Report on Extended Data, Platform and Service Interoperability

D5.6

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About OneNet

OneNet will provide a seamless integration of all the actors in the electricity network across Europe to create the conditions for a synergistic operation that optimizes the overall energy system while creating an open and fair market structure.

The project OneNet (One Network for Europe) is funded through the EU's eighth Framework Programme Horizon 2020. It is titled "TSO – DSO Consumer: Large-scale demonstrations of innovative grid services through demand response, storage and small-scale (RES) generation" and responds to the call "Building a low-carbon, climate resilient future (LC)".

While the electrical grid is moving from being a fully centralized to a highly decentralized system, grid operators have to adapt to this changing environment and adjust their current business model to accommodate faster reactions and adaptive flexibility. This is an unprecedented challenge requiring an unprecedented solution. For this reason, the two major associations of grid operators in Europe, ENTSO-E and EDSO, have activated their members to put together a unique consortium.

OneNet will see the participation of a consortium of over 70 partners. Key partners in the consortium include: already mentioned ENTSO-E and EDSO, Elering, E-REDES, RWTH Aachen University, University of Comillas, VITO, European Dynamics, Ubitech, Engineering, and the EUI's Florence School of Regulation (Energy).

The key elements of the project are:

1. Definition of a common market design for Europe: this means standardized products and key parameters for grid services which aim at the coordination of all actors, from grid operators to customers;
2. Definition of a Common IT Architecture and Common IT Interfaces: this means not trying to create a single IT platform for all the products but enabling an open architecture of interactions among several platforms so that anybody can join any market across Europe; and
3. Large-scale demonstrators to implement and showcase the scalable solutions developed throughout the project. These demonstrators are organized in four clusters coming to include countries in every region of Europe and testing innovative use cases never validated before.

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List of Abbreviations and Acronyms

Acronym	Meaning
API	Application Programming interface
BO	Business Object
CDPSM	Common Distribution Power System Model
CGMES	Common Grid Model Exchange Standard
CIM	Common Information Model
CRUD	Create Read Update Delete
DEP	Data Exchange Platform
DSO	Distribution System Operator
ESMP	European Style Market Profile
FSP	Flexibility Service Provider
IDSA	International Data Space Association
LD	Linked Data
MO	Market Operator
SGAM	Smart Grid Architecture Model
SV	State Variable
TSO	Transmission System Operator
TLS	Traffic Light System
PNP	Plug-n-Play

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Executive Summary

This report aims to have two core purposes: Firstly, it designates the appropriate formal semantic vocabularies for the data sources to be integrated into the OneNet Interoperable Network of Platforms, which will support the OneNet collection of cross-platform services (i.e., formally defined by Task 5.3). Therefore, this report will describe the methodological approach followed to collect the business objects that are set in place to describe each OneNet cross-platform service. This effort to provide the necessary data profiles takes into consideration the alignment with existing standard IEC profiles. In this way, the semantic definition based on harmonized data profiles provides extended data interoperability on this broad list of OneNet cross-platform services. This report provides the first effort of matching the identified (i.e., from cross-platform services) business object with existing data profiles, providing also insights and recommendations for the necessity in certain cases to enhance IEC standard profiles.

The second element aims to discuss the service interoperability of OneNet cross-platform services by providing their generalized definition in the form of rest-based APIs. The conceptual description of a request/response API is provided in this report based on the IDSA key principles among connector data exchanges.

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1 Introduction

This chapter presents the general context of T5.6 as well as its placement and interdependence with the activities of WP5. In addition, a detailed description of the structure and objectives of this document is provided.

1.1 OneNet scope

The OneNet will create a fully replicable, open, flexible and scalable architecture that enables the whole European electrical system to operate as a single efficient system in which a variety of markets allows the universal participation of stakeholders regardless of their physical location, at every level from small consumer to large producers. Also, by clearly defining stakeholder interactions and bringing all possible data exchanges to a European level of harmonization it will fully unlock markets at every level and expand the possibilities for real commercial exploitation.

The OneNet results will be:

- A data management framework that will support flexibility markets, but also monitor and optimize the overall European electrical infrastructure
- A clear and open architecture that will enable any player to participate in innovative market structures
- A smooth integration of the grid and market operation for TSO and DSO in the innovative market structure

A new set of customer-centric business models to support next generation service-based marketsAccording to OneNet Description of Action (DoA), WP5 contributes to the direction of fulfilling the OneNet vision by striving to attain two objectives; First, to design an open conceptual architecture for effective yet seamless operation of a smarter pan-European electricity system where the market and network technical operations are coordinated closer to real-time across countries, and second to provide requirements, functional and technical specifications, together with interoperable and standardisable interfaces for an open scalable decentralized interconnection of platforms, technology agnostic adaptable and flexible IT reference architecture which fully supports the OneNet concept and provides the necessary backbone for the WP6 subsequent implementation of the OneNet data sovereignty-preserving working space. The WP5, together with WP6, act as the IT pillar of the overall OneNet project. The IT pillar is closely linked to all the other pillars of the project, as shown in Figure 1. It takes into consideration all the results provided in the Market Pillar (WP2 and WP3) as well as the Operation Pillar (WP4). In addition, the OneNet Solution, implemented in WP6 will be tested and evaluated in four (4) Demonstration Clusters and the results of the evaluation will be used for adapting, improving, and enhancing the OneNet Solution.

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WPs Interactions

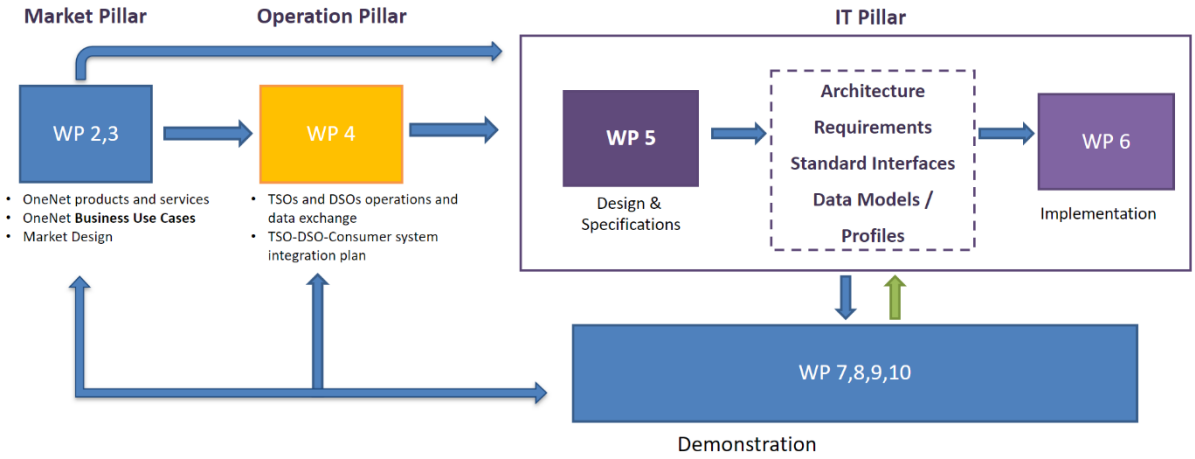

Figure 1 WP5 interdependencies

Task 5.6 within OneNet and Methodological approach

The target of this task is to devise formal semantic vocabularies for the data sources to facilitate the OneNet cross-platform services, which are formed to provide extended service interoperability all across OneNet participants. OneNetcross-platform services will form the basis for the OneNet participants, yet the catalogue will open to any additions or updates (i.e., semantic updates, usage contract). This task, then, explores a set of vocabularies that can be formalized as a set of ontologies, aiming at addressing the business and functional processes of OneNet cross-platform services. Data exchange in OneNet will rely on well-established standard data profiles, whereas in certain cases mapping into linked JSON-LD information will assume linked data principles functionalities.

The implementation of cross-platform services will use web standards (REST API) in communication protocols, a fact which is discussed in this report.

1. Methodologically, this task is organized as depicted in Figure 2. The approach followed is: The first step is to analyse the OneNet cross-platform services and derive the set of business objects that are necessary to semantically describe the functional processes to be achieved. Therefore, cross-platform services need to be semantically defined referring to specific business object(s) that have to be transacted.
2. The analysis of the business object, their sorting, correction, and merging (i.e., avoiding different business objects that are representing the same context) to refine the business object list.
3. This step refers to matching the appropriate business objects with existing IEC standards that could be utilized to describe them. For this purpose, the functional description of the cross-platform service was always kept assigned with the business object, i.e., for its proper interpretation.
4. The preliminary phase of defining OneNet harmonized data models for service interoperability relies on assigning the most appropriate IEC standard profile.

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5. Step 5, relies on the parallel work that takes over the business objects and performs GAP analysis to identify missing attributes from the data profiles.
6. Step 6 refers to the analytical data profiling process which is the enhancement of standard profiles, complemented with new additional attributes.

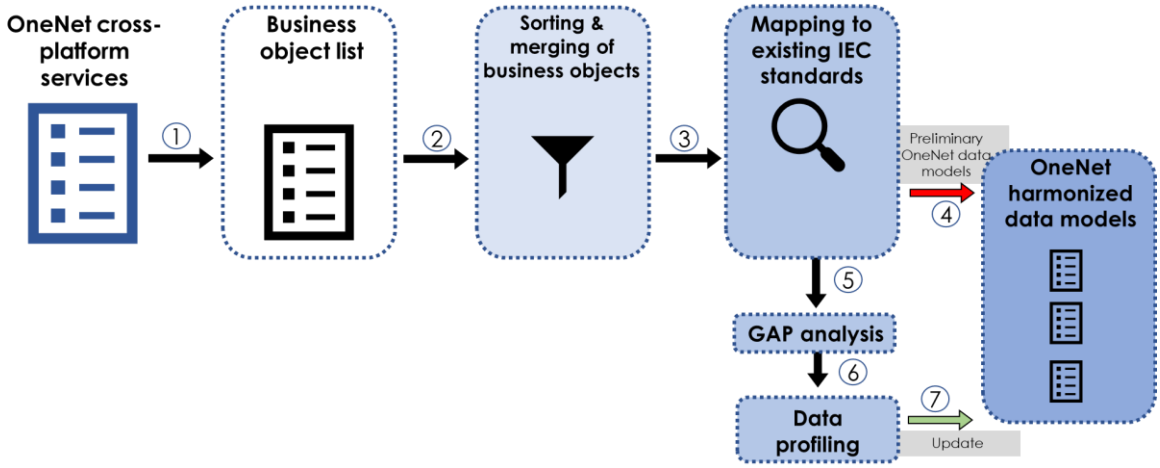

Figure 2 Methodological approach followed by Task 5.6

1.2 Report Outline

The report is structured into five main Chapters as follows:

Chapter 2 on OneNet extended services interoperability which provides an overview of the identified catalogue of OneNet cross-platform services to issue service interoperability among OneNet participants.

Chapter 3 presents the outcomes from a survey conducted to get the OneNet DSOs positioning on the adoption of harmonized/standard profiles for the different grid and market processes.

Chapter 4 discusses the main analysis of business objects and the current status of the analysis of them into mapped IEC data profiles. Some preliminary observations for the need to perform data profiling for enhancing existing profiles are also expressed. This Chapter also contains a survey conducted to capture the DSOs perspective and ensure that the data models and formats are defined regarding the functionalities that DSO information systems. Additionally, there is a specific section that assesses requirements for data exchange between DSOs and TSOs.

Chapter 5 provides the specification of data exchanges which is essentially the generalized formulation (API documentation) of cross-platform services, signifying mainly what is the general representation (i.e., a combination of connectors self-description -domain agnostic- and the payload that is the domain specific message).

Chapter 6 presents the general remarks and conclusion of the report along with the plans for the continuation of this task.

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2 OneNet extended services interoperability

The OneNet System enables interoperability among stakeholders in the energy sector, i.e., OneNet participants, in a decentralized way. Figure 3 provides an overview of the components of the OneNet System and their interfaces as defined in OneNet deliverables D5.2 and D5.3 [1]-[2]. The OneNet Connector is the key component for decentralized interoperability. It is installed locally at each OneNet Participant and enables interoperability in peer-to-peer connections with a low technological inhibition level. Furthermore, the OneNet Middleware wraps around the OneNet Connector and provides additional services to the participants that require semi-central provisioning such as data access management. As shown in Figure 3, the OneNet Middleware is part of the OneNet Framework which is complemented by the OneNet Orchestration Workbench and the OneNet Dashboard and Monitoring.

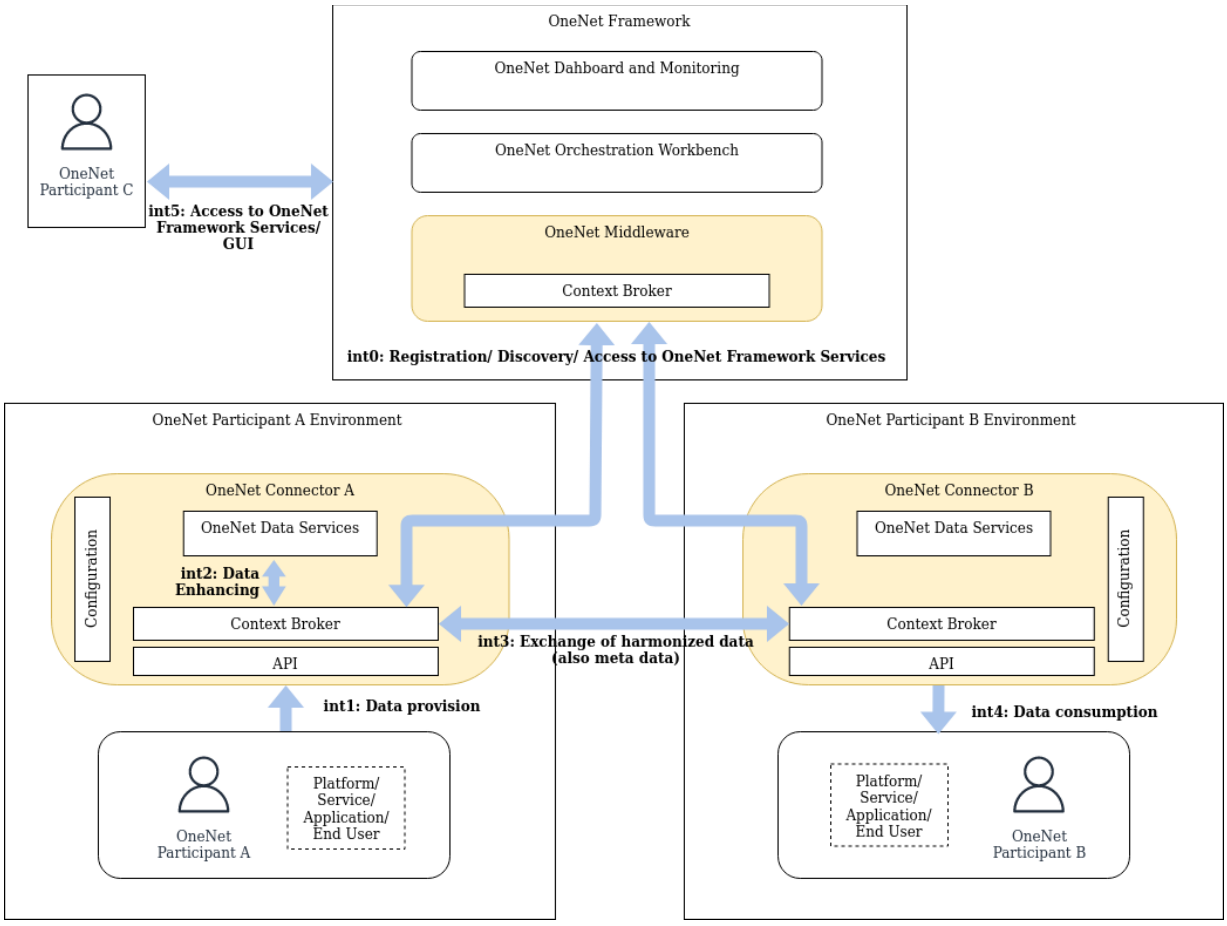

Figure 3 Overview about the components of the OneNet System and their interfaces (source: [2])

2.1 Actors, roles and cross-platform services of OneNet

In OneNet deliverable D5.3, ten categories of cross-platform services are identified based on an analysis of Horizon 2020 research projects and OneNet demonstrations. These categories are listed in Table 1. Per category,

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multiple cross-platform services have been identified in D5.3 [1]. Please refer to D5.3 for their detailed functional specifications.

The analysis of H2020 research projects and OneNet demonstrations led to an overview of roles that are active as sender or receiver of data per cross-platform service. The roles are harmonized as much as possible with the HEMRM of ebIX [3], EFET and ENTSO-E and the new roles suggested by the BRIDGE Regulation Working Group. Table 1 lists which roles are potentially active in which cross-platform service category. Roles marked with a "(B)" belong to the BRIDGE role model. A detailed definition of each role including examples for actors in each role can be found in the HEMRM and BRIDGE role models respectively. The variety of roles in Table 1 yields the conclusion that the OneNet Connector must be flexible and yet simple enough to connect a large variety of data production and processing systems in practice ranging from customer devices and resources in the grid to data platforms, market platforms and system operators.

Table 1 List of cross-platform services and involved active roles.

No	Category Name	#	OneNet Participant Data sender/ Producer Roles	OneNet Participant Data Receiver/ Consumer Roles
1	Authentication & Authorization	12	Consent Administrator, Customer Portal Operator (B), Data Delegated Third Party (B), Data Exchange Platform (DEP) Operator (B), Data Hub Operator (B), Data Owner (B), Data Provider, Flexibility Services Provider (B), Market Operator	Authentication Service Provider (B), Consent Administrator, Customer Portal Operator (B), Data Delegated Third Party (B), Data Hub Operator (B), Data Owner (B), Data Provider Flexibility Register Operator (B), Flexibility Services Provider (B), Market Operator, System Operator
2	Measurements & Monitoring	4	Consumer, Customer's In-House Device, Data Exchange Platform (DEP) Operator (B), Data Hub Operator (B), Distributed Energy Resources Operator, Flexibility Register Operator (B), Flexibility Services Provider (B), Market Operator,	Consumer, Data Exchange Platform (DEP) Operator (B), Data Hub Operator (B), Energy Supplier / Energy Trader, Flexibility Services Provider (B), Market Operator, Meter Operator, Resource, Resource Aggregator,

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			Metered Data Collection Tool, Meter Operator, Party Connected to the Grid, Resource Aggregator, Service Provider, Significant Grid Users, Sub-meter data collection tool, System Operator	System Operator
3	Forecasts	6	Data Exchange Platform (DEP) Operator (B), Flexibility Services Provider, System Operator	Data Exchange Platform (DEP) Operator (B), Market Operator, System Operator
4	Reports & Invoices	6	Data Exchange Platform (DEP) Operator (B), Flexibility Register Operator (B), Flexibility Services Provider (B)	Data Exchange Platform (DEP) Operator (B), Data Hub Operator (B), Flexibility Services Provider (B), Market Operator, System Operator
5	(Flexibility) Market Participation	12	Data Exchange Platform (DEP) Operator (B), Flexibility Services Provider (B), Market Operator, Resource Aggregator, System Operator	Balance Responsible Party, Balancing Service Provider Consumer, Data Exchange Platform (DEP) Operator (B), Data Hub Operator (B), Flexibility Services Provider (B), Market Operator, Resource Aggregator, System Operator
6	Grid Models	5	System Operator	Data Exchange Platform (DEP) Operator (B), System Operator
7	Simulation Results	3	Data Exchange Platform (DEP) Operator (B),	Data Exchange Platform (DEP) Operator (B),

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			Market Operator, Resource Aggregator, System Operator	Market Operator, System Operator
8	Resource (Pre-) Qualification	3	Data Exchange Platform (DEP) Operator (B), Flexibility Register Operator (B) Flexibility Services Provider (B), Market Operator, System Operator	Balance Responsible Party, Data Exchange Platform (DEP) Operator (B), Flexibility Register Operator (B), Flexibility Services Provider (B), Market Operator, Resource Aggregator, System Operator
9	System Service Activation	2	Data Exchange Platform (DEP) Operator (B), Market Operator, Resource Aggregator, System Operator	Balance Responsible Party, Balancing Service Provider, Data Exchange Platform (DEP) Operator (B), Market Operator, Resource, Resource Aggregator, System Operator
10	Resource Control	3	Balance Responsible Party, Consumer, Data Exchange Platform (DEP) Operator (B), Energy Supplier, Energy Trader, Flexibility Services Provider (B), Market Operator, Party Connected to the Grid, Resource Aggregator, System Operator	Balancing Service Provider Consumer, Data Exchange Platform (DEP) Operator (B), Data Hub Operator (B), Energy Manager, Flexibility Services Provider (B), Market Operator, Metered Data Collector, Resource Aggregator, Scheduling Agent, System Operator

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2.2 Interaction of services with OneNet middleware

The OneNet Decentralised Middleware aims to be platform and data model agnostic, to facilitate cross-country and cross-sector integration and interoperability at any level of stakeholder (e.g., energy stakeholders like TSOs, DSOs, Customers, etc)

The main goal of OneNet Decentralised Middleware is therefore to connect two or more platforms that need to exchange data to implement services such as the cross-platform services listed above. For this reason, the focus is on enabling data exchanges, between data consumers and data providers, to allow the integration of business services managed at the level of the platforms themselves.

The OneNet Decentralised Middleware does not offer business services, other than those related to the registration, identification, and authorization of the OneNet Participants, those relating to the enabling of data exchange and additional services that will enhance the data exchanged, such as Data Quality, Semantic Tool, etc.

To provide an advanced level of interoperability, but at the same time enhanced cooperation between TSO, DSO and Customers, these additional services must take into account the specific cross-platform service and therefore the characteristics of the exchanged data.

The activity carried out in this task will therefore allow us to identify some standard data models (i.e., currently CIM standards are solely identified) inherent to the data exchange of the identified cross-platform services, on which these data services can also refer.

In the D5.4 [4], it was already described how the data exchange process within the OneNet Connector is managed within the FIWARE Context Broker, and more specifically in its version that uses the NGSI-LD APIs that make leverage on Linked Data [5].

Some standard energy data models already mapped and supported by the FIWARE Context Broker have already been identified. Other relevant standard data models identified in this task will be integrated with the existing ones to support as many cross-platform services as possible.

2.2.1 Data exchange and Service Integration Example

Referring to the generic use cases described in D5.1 [6], OneNet Participants can install the OneNet Connector om their environment and use it together with the OneNet Decentralised Middleware to enable data exchange with other OneNet Participants.

A generic OneNet Participant can configure his own OneNet Connector, register it and enable himself as Data Sender/Producer and/or Data Receiver/Consumer. Once enabled, the OneNet Participant is registered as a Ddata source in the Data Source Catalogue or if it provides specific services and therefore also identifiable as Service Provider, in the Service Catalogue, to be discoverable by all the other OneNet Participants.

The interaction for data exchange between the OneNet Participant's platform and the OneNet System will take place via the OneNet Connector and more specifically through the integration of REST APIs that will allow access to the services offered by the OneNet Decentralised Middleware.

Within the OneNet Connector and OneNet Decentralised Middleware, standard data models will be supported for facilitating the integration of the identified cross-platform services and also the possibility of enhancing data exchange by providing additional data services.

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The data exchange process takes place through the FIWARE Context Broker NGSI-LD and allows the exchange of data based on standard data models, as described above, but also customized data models to be as flexible as possible.

Figure 4 shows an example of a possible interaction between the DSO and the Market Operator, for the bids/offers requests (Category 5 of Cross-platform services, see Table 1)

The registration and authentication of the connectors (step 0) takes place through the middleware, while the data exchange between the two platforms is end-to-end.

The data request is made by the DSO (Data Consumer) to the MO (Data Provider). The data exchanged is represented as a standard data model and is therefore enhanced by the data services offered by the OneNet Connector. The Consumer will thus receive the requested data is harmonised.

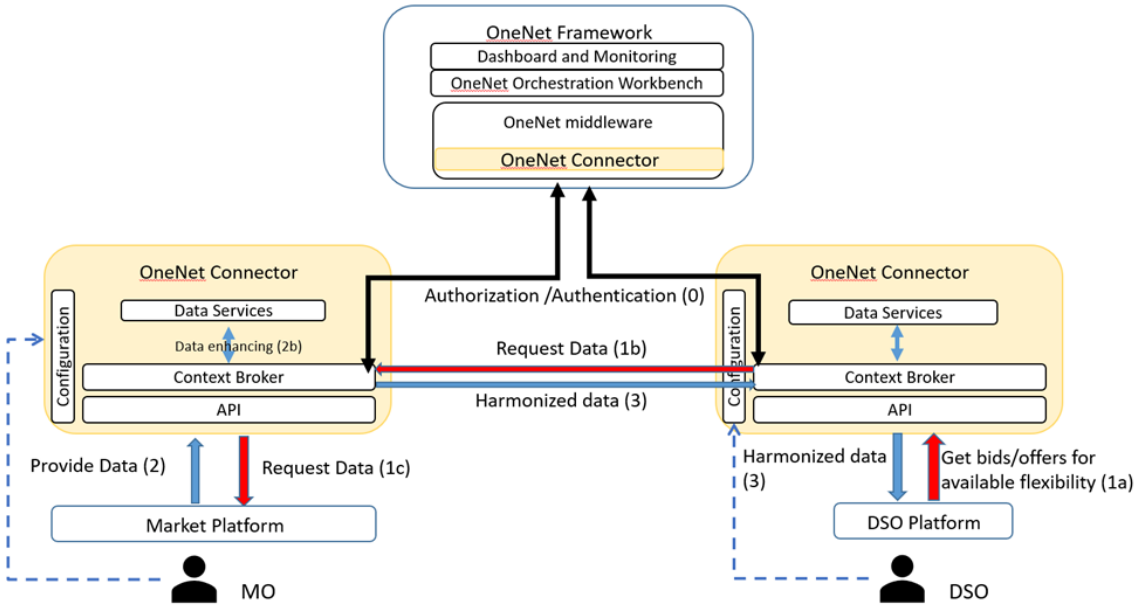

Figure 4 Example of OneNet participants' interaction for bids/offers requests

Finally, in the case of data exchanges that do not refer to the supported data models, no additional data services can be applied and the OneNet Participants must be aligned on the type of data exchanged, based on the service requested, without referring to the pre-existing models.

2.3 Additional requirements on data formats to accommodate external services' integration

To support the integration of the cross-platform services and exploitation of specific data services in the OneNet System, the OneNet Middleware (and the OneNet Connector) encourages and facilitates the adoption of standardized data models.

A standardised data model is an abstract model that allows organising data mapping them is a real-world entity with specific information and relationship. The adoption of standardized data models is fundamental for facilitating the interoperability and cooperation of different platforms and it plays a crucial role in the harmonisation formats and semantics that will be used by platforms both to consume and to publish data.

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In this context, the OneNet Middleware includes the FIWARE NGSI v2 (NGSI-LD) for supporting standardized and linked data models. The FIWARE NGSI v2 information model has been extended to support Linked Data (LD) which is including entities relationships, properties of graphs, and semantics. NGSI-LD targets semantic context information, its specification creates models of real-world entities, relationships, and properties and is expressive to connect and federate other existing information models, using JSON-LD as a lightweight linked data format. Linked data is structured data that is interlinked with other data, so it becomes more useful through semantic queries.

The OneNet Middleware data exchange will be based on the NGSI-LD standard, and as described in D5.4 [ref] it will support three different data models:

- the already existing FIWARE energy data models [7]
- new standard data models to be mapped in the NGSI-LD smart data models based on the analysis conducted within this task
- customized data models (not standardized)

In particular, is relevant the activity conducted in Task 5.6 about CIM profiling and data models for enriching the list of supported standardized data models (e.g., ESMP (62325), CGMES (61970), CDPSM (61968)) be used in the data exchange and facilitate the integration of cross-platform services to address flexibility trading, activation and settlement as well as grid topology exchanges.

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3 OneNet DSOs' perspective on data models

The aim of WP5 is to have seamless interoperability among IT scalable OneNet and/or third-party technology enablers, smart grid markets and the network management platforms. Considering the DSOs perspective and ensuring that the data models and formats are defined regarding the functionalities that DSO information systems are supporting is key when exploring data models to support the OneNet data exchange. This Chapter presents the status and approach of the OneNet DSOs regarding data models, their level of standardization and interest in CIM to foster a preliminary understanding. The content is based on a survey conducted in T5.6 to comprehend the current practices and visions of DSOs in the project on data models and generally towards the adoption of harmonised data profiles. The survey template can be found in Appendix 8.1.

The methodology carried out was the following:

- Creation of a questionnaire, with the input support of T5.6, and disseminate it to the OneNet DSOs.
- Analysis of OneNet DSOs answers

Follow up on the outcomes from the survey with the OneNet DSOs by presenting and discussing the answers to the questionnaire with all. The information in this chapter consists of the answers of 10 OneNet DSOs to the survey shared. Below you can find the cluster of which each DSO is part.

Table 2 Clusters associated with the 10 OneNet DSOs that answer the survey on Appendix 8.1

OneNet Cluster	OneNet DSOs
WP7 – Nothern Cluster	DSO1, DSO9
WP8 – Southern Cluster	DSO6
WP9 – Western Cluster	DSO5, DSO8, DSO10
WP10 – Eastern Cluster	DSO2, DSO3, DSO4, DSO7

This chapter is dived into 3 main sections. Section 3.1 gives an overview of the OneNet DSOs' perspectives and insights obtained with this exercise, to later explore the answers that each gave regarding the data models currently used if these are developed in their company or outsourced and if standards are being used or not in section 3.2. Section 3.3 finalises this chapter with OneNet DSOs interest on CIM model.

3.1 Data models: the OneNet DSOs perspective review

Data models play a crucial role in the digitalisation of the energy system with the relevance expected to grow. Several data models are currently being produced and developed based on projects, company necessities and regulations, to accommodate an increasingly dynamic grid, connected to distributed resources.

Some DSOs are particularly interested in smart meter data and load profiles, as they provide insight into LV and pose an interesting technical challenge to achieve high levels of accuracy and continuity (DSO6, DSO7). A wide-scale availability of data and possibilities to interchange such data can unlock many business processes (DSO6).

OneNet aims to accommodate the exploitation of flexibility services. Flexibility markets are still at a trial stage for some of the OneNet DSOs (DSO1, DSO2), with not yet a consolidated market for the use of flexibility.

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For others, OneNet DSOs standards related to flexibility are still in progress at the moment (DSO5). However there is a demand for developments regarding flexibility data models within companies, the standards, and the flexibility markets, that shall advance and develop in parallel (DSO8).

Some of these OneNet DSOs are at the beginning of the process regarding flexibility services. For instance, DSO8 is starting the business modelling of the actors, objects, flexibility offers, services and requests for activities. Another example is DSO1 which is in the early stages of building a new smart metering system and a data hub for the country also based on CIM.

Consequently, in addition to being an area that is still in assessment for these DSOs, it was signalled that some of the questions asked were currently open questions being discussed and decided within their companies. Nonetheless, some interesting insights were extracted and the understanding of the status and approach of OneNet DSOs to data models has been enhanced.

The questionnaire explored whether the work on data models was mostly produced in the company or outsourced. Eight out of ten companies mentioned that part of this work was outsourced. Contractual matters have been identified as a potential barrier to getting detailed input from some companies.

Furthermore, whether standards were being used was also explored. The specific responses of each DSO can be found in section 3.2.3. Some DSOs questioned whether standards are always the best option since they may not be supported by suppliers. In contrast, others considered that for DSOs, that contain a variety of systems, processes and data, standardisation of data models was key for achieving a high level of consumer satisfaction.

When asking about the interest of DSOs on CIM, 6 DSOs considered advancing CIM of interest for distribution and gave a list of reasons why this is the case (section 3.3). DSO3 highlighted the importance of implementing one standard of the data model exchange between IT systems based on the CIM IEC 61970-301 model in ver. 16 and 17 and data exchange envelopes following the IEC 61968 standard, to replace individual mappings in current systems in EOP. DSO3 also stresses the use of the CIM model, the database that has approx. 2,500 defined object classes with unique mRID identifiers, confirmed the correct direction of its use in EOP. On the other hand, 4 DSOs were unsure of the relevance of this model for the distribution and still had to assess and decide if they would go forward with CIM or not. CIM was perceived by some to be very detailed and focused on-field communication between equipment.

Finally, DSOs took the chance to share some comments and concerns. DSO5 emphasised that, when discussing interoperability of data and systems, best practices in the IT industry should play an important role in their definitions, as agile practices would facilitate the acceptance of future definitions.

DSO7 stressed that in several projects they got requests for data that they had but were unable to provide due to poor coordination on data models and formats with regards to the system's capabilities. It is of extreme importance that data models and data formats are defined with regard to the functionalities that DSOs information systems are supporting.

DSO2 comments that it is difficult to develop data models, that will fit all DSOs EU wide and not cause huge overhead in the data structure for practical use. So, concentrating on minimum (basic) needed data to be included in models used should be considered.

DSO5 highlighted the need to have the approach be as simple and generic as possible with regards to flexibility markets, to enable entry into the market of new players and businesses. The simpler the data model, the easier and more widely it will be accepted and used.

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3.2 OneNet DSOs' data models: summary of the DSO responses

This section summarises the answers provided by the OneNet DSOs in the same questionnaire regarding the data models currently being used, if they are developed in the company or outsourced and if it is a standard or not. This aims to provide preliminary insight on the status of DSO data models and experience, in the project.

3.2.1 Current data models used by OneNet DSOs

In DSO1, they are in the early stages of going forward with CIM, building a new smart metering system based on SGAM and CIM, and a data hub for the country also based on CIM. It is expected to take 2-3 years to be fully developed. Currently, the baseline calculation is being aligned with the TSO, also working on TSO-DSO coordination. DSO1 is interested in exploring capabilities to use, introduce and integrate CIM.

DSO2 highlights that flexibility markets are still at a trial stage, therefore, that no specific data model is established for flexibility, and that CIM is used for network and asset description.

DSO3 describes that data models are being developed such as SWI, a standard for information exchange, (pl. Standard Wymiany Informacji). For the exchange of information between systems, the DSO has started implementing CIM based on which the CIM_EOP profile was developed, covering the topology, objects and attributes of the power grid in the area of engineering calculations.

DSO4 indicates that GIS, SAP ERP, SAP ISU, SCADA, OMS, Workforce Management System, Meter Reading Centre have database and data models and that the data models in the company are not based on CIM.

DSO6 explains that several data models are being used for metering data, field processes, grid management/monitoring, consumers services, electromobility and energy market support.

DSO7 uses relational data models with the model data stored in SQL databases. They are used for grid operation, measurement storage, geospatial data, etc.

DSO8 indicates that 3 different types of data models are produced (a Business Object Model, a Conceptual Object Model and an Application Object Model) and the business modelling for flexibility services has started. For internal use, the DSO does not use external standards, the projects develop and specify the interfaces. When working with other market stakeholders, a specification of interfaces between the market actors and the distributors has led to a standard that only applies to the country market which is not based on CIM. However, recently, the DSO is collaborating with other actors such as the local territory administration that need to be provided with data, and using other standards is being considered. A decision has not yet been taken, but among the options considered, there is CIM and BIM (Building information model), which can use 3D models for the assets of the network.

DSO10 states that data models and analysis tools are used to support digital representations of the distribution system and the environment in which it operates. Examples include geospatial model, connectivity model, impedance model, load models, historical databases, forecasts, SCADA, etc.

In DSO9, data models are being used for several situations:

- Customer care and billing (client management, consumption and billing),
- Contractor operations (documents, contracts, and reports repository),
- Meter management and AMI (advanced metering infrastructure)- Meter and measurement database,
- Network management - NIS (network information system) based on geographic location and technical properties of the network.

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- OMS - outage management system.
- Distribution management – SCADA.
- Quality - Power quality management system.

3.2.2 Data models: developed in the company or outsourced

Some OneNet DSOs indicated that the data models they used are fully developed in their company such as DSO1 and DSO2. Others like DSO6 and DSO8 develop their specific data models for internal interactions and for external interactions they have other procedures. DSO6 develops most of the data models used in their company, with some also being third party proprietary models. DSO8 also develops most data models, for internal exchanges and inside their IT systems. For external third parties, for instance, use some models based on CIM, by outsourcing this activity to CIM expertise.

In contrast, other OneNet DSOs such as DSO7 and DSO10 mostly outsource all or part of this work. In DSO4, an IT company and third-party supplier develop their solutions. DSO3 indicates that data models are developed in the company as an order to the system contractor or as a result of regulations. DSO3 does not have a canonical data model and it is stated that there is no such need because the systems bought and purchased have their data models.

Eight out of the ten DSOs mentioned outsourcing at least part of the work on data models. Contractual matters with third parties are identified as a potential barrier to getting detailed input on data models from some companies.

3.2.3 Data models: Standards or not

The answers regarding the relevance of standards for DSOs and whether standards are been diverse. On the one hand, DSOs such as DSO7 and DSO1 mostly use data models that are not standard, as well as DSO6 uses several custom data models. DSO10 generally also does not use standard models.

On the other hand, other DSOs do use standard data models, CIM and others. DSO4 uses standardised solutions not based on CIM. DSO9 uses SCADA that follows a standard IEC 61968. DSO3 indicates that data models are being developed such as the SWI standard for information exchange, (pl. Standard Wymiany Informacji, information on this standard can be found here). DSO3 also uses the CIM model, based on the international standard within the committee structure TC57 SWI PSE is an exemplary PSE / ENTSO standard (there is a European version based on the CIM model).

Finally, other DSOs are in between. DSO2 uses data models based on CIM, however, there are different versions mixed and therefore in a sense unique with some parts not available in the standards. DSO8 also uses models that are based, when needed, on standards such as CIM or others, for instance, to support data exchanges with external third parties, but use their models for internal exchanges and inside their IT systems.

3.3 CIM profiling: interest of the OneNet DSOs

When asking about the interest of OneNet DSOs in the CIM data model, 6 DSOs considered advancing CIM of interest for DSOs, and 4 were unsure of the relevance of this model for the distribution.

From the 6 DSOs that considered CIM a possibility, DSO4 intends to use CIM in the future and DSO8 produces some of its models based on CIM. DSO2 is using it for the business process of ordering activation from an

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aggregator, as well as for exchanging information about traffic light systems (TLS). TLS is meant to inform the market (TSO, aggregator), that some distribution grid area has constraints in the use of the flexibility of the consumers connected to that grid area. If the distribution grid is on its power limit, it would not allow the consumer to increase its load because of TSL (mFRR or aFFR).

DSO9 explains that the CIM data model is being improved from SCADA ADMS to the network information system (NIS) data model to further integrate the two. That way it is easier to update the distribution management system's model with changes in the network specification when some substations or nodes have been changed. Other company domains are currently not being integrated with CIM.

CIM is considered of interest for most of the OneNet DSOs that answer this survey for the following reasons:

1. System integration: It will facilitate the integration between separate systems, with the advantages of having a high degree of integration-interoperability within the company (DSO6). Many information systems support some CIM standards, and it is easier to maintain one model (DSO7).
2. It will simplify the roll-out of new systems that may be missing from the company (DSO6).
3. Data exchange between stakeholders, third parties, TSOs, external service providers, other DSOs
   - Reduces the adaptation effort when implementing interfaces with third parties (DSO8).
   - It will lay the ground for more productive relations with external service providers on the various systems that are running in the company (DSO6).
   - The CIM standard will be a key element for efficient data exchange between SCADA DSO and TSO systems of information on the current state of the network as well as with other distribution companies (DSO3).
4. The CIM model has the advantage of its flexibility, i.e., the possibility of adding a new class of objects as an exception but under the principles of building a CIM model (DSO3).
5. It is a dedicated, complete, coherent solution in network topology, its objects and attributes, customer, measurements, automatization, and security. Ranking for data models is not carried out - the implemented data models in the systems result from broad business needs and regulations (DSO3).
6. It will best support the need to turn the DSO into a modern, data-intensive operator (DSO6).

However, it is relevant to understand that not all companies are using or planning to use CIM now. DSO5 believes that CIM still needs to be assessed to understand its relevance for distribution and that it might be challenging to define a specific standard to support all OneNet data exchanges. Each European member state must be considered and the impact this can have. Regardless of the model chosen, it must be sufficiently simple and generic. CIM is not used at this moment in DSO10, as CIM interfaces require very specific and heavy WS that often have the alternative of ad-hoc light interfaces (DB-link etc) designed to meet the specific needs of the energy control centres. Exploring DB could be of interest.

In conclusion, for most of the 10 OneNet DSOs, 6 in 10 DSOs, that answered this survey, the CIM model seems to be a model to use, as pointed out in the 6 points of interest above. Mainly due to the model's advantages in the way that operates and is structured and due to the facility to exchange data with other stakeholders. However, there are still some doubts from the other OneNet DSOs on the CIM model's impact on the distribution grid, compared with other models, and some barriers regarding the model complexity. Therefore is a need for additional analysis after the implementation of CIM profiles in OneNet. Where would be possible to have more details on OneNet DSOs CIM experience, and special to understand if the opinion of the DSOs that are still not sure of this model's relevance is the same.

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4 OneNet extended data interoperability

This Chapter bases its analysis on the developed Business Object List (BOL) (see Table 3) based on the OneNet cross-platforms. This section essentially analyzes the Business Objects (BO) that are used to address the different cross-platform services by providing their semantic definition on standard profiles.

4.1 Assessing DSO requirements on network data standardization

4.1.1 DER Structural Data

Description:

Exchange of resources information.

Standard analysis:

IEC 61850-7 or to model using CIM for the distribution grid: IEC 61968-11 and CDPSM IEC 61968-13. ENTSO-E: 61970-302 can also help here as it covers IEEE 1547 standard.

4.1.2 Flexible Resource Metering data

Description:

This information includes the real-time monitoring of the FSPs' response. The information is generated by the real-time monitoring use case and will be used by the evaluation of the FSPs response use case to assess the FSP operation.

Exchange of (real time) Metering Data.

Standard analysis:

It is possible to apply Measurement profile for this BO.

4.2 Assessing TSO requirements on network data standardization

4.2.1 Development plans for transmission network

Description:

Exchange of data related to the coordination of long-term network planning between TSO and DSO.

Standard analysis:

CIM is used as an informational model. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is recommended to use IEC CGMES profile. The relevant IRM business object is named “Network Model”. Power system project [15] can be used to exchange the project information.

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4.2.2 Network data of transmission system

Description:

Exchange of data related to coordination of short-term and long-term network planning between TSO and DSO.

Standard analysis:

CIM is used as an informational model. The relevant standard for the transmission grid is IEC 61970-452 – Static Transmission Network Model Profiles. It is recommended to use the IEC CGMES profile. The exchange of short circuit results builds on TDX-ASSIST project deliverables.

4.2.3 Network data of transmission system/TSO network information

Description:

Exchange and validate reconfiguration data.

Standard analysis:

CIM is used as an informational model, through 61970-456 document.

4.2.4 Transmission network outage plan

Description:

Exchange of data related to the outage plans for coordination of long-term network planning between TSO and DSO.

Standard analysis:

CIM is used as an informational model. OutageSchedule_MarketDocument. An alternative is IEC 61970-301 package Outage, which includes OutageSchedule class. It is recommended to use the Availability Plan profile developed for network codes related data exchanges.

4.3 Assessing services, market and network requirements on data standardization for both DSO/TSO

4.3.1 Market Results

Description:

Report: Day Ahead & Intra Day Results.

Standard analysis:

IEC 62325-451-‘X' standards, "publish auction results" & "publish trade results" covered in X=3. IEC 62325-451-7, provides contextual and assembly models. Includes MOL. IEC 62325-451-6 covers the publishing of market information (e.g. related to the transparency platform).

4.3.2 Product prequalification results

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Description:

-ID

-Name

-Resource

-Mode of activation (If it is Automatic should be tested)

-Minimum Quantity

-Flexibility direction (load/generation reduction/increase, both)

-Locational information and SO connected

-Maximum duration of delivery period offer

-Single or Aggregated portfolio?

-Capacity/Energy

-Maximum Full Activation time

-Mandatory: Product Prequalification Result: (Approved/Reproved)

Standard analysis:

ESMP market documents can be proposed in this business object.

4.3.3 Market participant pre-qualification information

Description:

- Contact information; Fiscal data; Access contract; bank details; power of representation; confidentiality agreement; declaration of non-collusion.
- Market participants provide information on the resources they want to prequalify: Facility/resource name; Type of technology; Location; Market participant; etc

Standard analysis:

This BO should be modelled in the scope of pre-qualification document, based on MarketDocument in ESMP.

4.3.4 Basic Participant Information

Description:

- Register and basic information about the market participant such as username and password.

Standard analysis:

This Business Object should be modelled in the scope of one pre-qualification document, based on MarketDocument in ESMP.

4.3.5 Invoicing Data

Description:

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Sending invoicing data.

Standard analysis:

IEC 62325-451-‘X' standards, reconciliation processes coverd in X=4.

4.3.6 Settlement Data

Description:

Exchange of Estimation Data.

Exchange reports about settlement processes (e.g. production & consumption plans).

Inform about under or overdelivered flexibilities in real-time.

Standard analysis:

IEC 62325-451-‘X' standards, settlement processes covers in X=4. IEC 62325-451-‘X' standards, "provide actual availability and planned unavailability" in X=6.

4.3.7 Aggregated Data

Description:

Aggregated data are computed for the national level, without location information.

Data are provided on an hourly basis, at D+1 (where possible due to technical limitation). On the request, the newest data should be provided. Aggregated data include:

- Total quantity of tendered power bids in kW per individual hour, aggregated

-> date, hour, type of service, quantity in kW

- Total quantity of tendered energy bids in kWh per individual hour, aggregated

-> date, hour, type of service, quantity in kWh

- Total amount taken for energy in kWh per hour, aggregated

-> date, hour, type of service, quantity in kW

- Total value of accepted bids in € on an hourly basis (here we assume that this value will also be 0 € and all money will be "turned over" on activated energy)

-> date, hour, type of service, €

- Total activated amount of energy in kWh per individual hour

-> date, hour, type of service, quantity in kWh

- Total value of activated energy in € per individual hour

-> date, hour, type of service, €

- Planned outages

-> estimated duration, affected units/generators.

Standard analysis:

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CIM ESMP can be applied for this BO.

4.3.8 Network data of distribution system

Description:

Network models: Send distribution network model.

Development plans: Send the plans for distribution network

Standard analysis:

CIM is used as data format. The relevant standard is IEC 61968-13 – Distribution Model (CDPSM). In the context of TSO-DSO cooperation, CGMES profile should be used for distribution grid, and validated for Distribution requirements (unbalanced grid). In the simplified model, equivalents should be used. IEC 62325-451-6 (Generation and Load contextual model) is used for time series. For Load Management, the LoadModel package can be used.

4.3.9 Network Demand Forecast

Description:

Development plans: Send the plans for distribution network

Standard analysis:

CIM is used as data format. The relevant standard is IEC 61968-13 – Distribution Model (CDPSM). In the context for TSO-DSO cooperation, CGMES profile should be used for distribution grid, and validated for Distribution requirements (unbalanced grid). In the simplified model, equivalents should be used. IEC 62325-451-6 (Generation and Load contextual model) is used for time series. For Load Management, the LoadModel package can be used.

4.3.10 Network Information

Description:

Development plans: Send the plans for distribution network

Standard analysis:

CIM is used as data format. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is recommended to use CGMES profile. The relevant IRM business object is named “Network Model”.

4.3.11 Network reconfiguration data

Description:

Exchange and validate reconfiguration data

Standard analysis:

IEC 62325-451-6 can be used to "provide transmission asset configuration information".

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4.4 Assessing requirements for TSO – DSO information exchange

TSO and DSO need to adopt common process on information exchange that would enable unlocking the full potential of distributed flexibility [16]. Regarding the flexibility market facilitation, two aspects of TSO-DSO information exchange are foreseen. The first is introduction of a common flexibility resources register, with the objective "to gather and share relevant information on potential sources of flexibility". The second is Traffic Light System (TLS), which is a concept of signalling distribution grid operating state violation (e.g. congestion, voltage profile violation etc). Since business objects (BOs) related to the flexibility register have been considered in the previous sections, this section describes CIM profile for information exchange within TLS.

TLS assumes the three phases: green, orange and red. These states are assigned to one zone or even to one node of the distribution grid. The green phase corresponds to the normal operation of the distribution grid, with no violation of state variables. In such phase, for instance, TSO can activate distributed flexibility resources without limitations. When violation (e.g. congestion) is expected, TLS is orange and DSO activates flexibility service to bring affected area of the grid into a green state. Flexibility service is procured and activated through the flexibility market, according to the market processes. If this action fails, TLS is in the red state and DSO can follow other rules. Already in the orange phase, FSP is limited to activate distributed flexibility, in the affected area, for the balancing market purposes.

Currently there is no available CIM profile provided by ENTSO-E that models information exchange within TLS implementation. In this section we propose CIM profile for TLS as an extension to ESMP. In this concept, for each node in the distribution grid (class *UsagePoint*) TLS signal is reported for two directions:

- increase of P is allowed (True/False) and
- decrease of P is allowed (True/False).

With such system, the red phase of TLS is omitted (DSO follows other rules). TLS signal is shared with TSO, FSP and other interested market participants. Contextual model (in UML) for TLS profile is given in Figure 5 Data is serialized as an XML file. The corresponding XML schema (XSD) for the serialization of the TLS profile is presented in Figure 6.

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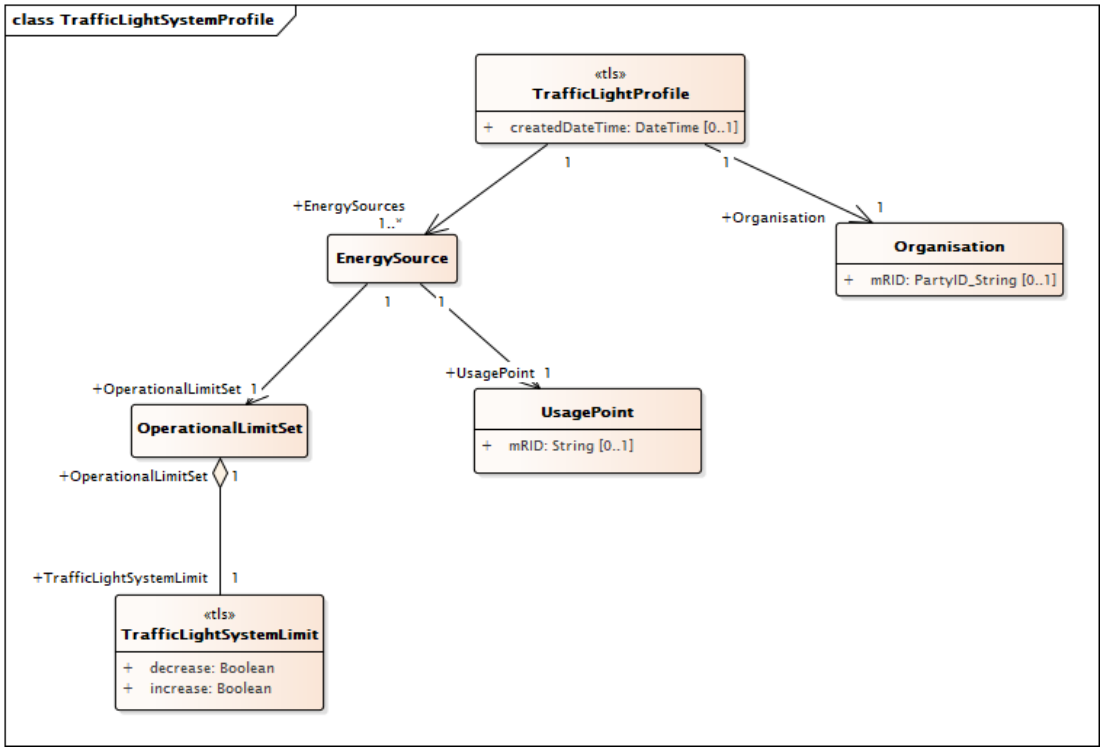

Figure 5 TLS CIM profile

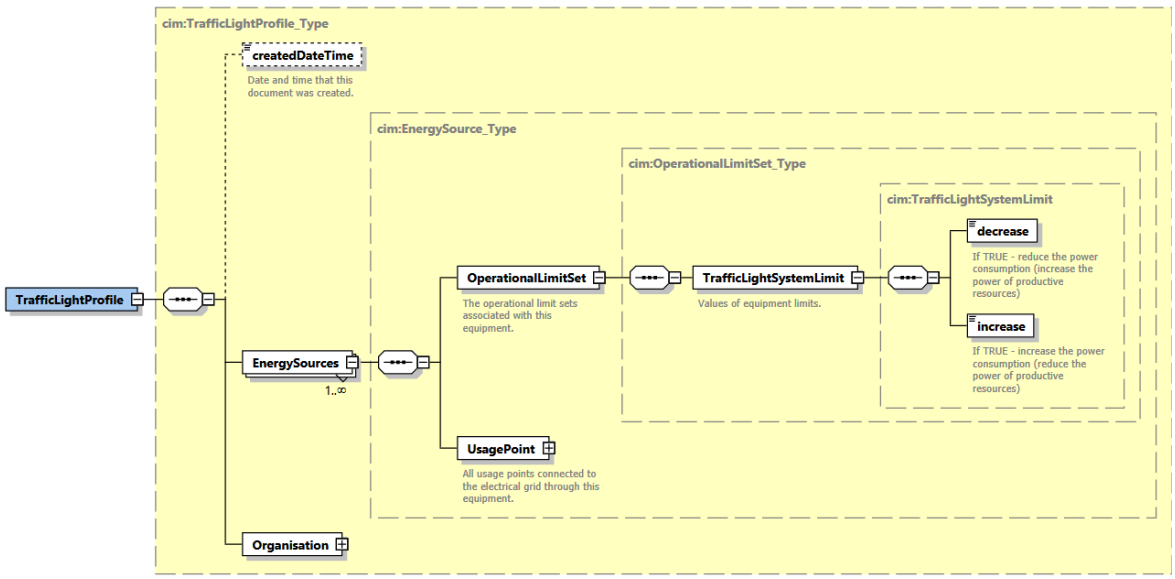

Figure 6 TLS XML Schema

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4.4.1 (Flexibility) Resources

Description:

Activation of Assets (RES, storage, flexibility resources, DSO assets): Exchange of activation signals for a specific asset or group of assets.

Standard analysis:

IEC 62325-451-'X' standards, "activation phase: activate balancing energy bids" covered in X=7 (Activation document).

4.4.2 (Flexibility) Resources Qualification results (Grid)

Description:

Resource Qualification after new resource group registration: Product qualification ,Product prequalification, Market prequalification of FSP,Prequalifiyng balancing resources: GetPrequalifiedResources. IMO registers the successful resource pre-qualification to the LMP

- ID
- Name
- Resource
- Mode of activation (If it is Automatic should be tested)
- Minimum Quantity
- Flexibility direction (load/generation reduction/increase, both)
- Locational information and SO connected
- Maximum duration of delivery period offer
- Single or Aggregated portfolio?
- Capacity/Energy
- Maximum Full Activation time
- Mandatory: Product Prequalification Result: (Approved)

Standard analysis:

IEC 62325-451-'X' standards, activation may be used/or the bid document itself to transmit bid and resource information.

4.4.3 Scheduling process: Activation signal correction / counter action (tender reduction)

Description:

- Activation with corrections/counter actions

- Request for activation

- Exchange reports about activated resources

Standard analysis:

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This BO is related to the scheduling process and IEC 62325-451-2 should be used if scheduling information is exchanged between market participant and TSO. Note there is a discussion on a model to allow exchange of schedules close to network model. It is recommended to use this solution developed for network codes related data exchanges.

4.4.4 Execution order

Description:

Management of Assets: Exchange of execution orders to achieve a specific objective (e.g. Islanding operation, balancing, energy efficiency enablement, flexibility services)

Automated order, automated order end

Order registration, order reception registration

Limitation order, limitation order end

Order reception log, end or order reception log, order execution log, end of order execution log

Standard analysis:

IEC 62325-451-'X' set of standards, "scheduling business process" covered in X=2. Note there is a discussion on a model to allow exchange of schedules close to network model. It is recommended to use this solution developed for network codes related data exchanges.

4.4.5 Baselines reports

Description:

Exchange of FSP baselines.

Standard analysis:

urn:iec62325.351:tc57wg16:451-4:energyaccountdocument baseline is a time series and for this case we can adapt Schedule_MarketDocument. GenerationLoad_MarketDocument (IEC 62325-451-6). The last can refer to daily, monthly, weekly and yearly generation and load forecasts. DSO exchanges with TSO: forecasted connection state of distribution grid loops and updates scheduled maintenance needs for DAY D+3, D+2, D+1. For more information see D1.2 TDx-Assist

4.4.6 Connection state forecast

Description:

All DRES under incentive: Send connection state of distribution grid loops forecast, All DRES under incentive: Send common observability area TSO assets connection state forecast to DSO.

Standard analysis:

For more information consult the following link: https://eu-sysflex.com/wp-content/uploads/2020/10/Task-5.2-use-case-Exchange-data-between-DERs-and-System-Operators.pdf

Depending on the context CGMES and area model information can be exchange with Network codes related profiles.

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4.4.7 DER Structural Data

Description:

Exchange of Resources' Information.

Standard analysis:

Depends on the data content. Some part on DER is included in 61970-302.

4.4.8 Development plans for distribution network

Description:

Exchange of data related to Development plans: Send the plans for distribution network.

Standard analysis:

CIM is used as an informational model. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is recommended to use IEC CGMES profile. The relevant IRM business object is named “Network Model”. Power system project [15] an be used to exchange the project information.

4.4.9 Dynamic Line Rating Forecast for overhead lines

Description:

Enhance method for PNP estimation. Dynamic Line Rating Forecast for overhead lines. Determination of capacity calculation input data. Enhance transmission system resilience during emergencies.

Standard analysis:

The TransmissionNetwork_MarketDocument (IEC 62325-451-6) can be used to transmit information relating to the congestion management. Note there is a discussion on a model to allow exchange of schedules close to network model. It is recommended to use this solution developed for network codes related data exchanges.

4.4.10Transmit planned schedules [Energy clearing results]

Description:

Exchange reports about activated resources

Exchange market (clearing) results

Exchange information on market

Exchange information on matching of bid and grid needs for decision support

Open/Close Market Session

Offers Assessment (Validation, acceptance, re-definition)

Standard analysis:

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IEC 62325-451-'X' standards, "Transmit planned schedules" covered in X=2, Energy Account document covered in X=4// See also: IEC 62325-301 "CIM extensions for markets" and IEC 62325-351 "CIM European market model exchange profile". Note there is a discussion on a model to allow exchange of schedules close to network model. It is recommended to use this solution developed for network codes related data exchanges.

4.4.11 Flexibility needs (i.e., balancing, congestion)

Description:

Exchange reports about activated resources

Exchange market (clearing) results

Exchange information on market

Exchange information on matching of bid and grid needs for decision support

Open/Close Market Session

Offers Assessment (Validation, acceptance, re-definition)

Standard analysis:

IEC 62325-451-'X' standards, "Transmit planned schedules" covered in X=2, Energy Account document covered in X=4// See also: IEC 62325-301 "CIM extensions for markets" and IEC 62325-351 "CIM European market model exchange profile". Note there is a discussion on a model to allow exchange of schedules close to network model. It is recommended to use this solution developed for network codes related data exchanges.

4.4.12 Forecast data (load, generation, FSP)

Description:

Exchange of grid state information

Grid Constraints Assessment

Exchange forecast data for environmental parameters (weather), load, generation, or storage (either combined or one forecast per type)

Development plans: Send the plans for distribution network

Storm and Icing predictive maintenance process in DSO grid and local microgrid

Standard analysis:

GenerationLoad_MarketDocument (IEC 62325-451-6), The GenerationLoad_MarketDocument enables the transmission of generation and load information on a regular basis. The information transmitted may be actual generation and load, planned generation and load or forecast generation and load depending on market requirements. Note: The relevant standard is IEC 61968-13 – Distribution Model (CDPSM). In the context of TSO-DSO cooperation, CGMES profile should be used for distribution grid, and validated for Distribution requirements (unbalanced grid). In the simplified model, equivalents should be used. IEC 62325-451-6 (Generation and Load contextual model) is used for time series. For Load Management, the LoadModel

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package can be used. CIM weather profile might also be applicable https://eepublicdownloads.entsoe.eu/clean-documents/EDI/Library/cim_based/Weather_Process_Energy_Prognosis_IG_v1.3.pdf

4.4.13Grid congestions status

Description:

Grid Constraints Assessment

Standard analysis:

If this is related to the identification of congestion in the distribution grid and concept of "traffic light", than IEC 62325-301 can be used for data modelling. In a case that "status is needed" than IEC 62325-451-5 can be used to initiate "status request business process".

4.4.14Limits and margins for capacity (by zone)

Description:

Exchange demand/need of resources or system operators

I-03 (TSO and DSO send the prequalification limits to the Market Operator through the OneNet system)

Standard analysis:

IEC 62325-301 “CIM extensions for markets” and IEC 62325-351 “CIM European market model exchange profile”.

4.4.15Grid constraints Assessment

Description:

Grid Constraints Assessment

Standard analysis:

IEC 62315-451-6 is related to the market information publication process. Among other, it includes "Provide generation and load information" and "Provide actual availability and planed unavailability information".

4.4.16Network characteristics (internal) information

Description:

Network models: Send transmission and distribution network models. Both bus branch and node breaker representations. Network demand forecast.

Standard analysis:

CIM is used as an informational model. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is recommended to use IEC CGMES profile.

4.4.17Prediction of maintenance periods

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Description:

Storm and Icing predictive maintenance process in DSO grid and local microgrid. "Request of planned works with impact in the SO network. The request can be done in a specific observability area.

- Date
- Request ID
- Observability area ID or
- Bus ID
- "Request of planned works in the SO system.
- Date
- Request ID
- Year

Maintenance and expansion planned works exchanged internally. Jointly Work programs information exchanged between operators. Validated TSO/DSO planned works information exchanged internally.

Standard analysis:

CIM is used as an informational model. It is recommended to use availability plan profile.

4.4.18Possible temporary limits on balancing capacity bids

Description:

Exchange expected limits of balancing capacity.

Standard analysis:

According to Art. 182-5 SOGL classified as 1-Partial, 2-Total, or 3-None. The DSO can put a limit to any active power reserve connected to the distribution grid and inform TSO about that. This can be considered as "Provide actual availability and planned unavailability information" within IEC 62325-451-6. Also IEC 61970-301 OperationalLimits package can be used. Availability profile can also be used.

4.4.19Power flow simulation

Description:

Exchange of power flow results and settings.

Standard analysis:

It is recommended to use CGMES StateVariable Profile (SV) IEC 61970-456. And IEC 61970-600-2:2021. In addition the new edition of IEC 61970-457 defines a mechanism for exchange of power flow settings.

4.4.20Resource optimization information

Description:

Exchange information on resource optimization.

Standard analysis:

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A possibility is to model using IEC 62325-451-2 for energy scheduling or using CIM Meas/Control associated classes. However, it is recommended to use short circuit profile.

4.4.21Short-Circuit power forecast

Description:

Exchange and validate reconfiguration data.

Standard analysis:

IEC 62325-451-'X' set of standards, "Tendering phase: submit network constraints information necessary for tendering" covered in X=7.

4.4.22Solutions to avoid outage plans incompatibilities

Description:

Development plans: Send the plans for distribution network.

Standard analysis:

The information related to the outage plan should be exchanged with availability plan profile. Network development plans exchange should use information on power system project exchange.

4.4.23State Estimation Data

Description:

Exchange of grid state information

I-01 (Real time monitoring scheme sends the estimated states to the limit prequalification algorithm).

Standard analysis:

It is recommended to use IEC 61970-456.

4.4.24System parameter control schema/ instructions

Description:

Regulation of voltage and/or frequency: Exchange of instructions/control scheme for regulation of a system parameter.

Standard analysis:

It is recommended to use IEC 61970-452 and 61970-456.

4.4.25Weather forecast

Description:

Exchange forecast data for environmental parameters (weather), load, generation, or storage (either combined or one forecast per type).

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Standard analysis:

In IEC 62325 package Environmental contains environmental classes that inherits from measurements, and Forecast class inherits from Environmental Information within this tree.

4.4.26 Forecasts of icing and storm conditions

Description:

Storm and Icing predictive maintenance process in DSO grid and local microgrid.

4.5 Next steps

In section 4 it was possible to analyse the Business Objects detailing the necessary information to be exchanged by the different actors for each Use Case. This analysis is necessary for the development of each Common Information Model (CIM) profile to be proposed for the exchange of data on each demo proposed by the OneNet project.

The next steps will include the proposition of the CIM profiles, basically Common Grid Model Exchange Standard (CGMES) and European Style Market Profile (ESMP), both composing the CIM data exchange standard. There are currently profiles that fulfill the needs of TSOs and DSOs, but as a contribution to the electricity market, OneNet CIM profiles will propose the development of new profiles to support one of the main project's objectives, the interoperability of different actors in the electricity system.

After the Business Objectives study, a gap analysis will demonstrate which Use Case presents the possibility to apply existing profiles and which will demand a new proposition for CIM profile. As an example, the pre-qualification profile is under development and is not part of an official CIM standard. This pre-qualification process demonstrates to be an essencial step of the energy planning between electricy sector actors. This pre-qualification analysis enable to the TSOs and DSOs to ensure the security of energy supplier during the tendering and activation process.

Another step towards this CIM profiling is the presentation of the dependency tables, which consists of a table of information mapping with details which data must be exchanged between each actor, in every stage of the sequence diagram presented by the use cases. This next step is a fundamental step analysis for the CIM profiling proposition. This step will involve important electricity exchange documents such as the Harmonised electricity market Role Model (HRM) and the EIC codes, implemented by European Commission mandated standards by TSOs during the energy planning.

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5 On the definition of APIs for OneNet cross-platform services

Our focus in this chapter is to further elaborate on the API standards on which OneNet cross-platform services implementation will be based, by providing an overview of the two different initiatives of OneNet Reference Architecture from a technical point of view (e.g. IDSA, FIWARE NGSI-LD).

5.1 Overview of OneNet cross-platform services operations

A cross-platform service is an interaction between at least two entities. The sending entity (requester) decides which CRUD operation - Create, Read, Update or Delete - shall be performed, while the receiving entity (or entities in case of one-to-many communication) performs the actual operation in its system and returns a respective response to the sending (requesting) entity. In general, the receiving entity will only perform the requested operation if the sending entity has sufficient permissions for this operation on the requested elements. If permissions are not sufficient, an operation is not performed and a respective error response is returned to the sending entity. The CRUD operations work as follows:

Create: The Create operation creates one or more elements in the system of the receiving entity that was/ were not present before. New elements can be accessed through Read and Update operations afterwards to get or change their content respectively. The success of a Create operation is typically confirmed with a respective response to the sending entity or an error is returned.

Read: The Read operation requests one or more elements from the receiving entity. The receiving entity gathers the requested element(s) from its system and returns them as a response to the sending entity. In case of an error during the Read operation, an error response is returned to the sending entity.

Update: The Update operation provides an update for one or more elements that are already present in the system of the receiving entity. The success of an Update operation is typically confirmed with a respective response to the sending entity or an error is returned.

Delete: The Delete operation deletes one or more elements that are present in the system of the receiving entity. The success of a Delete operation is typically confirmed with a respective response to the sending entity.

5.2 Technical description of data exchanges

The purpose of this section is not to detail the process on how to perform all the necessary processes to interact with other connector(s) but rather to conceptualize how a cross-platform service documentation can be assumed. The formal data exchange that is at each time foreseen requires certain preconditions which are briefly in the next paragraphs.

The resources and operations of the NGSI-LD API according to the **Context Information Management (CIM) ETSI Industry Specification Group (ISG)**[1] which will serve as an implementation guideline. The NGSI-LD API [9] is structured in terms of HTTP [10], [11] verbs, input and output payloads. A non-normative OAS specification [12] of the referred HTTP binding can be found at [8].

[1] https://www.etsi.org/

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5.2.1 Data exchanges among data provider and consumer

The described procedure follows the disciplines as proposed by the IDS reference architecture [13]. Conceptually, the Data Provider makes data available for being exchanged between a Data Owner and a Data Consumer. For the sake of completeness, the Data Provider is in many cases identical with the Data Owner, but not necessarily as it will generally happen in OneNet since a single connector will be deployed into national data exchange platforms. To submit metadata to a Broker, or exchange data with a Data Consumer, the Data Provider uses software components that are compliant with the Reference Architecture Model of the International Data Spaces; such software will be based on FIWARE TRUE Connector [5] which is comprised in turn by multiple components (Execution Core Container, Data Application and Usage Control Data Application). These components and any descriptions related to them will be omitted to avoid confusion of the reader; those, will be detailed and further developed in Work Package 6.

Providing a Data Consumer with data from a Data Owner is the main activity of the Data Provider. To facilitate a data request from a Data Consumer, the Data Provider should provide a Broker Service Provider (Figure 7) with proper metadata about the data. However, a Broker Service Provider is not necessarily required for a Data Consumer and a Data Provider to establish a connection assuring decentralized communication between them.

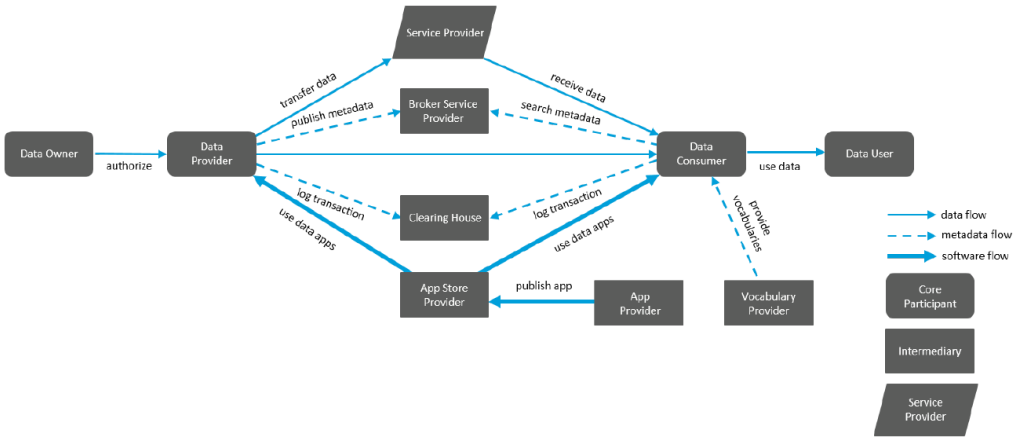

Figure 7 Roles and interactions in the Industrial Data Space (source: [13])

Exchanging data with a Data Consumer needs not necessarily be the only activity of the Data Provider. At the end of a data exchange transaction completely or partially executed, for example, the Data Provider may log the details of the successful (or unsuccessful) completion of the transaction at a Clearing House to facilitate billing or resolve a conflict. Furthermore, the Data Provider can use Data Apps to enrich or transform the data in some way, or to improve its quality. (Data Apps are specific applications that can be integrated into the data exchange workflow between two or more participants in the International Data Spaces) [13].

The Data Consumer receives data from a Data Provider. From a business process modeling perspective, the Data Consumer is the mirror entity of the Data Provider; the activities performed by the Data Consumer are therefore similar to the activities performed by the Data Provider. Before the connection to a Data Provider can be established, the Data Consumer can search for existing datasets by making an inquiry at a Broker Service Provider. The Broker Service Provider then provides the required metadata for the Data Consumer to connect to a Data Provider. Alternatively, the Data Consumer can establish a connection with a Data Provider directly (i.e., without involving a Broker Service Provider). In cases in which the information to connect with the Data Provider is already known to the Data Consumer, the Data Consumer may request the data (and the

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corresponding metadata) directly from the Data Provider. Like a Data Provider, the Data Consumer may log the details of a successful (or unsuccessful) data exchange transaction at a Clearing House, use Data Apps to enrich, transform, etc. the data received, or use a Service Provider to connect to the International Data Spaces (if it does not deploy the technical infrastructure for participation itself).

5.2.2 Generalized API specification for data exchanges

The connector configuration is necessary to perform any OneNet functionalities including the execution of a cross-platform service. Upon the deployment of a connector, certain configurations are deemed necessary such as the connectors on-boarding (e.g., ports setup, data policy, usage control rules, issuing certificates, broker registration etc). This relevant information for the connector configuration can be obtained from the so-called self-description. In this report details are avoided, yet it is important to highlight that OneNet participating actors will not be involved necessarily into the comprehension of the domain-agnostic data model which is based on the IDS information model. A characteristic example is the provided description for the connector self-description, as follows:

The description of a Connector participating in the IDS for being read by other IDS Participants; created by the Data Provider or Data User as the first step of the Connector configuration process; contains information such as the name of the Connector provider or the name of the maintainer, as well as information about the content and type of the data offered or requested, about data communication interfaces, and about usage policies and contracts.


```
{
  "@context" : {
    "ids" : "https://w3id.org/idsa/core/",
    "idsc" : "https://w3id.org/idsa/code/"
  },
  "@type" : "ids:BaseConnector",
  "@id" : "https://w3id.org/engrd/connector/",
  "ids:description" : [ {
    "@value" : "Data Consumer Connector description",
    "@type" : "http://www.w3.org/2001/XMLSchema#string"
  } ],
  "ids:resourceCatalog" : [ {
    "@type" : "ids:ResourceCatalog",
    "@id" : "https://w3id.org/idsa/autogen/resourceCatalog/af9b9b5d-73e1-
42fe-87e7-fb0a9bdc4a06",
    "ids:offeredResource" : [ ]
  } ],
  "ids:title" : [ {
    "@value" : "Data Consumer Connector title",
    "@type" : "http://www.w3.org/2001/XMLSchema#string"
  } ],
  "ids:maintainer" : {
    "@id" : "http://consumer.maintainerURI.com"
  },
  "ids:curator" : {
    "@id" : "http://consumer.curatorURI.com"
  },
  "ids:hasDefaultEndpoint" : {
    "@type" : "ids:ConnectorEndpoint",
    "@id" : "https://connector.uri:8091/",
    "ids:accessURL" : {
```


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```
      "@id" : "https:// connector.uri:8091/"
    }
  },
  "ids:securityProfile" : {
    "@id" : "idsc:BASE_SECURITY_PROFILE"
  },
  "ids:inboundModelVersion" : [ "4.0.0" ],
  "ids:outboundModelVersion" : "4.0.0"
}
```

One may notice, among the content of this JSON-LD payload, that it follows the ids information model 4.0.0 [14].

The definition of any cross-platform service will be assumed as the formulation of the following example:

curl --location --request POST 'https://data-app-consumer.URI' \

--header 'Content-Type: text/plain' \

--data-raw

{

"multipart": "mixed",

"Forward-To": "https://data-provider-connector.URI",

"messageType": "ArtifactRequestMessage" ,

"requestedArtifact": "http://w3id.org/engrd/connector/artifact/1" ,

"payload" : {

"catalog.offers.0.resourceEndpoints.path":"/flexBid2"

}

}

In this case a data consumer makes a POST request to its own data App endpoint, which in turn forwards the request to the data provider's endpoint (i.e., execution core container). For this particular example, the configuration of all connectors is a multipart mix request one, yet, this can follow other configurations. The messageType defines essentially the objective of this POST request (i.e., it is an ids based formulation, more details can be found in D5.5 [8]). The *ArtifactRequestMessage*: *Message asking for retrieving the specified Artifact as the payload of an ArtifactResponse message.* The "requestedArtifact", specifies the schema of the requested resource/artifact, which is defined on the central broker of the ecosystem. The specific payload details specific resource that is requested. Accordingly, the response on this request -if successful- will provide details on the issuer and of course the requested resource as follows:

--aDbue-EGZyC4BcMi99dnOgN5AEfBsGOQrcT

Content-Disposition: form-data; name="header"

Content-Length: 1148

Content-Type: application/ld+json

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```
{
  "@context" : {
    "ids" : "https://w3id.org/idsa/core/",
    "idsc" : "https://w3id.org/idsa/code/"
  },
  "@type" : "ids:ArtifactResponseMessage",
  "@id" : "https://w3id.org/idsa/autogen/artifactResponseMessage/05f486c7-c1d3-4073-ae64-adef0de0257b",
  "ids:securityToken" : {
    "@type" : "ids:DynamicAttributeToken",
    "@id" : "https://w3id.org/idsa/autogen/dynamicAttributeToken/be20ab22-9af0-4c4b-9179-bf5e84147f86",
    "ids:tokenValue" : "DummyTokenValue",
    "ids:tokenFormat" : {
      "@id" : "https://w3id.org/idsa/code/JWT"
    }
  },
  "ids:issuerConnector" : {
    "@id" : "https://w3id.org/engrd/connector/provider"
  },
  "ids:senderAgent" : {
    "@id" : "https://w3id.org/engrd/connector/provider"
  },
  "ids:modelVersion" : "4.0.0",
  "ids:issued" : {
    "@value" : "2022-12-03T16:41:31.515Z",
    "@type" : "http://www.w3.org/2001/XMLSchema#dateTimeStamp"
  },
  "ids:recipientConnector" : [ {
    "@id" : "http://w3id.org/engrd/connector"
  } ],
  "ids:recipientAgent" : [ ],
```


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"ids:correlationMessage" : {

"@id" : "https://w3id.org/idsa/autogen/artifactRequestMessage/dacd7695-cf7c-43af-b80c-54931b803cfc"

}

}

--aDbue-EGZyC4BcMi99dnOgN5AEfBsGOQrcT

Content-Disposition: form-data; name="payload"

Content-Length: 160

{"RequestedResource"}

--aDbue-EGZyC4BcMi99dnOgN5AEfBsGOQrcT--

The artifcat “RequestedResource” -as placed in the above payload- message refers to the payload of interest for the OneNet data consumers. This payload in the initial demo cases will be the defined CIM data models following their XML based format. Later implementation will consider the integration of XML based data models into JSON-LD context definitions. Obviously, the utilization of JSON-LD schemas benefits the system with the functionalities of linked data which can be essential to steer smart data transactions. Nonetheless, this requires the CIM model(s) mapping into JSON-LD schemas.

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6 Conclusions

The report discussed thoroughly the data sources to be integrated into the OneNet Interoperable Network of Platforms, which will support the OneNet collection of cross-platform services (i.e., formally defined by Task 5.3). The OneNet cross-platform services adoption along with their semantic definition (i.e., vocabulary provider) based on harmonized and IEC standard practices aims to establish data and service interoperability among the OneNet participants.

The DSOs' survey conducted in the context of this task highlighted that there are several tailored made solutions used towards flexibility incorporation, yet there is noticeable interest to assess CIM IEC standard profiles to unleash seamless TSO/DSO coordination. TSO and DSO need to adopt a common process on information exchange that would enable unlocking the full potential of distributed flexibility. Regarding the flexibility market facilitation, two aspects of TSO-DSO information exchange are foreseen

Towards the analysis of the semantic description of business objects, it was concluded so far that they can be generally addressed by IEC profiles such as IEC 62325 (ESMP), IEC 61970 (CGMES), IEC 61968 (CDPSM) and potentially by their subsequent enhancements. The data profiling effort will continue, after the conclusion of this deliverable, focusing on addressing the highlighted data gaps.

Finally, the report made the first effort to conceptualized the description of a request/response API providing the IDSA key principles among connectors for data exchanges.

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7 References

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[4] OneNet – Deliverable D5.4 “AI, Big Data, IoT Enablers and FIWARE compliant interoperable interfaces for grid services”, 2022

[5] https://fiware-true-connector.readthedocs.io/en/latest/

[6] OneNet – Deliverable D5.1 “Concept and Requirements”, 2021

[7] https://github.com/smart-data-models/SmartEnergy

[8] OneNet – Deliverable D5.5 “Report on Technical specifications for data models/platform agnostic middleware”, 2022

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8 Appendix

8.1 DSOs survey on Data models to support the OneNet data exchange

The aim of WP5 of OneNet, 'Extended data and service interoperability' is to have seamless interoperability among IT scalable OneNet and/or third-party technology enablers, smart grid markets and the network management platforms.

The objective of this questionnaire is to gain insight on the **DSO status and position on data models and interoperability**, to ensure that the DSO perspective is considered when exploring data models to support the OneNet data exchange in T5.6.2.

A meeting will be scheduled to discuss the results of the questionnaire.

The deadline to fill in the questionnaire is the **22 April** 2021.

For any doubt you may have regarding the questionnaire, please write to:

- Elisa Anderson – elisa.anderson@edsoforsmartgrids.eu

The personal data provided is processed for purposes strictly connected and necessary for the OneNet project, that is, statistical analysis, sending of information material and queries of clarification for the answers provided, according to the European General Data Protection Regulation (GDPR).

Respondent Information		
1.	Name:	
2.	E-mail:	
3.	Organisation:	

Data models currently used in your company		
1.	What data models are being used in your company to accommodate market and service processes, operational processes, field processes etc? [Please provide a short description.]	
2.	Are the data model(s) developed in your company?	

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3.	Is it standard? [Y/N, which one?]
4.	What is the status on data model usage? Is it evolving?

Data models in research project you have participated in.	
1.	What data models have been used in the projects you have participated in? [Please provide a short description]
2.	Which of these were of most interest?Please provide some reasoning?

Data models to support OneNet data exchange:	
1.	Is advancing CIM data model of interest from the DSO perspective? [Y/N, please provide a short explanation of why and in which business processes)/why not]
2.	If not, exploring what data model would be preferable to support OneNet data exchange processes? [Which one and why?]
3.	Could you provide input, material, or expertise on CIM, the data model proposed or data models in general, or refer to someone that could?

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4.	Could you provide input or expertise regarding the requirements needed to make it possible for the DSO to communicate and exchange data with OneNet?

Other	
1.	Do you have any comments on the topic?

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8.2 Business Objecti list development

The following table reflects the created and living content of OneNet cross-platform services' Business Object list towards the collection all appropriate data formats and data profiles that shall be considered.

Table 3 Business Object List developed in the context of T5.6

Business objects	OneNet ID (T5.3)	Service Name (T5.3)	Related BUC(s) (T5.3)	Short description of cross-platform data exchange/attributes incorporated (T5.3)	Data format (T5.6)
(Day ahead and Intra Day) Market Results	OneNet_04REIN_0003	Market results	Congestion Management and voltage violation elimination	Report: Day Ahead & Intra Day Results	IEC 62325-451-'X' standards, "publish auction results" & "publish trade results" covered in X=3. IEC 62325-451-7, provides contextual and assembly models.Includes MOL. IEC 62325-451-6 covers publishing of market information (e.g. related to the transparency platform).
(Flexibility) Resources	OneNet_10RECO_0001	Activation of assets	Congestion Management, Data management, Voltage Control, Balancing	Activation of Assets (RES, storage, flexibility resources, DSO assets): Exchange of activation signals for a specific asset or group of assets	IEC 62325-451-'X' standards, "activation phase: activate balancing energy bids" covered in X=7 (Activation document)

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(Flexibility) Resources	OneNet_10RECO_0001	Activation of assets	Congestion Management, Data management, Voltage Control, Balancing	Activation of Assets (RES, storage, flexibility resources, DSO assets): Exchange of activation signals for a specific asset or group of assets	IEC 62325-451-'X' standards, "activation phase: activate balancing energy bids" covered in X=7 (Activation document)
(Flexibility) Resources Qualification results (Grid)	OneNet_08REQU_0002	Grid qualification results (for new resource group registration)	Applied to all BUC ,BUC Prequalification, BUC Prequalification,Long-term balancing services for TSO – Central Market Model - Spain	Resource Qualification after new resource group registration: Product qualification ,Product prequalification, Market prequalification of FSP,Prequalifiyng balancing resources: GetPrequalifiedResources, IMO registers the successful resource pre-qualification to the LMP	IEC 62325-451-'X' standards, activation may be used/or the bid document itself to transmit bid and resource information

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(Flexibility) Resources Qualification results (Grid)	(Portugal)			ID Name Resource Mode of activation (If it is Automatic should be tested) Minimum Quantity Flexibility direction (load/generation reduction/increase, both) Locational information and SO connected Maximum duration of delivery period offer Single or Aggregated portfolio? Capacity/Energy Maximum Full Activation time Mandatory: Product Prequalification Result: (Approved)	IEC 62325-451-'X' standards, activation may be used/or the bid document itself to transmit bid and resource information

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Product prequalification results	Portuguese Demo			ID Name Resource Mode of activation (If it is Automatic should be tested) Minimum Quantity Flexibility direction (load/generation reduction/increase, both) Locational information and SO connected Maximum duration of delivery period offer Single or Aggregated portfolio? Capacity/Energy Maximum Full Activation time Mandatory: Product Prequalification Result: (Approved/Reproved)	ESMP - Market document
Market participant pre-qualification information				Contact information; Fiscal data; Access contract; bank details; power of representation; confidentiality agreement; declaration of non-collusion	Alll these BOs should be model in the scope of one prequalification document, based on MarketDocument in ESMP.

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Market resource pre-qualification information				Market participants provide information on the resources they want to prequalify: Facility/resource name; Type of technology; Location; Market participant; etc	Alll these BOs should be model in the scope of one prequalification document, based on MarketDocument in ESMP.
List of pre-qualified units				List of pre-qualified units for a given market session	
List of qualified units (market, technical or consolidated)				List of qualified units for a given market session. The list can refer to the market qualification, technical qualification or the consolidated list.	
Basic Participant Information				Register and basic information about the market participant such as username and password	Alll these BOs should be model in the scope of one prequalification document, based on MarketDocument in ESMP.
Scheduling process [Activation signal correction/ counter action	OneNet_09SSAC_0002	Activation document (including corrections/ counter action)	- Data management for facilitation of new flexibility solutions ("Flexibility Platform" services) Data management for facilitation of new	Activation with corrections/counter actions	This BO is related to the scheduling process and IEC 62325-451-2 should be used if scheduling infomration is exchanged between market participant and TSO.

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(tender reduction)]			flexibility solutions ("Flexibility Platform" services) - HLUC12 Aggregate geographically distributed third-party (multi-client) resources to offer ancillary services to TSO (frequency) and DSO (non-frequency)		
Scheduling process [Activation signal correction/ counter action (tender reduction)]	OneNet_09SSAC_0001	Activation document	- UC-IT-1 Voltage Management in transmission and distribution systems - UC-IT-2 Congestion Management in transmission and distribution system - Optimize active power management by the System Operators for congestion management purposes - Data management	Request for activation	This BO is related to the scheduling process and IEC 62325-451-2 should be used if scheduling infomration is exchanged between market participant and TSO.

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			for facilitation of new flexibility solutions ("Flexibility Platform" services)		
Scheduling process [Activation signal correction/ counter action (tender reduction)]	OneNet_04REIN_0001	Energy Account Document	Congestion Management and voltage violation elimination	Exchange reports about activated resources	This BO is related to the scheduling process and IEC 62325-451-2 should be used if scheduling infomration is exchanged between market participant and TSO.
Execution order	OneNet_10RECO_0002	Execution orders	Balancing, Voltage Control, Islanding Operation, Flexibility services, Energy Efficiency	Management of Assets: Exchange of execution orders to achieve a specific objective (e.g. Islanding operation, balancing, energy efficiency enablement, flexiblity services) Automated order, automated order end Order registration, order reception registration	IEC 62325-451-'X' set of standards, "scheduling business process" covered in X=2

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				Limitation order, limitation order end Order reception log, end or order reception log, order execution log, end of order execution log	
Baselines reports	OneNet_03FORC_0002	Baselines	Local Congestion Management	Exchange of FSP baselines	urn:iec62325.351:tc57wg16:451-4:energyaccountdocument. baseline is a time series and for this case we can adapt Schedule_MarketDocument. We can also modify GenerationLoad_MarketDocument (IEC 62325-451-6). The last can refer to daily, monthly, weekly and yearly generation and load forecasts.
Connection state forecast	OneNet_03FORC_0006	Connection state forecast	Coordination of operational planning activities between TSO and DSO	All DRES under incentive: Send connection state of distribution grid loops forecast, All DRES under incentive: Send common observability area TSO assets connection state forecast to DSO	Nermin: we need more info about this BO. Depending on the context, there two options: CGMES or IEC 62325-301. ENTSO-E: this seems also linked to schedules and also SSH in 61970-456
DER Structural Data	OneNet_02MEMO_0001	Resource information	Congestion Management	Exchange of Resources' Information	IEC 61850-7 or to model using CIM for the distribution grid: IEC 61968-11 and CDPSM IEC 61968-13.

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					ENTSO-E: 61970-302 can also help here as it coveres IEEE 1547 standard
DER structural Data	OneNet_02MEMO_0001	Resource information	Congestion Management	Exchange of Resources' Information	CGMES profile defined in IEC 61970-600-2
Development plans for distribution network	OneNet_06GRMO_0003	Network planning (in distribution system)	Coordination of long-term network planning between TSO and DSO	Development plans: Send the plans for distribution network	CIM is used as data format. The relevant standard is IEC 61968-13 – Distribution Model (CDPSM). In the context fo TSO-DSO cooperation, CGMES profile should be used for distribution grid, and validated for Distribution requirements (unbalanced grid). In the simplified model, equivalents should be used. IEC 62325-451-6 (Generation and Load contextual model) is used for time series. For Load Management, the LoadModel package can be used.
Development plans for transmission network	OneNet_06GRMO_0002	Network planning (in tansmission system)	Coordination of long-term network planning between TSO and DSO	Development plans: Send the plans for changes in the transmission network	CIM is used as data format. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is

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					recommneded to use CGMES profile. The relevant IRM business object is named “Network Model”.
Dynamic Line Rating Forecast for overhead lines	OneNet_03FORC_0005	Dynamic line rating	HLU1 Regional Operation Centre	Enhance method for PNP estimation. Dynamic Line Rating Forecast for overhead lines. Determination of capacity calculation input data. Enhance transmission system resilience during emergencies.	The TransmissionNetwork_MarketDocument (IEC 62325-451-6) can be used to transmit information relating to the congestion management.
Transmit planned schedules [Energy clearing results]	OneNet_04REIN_0001	Energy Account Document	Congestion Management and voltage violation elimination	Exchange reports about activated resources	IEC 62325-451-‘X' standards, "Transmit planned schedules" covered in X=2, Energy Account document covered in X=4// See also: IEC 62325-301 “CIM extensions for markets” and IEC 62325-351 “CIM European market model exchange profile”
Transmit planned schedules [Energy clearing results]	OneNet_05MRKT_0002	Market clearing/ results	Congestion Management, Voltage Control	Exchange market (clearing) results	IEC 62325-451-‘X' standards, "Transmit planned schedules" covered in X=2, Energy Account document covered in X=4// See also: IEC 62325-301 “CIM extensions for markets” and IEC 62325-351 “CIM European market model exchange profile”

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Transmit planned schedules [Energy clearing results]	OneNet_05MRKT_0004	Market information	Congestion Management, Balancing, OneNet Northern Demo - Market Operator services	Exchange information on market	IEC 62325-451-'X' standards, "Transmit planned schedules" covered in X=2, Energy Account document covered in X=4// See also: IEC 62325-301 "CIM extensions for markets" and IEC 62325-351 "CIM European market model exchange profile"
Transmit planned schedules [Energy clearing results]	OneNet_05MRKT_0007	Matching bids and grid needs	Congestion Management	Exchange information on matching of bid and grid needs for decision support	IEC 62325-451-'X' standards, "Transmit planned schedules" covered in X=2, Energy Account document covered in X=4// See also: IEC 62325-301 "CIM extensions for markets" and IEC 62325-351 "CIM European market model exchange profile"
Transmit planned schedules [Energy clearing results]	OneNet_05MRKT_0010	Market opening/ closing	Congestion Management	Open/Close Market Session	IEC 62325-451-'X' standards, "Transmit planned schedules" covered in X=2, Energy Account document covered in X=4// See also: IEC 62325-301 "CIM extensions for markets" and IEC 62325-351 "CIM European market model exchange profile"
Transmit planned schedules [Energy clearing results]	OneNet_05MRKT_0011	Offer assessment result	Congestion Management, Balancing	Offers Assessment (Validation, acceptance, re-definition)	IEC 62325-451-'X' standards, "Transmit planned schedules" covered in X=2, Energy Account document covered in X=4// See also: IEC 62325-301 "CIM extensions for markets" and IEC 62325-351 "CIM European market model exchange profile"

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Flexibility needs (i.e., balancing, congestion)	OneNet_05MRKT_0008	Congestion data	Congestion Management	Exchange congestion data	See also: IEC 62325-301 “CIM extensions for markets” and IEC 62325-351 “CIM European market model exchange profile”
Flexibility needs (i.e., balancing, congestion)	OneNet_02MEMO_0001	Resource information	Congestion Management	Exchange of Resources' Information	See also: IEC 62325-301 “CIM extensions for markets” and IEC 62325-351 “CIM European market model exchange profile”
Flexibility needs (i.e., balancing, congestion)	OneNet_05MRKT_0010	Market opening/ closing	Congestion Management	Open/Close Market Session	See also: IEC 62325-301 “CIM extensions for markets” and IEC 62325-351 “CIM European market model exchange profile”
Flexibility needs (i.e., balancing, congestion)	Portuguese Demo			The amount of flexibility required per flexibility aggregation node/zone will be quantified. Node/Zone Quantity (MW)	See also: IEC 62325-301 “CIM extensions for markets” and IEC 62325-351 “CIM European market model exchange profile”
Flexible Resource Metering data	OneNet_02MEMO_0002	Metering data	Congestion Management, Islanding, Volatage Control, Operational Planning, Power Quality	Exchange of (real time) Metering Data	urn:iec62325.351:tc57wg16:451-4:energyaccountdocument:4:0

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Flexible Resource Metering data	Cyprus demo			This information includes the real-time monitoring of the FSPs response. The information is generated by the real-time monitoring use case and will be used by the evaluation of the FSPs response use case to assess the FSP operation.	Probably we can use Measur profile for this. BO "Meter Data"
Forecast data (load, generation, FSP)	OneNet_02MEMO_0004	Grid State	Voltage Control	Exchange of grid state information	GenerationLoad_MarketDocument (IEC 62325-451-6), The GenerationLoad_MarketDocument enables the transmission of generation and load information on a regular basis. The information transmitted may be actual generation and load, planned generation and load or forecast generation and load depending on market requirements.

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Forecast data (load, generation, FSP)	OneNet_07SIRE_0002	Grid constraints assessment	0	Grid Constraints Assessment	GenerationLoad_MarketDocument (IEC 62325-451-6), The GenerationLoad_MarketDocument enables the transmission of generation and load information on a regular basis. The information transmitted may be actual generation and load, planned generation and load or forecast generation and load depending on market requirements.
Forecast data (load, generation, FSP)	OneNet_03FORC_0001	Forecast data (general)	Congestion Management, Voltage Control, Cross border RES management, Smart energy storage/DSO forecasts flexibility demands	Exchange forecast data for environmental parameters (weather), load, generation, or storage (either combined or one forecast per type)	GenerationLoad_MarketDocument (IEC 62325-451-6), The GenerationLoad_MarketDocument enables the transmission of generation and load information on a regular basis. The information transmitted may be actual generation and load, planned generation and load or forecast generation and load depending on market requirements.
Forecast data (load, generation, FSP)	OneNet_06GRMO_0003	Network planning (in distribution system)	Coordination of long-term network planning between TSO and DSO	Development plans: Send the plans for distribution network	GenerationLoad_MarketDocument (IEC 62325-451-6), The GenerationLoad_MarketDocument enables the transmission of generation and load information on a regular basis. The information transmitted may be actual generation and load, planned generation and load or forecast

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					generation and load depending on market requirements.
Forecasts of icing and storm conditions	OneNet_03FORC_0004	Maintenance forecast	Enhanced severe weather condition management and outage management	Storm and Icing predictive maintenance process in DSO grid and local microgrid	IEC 61970-458 defines extensions to CIM. In IEC 62325 package Enviromental contains enviromental classes that inherits from measurements, and Forecast class inherits from EnviromentalInformation within this tree.
Grid congestions status	OneNet_07SIRE_0002	Grid constraints assessment	0	Grid Constraints Assessment	If this is related to the identification of congestion in the dsitribution grid and concept of "traffic light", than IEC 62325-301 can be used for data modelling. In a case that "status is needed" than IEC 62325-451-5 can be used to initiate "status request busniess process".
Grid constraints Assessment	OneNet_07SIRE_0002	Grid constraints assessment	0	Grid Constraints Assessment	IEC 62315-451-6 is related to the market information publication process. Among other, it includes "Provide generation and load informaton" and "Provide actual availability and planed unavailability information".

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Invoicing data	OneNet_04REIN_0006	Invoicing data	Northern demo - Flexibility Register services	Send invoicing data	IEC 62325-451-'X' standards, reconciliation processes coverd in X=4
limits and margins for capacity (by zone)	OneNet_05MRKT_0003	Required resources	Congestion Management, Voltage Control, Islanding, Balancing	Exchange demand/need of resources or system operators	See also: IEC 62325-301 "CIM extensions for markets" and IEC 62325-351 "CIM European market model exchange profile"
limits and margins for capacity (by zone)	Cyprus demo			I-03 (TSO and DSO send the prequalification limits to the Market Operator through the OneNet system)	See also: IEC 62325-301 "CIM extensions for markets" and IEC 62325-351 "CIM European market model exchange profile"
Network characteristics (internal) information	OneNet_06GRMO_0004	Network model (transmission system)	Coordination of short-term network planning between TSO and DSO	Network models: Send transmission network model	CIM is used as data format. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is recommneded to use CGMES profile. The relevant IRM business object is named "Network Model".
Network characteristics (internal) information	OneNet_06GRMO_0005	Network model (distribution system)	Coordination of short-term network planning between TSO and DSO	Network models: Send distribution network model	CIM is used as data format. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is recommneded to use CGMES profile. The relevant IRM business object is named "Network Model".

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Network characteristics (internal) information using node-breaker representation	OneNet_06GRMO_0004	Network model (transmission system)	Coordination of short-term network planning between TSO and DSO	Network models: Send transmission network model	CIM is used as data format. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is recommneded to use CGMES profile. The relevant IRM business object is named “Network Model”.
Network characteristics (internal) information using node-breaker representation	OneNet_06GRMO_0005	Network model (distribution system)	Coordination of short-term network planning between TSO and DSO	Network models: Send distribution network model	CIM is used as data format. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is recommneded to use CGMES profile. The relevant IRM business object is named “Network Model”.
network data of distribution system	OneNet_06GRMO_0005	Network model (distribution system)	Coordination of short-term network planning between TSO and DSO	Network models: Send distribution network model	CIM is used as data format. The relevant standard is IEC 61968-13 – Distribution Model (CDPSM). In the context fo TSO-DSO cooperation, CGMES profile should be used for distribution grid, and validated for Distribution requirements (unbalanced grid).

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network data of distribution system	OneNet_06GRMO_0003	Network planning (in distribution system)	Coordination of long-term network planning between TSO and DSO	Development plans: Send the plans for distribution network	CIM is used as data format. The relevant standard is IEC 61968-13 – Distribution Model (CDPSM). In the context fo TSO-DSO cooperation, CGMES profile should be used for distribution grid, and validated for Distribution requirements (unbalanced grid). In the simplified model, equivalents should be used. IEC 62325-451-6 (Generation and Load contextual model) is used for time series. For Load Management, the LoadModel package can be used.
network data of distribution system	OneNet_06GRMO_0003	Network planning (in distribution system)	Coordination of long-term network planning between TSO and DSO	Development plans: Send the plans for distribution network	CIM is used as data format. The relevant standard is IEC 61968-13 – Distribution Model (CDPSM). In the context fo TSO-DSO cooperation, CGMES profile should be used for distribution grid, and validated for Distribution requirements (unbalanced grid). In the simplified model, equivalents should be used. IEC 62325-451-6 (Generation and Load contextual model) is used for time series. For Load Management, the LoadModel package can be used.
network data of transmission system	OneNet_06GRMO_0004	Network model (transmission system)	Coordination of short-term network planning between TSO and DSO	Network models: Send transmission network model	CIM is used as data format. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is recommneded to use CGMES profile. The relevant IRM business object is named “Network Model”.

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network data of transmission system	OneNet_06GRMO_0002	Network planning (in tansmission system)	Coordination of long-term network planning between TSO and DSO	Development plans: Send the plans for changes in the transmission network	CIM is used as data format. The relevant standard is IEC 61968-13 – Distribution Model (CDPSM). In the context fo TSO-DSO cooperation, CGMES profile should be used for distribution grid, and validated for Distribution requirements (unbalanced grid). In the simplified model, equivalents should be used. IEC 62325-451-6 (Generation and Load contextual model) is used for time series. For Load Management, the LoadModel package can be used.
network data of transmission system/TSO network information (on specific period and substation aggregate short circuit power-Scc and phase angle-degree)	OneNet_06GRMO_0001	Network reconfiguration	Congestion and voltage violation estimation	Exchange and validate reconfiguration data	IEC 61970-456

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Network demand forecast	OneNet_06GRMO_0003	Network planning (in distribution system)	Coordination of long-term network planning between TSO and DSO	Development plans: Send the plans for distribution network	CIM is used as data format. The relevant standard is IEC 61968-13 – Distribution Model (CDPSM). In the context fo TSO-DSO cooperation, CGMES profile should be used for distribution grid, and validated for Distribution requirements (unbalanced grid). In the simplified model, equivalents should be used. IEC 62325-451-6 (Generation and Load contextual model) is used for time series. For Load Management, the LoadModel package can be used.
Network information	OneNet_06GRMO_0004	Network model (transmission system)	Coordination of short-term network planning between TSO and DSO	Network models: Send transmission network model	CIM is used as data format. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is recommneded to use CGMES profile. The relevant IRM business object is named “Network Model”.
Network information	OneNet_06GRMO_0005	Network model (distribution system)	Coordination of short-term network planning between TSO and DSO	Network models: Send distribution network model	CIM is used as data format. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is recommneded to use CGMES profile. The relevant IRM business object is named “Network Model”.
Network reconfiguration data	OneNet_06GRMO_0001	Network reconfiguration	Congestion and voltage violation estimation	Exchange and validate reconfiguration data	Nermin: IEC 62325-451-6 can be used to "provide transmission asset configuration information".

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Prediction of maintenance periods	OneNet_03FORC_0004	Maintenance forecast	Enhanced severe weather condition management and outage management	Storm and Icing predictive maintenance process in DSO grid and local microgrid	is it foreseen to be covered by any CGMES?
Prediction of maintenance periods	Portuguese Demo	Request (external) of Planned works (PT)		Request of planned works with impact in the SO network. The request can be done in a specific observability area. Date Request ID Observability area ID or Bus ID	
Prediction of maintenance periods	Portuguese Demo	Request(internal) of Planned works (PT)		Request of planned works in the SO system. Date Request ID Year	
Prediction of maintenance periods	Portuguese Demo	Maintenance and expansion planned works (internal) information (PT)		Maintenance and expansion planned works exchanged internally	We handle request/respone with IEC 61968-100
Prediction of maintenance periods	Portuguese Demo	TSO/DSO Planned works (external) information (PT)		Jointly Work programmes information exchanged between operators	

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Prediction of maintenance periods	Portuguese Demo	TSO/DSO Planned works (internal) information		Validated TSO/DSO planned works information exchanged internally	
Possible temporary limits on balancing capacity bids according to Art. 182-5 SOGL classiefied as 1-Partial, 2-Total, or 3-None	OneNet_03FORC_0003	Capacitiy bid limits	Short-term balancing services for TSO	Exchange expected limits of balancing capacity	This article of the System operation code defines that DSO can put a limit to any active power reserve connected to the distribution grid and inform TSO about that. This can be considered as "Provide actual availability and planned unavailability information" within IEC 62325-451-6. Also IEC 61970-301 OperationalLimits package can be used.
Power flow simulation	OneNet_07SIRE_0001	Grid power flows data	Congestion Management	Exchange of Grid Power Flows data	It is probably reluted to the power flow calculation results. CGMES StateVariableProfile (SV) package should be used. Use IEC 61970-456.
Resource optimization information	OneNet_05MRKT_0006	Resource optimization	Congestion Management	Exchange information on resource optimization	IEC 62325-451-'X' set of standards, "Tendering phase: submit network constraints information necessary for tendering" covered in X=7
Settlement Data	OneNet_02MEMO_0003	Estimation data	Congestion Management, Islanding, Volatage Control, Operational	Exchange of Estimation Data	urn:iec62325.351:tc57wg16:451-4:energyaccountdocument:4:0

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			Planning, Power Quality		
Settlement Data	OneNet_04REIN_0002	Settlement process	Congestion Management and voltage violation elimination	Exchange reports about settlement processes (e.g. production & consumption plans)	IEC 62325-451-'X' standards, settlement processes coverd in X=4
Settlement Data	OneNet_04REIN_0004	Under or overdelivered flexibilities	Northern demo - Flexibility Register services	Inform about under or overdelivered flexibilities in real-time	IEC 62325-451-'X' standards, "provide actual availability and planned unavailability" in X=6
Short-Circuit power forecast.	OneNet_06GRMO_0001	Network reconfiguration	Congestion and voltage violation estimation	Exchange and validate reconfiguration data	A possibility is to model using IEC 62325-451-2 for energy scheduling or using CIM Meas/Control associated classes.
Solutions to avoid outage plans incompatibilities	OneNet_06GRMO_0003	Network planning (in distribution system)	Coordination of long-term network planning between TSO and DSO	Development plans: Send the plans for distribution network	CIM is used as data format. The relevant standard is IEC 61968-13 – Distribution Model (CDPSM). In the context fo TSO-DSO cooperation, CGMES profile should be used for distribution grid, and validated for Distribution requirements (unbalanced grid). In the simplified model, equivalents should be used. IEC 62325-451-6 (Generation and Load contextual model) is used for time series. For Load Management, the LoadModel package can be used.
State Estimation Data	OneNet_02MEMO_0004	Grid State	Voltage Control	Exchange of grid state information	IEC 61970-456

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State Estimation Data	Demo Cyprus			I-01 (Real time monitoring scheme sends the estimated states to the limit prequalification algorithm)	IEC 61970-456
system parameter contol schema/ instructions	OneNet_10RECO_0003	Regulation, instruction and control schema	Voltage Control, System stability, energy quality control and Frequency control	Regulation of voltage and/or frequency: Exhange of instructions/control scheme for regulation of a system parameter	can this be addressed by the scheduled actions (procurring services) i.e.: transmitting schedules: EC 62325-451-'X' standards, "Transmit planned schedules" covered in X=2?
Transmission network outage plan	OneNet_06GRMO_0002	Network planning (in tansmission system)	Coordination of long-term network planning between TSO and DSO	Development plans: Send the plans for changes in the transmission network	CIM is used as data format. The relevant standard for the transmission grid is IEC 61970-452 - Static Transmission Network Model Profiles. It is recommneded to use CGMES profile. The relevant IRM business object is named "Network Model".
Verification process results	OneNet_04REIN_0005	Verification process results	Northern demo - Flexibility Register services	Exchange information about verification process (communicate verification results to entitled parties)	CIM: IEC 62325-451-'X' standards, to be clarified where verificaton process is covered, perhaps in X=1 or X=4?
weather forecast	OneNet_03FORC_0001	Forecast data (general)	Congestion Management, Voltage Control, Cross border RES management, Smart energy storage/DSO	Exchange forecast data for environmental parameters (weather), load, generation, or storage (either combined or one forecast per type)	IEC 61970-458 defines extensions to CIM. In IEC 62325 package Enviromental contains enviromental classes that inherits from measurements, and Forecast class inherits from EnviromentalInformation within this tree.

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			forecasts flexibility demands		
Hydrological forecast	OneNet_03FORC_0001	Forecast data (general)	Congestion Management, Voltage Control, Cross border RES management, Smart energy storage/DSO forecasts flexibility demands	Exchange forecast data for environmental parameters (weather), load, generation, or storage (either combined or one forecast per type)	IEC 61970-458 defines extensions to CIM. In IEC 62325 package Enviromental contains enviromental classes that inherits from measurements, and Forecast class inherits from EnviromentalInformation within this tree.
Bids/offers	OneNet_05MRKT_0001	Market bid/ offer	Communicate bids/ offers for available flexibility by initiative (Create).	Bid ID Resource Connected SO Day Hour Duration Quantity Flexibility direction Full Activation time Price	IEC 62325-451-'X' set of standards, "Bid and allocate capacity" & "Submit bids and offers to local exchange" covered in X=3 (Market Document)

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Bids/offers	(Portugal)	Market bid/ offer	Communicate bids/ offers for available flexibility by initiative (Create).	Bid ID Resource Connected SO Day Hour Duration Quantity Flexibility direction Full Activation time Price	iec62325.351:tc57wg16:451-7:reservebiddocument:7:1

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Product parameters definition				Composed of product parameters concerning the market session being requested. E.g.: 1. Service window: Selection of the required date and duration of the service o Start date: 01/06/2021 o Duration: 2 months o Selection of days: M, T, W, T, F, S and S. o Opening time: 8:00 PM o Closing time: 10:00 PM 2. Availability: Selection of the capacity, the direction and the estimated hours of activation. o Capacity: 4MW o Direction: Upwards (up for generation, down for consumption) o Estimated hours of activation: 120h 3. Activation window (in case of activation product): Specific subperiod in an activation window when a particular DER could be	These are attributes off the product. It is probably part of another BOs, e,g, Bid.

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				activated and thus it must be available. Multiple sets of activation windows can be defined. E.g.: o Day: 01/06/2021 o Hour: 19h o Duration: 2h o Capacity to modify: 1MW o Direction: Upward 4. Local area: Selection of the trading area. Choice by postal code, connection point, lines… (to be determined). o Area: postal code 5. Activation Announcement: Time in advance that a DSO informs a DER that its activation is programmed confirmed. 6. Form of Remuneration: It establishes form of payment to winner DERs Two different terms are defined availability and activation (depending on the product). o Type of product: availability/activation	

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				Availability/Activation cap price: X €/MW or X €/MWh	

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Aggregated data	Cluster East (WP10)	Market results	Regional SUC Cluster East	Aggregated data are computed for the national level, without location information. Data are provided on an hourly basis, at D+1 (where possible due to technical limitation). On the request, the newest data should be provided. Aggregated data include: • Total quantity of tendered power bids in kW per individual hour, aggregated -> date, hour, type of service, quantity in kW • Total quantity of tendered energy bids in kWh per individual hour, aggregated -> date, hour, type of service, quantity in kWh • Total amount taken for energy in kWh per hour, aggregated -> date, hour, type of service, quantity in kW • Total value of accepted bids in € on an hourly basis	CIM ESMP

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				(here we assume that this value will also be 0 € and all money will be "turned over" on activated energy) -> date, hour, type of service, € • Total activated amount of energy in kWh per individual hour -> date, hour, type of service, quantity in kWh • Total value of activated energy in € per individual hour -> date, hour, type of service, € • Planned outages -> estimated duration, affected units/generators	
Aggregated data request	Cluster East (WP10)	Market results	Regional SUC Cluster East	The request for the aggregated data. It contains information about the market, time period of requested data and the data type.	IEC 61968-100

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Rejection of the request	Cluster East (WP10)	Market results	Regional SUC Cluster East	Request can't be fulfilled.	IEC 61968-100

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