Platone

PLATFORM FOR OPERATION OF DISTRIBUTION NETWORKS

Platone

PLATform for Operation of distribution NEtworks

D6.2 v1.0

Standard guidelines for each demonstration

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Abstract

This deliverable identifies the standards that will be of direct relevance in the Platone demo sites. Based on the analysis and descriptions of D6.1, this report describes which standards are chosen as the most appropriate standards for each demonstration and can serve as guidelines or recommendations for similar field trials. The analysis is based on the use case functionalities where possible. For each demo the identified standards are discussed according to the technical fields they are applied to, namely SCADA communications, DMS/EMS, AMI, DRMS, Energy and Battery storage, BEMS, cybersecurity, Energy Markets and Blockchain. Implementation guidelines are discussed, were required.

Keyword list

Standards, platform, SCADA, DMS, EMS, AMI, DRMS, energy storage, battery storage, BEMS, cybersecurity, energy markets, blockchain

Executive Summary

This report provides an analysis on the standards employed in Platone demonstrations. The Platone Open Framework's multilayer platform architecture collects data and delivers secure information both to DMS and to an open Market framework, using blockchain technology for data certification, integrity and interoperability, to provide a seamless integration of operation and market, improving electricity services to end-users, distribution grid operator, aggregators and other energy related actors. Platone aims at identifying new approaches to enhance renewable energy sources (RES) integration, improve grid observability, and enable the load predictability in order to achieve a reliable and cost-effective power system. To this end, the main goal is to develop advanced management platforms which will give priority to the distribution system operators' (DSO) policies and putting the consumers' involvement in the centre.

Following D6.1, where the standardization ecosystem was described and the standards that might be of interest to Platone are shortlisted, this deliverable focusses on the standards that are going to be deployed in Platone's field trials are identified and put in the context of the project. In addition, for functionalities where a specific standard is not deployed, the most appropriate choice of standard is suggested in order to have complete report on Platone's area of interest. Thus, this document can serve also as a recommendation list for similar projects.

Authors and Reviewers

Main responsible		
Partner	**Name**	**E-mail**
NTUA		
	Panagiotis Pediaditis	panped@mail.ntua.gr
Author(s)/contributor(s)		
Partner	**Name**	
NTUA		
	Panagiotis Pediaditis	
	Savvas Karras	
HEDNO		
	Stavroula Tzioka	
	Dimitrios Stratogiannis	
	Eleni Daridou	
ARETI		
	Antonio Vito Mantineo	
AVACON		
	Thorsten Gross	
	Helmut Pfingsten	
ENG		
	Ferdinando Bosco	
Reviewer(s)		
Partner	**Name**	
SIEM		
	Carlo Adriano Arrigoni	
APIO		
	Alessandro Chelli	
Approver(s)		
Partner	**Name**	
RWTH		
	Padraic McKeever	

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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 acquisitions system based on a two-layer approach (an access layer and a service 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 [31], 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 in 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".

WP6 focuses on the topics of standardization and legislation. With regards to standardization the goal is to support the Platone demos on this aspect by presenting and analysing the standardization ecosystem and highlight standards that are relevant to Platone. This is important because this way the Platone project demos will have a clear reference on which standards can be used and which functionalities lack any standardization.

1.1 Task 6.2.1

The purpose of Task 6.2.1 is to describe which standards will be used in, or are best suited for, the Platone project demos. Based on the ecosystem description of Task 6.1, WP6 identifies which standards best serve their goals for each Use Case functionality. The standards cover all technical areas analysed in Task 6.1 such as SCADA communications, DMS/EMS, AMI, DRMS, Energy and Battery storage, BEMS, cybersecurity, Energy Markets and Blockchain.

1.2 Objectives of the Work Reported in this Deliverable

In Deliverable 6.2 the standards that will be used for the Platone demos are related to the Use Cases and functionalities identified for each demo. With the help of the analysis performed in D6.1 [54], WP6 identifies which standards apply to their specific demo functionalities. Any possible gaps in the current standards will be highlighted. The objective of the document is to provide a comprehensive and well-structured description of the standards aligned to Platone and identify where more standardization efforts are needed.

1.3 Outline of the Deliverable

The second chapter gives a short overview of the Platone project, the Platone platform with its distinctive two blockchain layers and the implementation technologies. The third chapter gives a short summary of the standardization ecosystem as described in detail in D6.1. The fourth, fifth and sixth chapters describe the standards used in each demonstration. The conclusion presents the main highlights of the document.

1.4 How to Read this Document

The reader is not expected to have a detailed knowledge of Platone or the specific standards, he should have however some basic understanding of electrical engineering, ICT and the modern power system structure. It is advisable that the reader refers to D6.1 for more details, when necessary.

2 The Platone ecosystem

Platone aims at creating unique synergies between electricity market and operation, developing a multi-layer platform for customer integration in network operation. The key focus will be placed on seamless, low-cost and efficient integration of the customers, or better prosumers. Platone can be considered as a change of philosophy in grid operation: a change where the key is the customer. In effect, Platone focuses on offering to the final customers connected to the DSOs' grids a full range of solutions both on HW/SW (Hardware/Software) access layer to the flexibility market and all the financial/economic opportunities coming from supply-demand of energy services (from TSOs, DSO, EV providers, P2P local/virtual market players).

The following are the areas that are of interest to the Platone demos and therefore were the main focus of the standardization ecosystem analysis.

1) Electric system operation
2) Home and Building Automation
3) Retail energy markets, Wholesale energy markets, Enterprise
4) Security
5) Blockchain

The above areas of interest are categorized with the help of IEC's standards map [1]:

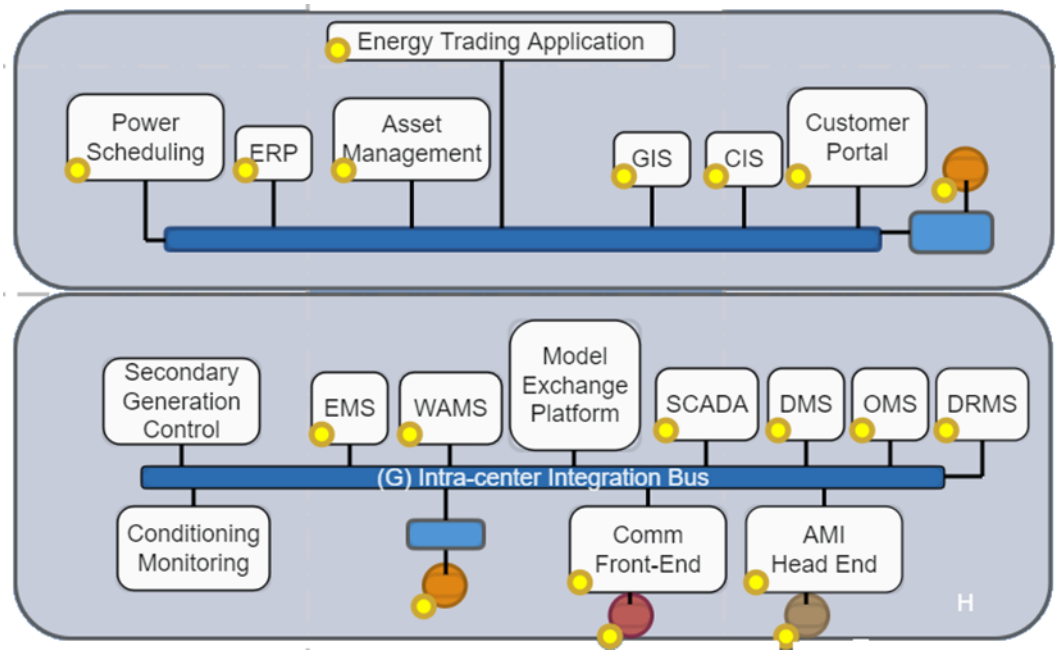

Figure 1: The categorization of sub-grouped area in smart grid standards map [1].

Platone consists of three demonstration sites deployed in Italy, Greece and Germany. The three demos will not be identical but will each develop different Use Cases (UCs). However, a common platform is being developed by Engineering in WP2. The common Platform will be tested in three countries, Italy, Greece, and Germany.

2.1 Field trial in Italy

The aim of the Italian demo is to define a fully functional system that enables distributed resources connected to medium and low voltage grid to provide services in the flexibility market, including all the stakeholders (like TSO, DSO, aggregators, end-users). The trial interests a network completely underground, because the area is in an urban contest, and the users present are very heterogeneous: passive customers, prosumers, charging points, producers, and buildings.

The demo requires extensive use of standard associated with DSO data exchange. For example, standards associated with SCADA systems, like IEC 60870 part 5 [2] which define systems used for remote control in electrical engineering and power system automation applications, aimed for communication of data between control centre and field units such as RTUs and relay protection. This extends also to consideration of the more novel IEC 61850 [23] standard. In addition, the standards for communication between control centres, such as IEC 60870 part 6 [6] are relevant. Moreover, blockchain standards associated with electricity market apply here, too.

2.2 Field trial in Greece

The aim of the Mesogeia demo is to demonstrate the ability of DERs to provide ancillary services to the system, participate in the Day-Ahead (DA) and Balancing markets and contribute to the secure operation of the distribution network. The pilot site is located in the area of Mesogeia at the south-eastern part of Attica, near Athens and is considered as ideal for demonstration purposes since: a) it combines parts of the mainland and interconnected islands, which is an interesting mixture of locations, systems and infrastructure to be studied; b) provides a mix of rural, urban and suburban areas; c) consists of a customer mix including households, small, medium and large industries; d) has high RES penetration of various types and e) is close to the capital.

This demo site requires the use of standard associated with DMS standards due to operations that aim to manage resources in the distribution system, and standards associated with SCADA systems aimed for communication of data between control centre and field units such as RTUs and relay protection, among others. Also, low-cost PMU developed by RWTH Aachen will be used. Active distribution network standards associated with DRMS, as do standards described in AMI.

2.3 Field trial in Germany

The German demo site will focus on a low voltage network in a rural area with a high penetration of DERs. It is these regions where a high potential for DER meets a low residential and commercial load that the challenges of the energy transition surface first. This demonstration example aims at the supervision between local balancing mechanisms and centralized grid operation. Furthermore, the flexibility arrangement in local networks among the local network and the higher-level networks will be addressed. An effective informational and temporal uncoupling of low and medium voltage networks is another goal which will be treated by handling energy supply and export in bulk packages instead of a real-time exchange.

This demo site also requires use of standards associated with DSO data exchange, namely standards associated with SCADA systems aimed for communication of data between the control centre and smart distribution stations. Particular consideration of storage standards is relevant for this demo site. Active distribution network standards also described in the following chapters apply as well, as do standards described in AMI and building management systems. In particular, blockchain standards associated with the electricity market apply here too.

Platone's ecosystem concerning the relevant standards of each site has been analytically presented in D6.1 [54].

3 The Standardization ecosystem

The Standardization ecosystem has been analytically described in D6.1 [54] which analysed the standardization ecosystem of Smart Grids and identified areas relevant to the solutions proposed in the 3 demonstrations that are the main part of the project. The deliverable described protocols and standards utilized in the smart grid technology already defined by Institute of Electrical and Electronic Engineering (IEEE), International and Electrotechnical Commission (IEC), International organization for Standardization (ISO) which could potentially be used in the Platone Project.

Certain common standards characteristic for the main Platone platform and associated with electricity system operation, blockchain and cyber security are common for all demos. However, each demo has its own specific characteristics (e.g. storage technology, PMU etc.) that need to be taken into consideration for future design and associated standards were added in the analysis.

The objective of this document was providing broader context in the domain of relevant standards for Platone implementation that will be subsequently be chosen as a final solution in the present deliverable D6.2. The standards that were identified as relevant for the 3 demonstration sites were grouped under relevant domain of application in the following categories:

3.1 Standards regarding SCADA communications

- **IEC 60870** [2-5] - Telecontrol equipment and systems
- **IEC 60870-5** [2-5] - Telecontrol equipment and systems - Part 5: Transmission protocols
- **IEEE C37.118.1-2011** [7] - IEEE Standard for Synchrophasor Measurements
- **IEEE C37.118.2-2001** [8] - IEEE Standard for Synchrophasor Communication
- **IEEE 1815-2012** [9] - Standard for Electric power system communication Distributed Network protocol (DNP)

3.2 Standards regarding DMS and EMS

- **IEC 61970** [10] - Energy management
- **IEC 61968** [11] - Distribution management
- **IEC 62357** [12] - Service Oriented Architecture

3.3 Standards regarding AMI

- **IEC 62056** [13] - Standards for Electricity Metering - Data exchange for meter reading, tariff and load control specifies meter data exchange, including data models, messaging methods and communication media specific protocols
- **The IEC 62055** [14-18] Series - Electricity metering – Payment System
- **ANSI C12.19** [19] - American National Standard for Utility Industry End Device Data Tables
- **IEEE 1377-2012** [20] - Standard for Utility Industry metering Communication Protocol Application Layer (End Device Data Tables)
- **IEEE 1701-2011** [21] - Standard for Optical Port Communication Protocol to Complement the Utility Industry End Device Data Tables
- **IEEE 1703-2012** [22] - Standard for Local Area Network/Wide Area Network(LAN/WAN) Node Communication Protocol to Complement the Utility Industry End Device Data Tables

3.4 Standards regarding DRMS

- **IEC 61850** [23] - Power Utility Automation
- **Open Automated Demand Response (OpenADR)** [91]
- **1547- IEEE** [24-29] - Standard for Interconnecting Distributed Resources with Electric Power Systems
- **IEEE P2030** [30] - Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS) and End-Use Applications and Loads

- **IEEE P2030.4** [30] - Guide for Control and Automation Installations Applied to the Electric Power Infrastructure
- **IEEE P1815.1** [30] - Standard for exchanging information between Networks implementing IEC 61850 and IEEE std 1815 (Distribution Network Protocol)

3.5 Standards concerning energy storage and battery storage systems

- **IEC 62933** [32-34] - Electrical energy storage systems (EESS)
- **IEC 62933-1** [32] - Electrical energy storage (EES) systems
- **IEC 62933-2-1** [33] - Electrical energy storage (EES) systems – Part 2–1: Unit parameters and testing methods – General specification
- **IEC 62933-4-1** [34] - Electrical energy storage (EES) systems – Part 4–1: Guidance on environmental issues – General specification
- **IEEE 2030.2.1-2019** [35] - Guide for Design, Operation and Maintenance of Battery Energy Storage Systems, both Stationary and Mobile and Applications Integrated with Electric Power System
- **IEEE 937-2019** [36] - Recommended Practice for Installation and Maintenance of Lead-Acid Batteries for Photovoltaic (PV) Systems
- **IEEE 1679-2010** [37] - Recommended Practice for Characterization and Evaluation of Emerging Energy Storage Technologies in Stationary Applications
- **IEEE 1013-2019** [38] - Recommended Practice for Sizing Lead-Acid Batteries for Stand-Alone Photovoltaic (PV) Systems
- **IEEE 1361-2014** [39] - Guide for Selecting, Charging, Testing and Evaluating Lead-Acid Batteries Used in Stand-Alone Photovoltaic (PV) Systems
- **IEEE 1561-2019** [40] - Guide for Optimizing the Performance and Life of Lead-Acid Batteries in Remote Hybrid Power System
- **IEEE 1661-2019** [41] - Guide for Test and Evaluation of Lead-Acid Batteries used in Photovoltaic (PV) Hybrid Power System

3.6 Standards and Protocols Concerning Building Energy Management System (BEMS) and Home Automation

- **ISO 17800: 2017 [**42] - Facility Smart Grid Information Model
- **Open Building Information Exchange (oBIX)** [43]
- **IEEE 802.15.4** - Draft Standard for Low-Rate Wireless Network [44]

3.7 Cybersecurity standards

- **IEC 62351:2020** [45] - Power systems management and associated information exchange - Data and communications security
- **ISO/IEC 27001:2013 [**47] - Information security management systems
- **ISO/IEC 27002:2017** [48] - Code of practice for information security control
- **ISO/IEC 27019:2017** [49] - Information security controls for the energy utility
- **ISO/IEC 30111:2019** [50] - Vulnerability handling processes
- **ISO/IEC 15408** [51-53]
- **IEEE 1686 – 2013** [51] – IEEE Standard for Intelligent Electronic Devices (IEDs) Cybersecurity Capabilities
- **P1402** [55] – IEEE Draft Guide for Physical Security of Electric Power Substation
- **IEEE 1711-2010** [56] – IEEE Trial Use Standard for a Cryptographic Protocol for Cyber Security of Substation Serial Links
- **IEEE 1711.2-2019** [57] – IEEE Standard for Secure SCADA Communications Protocol (SSCP)
- **IEEE PC37.240** [58] Standard for Cyber Security Requirements for Substation Automation, Protection and Control System
- **ANSI/ISA- 99** [59] - Security for Industrial Automation and Control System
- **NERC CIP-002 and CIP-003 to CIP-009** [60] - Cyber Security - Critical Cyber Asset Identification

3.8 Standards concerning energy market

- **IEC 62325** [61-72] – Framework for Energy Market Communication

3.9 Blockchain technology standardisation

- **IEEE P2418.5** [78]– Standard for Blockchain in Energy
- **IEEE P2418.1** [79] – Standard for the Framework of Blockchain Use in Internet of Things
- **IEEE P2418.2:2020** [80] – IEEE Approved Draft Standard Data Format for Blockchain System
- **IEEE P2140.1** [75] – Standard for General Requirements for Cryptocurrency Exchanges
- **IEEE P2140.2** [75] – Standard for Security Management for Customer Cryptographic Assets on Cryptocurrency Exchanges
- **IEEE P2140.4** [75] – Standard for Distributed/Decentralized Exchange Framework using DLT (Distributed Ledger Technology)
- **IEEE P2141.3** [75] – Standard for Transforming Enterprise Information Systems from Distributed Architecture into Blockchain-based Decentralized Architecture
- **IEEE P2144.1** [74] – Standard for Framework of Blockchain-based Internet of Things Data Management
- **IEEE P2144.2** [74] – Standard for Functional Requirements in Blockchain-based Internet of Things Data Management
- **IEEE P2144.3** [74] – Standard for Assessment of Blockchain-based Internet of Things Data Management

The following chapters (4, 5 & 6) describe the standards that are used in each demo site, or are suitable for use in each demo site if a standard based implementation was chosen.

4 Standards used in the Italian demo

In this chapter we describe the standards that are chosen to be more deeply evaluated for possible application or are the frontrunners to be chosen for the Italian demo

4.1 Standards per technical area

In this subchapter, the standards that are considered as to be evaluated in the Italian demo are described divided per technical area they apply to, taking into account the list of main technical standards reported in D6.1 [54] as reference and suggestions. It should be noted that, in the current phase, the Italian Demo subsystem solution is under design and the single component is under identification; the final solution adopted will be detailed and described in the next WP3 Technical report (in supporting report to Deliverable 3.3. “Delivering of technology (v1)” and in Deliverable 3.2 “Report of optimal communication solutions between customer database and marker players” and 3.6 “Report on first integration activity in the field”,

4.1.1 SCADA communication

In the Italian Demo, SCADA communication fulfils accordingly to IEC 60870-5 [2] standard. The IEC 60870-5 standard is a protocol for sending basic remote control messages from a master station to other outside located and stations that are connected via a permanent communication infrastructure.

It is used for all UCs foreseen in WP3 (IT-1 and IT-2 / Voltage violation management and Congestion management) since it allows communication between Peripheral Units (UPs), installed in the primary or secondary substations, and the SCADA central system. In detail, UPs located in secondary substations communicate to SCADA using protocols IEC 60870-5-101 [3] and IEC 60870-5-104 [5].

Some data collected by SCADA are then made available to the DSO Technical Platform that uses them, together with other historical data, to perform forecasting estimation. Moreover, SCADA collects additional data concerning electrical model of the grid coming from other Operational Systems (e.g. the ones provided by GIS) and makes them available to the DSO Technical Platform. These communications could be put in place through non-standardized protocols.

4.1.2 DMS, EMS and DRMS

In the Italian Demo the main DMS, EMS (in DSO domain) and DRMS functionalities are integrated in the DSO TP,

The DSO TP performs several functions. The most important are the following:

- Estimation of the forecasting status of the grid,
- Calculation of local flexibility services request,
- Assessment of flexibility offers with grid constraints,
- Sending of activation orders.

With reference to the Distribution Management Systems (DMS) and Energy Management Systems (EMS), the CIM (Common information model) IEC 61970 [10], 61968 [11] standards can apply.

To do this, the DSO Technical Platform needs to exchange data with other Operational Systems (like GIS, Metering Infrastructures, SCADA etc.) and to external Platforms and Systems (e.g. Shared Customer Database, Customers’ EMS).

Generally, the abovementioned systems use different interfaces and run-time environments and IEC 61968 [11] could be used to define some standardized solutions to enable the data exchanges. In general, IEC 61968 [11] is the first part in a series of standards that define interfaces for the major elements of an interface architecture for Distribution Management Systems. It identifies and establishes requirements for standard interfaces based on an Interface Reference Model. This set of standards is limited to the definition of interfaces and is implementation independent; it provides for interoperability among different computer systems, platforms, and languages. Therefore, it can provide a suitable standard for the implementation of interfaces among the different devices used in the Italian demo.

Concerning DERs, also IEC 61970 standard could be used to define data model and to implement functions for Energy Management.

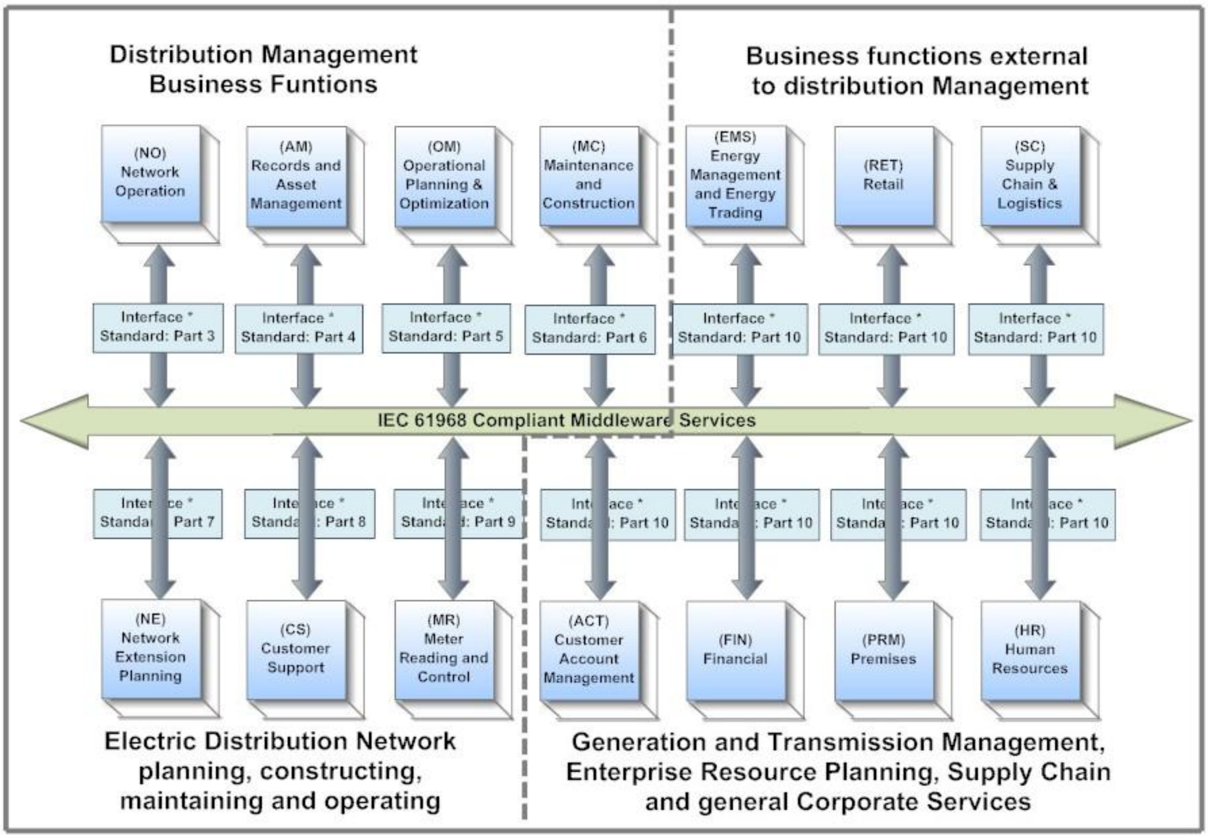

Figure 2: Proposed IEC 61968 Standard Based Utility Architecture as referred from IEC Standard Documents [11]

Communication methods/protocols that could be used in the Italian Demo include: Topic Kafka [97], REST-API [96] and MQTTs [95].

It should be noted that the modality with which and the standards in compliance to which (or not standardized solutions) the Customer's EMS manages controlled device and systems are out of Demo battery limits.

Both DMS and EMS are currently under design. In compliance with the functionalities defined, these systems will use proper protocols interfaces and interworking processes (e.g. the ones listed in D6.1).

4.1.3 AMI and Light Node

Within the Italian Demo, with reference to the Advanced Metering Infrastructure (AMI), the IEC 62056 [13] standards for Electricity Metering applies, defining data exchange for meter reading, including data models and communication media specific protocols. In general, the IEC 62056 standards suite is the international standard versions of the DLMS/COSEM suite [13]. DSLM/COSEM is a global standard for smart energy metering, control and management, which lies in application layer and includes smart metering.

Indeed, in the Italian Demo, data from Smart Meter are made available to the low voltage Customer through the Light Node. Specifically, Smart Meters 2G (2nd generation) send data to Light Node using PLC-C communication according to Italian technical standard CEI 13-83 and CEI 13-85 (developed in compliance with protocol DLMS/COSEM in accordance with EN 62056-7-5 [13]).

In the same way, the medium voltage customers involved in the Demo are equipped with other types of Smart Meter that send data to the Light Nodes through an additional device, called UPM (Unit Peripheral

Monitoring) owned by the customer. In this case communication between Light Node and UPM is performed by Modbus TCP communication and the protocol will be probably MQTT.

Moreover the Light Nodes, that are blockchain infrastructure entities with reduced functionality compared to full nodes, send and receive messages through the MQTT protocol based on ISO/IEC 20922.

The set point, to execute a flexibility order, is made available by Light Node to customers or customer systems (such EMS) by different solutions, including Modbus RTU/TCP, Ethernet, MQTT [95] and REST-API (HTTP) [96].

Data gathered by Light Node will be sent also to the Shared Customer Database by means of MQTTs, REST-API and Apache Kafka topics through multi-band communication (e.g. LTE/HSPA+/UMTS/GPRS/GSM). Apache Kafka is a platform for processing of data streams or records and a topic is a category or feed name to which records are published.

4.1.4 Battery Storage and Energy Storage Systems

Referring to Energy Storage, within the Italian Demo, it is foreseen that some flexible resources consist of Battery Storages and Electrical Vehicle Charging Systems.

It should be noted that the standards (or not standardized solutions) mentioned here concern only data exchange between Light Node and relevant Customer EMS (Battery Storage Management System or Electrical Vehicle Charging Systems). Standards and solutions used at customer's level (or better downstream the Light Node) from Customer EMS to Customer systems/applications will depend from the specific customer's equipment

On this base, the same indications available in paragraph 4.1.3 are valid here, too. Moreover, concerning Electrical Vehicle Charging System, OCPP (Open Charge Point Protocol) [94] will be taken in consideration. OCPP is an application level protocol for communication between EVs charging stations and a central management system.

Some of the most established options for application level standards on energy storage is the IEC 62933 [32-34] suite which includes definitions for unit parameters, test methods, planning, installation, safety and environmental issues.

4.1.5 BEMS

Concerning Building Energy Management Systems (BEMS), the same indications reported in chapter 4.1.3 are valid below the application layer. Regarding the application layer (meaning BEMS specific functionalities) ISO 17800 [42] is a promising standard which applies to single - and multi-family homes, commercial and institutional buildings, and industrial facilities that is independent of the communication protocol in use. Another valid options is oBIX [93], which is a XML and Web Services guideline to facilitate the exchange of information between intelligent buildings, enable enterprise application integration and bring forth true systems integration.

4.1.6 Cybersecurity

Concerning communication between Smart Meter 2G and Light Node, the use of encryption algorithms, authentication and non-copyability methods, in compliance with the IEC 62056-5-3 [13].

For information exchanges between market players (Market, System Operators and Aggregator) the IEC 62325 standard could be considered. IEC 62325 [62-72] is a framework for energy market communication.

4.1.7 Energy Market

With reference to the Energy market and the Italian Demo use cases, the IEC 62325 [62-72] – Framework for Energy Market Communication standard can be examined. The IEC CIM 62325 is currently under development by IEC TC 57 (Power System Management and Associated Information Exchange). It aims at providing a series of standards for the exchange of data in the context of a deregulated energy markets, for both the European and North American paradigms.

4.1.8 Blockchain Technology

The Italian Demo foresees the application of blockchain technology at the level of both Blockchain Access layer and Blockchain service layer.

The following standards could apply to both the Italian Demo use cases:

- IEEE P2418.5 [78] Standard for Blockchain in Energy, providing an open, common, and interoperable reference framework model for blockchain in the energy sector. It also covers three aspects: 1). It serves as a guideline for Blockchain use cases in Electrical Power industry; Oil & Gas industry and Renewable energy industry and their related services. 2) It creates standards on reference architecture, interoperability, terminology, and system interfaces for blockchain applications in Energy sector by building an open protocol and technology agnostic layered framework. 3) It evaluates and provides guidelines on scalability, performance, security, and interoperability through evaluation of consensus algorithm, smart contracts, and type of blockchain implementation, etc. for the Energy sector.

<u>With reference to the BC Access Layer:</u>

- IEEE P2418.1 [79] Standard for the Framework of Blockchain Use in Internet of Things, with reference to scalability, security and privacy challenges with regard to blockchain in IoT. Blockchain tokens, smart contracts, transaction, asset, credentialed network, permissioned IoT blockchain, and permission-less IoT blockchain are included in the framework;
- IEEE P2144.1 [85] Standard for Framework of Blockchain-based Internet of Things Data Management
- IEEE P2144.2 [86] Standard for Functional Requirements in Blockchain-based Internet of Things Data Management
- IEEE P2144.3 [87] Standard for Assessment of Blockchain-based Internet of Things Data Management

4.2 Standardization gaps

No relevant standardization gaps are highlighted with reference to the functionalities foreseen in the Italian Demo System.

4.3 Special considerations

The technical standards analysis led within WP6 will facilitate the assessment by Italian Demo partners of main existing standards, the definition of standards to be possibly applied with respect to the aforementioned technical areas and the identification of further elaboration or standards that do not apply to any of the described areas

5 Standards used in the Greek demo

In this chapter, the standards that are of very close relevance to the field trial that will take place in Mesogia, in Greece, are discussed. The discussion in this chapter is not always about standards and standardization efforts which will be implemented during the field trial. This means that some of the standards discussed here are well suited for the functionalities that are part of the demo but are not part of the features list either due to being out of the scope of the demo, their implementation cannot be performed for technical reasons.

5.1 Standards per technical area

In this chapter, the standards of the Greek demo are discussed.

5.1.1 SCADA communication

The IEC 60870–5 [4,5] and the IEC 60870–6 [6] standards are applied to all use cases of the Greek demo. Distribution Network measurements coming from the SCADA system of HEDNO are to be used in all use cases and they are communicated to other systems/devices/tools (e.g. DSO Data Server) according to the IEC 60870 – 5 and the IEC 60870 – 6.

The Greek demo will use measurement coming from HEDNO's SCADA systems to feed a state estimation tool with the necessary information in order to obtain a reasonably accurate state of the distribution network. These measurements will be enhanced with PMU devices, which output will also feed the state estimation tool.

The IEC 60780 [2-6] suite is a standard that applies to both application and protocol layers, which makes it suitable for exchanging data and telecontrol messages. According to the use cases planned by HEDNO, no telecontrol messages will be sent out in the Greek demo.

Regarding the PMU units, as discussed in Deliverable 6.1, standards IEEE C37.118.1-2011 on synchrophasor measurements [7] and IEEE C37.118.2-2001 on synchrophasor communication [8] are of strong relevance to Platone and the Greek demo. IEEE C37.118.1-2011 defines synchrophasors, frequency, and rate of change of frequency (ROCOF) measurements all of which are information that can greatly enhance the accuracy of state estimation algorithms when available. The fact that the standard can be of relevance to PMUs, that are standalone devices, makes it relevant to the Platone implementation where standalone PMUs will be installed in Mesogia.

5.1.2 DMS and EMS

In the centre of a discussion on management of electrical networks lies the CIM, an application level ecosystem. In its foundation an ontological framework, it encapsulates IEC 61970 [10] and IEC 61968 [11] which are of great relevance to the applications of the Greek demo as it was the case with the Italian demo.

IEC 61968 [11] is a standard suite under development that defines interfaces for the major elements of an interface architecture for Distribution Management Systems. Being an inherent suite of the ontologically oriented CIM, it defines several packages and objects that for DMS that are relevant to the Greek demo.

Under the Customer package, a number of objects such as pricing structure and tariff are of importance, as they include signals which RES and their Aggregators take into account when considering maximising their profit for exploiting those aforementioned resources. As is described in D4.1 [73], the focus of the Greek demo is to provide suitable tariffs for network use to Aggregators operating in a distribution network. In an end to end implementation of the UC-GR-3,4, where a real Aggregator, operating under a functional wholesale market and actual billing practices, exists, such information exchanges on pricing of electricity could be served by IEC 61968. Therefore, the standardization space on these matters is sufficient.

Expanding on the same discussion, the network usage prices or tariffs send in UC-GR-3,4 are covered by IEC 61968 package on Payment Metering with objects such as TariffProfile.

Regarding EMS and IEC 61970 on Energy Management, they are is no plan on the Greek demo to use energy resources on top of any flexibility achieved by network tariffs. However, it is a reasonable extension of such a train of thought to considering expanding the idea of network tariffs by considering the synergies between customers' cost driven flexibility with additional energy dominated flexibility provided by propriety resources directly controlled by a DSO. In such a case, IEC 61970 would the appropriate choice of protocol.

5.1.3 AMI

The IEC 62055 and the IEC 62056 standards are applied to all use cases of the Greek demo. Data from the smart meters of MV customers are collected and transferred to the corresponding HEDNO's telemetering system in compliance with the IEC 62055 and the IEC 62056 standards, to be then communicated to other systems/devices/tools (e.g. DSO Data Server) for the use cases' implementation.

5.1.4 DRMS

Demand response is one of the most central themes of the Greek demo. In the Greek demo, the most import element of flexibility hypothesized is that coming from demand that is flexible and can be shifted to different hours of the day. This central theme is covered most broadly from the OpenADR standard [91] outlined in D6.1. Not only relevant to DR as it covers DERs too, it provides a standardization suite that orbits some of the most basic ideas of the Greek demo. Not only it covers dynamic price and reliability signals, but it does so in the objective of cost minimization and energy efficiency. It is, therefore, a standard that should be shortlisted by applications that are close to the Greek demo.

Despite the undeniable relevance of OpenADR, two important distinctions have to be made. In the Greek demo value signals (tariffs) exchanged between the DSO and Aggregators are not energy value signals. This means that the DSO is not trying to directly dictate the value of energy to the Aggregators by the network tariffs exchanged, like a locational price would do. Instead, it indirectly tries to effect decisions by indicating the value of network usage, which differs from energy value. In addition, it is constrained by more requirements than a traditional energy value. Therefore, technically, the Greek demo network price signals are not covered by OpenADR, according to our understanding. This is expected as the Greek demo is implementing a novel concept. Furthermore, no other standard explicitly defines the Greek demo flexible network price signal approach, to the best of our knowledge.

Despite of the aforementioned observation, OpenADR can serve as a suitable framework for DR approaches similar to the Greek demo and can be launching a discussion for expanding the standardization efforts towards the concepts defined by the Greek demo in future standardization efforts.

5.1.5 Battery Storage and Energy Storage Systems

Battery and storage systems are not used by the Greek demo.

5.1.6 BEMS

Due to Aggregators being simulated entities in the Greek demo, it is out of the scope of the Greek demo to dive further into building energy management applications. The demand that is flexible in the Greek demo is of the generic load type that is best represented by conventional industrial loads for the most part. In case the discussion is expanded to commercial loads such as large market facilities, etc., standards like ISO 17800: 2017 [42] and oBIX [93] are relevant to the topic.

5.1.7 Cybersecurity

IEC 62351 [45]: This standard is associated with data and communication security. In the Greek demo, it defines data communication security in power systems management and associated information exchanges and information security as applied to power system operations.

ISO 27001 [47] for information security. In particular, the ISO 27001 standard functions as a framework for HEDNO's information security management system (ISMS). This includes all policies and processes relevant to how data is controlled and used. For the Platone project the Cybersecurity standards are used throughout the demo, in all use cases, mainly for the use and management of data stored in the DSO data server.

5.1.8 Energy Market

The Greek demo makes some very specific assumptions regarding the market functions that will be considered. Despite that any market interactions are simulated, due to the Greek target model roll-out not being fully completed, a competitive electricity market with various time frames is assumed. This means that the use cases are formulated in an environment where the Day-Ahead (DA) electricity market is deployed and the Aggregator entities participate freely in the market. In the Greek demo context, the only obligation of the Aggregators is to “pay” a flexible network price to which they react in a rational manner.

Furthermore, a frequency restoration reserve (FRR) market is assumed in UC-GR-4. This market is of a few minutes time frame, typical of FRR products.

To the end described above IEC 62325 [61-72] is the standard of choice that suits best the occasion. Also, part of CIM (like IEC 61968 [11] and IEC 61970 [10]) is a standard for the exchange of data required by deregulated electricity markets, just as the one assumed in the Greek demo.

As stated before, and in D4.1, a deregulated market where the Aggregator participates freely is assumed in order to model the behaviour of said Aggregator. This means that for the Greek demo the market is a vital indirect input to the methods used in UC-GR-3,4. The detailed description of the market impacts the quality of the Aggregator model used by the method to discover the most efficient dynamic network tariffs. Therefore, although in itself market messages are not exchanged, the market context, including standardization aspects, are of high importance.

5.1.9 Blockchain Technology

The Greek Demo will use the Platone Blockchain Access Platform provided by ENG, based on blockchain and smart contracts technology for ensuring energy data provenance and energy data immutability. In particular all the data coming from the network will be registered as blockchain transactions and then provided to DSOTP.

The blockchain technology is still a very new technology and in a preliminary phase of adoption, especially in the energy domain but some initiatives have already been born that aim to define standards to be adopted, in particular the IEEE blockchain initiative and ISO standards.

The Platone Blockchain Access platform already adopts the most used and (de facto) standardised solutions in the field of blockchain technology and smart contracts development but ENG will investigate on the possible use of the following standards in the Greek Demo:

- IEEE P2418.5 [78] Standard for Blockchain in Energy, providing an open, common, and interoperable reference framework model for blockchain in the energy sector. It also covers three aspects: 1) and serves as a guideline for Blockchain use cases in Electrical Power industry; Oil & Gas industry and Renewable energy industry and their related services. 2) It creates standards on reference architecture, interoperability, terminology, and system interfaces for blockchain applications in Energy sector by building an open protocol and technology agnostic layered framework. 3) It evaluates and provides guidelines on scalability, performance, security, and interoperability through evaluation of consensus algorithm, smart contracts, and type of blockchain implementation, etc. for the Energy sector.
- IEEE P2418.1 [79] Standard for the Framework of Blockchain Use in Internet of Things, with reference to scalability, security and privacy challenges with regard to blockchain in IoT. Blockchain tokens, smart contracts, transaction, asset, credentialed network, permissioned IoT blockchain, and permission-less IoT blockchain are included in the framework;

ISO/TR 23455:2019 [92] Blockchain and distributed ledger technologies — Overview of and interactions between smart contracts in blockchain and distributed ledger technology systems.

5.2 Standardization gaps

The most import standardization consideration raised by the first year of the Greek demo efforts is the undefined standardization aspects of a flexible network usage tariff. In the context of the Mesogia field trial, the interaction where such tariffs are exchanged are between DSO and Aggregator. It can be argued that an interaction between DSO and a DER operating independent of an Aggregator portfolio is a similar case. To the best of our knowledge, network tariff interactions are not covered explicitly by any standards at the moment.

5.3 Special considerations

,The standards mention in this chapter are a discussion compiled by the partners involved in the Greek demo aiming at giving their outlook on how the standardization ecosystem aligns with the functionalities and concepts implemented or evoked in the Greek demo. The discussion is not binding for the demo leader to use the aforementioned demos for the field trial.

6 Standards used in the German demo

In this chapter the standards that are implemented or are singled out as best serving the functionalities described in the German use cases are outlined. The standards are related with the use cases of the German demo when possible.

6.1 Standards per technical area

Following with the format of D6.1 the standards are broken down by technical field. All 4 use cases share the same platform and elements and as such all standards mentioned apply to all use cases in Germany alike.

6.1.1 SCADA communication

At the current stage no direct connection to SCADA is foreseen in the scope of the German demo. If a connection to SCADA is realized at a later stage, the interface will utilize the inter control centre protocol ICCP also known as Telecontrol Application Service Element 2 (TASE.2) (IEC 60870-6-503/802/702 apply [2]). As described in D6.1 [54], IEC 60870-6 [6] is part of the IEC 60870 suite that which define systems used for telecontrol (supervisory control and data acquisition) in electrical engineering and power system automation applications.

6.1.2 DMS and EMS

The ADMS / EMS will be a new development for the purpose of Platone field testing. The ADMS, coined Avacon Local Flex Controller or ALF-C will be hosted in an MS Azure environment and interface with the metering infrastructure in the field and controllable elements. ALF-C will employ

- MQTT for data exchange with Platone Technical Platform and Blockchain Access Platform
- Python as programming language for control algorithms
- HTTP/HTTPS to engage webservices via REST API to gather weather data and interface with domestic batteries
- MODBUS TCP to interface with the Large Battery Energy System

For the implementation of the ALF-C, the CIM of IEC 61970/61968 [10,11] could serve as a frame of reference on which to expand given their relation to energy and distribution management. In the German demo, use cases UC-GE-1,2 aim at using DERs to achieve specific targets of energy exchange between a feeder and the MV network (zero in UC-GE-1 and non-zero in UC-GE-2). In both cases, ALF-C can rely on especially IEC 61968 [11] for implementing the required control decisions derived from it.

6.1.3 AMI

It is currently planned to deploy phasor measurement units to measure and track the energy exchange at the secondary substation and select customer households. The PMUs will apply IEC 61850-90-5 [2] and are also capable of implementing MQTT [95] standard to collect and communicate data.

6.1.4 DRMS

The involvement of DRMS is not assured at this stage. If flexible demand can be included, it will be in the form of heat-pumps, likely to be integrated via a vendor-operated cloud-based backend which ALF-C can access using a REST API [96].

The distributed resources used in all four German use cases can be managed using a standard such as OpenADR [91]. This standard with cooperation with the DMS related standards can provide the full range of functionalities of the German demo.

6.1.5 Battery Storage and Energy Storage Systems

Both the Large BESS (LBES) and domestic batteries (DBES) on customers premises are currently planned to connect through web-based APIs owned and operated by the respective battery vendor.

Communication of data and control signals for the LBES will be based on MODBUS TCP protocol as defined in IEC 61158 and handled through an API. The control of the system in all use cases (adjusting the battery setpoint to maintain a certain value for the power exchange across the grid-transformer) can be done via OPC-UA, BAC-NET, IEC 60870-5-103/4 [4,5], with the latter being the most likely solution for this project. The connection to DBES remains unclear at this stage, possible solutions include interfacing via an API and employing MODBUS TCP protocol.

Beyond the communication standards, the battery system is designed in compliance with the following standards:

- IEC 61439-1 [90] – Low voltage switchgear and control gear assemblies
- IEC 61000-6-2:2016-05 [89] – Generic standards – Immunity standard for industrial environments
- IEC 61000-6-4:2011-09 [89] – Generic standards – Emission standard for industrial environments
- IEC 61619 [88] – Safety requirements for secondary lithium cells and batteries, for use in industrial applications
- UL 1642 [81] – Standard for Lithium Batteries
- UN 38.3 [82] – Transport of dangerous goods – Lithium batteries
- 2014/35/EU [83]– Low voltage directive
- 2014/30/EU [84] – Electromagnetic Compatibility Directive
- 2006/66/EU [77] – Batterien und Akkumulatoren sowie Altbatterien und Altakkumulatoren (…)
- CSC [76] – International Convention for Save Containers, IMO
- CE – Conformity with health, safety and environmental protection standards for products sold within the European Economic Area

6.1.6 BEMS

BEMS are not in the scope of the German demo.

6.1.7 Cybersecurity

The German demo is not planning on actively engaging with the cybersecurity standardization ecosystem.

6.1.8 Energy Market

The German demo does not consider an energy market context, but instead focuses on energy communities. To the best of our knowledge no energy communities' standards exist as of 2020.

6.1.9 Blockchain Technology

The German Demo will use the Platone Blockchain Access Platform and Platone Shared Customer Database (SCD) provided by ENG, for ensuring energy data provenance and energy data immutability as well as for implementing grid control mechanisms based on smart contracts technology.

In particular all the data coming from the network will be registered as blockchain transactions, stored on SCD and then provided to the DSP Technical Platform (DSOTP). On the other hand, setpoint coming from EMS via DSOTP will be registered and certified by the blockchain and sent to the network.

The Platone Blockchain Access platform already adopts the most used and (de facto) standardised solutions in the field of blockchain technology and smart contracts development but ENG will investigate on the possible use of the following standards in the German Demo:

- IEEE P2418.5 [78] Standard for Blockchain in Energy, providing an open, common, and interoperable reference framework model for blockchain in the energy sector. It also covers three aspects: 1) and serves as a guideline for Blockchain use cases in Electrical Power industry; Oil & Gas industry and Renewable energy industry and their related services. 2) It creates standards on reference architecture, interoperability, terminology, and system interfaces for blockchain applications in Energy sector by building an open protocol and technology agnostic layered framework. 3) It evaluates and provides guidelines on scalability, performance, security, and interoperability through evaluation of consensus algorithm, smart contracts, and type of blockchain implementation, etc. for the Energy sector.

- IEEE P2418.1 [79] Standard for the Framework of Blockchain Use in Internet of Things, with reference to scalability, security and privacy challenges with regard to blockchain in IoT. Blockchain tokens, smart contracts, transaction, asset, credentialed network, permissioned IoT blockchain, and permission-less IoT blockchain are included in the framework;
- ISO/TR 23455:2019 [92] Blockchain and distributed ledger technologies — Overview of and interactions between smart contracts in blockchain and distributed ledger technology systems.

6.2 Standardization gaps

So far, the German demo has not identified any gaps.

6.3 Special considerations

No special considerations have been identified. As with the other two demos, any suggestions made in this chapter are binding for the German demo and merely serve as reference for similar activities.

7 Conclusion

This deliverable provided a thorough inventory of the relationship between the Platone project and its field trials and the standardization ecosystem. One of the most import benefits from a demonstration-focused project is that different concepts are implemented close to end-to-end in real-life conditions. This implementation provides multiple opportunities for testing of concepts, mainly for deriving useful practical experience. However, another benefit is the creation of an environment where the standardization ecosystem has to be examined because the need for developing technical solutions demands it. This report registered the standards that align to the use cases that will be implemented in the three demonstrations of Platone. By align is meant here not that all standards reported here will be used in the implementations, but that the demo leaders with the support of the WP6 leader made an extensive discussion on the functionalities invoked in the demos and framed the result of this discussion as a useful reference document on standards for Platone and similar projects.

The Italian demo chapter discussed a number of subjects of standards such as SCADA communications, DMS/EMS systems and Blockchain technology. Especially in Blockchain technology, where the Italian demo has the most extensive application, with suites such as IEEE P2418.1 and IEEE P2144.1-2-3.

The Greek demo chapter focused more on issues such as metering infrastructure, demand response, markets and tariffs. The metering subjects was discussed in relation to the SCADA aspect and standards used in the existing infrastructure operated by the demo leader, such as IEC 60870. On the AMI aspect, the infrastructure employs IEC 62055, 62056. Regarding demand response, the Greek demo suggested the OpenADR suite which covers topics such as price signals. On the aspect of markets and tariffs, the Greek demo identified IEC 62325 for the overall framework under which the demo use cases operate and singles out the lack of standardization coverage on network usage specific tariffs as a potential standardization gap.

Finally, in the German demo chapter, one of the highlights was the discussion on the standards that will be used on the battery storage applications of the German demo, with the list being quite extensive.

8 List of Figures

9 List of References

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10 List of Abbreviations

Abbreviation	Term
AMI	Advanced Metering Infrastructure
ANSI	American National Standards Institute
API	Application Program Interface
BEMS	Building Energy Management System
BESS	Battery Energy Storage System
CIP	Critical Infrastructure Protection
CIM	Common Information Model
CIS	Customer Information Systems
COSEM	Companion Specification for Energy Metering
DA	Distribution Automation
DER	Distributed Energy Resources
DLT	Distributed Ledger Technology
DMS	Distribution Management System
DNP	Distributed Network Protocol
DR	Distributed Resources
DRMS	Demand Response Management Systems
DSO	Distribution System Operator
EESS	Electrical Energy Storage System
EES	Electrical Energy Storage
EMS	Energy Management System
EPS	Electric Power System
EV	Electric Vehicle
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
HEDNO	Hellenic Electricity Distribution Network Operator
HW	Hardware
ICT	Information and Communication Technology
IEC	International and Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineering
ISA	Industrial Automation
ISMS	Information Security Management System
ISO	International organization for Standardization
IT	Information Technology
ITU-T	Telecommunication Standardization Sector

LAN	Local Area Network
LV	Low Voltage
MAC	Medium Access Control
MAN	Metropolitan Area Network
MV	Medium Voltage
NEMA	National Electrical Manufacturers Association
NERC	North American Electric Reliability Corporation
NTUA	National Technical University of Athens
oBIX	Open Building Information Exchange
P2P	Peer to Peer
PDL	Permission Distributed Ledger
PHY	Physical Layers
PLC	Power Line Communication
PMU	Phasor Measurement Unit
PV	Photovoltaic
RES	Renewable Energy Source
ROCOF	Rate of Change of Frequency
RTU	Remote Terminal Unit
RS	Recommended Standard
SCADA	Supervisory control and Data Acquisition
SMS	Short Message Service
SSCP	Secure SCADA Communication Protocol
STS	Standard Transfer Specification
SW	Software
TCP	Transmission Control Protocol
TR	Technical Report
TSO	Transmission System Operator
WAN	Wide Area Network
WPAN	Wireless Personal Area Network
XML	Extensible Markup Language