information, bid features, about bid offered to TSO. Several possible descriptions are outlined, depending on the level of detail exposed during data transaction. Detailed description is passed once to cloud platform, later during operation only brief description is sent, referring to standard or specific product.

Detailed description of standard or specific product:

- Offered capacity, [-1000, 1000] [MW], 1 MW resolution
- Reference power point, [-1000, 1000] [MW], 1 MW resolution. Reference point of product (e.g. 25 MW starting baseline) that can offer positive (up), negative (down).
- Product length, 15 - 120 [min], 15 min resolution
- Full activation time (FAT), 1 - 30 [min], 1 min resolution. This is sum of times: BSP reaction to activation signal, communication to flexibility provider, reaction of flexibility node (DR/DG) and product ramping to full capacity.
- Ramp up rate, 0 - 100 [MW/min], 1 MW resolution
- Ramp down rate, 0 - 100 [MW/min], 1 MW resolution
- Type. Balancing or redispatching [Balancing/Redispatching]
- Location. Only for redispatch bids. Used as a tag to cross reference coordinates.
- Update period of signals: tupdate = 1/prequalification, essentially static
- DWH store: Yes

Brief description of a standard product:

- Offered capacity, [-1000, 1000] [MW], 1 MW resolution
- Reference power point, [-1000, 1000] [MW], 1 MW resolution. Reference point of product that can offer positive (up), negative (down).
- Product start time, [YYMMDDhhmm], 1 min resolution
- Product end time, [YYMMDDhhmm], 1 min resolution
- Standard product, [ST]. Used as a tag into cloud platform for cross referencing

of detailed data.

- Type. Balancing or redispatching [Balancing/Redispatching]
- Update period of signals: tupdate = 1/prequalification, essentially static
- DWH store: Yes

Brief description of a specific product:

- Offered capacity, [-1000, 1000] [MW], 1 MW resolution
- Reference power point, [-1000, 1000] [MW], 1 MW resolution. Reference point of product that can offer positive (up), negative (down).
- Product length, 15 - 120 [min], 15 min resolution
- Product start time, [YYMMDDhhmm], 1 min resolution
- Product end time, [YYMMDDhhmm], 1 min resolution.
- Specific product, [SP] [1, 255]. Specifies many possible specific products, used as a tag into cloud platform for cross referencing of detailed data.
- Type. Balancing or redispatching [Balancing/Redispatching]
- Update period of signals: tupdate = 1/prequalification, essentially static
- DWH store: Yes

11.1.2 BSP bid identification

BSP bids are anonymized and uniquely identified (BBID). BBID is assigned by CAF, while respecting information flow CAF-TSO-BSP. BBID is calculated from the following data set:

- Serial number of bid for current month [long]
- Bid type, balancing or redispatching [Balancing/Redispatching]
- BFPD
- TSO identification (TSID) [short]. Identification of TSO to which BSP belongs.
- Control zone ID (CZID) of flexibility source [short]. Identification of control zone to which BSP belongs.
- BSP identification (BSID) [short]. This is confidential information known only to TSO and BSP, exchanged offline, during TSO-BSP contract process.
- Date and time of gate closure [YYMMDDhhmm]
- DWH store: Yes

11.1.3 BSP bid to TSO

BSP bid to TSO (BBTT) data package is sent during bid collection time frame. It consists of a concatenation of: BFPD, BBID.

- BSP - TSO
- BFPD
- BBID
- Type balancing or redispatching [Balancing/Redispatching]
- Price for offered positive product, [0, 1000] [EUR/MWh], 0.01 EUR/MWh resolution. Applies only to positive (up) direction around reference.
- Price for offered negative product, [0, 1000] [EUR/MWh], 0.01 EUR/MWh resolution. Applies only to negative (down) direction around reference.
- Random string [256 or 1024 or 2048 bits] generated by suitable seed. String is used for information security purposes.
- Update period of signals: tupdate = CMOL update rate (1 h)
- Acknowledgement: Yes/No, BBID.
- DWH store: Yes (option)

11.1.4 TSO bid confirm

TSO bid confirmation to BSP (TBCB) is notified after TSO confirms and validates bid itself.

- TSO - BSP
- BBID
- Type balancing or redispatching [Balancing/Redispatching]
- Status [Confirm/Reject]
- Update period of signals: Before gate closure during allowed time, tupdate = CMOL update rate (1 h)
- Acknowledgement: Yes/No, BBID.
- DWH store: Yes (option)

11.1.5 TSO bid activation to BSP

TSO bid activation command to BSP (TBAB) is sent only after TSO has already received bid activation from CAF for the same product.

- TSO - BSP
- BBID
- Type balancing or redispatching [Balancing/Redispatching]
- Command [Activate/Not activate]
- Update period of signals: Once per CMOL update, tupdate = CMOL update rate (1 h)
- Acknowledgement: Yes/No, BBID.

- DWH store: Yes (option)

11.1.6 BSP bid cancel

BSP is allowed to cancel bid to TSO (BBCT), at any time, up until 30 min before gate closure, that is 30 min before new 1 h CMOL period.

- BSP - TSO
- BBID
- Type balancing or redispatching [Balancing/Redispatching]
- Status [Cancel]
- Update period of signals: Any time during bid collection time frame.
- Acknowledgement: Yes/No, BBID.
- DWH store: Yes (option)

11.1.7 BSP bid activation confirm

BSP bid activation confirmation to TSO (BBAT) is notified after BSP activates its product, to flexibility operator units (DR/DG).

- BSP - TSO
- BBID
- Type balancing or redispatching [Balancing/Redispatching]
- Status [Activated/Not activated]
- Update period of signals: Once per CMOL update, tupdate = CMOL update rate (1 h)
- Acknowledgement: Yes/No, BBID.
- DWH store: Yes (option)

11.1.8 BSP product activity measurement

BSP product activity measurement data (BPAM) is real time measurement of bid product MW delivery, towards TSO.

- BSP - TSO
- Type balancing or redispatching [Balancing/Redispatching]
- Bid product measurement, [-1000, 1000] [MW], 0.001 MW resolution
- Update period of signals: tupdate = 2 [s], 1 s resolution. Note: Must be the same as LFC control signal tupdate.
- Acknowledgement: Yes/No, BBID

11.1.9 BSP product historical measurement information

BSP product historical measurement data (BPHM) can optionally be exchanged for post

analytical purposes towards TSO, to be analytically processed by FutureFlow cloud platform.

- BSP - TSO
- Type balancing or redispatching [Balancing/Redispatching]
- flexibility baseline measurement, string, MW/t, t = 1 sec resolution/decimated resolution (e.g. 1:10, 1:60), [-1000, 1000] [MW], 0.001 MW resolution
- Update period of signals: tupdate = 24 h/12 h/6 h
- Acknowledgement: Yes/No, BBID
- DWH store: Yes, sent as bulk data transfer by BSP directly via Internet (option)

11.1.10 TSO flexibility activation and setpoint control

TSO flexibility activation and setpoint control data (TASC) is exercising direct control towards BSP signalling the required up and down control (MW) of each BBID.

- TSO - BSP
- BSID
- Type balancing or redispatching [Balancing/Redispatching]
- Setpoint of required capacity, [-1000, 1000] [MW], 0.001 MW resolution
- Update period of signals: tupdate = 2 [s], 1 s resolution. Note: Must be the same as LFC control signal tupdate.
- Acknowledgement: Yes/No, BSID.
- DWH store: Yes (option)

11.2 TSO - FutureFlow cloud platform data exchange

11.2.1 ACE open loop

ACE open loop specifies area control error signal (ACOL) within control zone. Can be used in both LFC controls: Option1, Option2.

- TSO - CAF
- TSID
- Open loop ACE, [-1000, 1000] [MW], 0.001 MW resolution
- Update period of signals: tupdate = TSO LFC control information signals
- Acknowledgement: Yes/No, open loop ACE
- DWH store: Yes

11.2.2 TSO LFC control

TSO LFC control data are control signals from TSO to CAF for up and down control. These are listed as mutually excluding alternatives of LFC control: Option1 or Option2. and are used during field pilots and for post analysis.

- TSO - CAF
- control demand, [-1000, 1000] [MW], 0.001 MW resolution (Option1) OR
- control target, [-1000, 1000] [MW], 0.001 MW resolution (Option2) OR
- control request, [-1000, 1000] [MW], 0.001 MW resolution (Option2)
- Update period of signals: tupdate = 2 [s], 1 s resolution
- Acknowledgement: Yes/No, TSID.
- DWH store: Yes

11.2.3 CAF bid activation type

CAF bid activation type (CBAT) is informing TSO of required setpoint control type (parallel, CMOL) of the activated bids. This enables different types of TSO control per control zone each CMOL update timeframe (e.g. 1 h).

- CAF - TSO
- TSID
- Activation type (Parallel, Merit order)
- Update period of signals: tupdate = CMOL update rate (1 h).
- Acknowledgement: Yes/No, TSID.
- DWH store: Yes

11.2.4 CAF control correction setpoint

CAF bid control correction setpoint data (CBCC) is the required up or down control (MW) correction within control zone for TSO, as input to LFC conforming to Option1.

- CAF - TSO
- TSID
- Control correction setpoint, cumulative required capacity, [-1000, 1000] [MW], 0.001 MW resolution
- Update period of signals: tupdate = 2 [s], 1 s resolution. Note: Must be the same as LFC control signal tupdate.
- Acknowledgement: Yes/No, TSID.
- DWH store: Yes

11.2.5 CAF bid control activation setpoint

CAF bid control activation setpoint data (CBCA) is the cumulative required up or down control (MW) within control zone for TSO, conforming to Option2. This type of control is active only when CAF sends setpoints to TSO and it is up to TSO to select products from its local MOL list. This enables cloud vs TSO local control.

- CAF - TSO
- TSID
- Activation setpoint, cumulative required capacity, [-1000, 1000] [MW], 0.001 MW resolution
- Update period of signals: tupdate = 2 [s], 1 s resolution. Note: Must be the same as LFC control signal tupdate.
- Acknowledgement: Yes/No, TSID.
- DWH store: Yes

11.2.6 CAF bid control activation list

CAF bid control activation list data (CBCL) is the cumulative list of bid products that satisfy required up or down control (MW) within control zone for TSO. This type of control is active only when CAF has full control over selected bids, (i.e. can perform global optimization) and TSO only generates required cumulative setpoint controls towards BSPs.

- CAF - TSO
- CZID
- TSID
- Activation list of BBIDs, exchanged as string (e.g. JSON) of all per local TSO MOL BBIDs
- gate closure time [YYMMDDhhmm]
- Update period of signals: tupdate = several times per CMOL update rate (1 h)
- Acknowledgement: Yes/No, CZID, TSID
- DWH store: Yes

TSO capacity reservation

TSO capacity reservation data (TCRE) is based on a separate TSO capacity reservation scheduling process, usually delivered from ESS files to carry ATC/CZC information.

- TSO - CAF
- TSID
- TLID [short]
- cross zone capacity, [0, 1000] [MW], 0.001 MW resolution

- Update period of signals: tupdate = CMOL update rate (1 h)
- Acknowledgement: Yes/No, TLID, parameter [MW].
- DWH store: Yes

11.2.7 TSO imbalance netting

CAF exchanges imbalance netting data (TIMN) with each TSO during real time operation. It is used in case of two stage optimization process: netting followed by activation requirement.

- CAF - TSO
- TSID destination.
- imbalance netted cross zones, [-1000, 1000] [MW], 0.001 MW resolution
- Update period of signals: tupdate = TSO LFC control data signals
- Acknowledgement: Yes/No, netted capacity volume
- DWH store: Yes

11.2.8 TSO cross border compensation

CAF exchanges cross border compensation data (TXBC) with each TSO during real time operation. It is used in control Option2.

- CAF - TSO
- TSID destination.
- compensation cross zones, [-1000, 1000] [MW], 0.001 MW resolution
- Update period of signals: tupdate = TSO LFC control data signals
- Acknowledgement: Yes/No, netted capacity volume
- DWH store: Yes

11.2.9 TSO bid list to CAF

TSO sends confirmed, validated and eligible bid list to CAF (TBLC) for global, cross zonal optimization, for specific gate closure time.

- TSO - CAF
- TSID
- Type balancing or redispatching [Balancing/Redispatching]
- BBID list, exchanged as string (e.g. JSON) of all local BBIDs
- gate closure time [YYMMDDhhmm]
- Update period of signals: tupdate = CMOL update rate (1 h)
- Acknowledgement: Yes/No, CZID, TSID

- DWH store: Yes

11.2.10 CAF CMOL bid list to TSO

CAF optimized global CMOL bid list for all participating control zones (CCMT), of confirmed and validated bids, for specific gate closure time, used for presentation on HMI bidding platform at each TSO.

- CAF - TSO
- TSID
- BBID list, exchanged as string (e.g. JSON) of all BBIDs in CMOL
- gate closure time [YYMMDDhhmm]
- Update period of signals: tupdate = CMOL update rate (1 h)
- Acknowledgement: Yes/No, CZID, TSID
- DWH store: Yes

11.2.11 CAF local MOL bid list to TSO

CAF optimized local MOL bid list is a subset of CMOL for specific TSO within control zone (CLMT), of confirmed and validated bids, for specific gate closure time, but contains only local bids, within control zone, per TSO.

- CAF - TSO
- CZID
- TSID
- BBID list, exchanged as string (e.g. JSON) of all per local TSO MOL BBIDs
- gate closure time [YYMMDDhhmm]
- Update period of signals: tupdate = CMOL update rate (1 h)
- Acknowledgement: Yes/No, CZID, TSID
- DWH store: Yes

11.2.12 CAF RBL bid list to TSO

CAF optimized global RBL bid list for all participating control zones (CRBT), of confirmed and validated redispatch bids, for specific gate closure time, used for presentation on HMI bidding platform at each TSO.

- CAF - TSO
- TSID
- BBID list, exchanged as string (e.g. JSON) of all BBIDs in RBL
- gate closure time [YYMMDDhhmm]
- Update period of signals: tupdate = CMOL update rate (1 h)

- Acknowledgement: Yes/No, CZID, TSID
- DWH store: Yes

11.2.13 CAF local RBL bid list to TSO

CAF optimized local RBL bid list is a subset of RBL for specific TSO within control zone (CLRT), of confirmed and validated bids, for specific gate closure time, but contains only local redispatch bids, within control zone, per TSO.

- CAF - TSO
- CZID
- TSID
- BBID list, exchanged as string (e.g. JSON) of all per local TSO MOL BBIDs
- Gate closure time [YYMMDDhhmm]
- Update period of signals: tupdate = CMOL update rate (1 h)
- Acknowledgement: Yes/No, CZID, TSID
- DWH store: Yes

11.2.14 TSO bid activation confirm

TSO bid activation confirmation to CAF (TBAC) is sent only after TSO has already received bid activation confirmation from BSP for the same product.

- TSO - CAF
- BBID
- Type balancing or redispatching [Balancing/Redispatching]
- Status [Activated/Not activated]
- Update period of signals: Once per CMOL update, tupdate = CMOL update rate (1 h)
- Acknowledgement: Yes/No, BBID.
- DWH store: Yes

11.2.15 Redispatch congestion forecasts

Redispatch congestion forecast (RCOF) contains day ahead and intraday congestions forecasts, exchanged as a string, matrix coded (e.g. JSON).

- TSO - CAF
- DACF, IDCF models
- Update period of signals: tupdate = CMOL update rate (1 h).
- Acknowledgement: Yes/No, TSID

11.2.16 Redispatch TSO grid model

Redispatch TSO grid model data exchange (RTGM) is for redispatch actions and can be in form of CGMES file.

- TSO - CAF
- TSID
- Grid model, CGMES file specification [XML]
- Update period of signals: tupdate = CMOL update rate (1 h)
- Acknowledgement: Yes/No, TSID.