Platone

PLATFORM FOR OPERATION
OF DISTRIBUTION NETWORKS

Platone

PLATform for Operation of distribution NEtworks

D2.14 v1.0

PlatOne Integrated Framework Prototype (v1)

The project PLATform for Operation of distribution NEtworks (Platone) receives funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no 864300.

Project name	Platone
Contractual delivery date:	30.04.2021
Actual delivery date:	28.04.2021
Main responsible:	Ferdinando Bosco (ENG)
Work package:	WP2 – Platform Implementation and Data Handling
Security:	P
Nature:	DEM
Version:	V1.0
Total number of pages:	27

Abstract

The Platone Open Framework aims to create an open, flexible, and secure system that enables distribution grid flexibility/congestion management mechanisms, through innovative energy market models involving all the possible actors at many levels (DSOs, TSOs, customers, aggregators). The Platone Framework is an open-source framework based on blockchain technology that enables a secure and shared data management system, allows standard and flexible integration of external solutions (e.g., legacy solutions), and is open to integration of external services through standardized open application program interfaces (APIs).

This document accompanies the software delivery of the first prototype of the Platone Open Framework. This version of the Platone Open Framework includes all the Platone Platforms and is integrated with the physical infrastructure and external systems deployed within the three different demo architectures.

The first integrated prototype of the Platone Open Framework will be the base for the first pilots' executions during which it will be tested and evaluated under different user and business requirements and following different deployment approaches.

Keyword list

Platone Open Framework, Platform Integration, Deployment, Testing and Validation

Executive Summary

“Innovation for the customers, innovation for the grid” is the vision of project Platone - Platform for Operation of distribution Networks. Within the H2020 programme “A single, smart European electricity grid”, Platone addresses the topic “Flexibility and retail market options for the distribution grid”. Modern power grids are moving away from centralised, infrastructure-heavy transmission system operators (TSOs) towards distribution system operators (DSOs) that are flexible and more capable of managing diverse renewable energy sources. DSOs require new ways of managing the increased number of producers, end users and more volatile power distribution systems of the future. Platone is using blockchain technology to build a platform to meet the needs of modern DSO power systems, including data management. The platform is built with existing regulations in mind, and will allow small power producers to be easily certified so that they can sell excess energy back to the grid. The platform will also incorporate an open-market system to link with traditional TSOs. The Platone platform will be tested in three European field trials and within the Canadian Distributed Energy Management Initiative (DEMI).

This solution, based on a two-layer blockchain architecture, and named Platone Open Framework, allows to integrate in easy way both the data coming from the devices installed on the physical infrastructure of distribution grid, as well any other external platform.

The Platone Open Framework offers a configurable and customizable architecture that can be exploited by the DSOs for empowering their solutions.

In particular, the first prototype of the Platone Open Framework includes:

- The first version of the Platone Blockchain Access Layer (BAL), that provides an interoperable layer for the integration of IoT devices and external Data Server, ensuring data privacy and security mechanisms;
- The first version of the Platone DSO Technical Platform (DSOTP), that allows the integration of external platforms as DMS, as well as specific DSO services as State Estimation Tool and Data Visualisation
- The first version of the Platone Market Platform, that enables a transparent and shared Flexibility Marketplace, based on blockchain technology, opened to all the Market Participants (TSOs, DSOs and Aggregators).

The first prototype of the Platone Open Framework, described in this deliverable, will be the base for the first round of pilot executions in Italy, Greece and Germany. Each of the demos, will integrate different versions of the Platone Open Framework, exploiting different user and business requirements based on their expectations and needs.

The Italian Demo integrates the Platone Market Platform for activating the Flexibility Market and resolving Congestion conflicts and Voltage violations within the distribution grids.

The Greek Demo exploits the Platone BAL for metering data integration and certification and the Platone DSOTP for integrating State Estimation Tool.

The German Demo exploits the Platone BAL for integrating and certifying data coming from Phasor Measurement Units (PMUs), as well as the Platone DSOTP for enabling services such as the balancing module or the load-forecasting, to be integrated and into the Avacon Local Flex Controller (A-LFC)

The Platone Open Framework could be hosted in a cloud infrastructure but is also deployable on dedicated hardware at the demo sites. Each demo will choose the deployment approach that best suits its needs.

The first demo execution and validation phase will start in May 2021(M21) and will end in October 2021 (M26). The feedback and the results of this phase will be exploited for the refinement of the requirements and the implementation of the intermediate version of the Platone Platforms and Platone Framework prototype.

Authors and Reviewers

Main responsible		
Partner	**Name**	**E-mail**
ENG		
	Ferdinando Bosco	Ferdinando.bosco@eng.it
Author(s)/contributor(s)		
Partner	**Name**	
ENG		
	Angelo Triveri	Angelo.triveri@eng.it
RWTH		
	Jonas Baude	jonas.baude@eonerc.rwth-aachen.de
Reviewer(s)		
Partner	**Name**	
NTUA		
	Panagiotis Pediaditis	
APIO		
	Alessandro Chelli	
Approver(s)		
Partner	**Name**	
RWTH		
	Padraic McKeever	

Table of Contents

1 Introduction

The project “PLATform for Operation of distribution Networks – Platone - aims to develop an architecture for testing and implementing a data acquisitions system based on a two-layer approach (an access layer for customers and distribution system operator (DSO) observability layer) that will allow greater stakeholder involvement and will enable an efficient and smart network management. The tools used for this purpose will be based on platforms able to receive data from different sources, such as weather forecasting systems or distributed smart devices spread all over the urban area. These platforms, by talking to each other and exchanging data, will allow collecting and elaborating information useful for DSOs, transmission system operators (TSOs), customers and aggregators. In particular, the DSO will invest in a standard, open, non-discriminating, economic dispute settlement blockchain-based infrastructure, to give to both the customers and to the aggregator the possibility to more easily become flexibility market players. This solution will see the DSO evolve into a new form: a market enabler for end users and a smarter observer of the distribution network. By defining this innovative two-layer architecture, Platone removes technical barriers to the achievement of a carbon-free society by 2050 [1], creating the ecosystem for new market mechanisms for a rapid roll out among DSOs and for a large involvement of customers in the active management of grids and in the flexibility markets. The Platone platform will be tested in three European trials (Greece, Germany and Italy) and within the Distributed Energy Management Initiative (DEMI) in Canada. The Platone consortium aims to go for a commercial exploitation of the results after the project is finished. Within the H2020 programme “A single, smart European electricity grid” Platone addresses the topic “Flexibility and retail market options for the distribution grid”.

The Platone solution consists of a two-layer blockchain architecture named Platone Open Framework that includes a series of core components: the Platone Blockchain Access Layer, the Platone DSO Technical Platform, and the Platone Market Platform.

All these platforms had integrated each other in the first integrated prototype of the Platone Open Framework described in this deliverable.

The integration phase was conducted considering the interoperability mechanisms and standards, as well as the system requirements expected for each Platone platforms as result of the Use Cases described in the different demos.

The development, integration and deployment have been planned to align with the time plan designed by each demo. For this reason, the first prototype of the integrated framework contains a subset of features and interoperability mechanisms, with the aim of being tested and validated during the pilot executions.

The Platone Open Framework was deployed on cloud infrastructure but was also released as a package to be installed on premises (e.g. at the Greek Demo site).

1.1 Task 2.6

This deliverable is related to the Task 2.6 [2] that aims at release the Platone Open Framework prototype, following an iterative approach. Three version of the Framework integrated prototype will be delivered in an incremental way and taking into account the results of the testing and validation phase performed during the pilot executions.

In addition, the task ensures that Platone Platforms can communicate with each other over the framework, as indicated in the system design and the system requirements defined in T2.1 [2] have been successfully implemented.

1.2 Objectives of the Work Reported in this Deliverable

The objective of this deliverable is to present the first prototype of the Platone Open Framework and its realization following the technical specification and requirements expected. The Platone Description of Action defines this deliverable as a demonstrator. This document accompanies the software release with a more detailed architecture description, the configuration of the Framework expected in the three demos and the system requirements implemented so far.

1.3 Outline of the Deliverable

The second Chapter of this document describe an overview of the Platone Open Framework and some technical details on the integration phase and the release of the first prototype. It also includes the status of the functional requirements implemented so far for each Platone Platforms, as expected in Deliverable D2.1 [3], following the implementation and integration plan agreed with the Demos. Chapter 3 provides a detailed description on how the Framework was integrated within the demo architectures and how it will be deployed in the different contexts for the piloting phase. Finally, Chapter 4 concludes this deliverable.

1.4 How to Read this Document

The document aims to give an overview to the Platone Open Framework first prototype release. A description of the foreseen functional and non-functional requirements expected can be found in D2.1 [3]. A detailed description of the demo use cases can be found in D1.1 [4], while more details on the technological implementations of each single demo can be found respectively in D3.3 [5] (Italian Demo), D4.1 [6] (Greek Demo) and D5.1 [7] (German Demo).

2 Platone Open Framework – First Prototype

The Platone Open Framework was implemented following the Architecture specification and the system requirements described in D2.1 [3], as well as the interoperability mechanisms identified so far in T2.5 [2].

Following an iterative process, a first prototype of the framework was developed implementing the prioritized system requirements and integrating the Platone Platforms as result of the tasks T2.2, T2.3, T2.5 [2]. Then this initial prototype will be tested under the different user and business requirements in the different demo sites context during the pilots' execution.

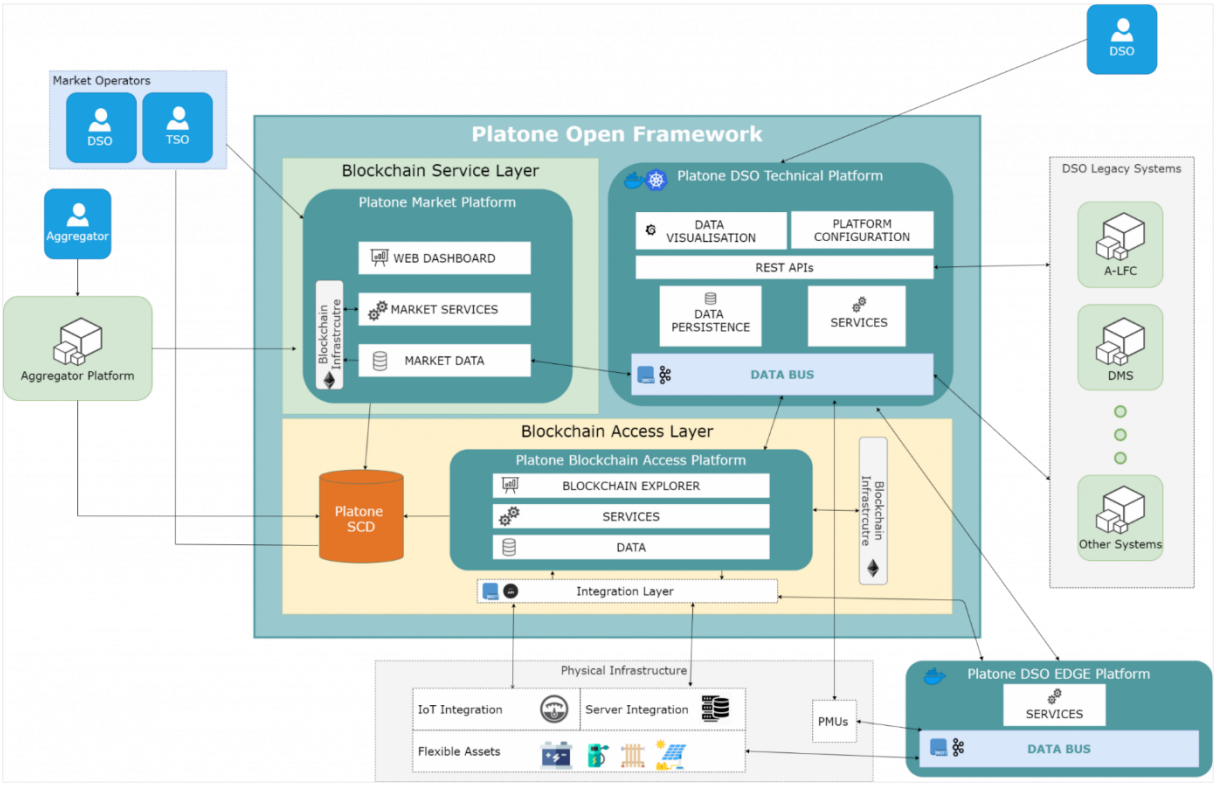

Figure 1: Platone Open Framework Architecture

2.1 Platone Platforms Integration

Starting from the output of D2.3 [8], D2.6 [9] and D2.11 [10], the main activity of this task was enabling the inter-communication of the different Platone Platforms, ensuring a secure and scalable deployment process of the entire Framework.

In particular, in this first prototype, we focussed into three main steps:

- Integration of the Platone BAL with the Physical Infrastructure and DSOTP;
- Integration of DSOTP with BAL and External systems;
- Integration of the Market Platform with the Italian Architecture components.

2.1.1 Blockchain Access Layer Integration

The Platone Blockchain Access Layer is the entry point for the data collected from the network grid. The first prototype of the BAL, described in D2.11 [10] implements two specific interoperable layers for the integration: on the one hand, the integration layer enables the integration of the physical infrastructure and allows the collection of the data, and on the other hand, the communication layer enables the integration with other systems and actors who want to use that data. Figure 2 represents the integration schema of the Platone Blockchain Access Layer.

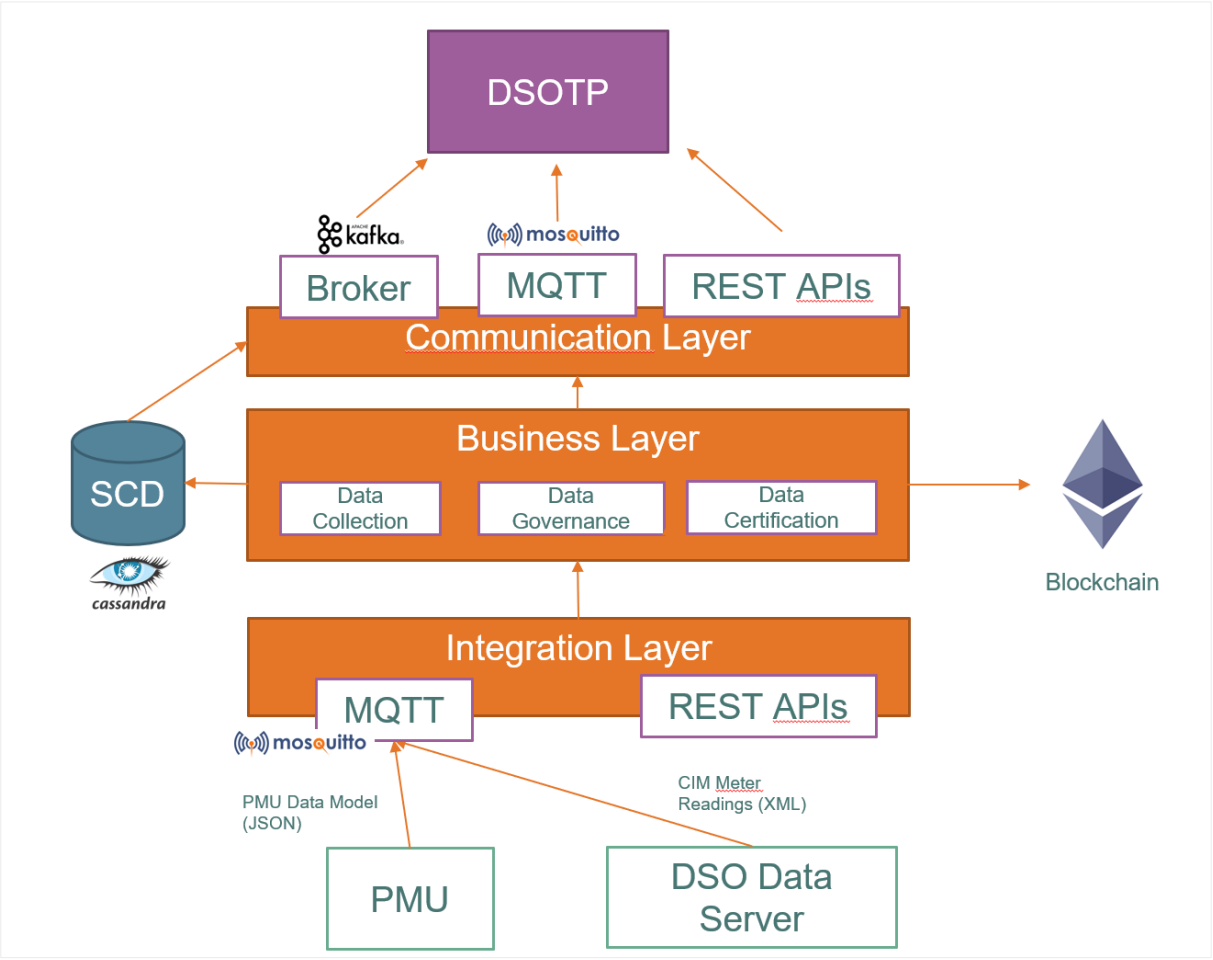

Figure 2: BAL integration and communication schema

The Integration Layer has the fundamental role to allow the entire Platone Framework to collect data, coming from any type of external device or component, in a standard and interoperable way.

In this first prototype two communication mechanisms were implemented the MQTT broker and REST API interface. In the context of the first demo integration only the MQTT broker will be used for the integration of the data.

The MQTT broker, based on Mosquitto [11], allows the integration of data coming from PMU and Metering devices, defining authentication and authorization mechanisms that allow to uniquely identify the data owner. It allows to publish data with high frequency without placing any restrictions on the data format.

The Business Layer of the BAL oversees, among other things, to introduce data format and data modelling restriction. In this first prototype JSON and XML are allowed as data format and CIM IEC-61968-9 [12] was identified as standard data model for the meter readings.

The Platone Shared Customer Database (SCD) ensures the secure storage and availability of the data, respecting data standards modelling, data access policies, as well as data privacy.

The Communication Layer enables the access to the data to external stakeholders and external platforms (e.g., the DSOTP). This approach ensures the modularity of the Platone Open Framework, in which each Platform is independent from the others but easily integrated. This layer implements many communication mechanisms and protocols for retrieving data: Apache Kafka Broker [13], MQTT and REST APIs. Each “actor” can decide how to access the data, which of these to retrieve and how often. The BAL implements a set of configurable rules for the data access, including permission and security mechanisms. Furthermore, all the communications, both in the Integration and Communication Layer, are implemented using secure connections (over TLS/SSL) and protected using authorization and authentication mechanisms (username and password, topic restrictions, etc.).

2.1.2 DSOTP Integration

The Platone DSO Technical Platform enables distribution system operators to fulfil market requests by evaluating the current grid state and activating local flexibility requests while ensuring the reliability and operational quality of service by enlarged grid observability. The platform design builds on previous work done in the Horizon 2020 project *SOGNO* [14] and relies massively on a micro-service architecture in which a DSO can easily deploy additional services onto the platform. The first prototype of the DSOTP is described in Platone D2.6.

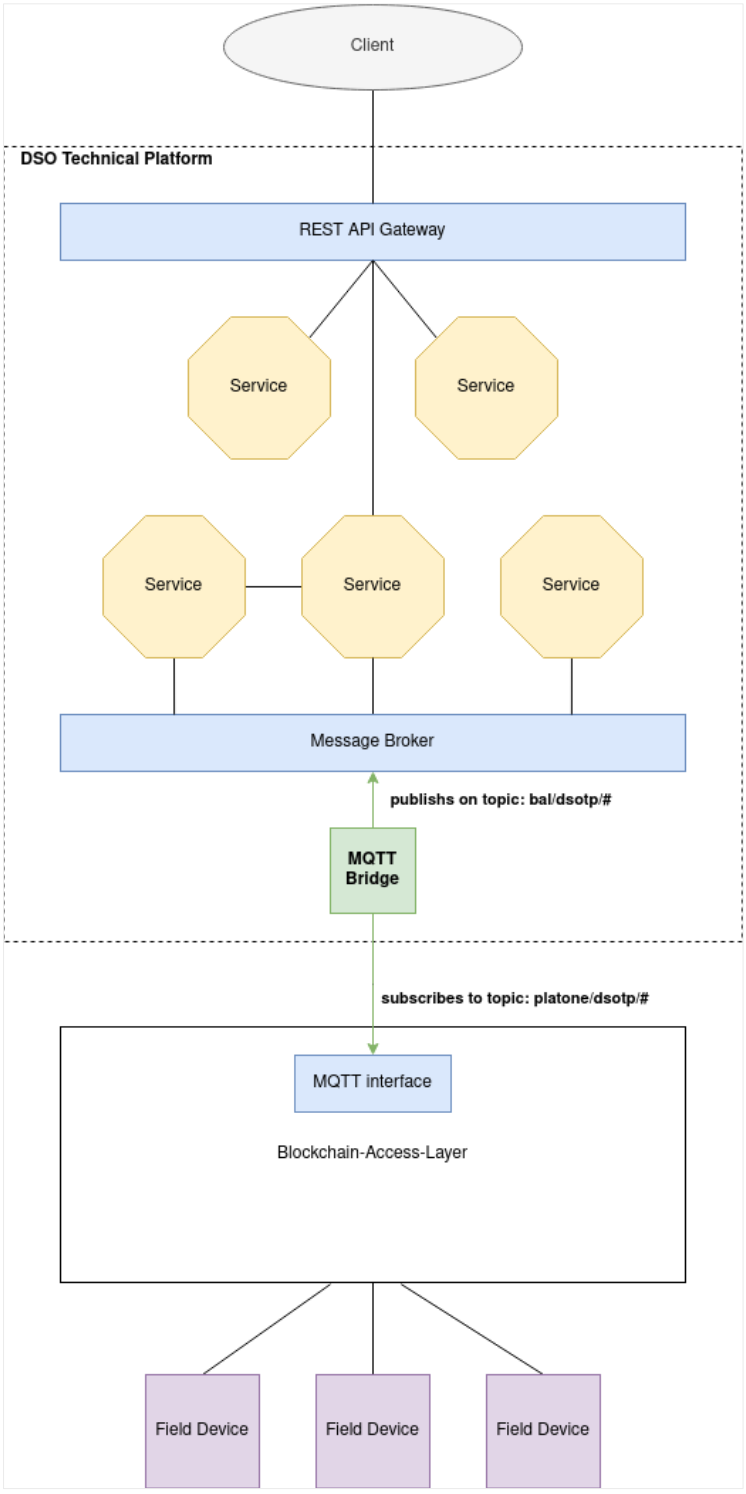

Figure 3: DSOTP MQTT bridging with BAL

In the first release cycle, the DSOTP integrates with the BAL by means of an MQTT-Bridge (cf. Figure 3). In the architecture of the Platone Open Framework, the MQTT Bridge is part of the DSOTP and is based on Mosquitto [11] in a special bridge-mode configuration.

The bridge connects to the MQTT interface of the BAL and forwards certain MQTT topics from the BAL into the message broker of the DSOTP. The set of topics to bridge between the platforms is configurable. Furthermore, the bridge allows for a topic-remapping. For example, all MQTT subtopics of "platone/dsotp/#" from the BAL can be mapped to topics with the prefix “/bal/" within the message broker of the DSOTP order to avoid any naming conflicts between the MQTT topic namespaces of the two platforms.

In this integration approach, the MQTT-bridge of the DSOTP acts as a client that connects to the BAL. Therefore, the BAL has to provide credentials for the DSOTP and can apply its internal authentication and authorization mechanisms. During the integration phase of the first release cycle, the bridge was successfully tested to forward data from the BAL to the DSOTP while remapping the MQTT topics.

Technically, the MQTT-Bridge is based on the Mosquitto MQTT Broker using a bridge mode configuration to connect to the internal MQTT Brokers of the BAL and the DSOTP. It is based on the official Mosquitto docker image. In addition, the Platone DSOTP git repository contains a template for the custom bridge configuration file and a Kubernetes deployment allowing to deploy the bridge along-side the DSOTP (cf. Platone D2.6 [9]).

Furthermore, DSOTP provides a **REST API Gateway** (cf. Figure 3) for exposing RESTful APIs. Services running on DSOTP should expose RESTful APIs as an interface for configuration or triggering of the service. The API Gateway is responsible for routing API requests from clients (i.e., users or external systems) to the related services while ensuring authentication, authorization, and security policies. For the next release, we foresee the integration of a balancing service (WP5) and a state-estimation tool (WP4) which are supposed to expose APIs for service triggering and configuration, respectively.

2.1.3 Market Platform Integration

The Platone Market Platform aims to enable a fully secure and transparent Flexibility Market, open to all the market participants, exploiting blockchain technology and smart contracts, for handling the management of flexibility services, providing market results to all the stakeholders, validating the flexibility provisioning, and performing the settlement outcome with an innovative incentivisation mechanism for improving customer engagement.

The first release of the Market Platform, described in D2.3 [8], implements a complete Day Ahead Flexibility Market solution that includes: the collection of the flexibility requests and offers from DSOs, TSOs and Aggregators; the clearing of the market data at the end of the market session; the provisioning of the market data to all the involved market participants; the settlement of the market and activation results with blockchain-based token provisioning to all the flexibility providers.

The integration of the Market Platform was mainly focused on the communication and data integration with the Actors and Platforms developed in the WP3 for the Italian Demo architecture. As described, in D2.1 [3], Italian Demo implements a different version of DSOTP, Blockchain Access Platform and Shared Customer Database which however follow the characteristics defined in Platone Open architecture. For this reason, all the choices made for the integration of the Platone Market Platform with these components, is completely compatible with those of the Platone Open Framework, developed within the WP2.

The Communication Layer of the Market Platform is the core component deputy for the integration of external Actors and/or Platforms. It mainly provides two communication and integration mechanisms: an API Gateway and a Message Broker.

The API Gateway exposes a list of REST APIs, documented as OpenAPI 3.0 [15], that can be exploited by external actors or system for participating to the market. In particular, the APIs allows creation of flexibility requests and offers, receiving baseline and measurements from the devices of the grid and performing the settlement of the flexibility market.

The API Gateway ensures a high level of security, since all the actors that want to access to the APIs must be registered in the system and must be authenticated using Oauth2.0 Client Credentials mechanism [16]. Moreover, all the communication are over HTTPS protocol.

The Message Broker implemented using Apache Kafka [13], allows to the actors and systems to access to the market results at the end of the market session (only day-ahead market for this first release of the platform). The result of the market is available for all the market participant in a selected Kafka Topic that can be accessed only by Two-Way authenticated systems [17], using signed certificate and over TLS/SSL communication.

The Figure 4, represents the integration mechanisms provided by the Platone Market Platform.

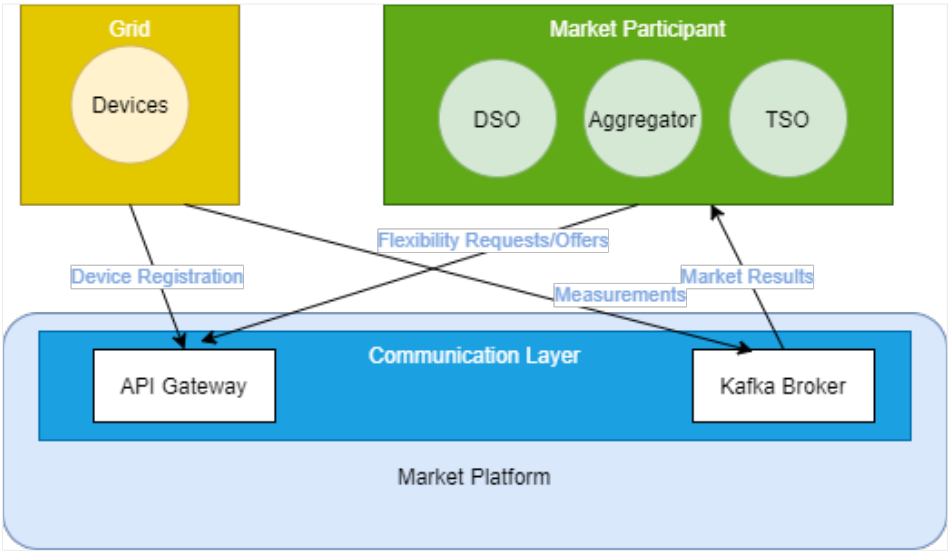

Figure 4: Platone Market Platform Communication mechanisms

2.2 Platone Platforms Requirements – Status

The first prototype of the Platone Open Framework implements a subset of system requirements, as planned on each demo.

The other requirements expected, together with any new requirements, will be implemented in the next version of the prototype, following an iterative process in which any feedback collected during the pilots' execution will be considered for the next implementation phases.

More in detail, the next paragraphs describe the status of the system requirements implemented (functional and non-functional requirements) for each Platone Platform.

For each expected requirement, the status can be:

- **OK** – Green colour – The requirement is completed and implemented in the Platform;
- **Partially** – Yellow colour – The requirement was partially implemented and will be completed in the next version of the Platform;
- **Expected in the next release** – Purple colour – The requirements will be implemented in the next release of the Platform, following the time plan and the specification expected in the different demos;
- **No longer Expected** – Orange colour – The requirement is no longer expected. It was deemed not relevant for the technical specifications of the Platform or is no longer foreseen by the demo. The updated list of the requirements will be provided in D2.2 at February 2022 (M30).

2.2.1 Platone Market Platform

Table 1: Platone Market Platform requirements

Requirement ID	Requirement name	Requirement description	Status
Functional Requirements			
FR-MP-FSM-01	Flexibility Services Management	The Market Platform allows DSOs and TSOs to create flexibility requests in automatic way	Partially (Scenario n.2 – Real Time - expected for the next release)
FR-MP-FSM-02	Flexibility Services Management	The Market Platform allows DSOs to create flexibility requests through UI	No longer expected
FR-MP-FSM-03	Flexibility Services Management	The Market Platform allows Aggregator Platform to create flexibility offers in automatic way	Partially (Scenario n.2 – Real Time - expected for the next release)
FR-MP-FSM-04	Flexibility Services Management	The Market Platform acquires and stores all the flexibility requests and offers	OK
FR-MP-MOMV-01	Market Outcomes Matching and Validation	The Market Platform is able to match flexibility requests and offers through clearing market algorithms	OK
FR-MP-MOMV-02	Market Outcomes Matching and Validation	The Market Platform is able to provide the Market Outcomes (results of market clearing) to the DSO Technical Platform for the technical validation	Partially (Scenario n.2 – Real Time expected for the next release)
FR-MP-MOMV-03	Market Outcomes Matching and Validation	The Market Platform receives the validated market outcomes from DSO Technical Platform	OK
FR-MP-MOMV-04	Market Outcomes Matching and Validation	DSOs, TSOs and Aggregators receives Market Day Ahead outcomes from the Market Platform	OK
FR-MP-SA-01	Services activation	The Market Platform allows to DSOs and TSOs to create service activation requests in automatic way	No longer expected
FR-MP-SA-02	Services activation	The Market Platform allows to Market participant to create	No longer expected

		service activation requests through UI	
FR-MP-SA-03	Services activation	The Market Platform is able to aggregate the service activation requests (from DSOs and TSOs) and provide them to all the other stakeholders	No longer expected
FR-MP-BC-01	Blockchain certification	The Market Platform is able to register on the blockchain all the market data trough Smart Contracts based functionalities	Expected in next release
FR-MP-BC-02	Blockchain certification	The Market Platform allows to Market participant to verify all the market data registered in the blockchain	Expected in next release
FR-MP-S-01	Settlement	The Market Platform is able to read meters measurements from SCD	OK
FR-MP-S-02	Settlement	The Market Platform performs the settlement comparing the metering data and BRP baseline	OK
FR-MP-S-03	Settlement	The Blockchain Service Layer is able to provide tokenization system for the settlement through Smart Contracts functionalities	OK
FR-MP-S-04	Settlement	The Market Platform allows to DSO, TSO and Aggregator to read the settlement outcomes	OK
Non-Functional Requirements			
P-MP-01	Communication protocols	The Market Platform exposes REST APIs for collecting flexibility requests and flexibility offers	OK
P-MP-02	Communication protocols	The Market Platform provides a message broker for communicating market results	OK

2.2.2 Platone DSO Technical Platform

Table 2: Platone DSO Technical Platform requirements

Requirement ID	Requirement name	Requirement description	Status
Functional Requirements			
FR-DSOTP-DA-01	Data Acquisition	The DSOTP is able to receive Measurements that reflect the network state from DSO Data Server	OK
FR-DSOTP-DA-02	Data Acquisition	The DSOTP is able to receive data coming from State Estimation Tool	Partially, but the SE tool has not been integrated yet
FR-DSOTP-DA-03	Data Acquisition	The DSOTP is able to receive PMU measurements that reflect the network state	OK
FR-DSO-TP-DA-04	Data Acquisition	The DSOTP is able to receive certified measurement from BAP	OK
FR-DSO-TP-DA-05	Data Acquisition	The DSOTP is able to receive setpoints from EMS	Expected in next release
FR-DSOTP-SE-01	State Estimation	The DSOTP is able to trigger the State Estimation Tool via REST API.	No longer expected
FR-DSOTP-SE-02	State Estimation	The DSOTP provides the results of State Estimation as estimated state vector to DSO	Expected in next release
FR-DSOTP-PMU-01	PMU Data Integration	The DSOTP is able to integrate PMU and conventional measurements into a unified measurement set for performing observability assessment via the State Estimation Tool.	OK
FR-DSOTP-T-01	Tariffs retrieval	The DSOTP sends to the DSO/Aggregators tariffs that reflect the expected state of the network	Expected in next release
FR-DSOTP-T-02	Tariffs retrieval	The DSOTP is able to receive data coming from the Algorithm for DER Control	Expected in next release

		and Algorithm for ancillary services	
FR-DSOTP-DER-01	Optimal DER dispatching	DSOTP is able to trigger the Algorithm for DER Control via REST API	Expected in next release
Non-Functional Requirements			
P-DSOTP-01	Communication protocols	DSOTP is able to receive data from PMUs via MQTT protocol	OK
P-DSOTP-02	Communication protocols	DSOTP is able to receive data from DSO Data Server via TCP/IP protocol	OK
P-DSOTP-03	Communication protocols	DSOTP is able to receive setpoints from A-LFC via TCP/IP protocol	Expected in next release
T-DSOTP-01	Timing	DSOTP is able to receive measurement every 10 seconds from sensors	OK
T-DSOTP-02	Timing	DSOTP is able to receive measurement every 15 minutes from Data Management Backend	OK
T-DSOTP-03	Timing	DSOTP is able to receive setpoints every 10 seconds for BESS and every 15 minutes for flexible loads and storages	Expected in next release

2.2.3 Platone Blockchain Access Layer

Table 3: Platone Blockchain Access Layer requirements

Requirement ID	Requirement name	Requirement description	Status
Functional Requirements			
FR-BAP-DM-01	Blockchain Data Management	The BAP is able to acquire Measurements from network	OK
FR-BAP-DM-02	Blockchain Data Management	The BAP certifies Measurements via Smart Contracts	OK
FR-BAP-DM-03	Blockchain Data Management	The BAP provides certified measurement in a secure way to DSOTP	OK
FR-BAP-NC-01	Network Control	The BAP is able to receive set points from DSOTP	Expected in next release
FR-BAP-NC-02	Network Control	The BAP certifies set points via Smart Contracts	Expected in next release
FR-BAP-NC-03	Network Control	The BAP is able to send certified set points to Data Management Backend	Expected in next release
Non-Functional Requirements			
P-BAP-01	Communication protocols	The BAP is able to receive data from sensors via MQTT protocol	OK
P-BAP-02	Communication protocols	The BAP is able to integrate data coming from external server via TCP/IP protocol	Expected in the next release
T-BAP-01	Timing	BAP is able to receive measurement every 10 seconds from sensors	OK
T-BAP-02	Timing	BAP is able to receive measurement every 15 minutes from Data Management Backend	Partially (Implemented for DSO Data server – Greek Demo)

3 Platone Demo sites integration and deployment

3.1 Italian Demo

The Italian Demo aims to manage Grid Congestion and Voltage Violation through an open and transparent Flexibility Market.

Within the Italian Demo architecture, parts of the Platone Framework (Italian SCD, Italian DSOTP and Italian BAL) was specifically implemented for the Italian Demo site, following the Platone Open Reference Architecture specification. The Platone Market Platform developed within the Framework was instead integrated in this architecture as one of the core platforms.

In this first demo execution, the entire day-ahead market life cycle will be tested and evaluated. More details can be found in D3.3 [5].

Focusing on the integration of the Platone Market Platform, the following integration steps were implemented.

3.1.1 Integration steps

1. Market Platform updates Pod registry from Italian SCD via REST APIs, under TLS connection and Oauth2.0 authentication;
2. Market Platform create an active Market Session;
3. Market Platform receives flexibility requests and offers from Aggregator Platform, Italian DSOTP and TSO Simulator via REST APIs, under TLS connection and Oauth2.0 authentication;
4. Market Platform close the active Market Session;
5. Market Platform matches requests and offers (clearing algorithm) and produces a market outcome;
6. Market Platform sends market outcome to DSOTP for technical validation via REST APIs under TLS connection and Oauth2.0 authentication;
7. DSOTP performs technical validation and sends technical outcome to the Market Platform via REST APIs under TLS connection and Oauth2.0 authentication;
8. Market Platform produces the final validated outcome (market validation and technical validation) and communicates it via Kafka Broker. Each platform authenticate itself using Two-Way authentication mechanism;
9. Market Platform receives measurements for market data verification and settlement (blockchain and smart contracts based), via Italian SCD Message Broker;
10. Market Platform performs settlement and makes available data to all the Market Participants
11. Aggregator, TSO and DSO can visualise all the data via web UI.

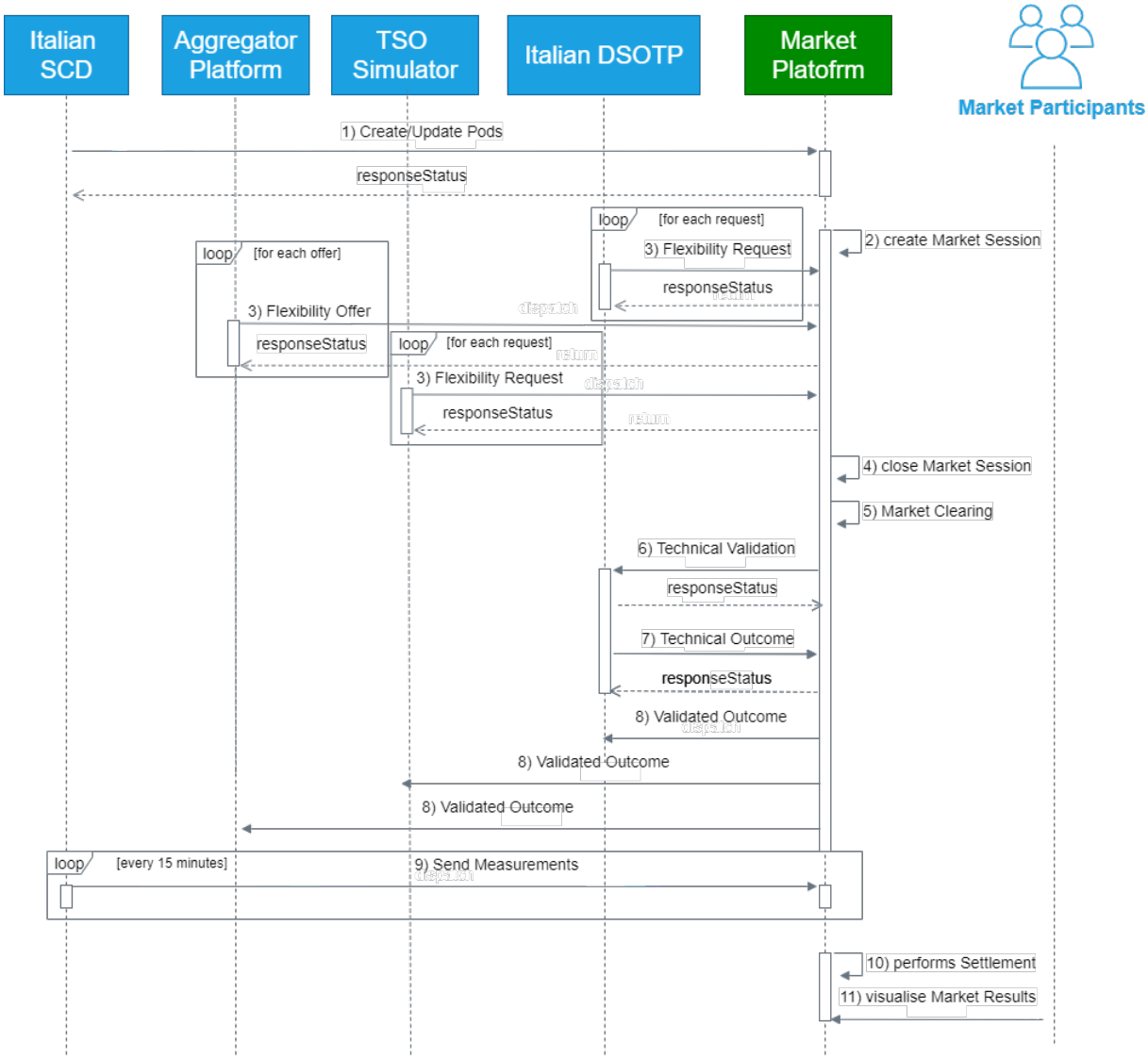

Figure 5: Italian Demo integration – Sequence Diagram

3.1.2 Deployment

The Platone Market Platform is hosted in cloud in ENG infrastructure and will communicate with Aggregator Platform, Italian Shared Customer Database and Italian DSOTP hosted in other cloud infrastructures, following secure authentication mechanisms (Oauth2.0 for REST APIs and Two-Way certification for Apache Kafka).

3.2 Greek Demo

The main objectives of the Greek Demo are to economically optimize the use of distributed energy sources to provide ancillary services and balancing market participation to the transmission system operator, advanced observability, automation and controllability in the distribution network fault-detection, self-reconfiguration and self-healing for increased security and resilience of the distribution system and optimal control of distributed energy sources both in the day-ahead and real-time time frames for market participation, mitigation of congestions and voltage limit violations, and minimization of losses.

All these objectives, will be pursued, integrating the Platone Open Framework, that allows to manage easily the integration and the certification of the data coming from the grid and at the same time, makes these data available in real time to the DSOTP that enables DSOs to exploit a series of innovative services as evaluating the current grid state, activating local flexibility requests, as well as ensuring the reliability and operational quality of service by enlarged grid observability.

In this first integration within the Greek Demo architecture, metering data coming from the DSO Data server will be integrated and certified into the Platone BAL and provided to the Platone DSOTP to be used for data visualisation and by State Estimation Tool developed within WP4. For releasing the integrated Platone Open Framework within the Greek Demo architecture, the following integration steps were implemented.

3.2.1 Integration steps

1) MQTT Broker of the BAL receives metering data from DSO Data Server, every 15 minutes, in CIM standard model, in authenticated way and under TLS connection;
2) BAL stores data into SCD and certify aggregated data into BAP;
   a) BAL updates data with certification hash into SCD;
3) BAL provides metering data to DSOTP via MQTT bridging;
4) DSOTP makes selected topics available on its internal message bus for processing by services;
5) Within DSOTP, Metering data are stored in a timeseries database and visualized in customizable dashboards;
6) Within DSOTP, the data from DSO Data server are made available to services (e.g. State Estimation Tool) by forwarding the related topic from the BAL into the DSOTP.

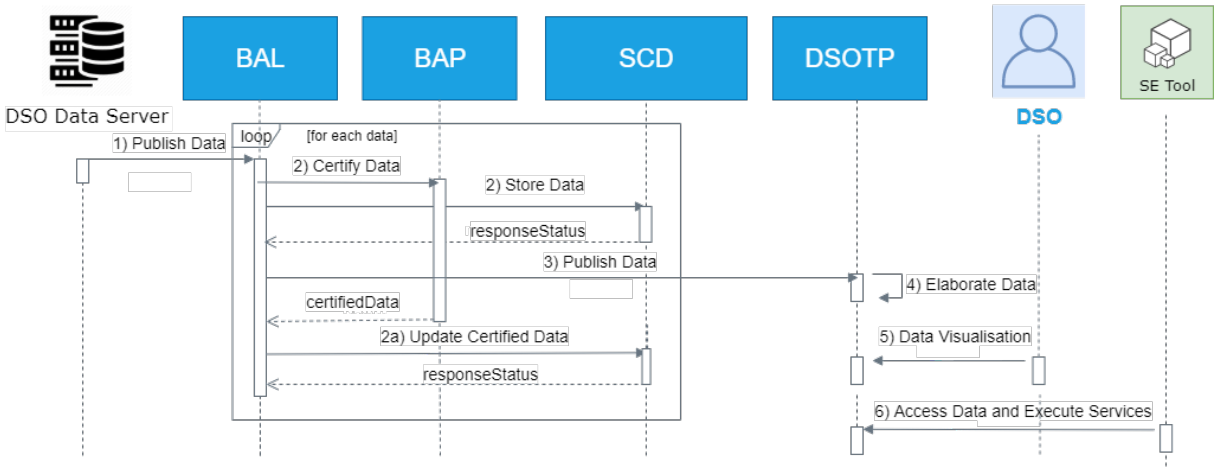

Figure 6: Greek Demo Integration – Sequence Diagram

3.2.2 Deployment

The entire Platone Framework will be deployed on site within the Greek demo infrastructure. The Platone Open Framework will be packaged as Docker Container and released to the partner of the Greek demo.

The deployment phase will be followed both from WP2 partners and WP4 partners, in order to ensure an easy and effective release of the software packages. The integration tests, already performed in cloud environment, will be reproduced on site.

3.3 German Demo

The main objectives of the German Demo are the coordination between local balancing mechanism and centralized grid operation and the allocation of flexibility in local networks between the local network and higher-level networks. A further objective is an effective informational and temporal uncoupling of low and medium voltage networks by handling energy supply and export in bulk packages rather than a real time exchange.

All these objectives, will be pursued, integrating the Platone Open Framework, that allows to manage easily the integration and the certification of the data coming from the grid and at the same time, makes these data available in real time to the DSOTP that enables DSOs to exploit a series of innovative services as evaluating the current grid state, activating local flexibility requests, as well as ensuring the reliability and operational quality of service by enlarged grid observability.

In this first integration within the German Demo architecture, PMU data coming from the PMU devices will be integrated and certified into the Platone BAL and provided to the Platone DSOTP to be used for data visualisation and by A-LFC developed within WP5.

For releasing the integrated Platone Open Framework within the German Demo architecture, the following integration steps were implemented.

3.3.1 Integration steps

1. MQTT Broker of the BAL receives data from PMU, in authenticated way and under TLS connection every seconds. Every device can only write in its dedicated topic;
2. BAL stores data into SCD;
3. BAL provides data to DSOTP via MQTT bridging;
4. DSOTP makes selected topics available on its internal message broker for processing by services;
5. Within DSOTP, PMU data are stored in a timeseries database and visualized in customizable dashboards;
6. DSOTP hosts services such as the balancing module or the load-forecasting service and expose a REST API towards the A-LFC;
7. BAL periodically request aggregated Data to SCD;
8. BAL send aggregated data to BAP for data certification;
9. BAP certify data;
10. BAL update data into SCD.

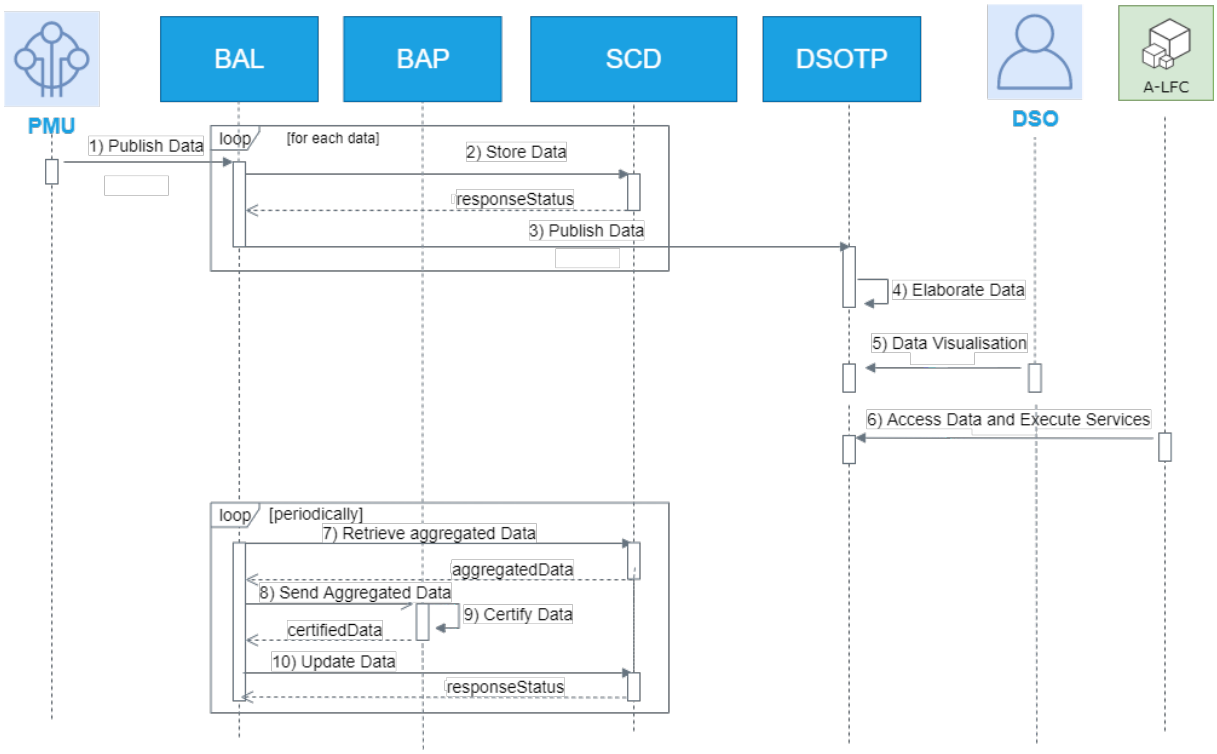

Figure 7: German Demo Integration – Sequence Diagram

3.3.2 Deployment

The deployment of the Platone Open Framework within the German Demo is under discussion. The German Demo infrastructure already foresees its own cloud infrastructure in which we could deploy the Platone Open Framework as packaged Docker Container. In alternative, the different Platforms of the framework could be hosted in different cloud infrastructures (e.g., ENG and RWTH) and communicate with German Demo Platforms and Devices with the communication mechanisms already tested: MQTT protocols for integrating PMU data and REST APIs for integration of A-LFC.

Since both approaches are foreseen on cloud infrastructures, they do not require any additional integration tests because they are equally comparable.

4 Conclusion

Starting from the Platone Open Reference Architecture and the first version of the Platone Platforms delivered two months ago in M18, this first version of the integrated Platone Open Framework includes all the specifications, requirements and communication mechanisms expected for this first release.

This first prototype reflects all the main characteristics pursued as a goal by Platone overall concept: it is easy integrable and deployable in different context, it is configurable for different purposing and goals and it increases the level of security and reliability of the entire DSO architecture.

All these characteristics will be demonstrated in three different contexts: the three different trials of the Platone project. During the execution of the three demos, we will collect the important results and the feedback that will come out and we will use them for improving the Platone Open Framework in all its main aspects as well as to add any other possible requirements and features to the general architecture and the various Platone Platforms.

5 List of Tables

6 List of Figures

7 List of References

[1] European Commission, "2050 long-term strategy", [Online]. Available: https://ec.europa.eu/clima/policies/strategies/2050_en

[2] *Grant Agreement No. 864300 – Platone.*

[3] "D2.1 Platone platform requirements and reference architecture (v1) ", [Online]. Available: https://www.platone-h2020.eu/data/deliverables/864300_M12_D2.1.pdf

[4] "D1.1 General functional requirements and specifications of joint activities in the demonstrators", [Online]. Available: https://www.platone-h2020.eu/data/deliverables/864300_M12_D1.1.pdf

[5] "D3.3 Delivering of technology (v1)", Platone EU Horizon 2020 Project, 2021

[6] "D4.1 Report on the definitions of KPIs and UCs", [Online]. Available: https://www.platone-h2020.eu/data/deliverables/864300_M12_D4.1.pdf

[7] "D5.1 Solution design and technical specifications", [Online]. Available: https://www.platone-h2020.eu/data/deliverables/864300_M6_D5.1.pdf

[8] "D2.3 Platone Market Platform (v1) ", Platone EU Horizon 2020 Project, 2021

[9] "D2.6 Platone DSO Technical Platform (v1) ", Platone EU Horizon 2020 Project, 2021

[10] "D2.11 Platone Blockchain Customer Access Layer (v1) ", Platone EU Horizon 2020 Project, 2021

[11] "Mosquitto," [Online]. Available: https://mosquitto.org/.

[12] "CIM IEC-61968-9 standard specifications", [Online]. Available: https://webstore.iec.ch/publication/6204

[13] "Apache Kafka", [Online]. Available: https://kafka.apache.org/

[14] "SOGNO H2020 Project – Service Oriented Grid for the Network Of the future", [Online]. Available: https://www.sogno-energy.eu/About/H2020

[15] "Open API 3.0 - Specifications," [Online]. Available: https://swagger.io/specification

[16] "Oauth 2.0," [Online]. Available: https://oauth.net/2/

[17] B. Pournader, "What is two-way TLS?", 23 May 2018. [Online]. Available: https://benpournader.medium.com/what-is-two-way-tls-d90600e2fc06.

8 List of Abbreviations

Abbreviation	Term
A-LFC	Avacon Local Flex Controller
API	Application Programming Interface
BAL	Blockchain Access Layer
DSO	Distribution System Operator
DSOTP	DSO Technical Platform
MQTT	Message Queue Telemetry Transport
PMU	Phasor Measurement Unit
PoD	Point of Delivery
REST	REpresentational State Transfer
TSO	Transmission System Operator