Platone

PLATFORM FOR OPERATION OF DISTRIBUTION NETWORKS

Platone

PLATform for Operation of distribution NEtworks

D2.13

Platone Blockchain Customer Access Layer (v3)

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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 final software delivery of the Platone Blockchain Access Layer and reports all the updates respecting to the previous versions of the software. It also includes technical specifications and guidelines for installation and deployment of the software.

The Platone Blockchain Access Layer is part of the Platone Open Framework and includes two main components: the Platone Blockchain Access Platform and the Platone Shared Customer Database.

The final prototype of the Platone Blockchain Access Layer will be integrated in the final version of Platone Open Framework but does not foresee a final validation in the demo sites.

Keyword list

Platone Blockchain Access Layer, Platone Blockchain Access Platform, Platone Shared Customer Database, Data Integration, Data Certification, Data Access Management, Smart Contracts

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 the Platone Open Framework to meet the needs of modern DSO power systems, including data management. 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). It 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). It 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 Platone Open Framework will also incorporate an open-market system to link with traditional TSOs. The Platone Open Framework will be tested in three European demos and within the Canadian Distributed Energy Management Initiative (DEMI).

The **Platone Blockchain Access Layer** is one of the Key Exploitable Results (KERs) of the Platone project. It is a blockchain-based solution that includes two different components: the **Platone Blockchain Access Platform,** which allows the integration of the data coming from the physical infrastructure adding a level of security, transparency and trustworthiness thanks to the blockchain technology and smart contracts, and the **Platone Shared Customer Database,** which contains all the energy data (e.g., measurements, set points, etc.), providing access to it to all the stakeholders involved, implementing data security, data privacy and data access policies mechanisms.

The first two prototypes of the Platone Blockchain Access Layer implemented all the functionalities expected in the implementation plan, among which: IoT integration with unique blockchain certification, data modelling and sharing as well as a basic data access management.

All those functionalities were implemented using blockchain technology and smart contracts, ensuring a high-level of transparency and trustworthiness among the energy stakeholders, ensuring an easy access to the shared database without compromising the security and data governance aspects.

The final prototype of Platone Blockchain Access Layer focused on the consolidation of the functionalities already implemented (with minor fixing) and the extension of the data access and control management, implementing now a fully blockchain-based process.

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1 Introduction

The project “PLATform for Operation of distribution Networks – Platone” aims to develop an architecture for testing and implementing a data acquisition system based on a two-layer Blockchain approach: an “Access Layer” to connect customers to the Distribution System Operator (DSO) and a “Service Layer” to link customers and DSO to the Flexibility Market environment (Market Place, Aggregators, …). The two layers are linked by a Shared Customer Database, containing all the data certified by Blockchain and made available to all the relevant stakeholders of the two layers. This Platone Open Framework architecture allows a greater stakeholder involvement and enables 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), Market, customers and aggregators. In particular, the DSOs will invest in a standard, open, non-discriminatory, blockchain-based, economic dispute settlement infrastructure, to give to both the customers and to the aggregator the possibility to become flexibility market players more easily. This solution will allow the DSO to acquire a new role as a market enabler for end users and a smarter observer of the distribution network. By defining this innovative two-layer architecture, Platone strongly contributes to aims to removing technical and economic 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 demos (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, including the Platone Blockchain Access Layer.

The Platone Blockchain Access Layer’s main goal is to enable a standard, secure, and easy integration of energy data coming from the physical infrastructure and grant the access to this data to DSOs and other energy stakeholders.

The first and second versions of the Platone Blockchain Access Layer were already tested and successfully integrated in the three different environments: RWTH laboratory as an experimental testbed and within the German and Greek demo for a real field test.

The feedback collected in the second validation phase allowed to consolidate the overall functionalities of the Platone Blockchain Access layer and to release a final version to be integrated in the last version of the Platone Open Framework.

1.1 Task 2.5

This deliverable is related to the Task 2.5 [2] that aims at the implementation of the Platone Blockchain Customer Access Layer.

The Platone Blockchain Customer Access Layer was renamed **Platone Blockchain Access Layer**, to avoid misunderstandings on the word “Customer”, as customers are not the only stakeholders to which the component is addressed. In fact, the Blockchain Access Layer aims to integrate and to manage all the data coming from the physical infrastructure and offers its features to all energy stakeholders.

The third version of the Platone Blockchain Access Layer follows the functional and non-functional requirements defined in D2.2 [3] as results of the update on Platone Architecture and Platform requirements.

1.2 Objectives of the Work Reported in this Deliverable

The objective of this deliverable is to present the final prototype of the Platone Blockchain Access Layer. The Platone Description of Action defines this deliverable as a demonstrator. This document accompanies the code repository (link available in Chapter 5.1) with a more detailed architecture

description as well as some extended deployment instructions for deploying, testing, and integrating the platform.

1.3 Outline of the Deliverable

Chapter 2 of this document describes the third realization of the Platone Blockchain Access Layer according to feedback collected in the second validation phase as well as the description of the new blockchain-based data access and control management. Chapter 3 provides the updated interfaces and communication mechanisms. Chapter 4 delivers a list of languages, technologies and external tools used within the platform. Chapter 5 is closely linked to the software delivery and provides detailed installation, setup, and configuration instructions. Finally, Chapter 6 concludes this deliverable.

1.4 How to Read this Document

The document aims to give an overview to the Platone Blockchain Access Layer final prototype release. A description of the foreseen functional and non-functional requirements expected can be found in D2.1 and D2.2. As this document presents an update with respect to the previous versions, it is strongly recommended to refer to D2.11 [5] and D2.12 [6] for an exhaustive description of the Platone Blockchain Access Layer. However, for the convenience of the reader, some important information already reported in D2.11 and D2.12 is also reported in this document.

2 Platone Blockchain Access Layer (v3) – Final updates

In terms of architecture, no updates from previous versions were necessary for the realization of the final Platone Blockchain Access Layer prototype.

A brief recap of the architecture is reported below, for more details please refer to D2.11 [5].

The Platone Blockchain Access Layer (BAL) includes two main components:

- **Platone Blockchain Access platform (BAP)**, that implements all the functionalities offered by the blockchain technology through smart contracts and provides an interface for the integration of the data coming from the physical infrastructure.
- **Platone Shared Customer Database (SCD)**: it contains all the measurements, set points and other needed data collected from customer physical infrastructure. It allows the other components and stakeholders of the Platone Open Framework to access data in an easy way and without compromising security and privacy.

It also includes:

- **Integration Layer**, that allows the integration of data coming from the physical infrastructure using standard communication protocols for IoT (e.g., MQTT) and REST services.
- **Communication Layer**, that enables the communication among the different internal layers of the BAP, the SCD and other components (e.g., DSO Technical Platform). It provides standard communication mechanisms like REST APIs and Message Broker.

Blockchain infrastructure, that includes a private implementation of Ethereum Blockchain infrastructure including some Ethereum nodes. Figure 1 shows the updated version of the BAL architecture.

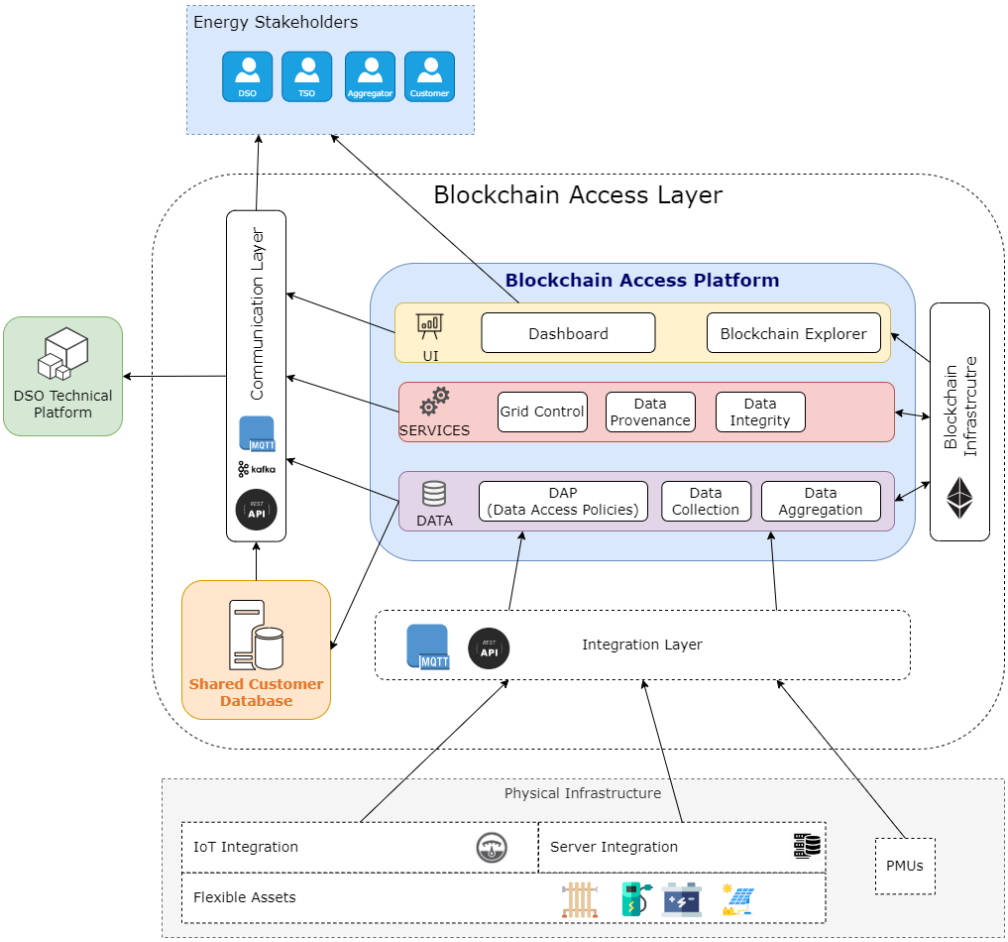

Figure 1: BAL Architecture (v2)

2.1 Functionalities

The second version of the BAL included all the expected functionalities to be implemented and evaluated in the German and Greek demo.

For this reason, the final phase of the project focused on the consolidation of the existing functionalities, including some minor fixes, as well as the extension of the data management tool, which now implements all the processes using blockchain technology and smart contracts.

2.1.1 Data Management Tool – First Version

As described in D2.12 [6], in the second version of the BAL a complete data access management was implemented in the Data Management Tool.

This Data Management Tool allows energy stakeholders to handle the data provisioning and consumption in a secure and trusted way, following specific Data Access Policies.

In the first version of the Data Management Tool, a low layer access control, exploiting the Mosquitto Dynamic Security Plugin [7] was implemented. This basic access control allows, through standardized APIs, to interface with the Mosquitto Access Control List [8] and define access control rules.

In addition, a Web Dashboard for the Data Management tool was implemented for managing the subscription to specific resources via a Graphical User Interface (GUI), facilitating the data provider and consumers activities.

2.1.2 Blockchain-Based Data Management Tool

Blockchain technology and Smart Contracts can support data sharing without losing control and ownership of it.

The blockchain technology can address three important challenges:

- ensure data privacy,
- manage data access and usage control,
- incentivize secure data sharing.

Through smart contracts, it is possible to track who shared what, with whom, when, by what means and for what purposes in a verifiable fashion.

The Blockchain-Based Data Management tool is an extension of the first version of the Data Management Tool implemented in the BAL v2. In this final version, all the topic subscriptions are converted to a specific format and registered within the blockchain technology using a specific smart contract. The smart contract registers the subscription declaration and allows to verify (at any moment) the status and the date of the subscription.

Figure 2 represents the new schema of subscription management, using blockchain technology.

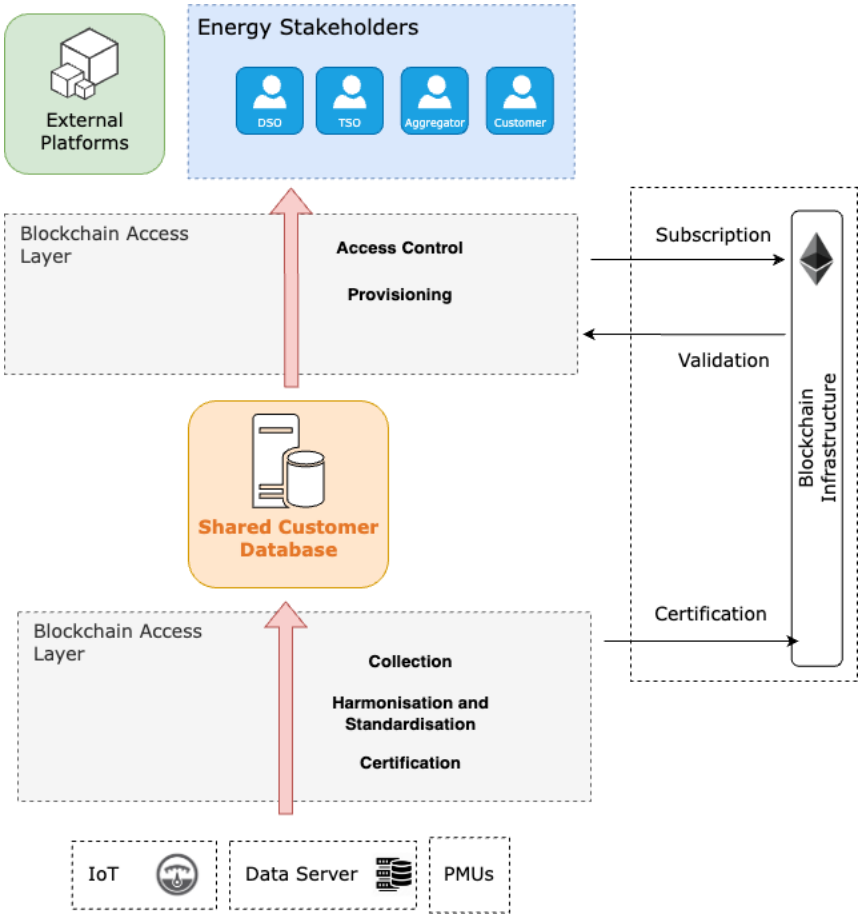

Figure 2: Data Management with Blockchain and Smart Contracts

Smart Contract

The implemented smart contract contains the subscription declarations of the data actors (provider and consumer). It consists of the following properties:

- Provider Identity: wallet Address of the data provider
- Consumer Identity: wallet Address of the data consumer
- Topic: unique identifier for subscription topic
- Timestamp: timestamping proof of the subscription declaration
- Status: the status of the subscription declaration (accepted or rejected)

2.2 Data Models

In addition to the data models implemented for the previous prototypes of the BAL, a specific data model for the blockchain-based subscription management was defined, too.

Subscription certification

Table 1: Subscription certification

Field	Type	Description
providerId	String	**Required**, the wallet address of the data provider

consumerId	String	**Required,** the wallet address of the data consumer
topic	String	**Required,** the topic available for the subscription
timestamp	String	**Required**, the timestamp for the proof of the subscription
status	String	**Required,** the status of the subscription (Requested, Accepted or Declined)

3 Interfaces and Communication Mechanisms

As described in D2.11, the BAL implements two types of interfaces with different communication mechanisms: MQTT for the data provisioning and consuming, REST APIs for backend services and synchronous requests.

In addition to the previous versions of the BAL, two new APIs were implemented for allowing the subscription certification and validation.

The new APIs are reported below in Table 2.

Table 2: New APIs

Name	Url	Method	Parameters	Responses
Subscription Certification	/api/certification/	POST	In Body: ProviderId: (String) wallet address of the data provider ConsumerId: (String) wallet address of the data consumer Topic: (String) subscription topic	Success (200) Certified Subscription Error (500) Error Message – *String*
Subscription Validation	/api/certification/:topic	GET	In params: topic (String) subscription topic	Success (200) List of Certified Subscription (by topic) Error (500) Error Message – *String*

Similar to the previous releases, a complete list of the APIs is provided together with the source code in the Open API [9] standard format [10].

4 Languages, Technologies and External Tools

There are no updates with respect to the previous versions of the BAL. For a complete list of used languages, technologies and tools please, refer to D2.11 and D2.12.

5 Packaging and Deployment

This chapter reposts a technical step-by-step guideline for the deployment and installation of the software. Specifications in terms of hardware and software are also provided for a correct installation.

Hardware

Operating System: Linux Host

Ram: > 4GB

Disk: > 100GB

Software

Docker > 18.06.1-ce

The steps below report the complete installation of the BAL. Additional information can be found in the READ.ME file within the source code repository [10].

Network Creation

```
$ docker network create bap-net
```

SCD Container

```
$ docker run --network bap-net -d --name db -v <your-volume-path>:/data/db -p 27017:27017
mongo:latest
```

Mosquitto Container

```
$ cd app/mosquitto #location of docker-compose.yml
$ docker-compose up -d
```

BAP Container

```
$ cd app #location of DockerFile
$ docker build -t platone-bap:1.0 .
$ docker run --name bap -p 8082:8082 --network bap-net -e DATABASE_URL=db:27017 -e
MQTT_HOST=mqtt://mosquitto_container:1883 -d platone-bap:1.0
$ docker exec -it bap bash
$ npm run deploy-local
$ exit
$ docker restart bap
```

Web Dashboard

```
$ cd client #location of DockerFile
$ export API_URL=<your-api-url> #URL of BAP
$ docker build -t platone-bal-ui:1.0
$ docker run -p 80:80 -p 443:443 -d platone-bal-ui:1.0
```

5.1 Availability

The source code and the Docker Files necessary for the deployment are available in the RWTH GIT repository.

Software REPO

GitLab-> https://git.rwth-aachen.de/acs/public/deliverables/platone/platone-blockchain-access-layer

6 Conclusion

The work done at this stage concluded the implementation of the Platone Blockchain Access Layer with the release of its final prototype.

The second version of the Platone Blockchain Access Layer was already implemented as fully functional, satisfying all the functional and non-functional expected requirements. Therefore, in this final version, only a consolidation of the already existing functionalities (with some minor fixing) and an improved version of the Data Management Tool were implemented.

This final version includes the new version of the Data Management Tool based on blockchain technology and leveraging on smart contracts for data access management. In particular, the smart contract is able to register any subscription request and verify it during the access request.

This upgrade made it possible to have all the functionalities of the Blockchain Access Layer based on blockchain technology and smart contracts, ensuring the benefits of this technology at any level and increasing the level of transparency, security and trustworthiness.

As already done for the other releases, the final version of the source-code is publicly available and released. Additionally, the final prototype will be integrated in the final version of the Platone Open Framework which is going to be reported by the end of the project in D2.16.

7 List of Tables

8 List of Figures

9 List of References

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[7] «Mosquitto - Dynamic Security Plugin,» [Online]. Available: https://mosquitto.org/documentation/dynamic-security/.

[8] «MQTT authentication & authorization, » [Online]. Available: https://www.chirpstack.io/project/guides/mqtt-authentication/.

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10 List of Abbreviations

Abbreviation	Term
API	Application Programming Interface
BAL	Blockchain Access Layer
BAP	Blockchain Access Platform
DSO	Distribution System Operator
DSOTP	DSO Technical Platform
GUI	Graphical User Interface
KER	Key Exploitable Result
MQTT	Message Queue Telemetry Transport
OS	Operating System
REST	REpresentational State Transfer
SCD	Shared Customer Database
TSO	Transmission System Operator