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European (energy) data exchange reference architecture 3.1

Data Management Working Group

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List of Acronyms and Abbreviations

ADMS	Advanced Distribution Management Systems
AI	Artificial Intelligence
AIIDA	Administrative Interface for In-house Data Access
AIOTI	Alliance for Internet of Things Innovation
AMQP	Advance Message Queuing Protocol
API	Application Programming Interface
BDVA	Big Data Value Association
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CGMES	Common Grid Model Exchange Specification
CIM	Common Information Model
COSEM	Companion Specification for Energy Metering
CPS	Cross-Platform Services
CSV	Comma-Separated Values file
DCAT	Data Catalog vocabulary
DEP	Data Exchange Platform
DER	Distributed Energy Resources
DERA	Data Exchange Reference Architecture
DERMS	Distributed Energy Resource Management System
DESAP	Digitalising the Energy System - EU Action Plan
DSBA	Data Space Business Alliance
DSO	Distribution System Operator
EC	European Commission
ECB	European Central Bank
ECCoSP	ENTSO-E Communication & Connectivity Service Platform
EIB	European Investment Bank
eIDAS	EU regulation on electronic Identification, Authentication, and trust Services
EMS	Energy Management System
EFRAG	European Financial Reporting Advisory Group
ENTSO-E	European Network of Transmission System Operators for Electricity
ETSI	European Telecommunications Standards Institute
EU	European Union
FAIR	Findability, Accessibility, Interoperability and Reusability
FSP	Flexibility Service Provider
FTP	File Transfer Protocol
GDPR	General Data Protection Regulation
GUI	Graphical User Interface
HAN	Home Area Network
HDFS	Hadoop Distributed File System
HEMRM	Harmonised Electricity Market Role Model
HERM	Harmonised Energy Role Model
HGMR	Harmonised Gas Role Model
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
IaS	Infrastructure as a Service
ICT	Information and Communications Technology
IDSA	International Data Spaces Association

IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IEGSA	Interoperable pan-European Grid Services Architecture
IoT	Internet of Things
IP	Internet Protocol
ISO	International Organisation for Standardisation
JPEG	Joint Photographic Experts Group
JSON	JavaScript Object Notation
ML	Machine Learning
MQTT	Message Queuing Telemetry Transport
NCDR	Network Code for Demand Response
NGSI	Next Generation Service Interfaces
NIS	EU directive on security of Network and Information Systems
OCPP	Open Charge Point Protocol
OEO	Open Energy Ontology
OPC	Open Platform Communications
PNG	Portable Graphics Format
RDF	Resource Description Framework
RDFS	Resource Description Framework Schema
REST	Representationally State Transfer
SaaS	Software as a Service
SAREF	Smart Appliances Referenced Ontology
SCADA	Supervisory Control and Data Acquisition
SGAM	Smart Grid Architecture Model
SGTF	European Smart Grids Task Force
SOAP	Simple Object Access Protocol
TCP	Transmission Control Protocol
TLS	Transport Layer Security
TSO	Transmission System Operator
UML	Unified Modelling Language
WG	Working Group
XLSX	Microsoft Excel Open XML Spreadsheet
XML	Extensible Markup Language
XMPP	Extensible Messaging and Presence Protocol
XSD	XML Schema Definition

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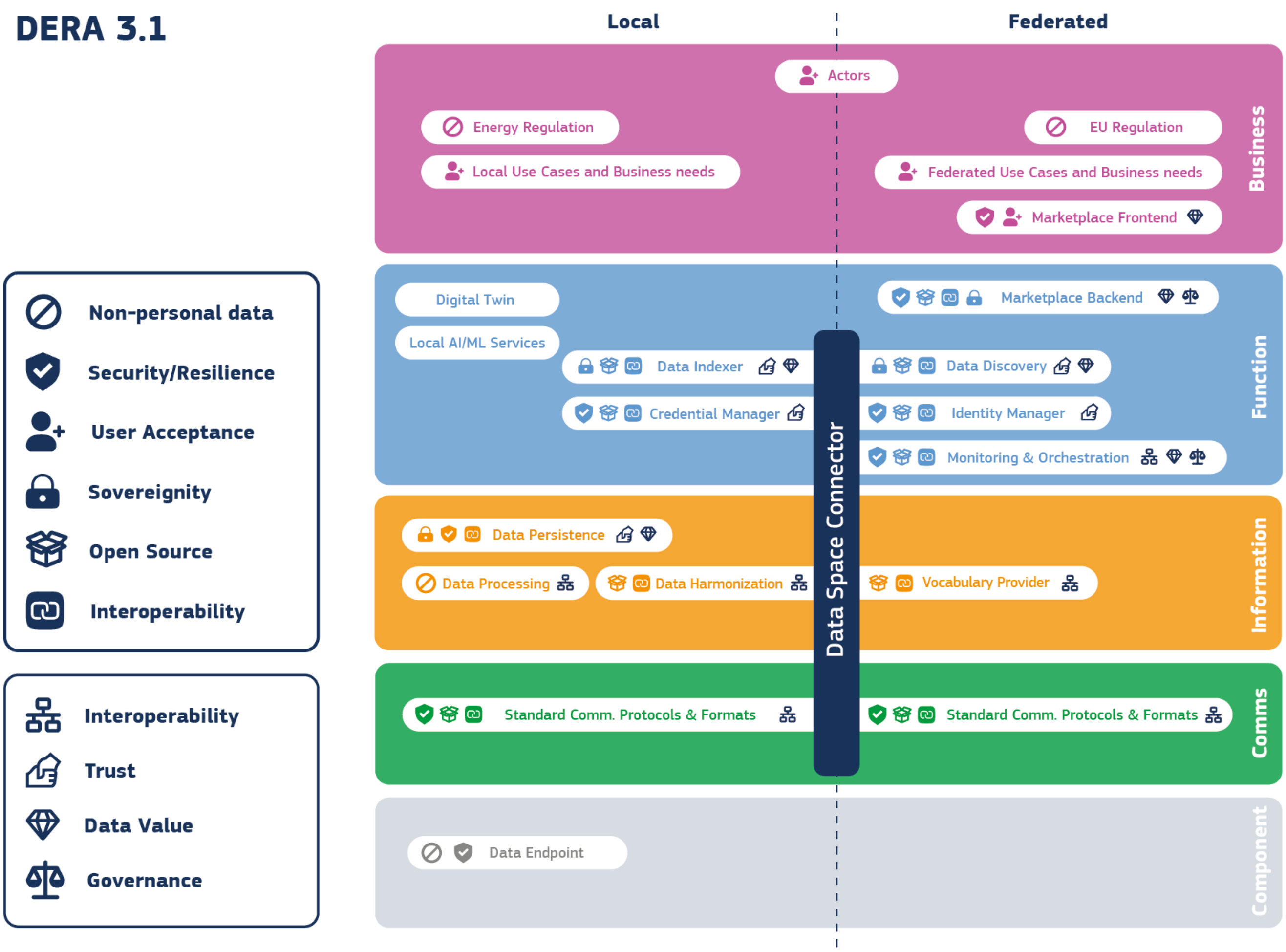
Executive Summary

This is the version 3.1 of **D**ata **E**xchange **R**eference **A**rchitecture – DERA 3.1. The BRIDGE report on energy data exchange reference architecture aims at contributing to the discussion about and the practical steps towards truly interoperable and business process agnostic data exchange arrangements on European scale both inside energy domain and across different domains.



Recommendations related to the implementation of DERA:

A. Promote business process agnostic data exchange platforms (DEPs) and ensure interoperability through the development of APIs (application programming interfaces). These APIs should facilitate easy connection for both data providers and users to any European DEP. This will create a seamless data exchange environment, aligning with the aim to push brands and technology providers, through regulations, to open their communication layers. DEPs should explore integrating data space connectors to enable connectivity with other DEPs, including cross-sector platforms, fostering a broader data ecosystem, and facilitating the exchange of data.

B. Develop universal data applications capable of serving any domain, aligning with the push for regulations to open communication layers among brands and technology providers. Additionally, foster the development of open data-driven services that promote cross-sector integration. These services should be collectively available in application repositories, ensuring accessibility and facilitating the exchange of data across various domains.

C. Ensure a protocol agnostic approach to cross-sector data exchange by selecting standardised and open protocols. This entails emphasising interoperability and openness in protocol selection to facilitate seamless communication across sectors.

D. Ensure a data format agnostic approach, prioritising interoperability. Leverage CIM and industry standards like Kafka and MQTT. Implement a dynamic framework for emerging technologies. Develop guidelines for format selection based on security and interoperability. Explore relationships with key demand response standards. Acknowledge cases where specific formats are necessary.

E. Establish and maintain a common reference semantic data model, ensuring access to its model files for cross-sector data exchange. This involves leveraging existing data models like the Common Information Model (CIM) of the International Electrotechnical Commission (IEC) and ontologies like the Smart Appliances Reference Ontology (SAREF). Incorporate mechanisms for life-cycle management of the canonical data model to facilitate enrichment with new concepts, extension to further domains, and relations management. Collaborate with other projects to improve the mapping of CIM and SAREF at the residential energy resources level, enabling cross-sector profile exchange, especially in residential energy management and electromobility sectors. Investigate the possibility of integrating CIM-based data exchanges through key standards like OpenADR and OCPP for cross-sectorial integration. Address the lack of abstraction and standards in communicating asset flexibility, incorporating concepts as described in CEN/CENELEC EN50491-12-2. Consider the management and maintenance of a network of canonical models to address different domains, emphasising the importance of a common and stable reference to the data model descriptions.
F. Develop cross-sector data models and profiles, emphasising private data exchange and ensuring open access to model files. Adhere to robust methodologies, leveraging standards like IEC CIM and IEC 61850. Address identified gaps by implementing stronger governance in data vocabulary, clarifying terms, and collaborating on mapping efforts. Investigate integration possibilities for CIM-based data exchanges through standards like OpenADR and OCPP. Emphasise the importance of maintaining a common and stable reference to data model descriptions for effective interoperability.
G. Define and harmonise functional data processes for cross-sector domains, leveraging common vocabulary, templates, and repositories for describing respective use cases. Harmonisation efforts should encompass vocabulary provider, federated catalogue, data quality, data accounting processes, clearing process (audit, logging, etc.), and data tracking and provenance to ensure seamless interoperability and efficient data management across sectors. Furthermore, ensure real-time data processing capabilities, standardize protocols, and adapt frameworks for technological advancements to enable immediate decision-making. Incorporate local AI/ML services with federated counterparts, address access policies, data provenance, bartering mechanisms, and metadata brokering functionalities within the framework to support comprehensive cross-sector data management.
H. Ensure cooperation among appropriate associations, countries, and sector representatives to advance cross-sector and cross-border data management by establishing a European data cooperation agency. This entails ongoing empowerment of the Data Management Working Group of the BRIDGE Initiative to engage other sectors and expand cooperation with projects beyond EU funding. Collaboration with European Standardization Organizations (CEN-CENELEC-ETSI) should also be prioritised.
I. Harmonise cross-sector data exchange business use cases via the BRIDGE Use-Case Repository, ensuring clarity on marketplace references and aligning actor roles with the Harmonised electricity market role model (HEMRM). Strengthen cooperation with regulators to align use cases with evolving regulatory frameworks. Base the repository on the HarmoniseHEMRM, acknowledging additional roles from other sectors like in the Harmonised gas role model (HGRM). Facilitate ongoing process harmonisation efforts through regular meetings, keeping the repository updated with the latest developments. Incorporate cross-sector needs into the marketplace frontend, renaming it to reflect a business-oriented approach, and ensuring it remains an integrated component.
J. Facilitate a comprehensive European strategy and regulatory framework, including the harmonisation of national regulations, to support cross-sector exchange of both private and public data. This involves establishing reference models for data spaces, implementing common data governance practices, and promoting data interoperability through practical tools and guidelines.

Possible next steps (“sub-actions”) for 2024/2025:

a) Working on DERA version 3.2 with focus on SGAM compliance, business aspects and synergies with other vertical data spaces. Taking best parts from DERA 2.0 and DERA 3.1, potentially combining these two also visually.
b) Making sure that recommendations are still relevant and in line with DERA.

c) Elaborating further data role models, including with data space specific roles. Ensuring alignment with European initiatives and legislation – like Demand Response Network Code and data interoperability implementing acts.
d) Interface of Federated Service Catalogue tool to be made available in 2024.
e) Implementing and deploying DERA based on concrete use cases. Cross-project demonstration of DERA, cross-project testing of data exchange use cases, in cooperation with int:net project.

1. Introduction

The Data Management Working Group (WG) aims to cover a wide range of aspects, from the technical meansfor exchanging and processing data between stakeholders to the definition of rules for exchanging data, includingsecurity issues and responsibility distribution in data handling. Accordingly, the WG has identified 3 areas of collaboration around which mutual exchange of views and discussions have been set:

- **Communication Infrastructure**, embracing the technical and non-technical aspects of the communication infrastructure needed to exchange data and the related requirements;
- **Cybersecurity and Data Privacy**, entailing data integrity, customer privacy and protection;
- **Data Handling**, including the framework for data exchange and related roles and responsibilities, together with the technical issues supporting the exchange of data in a secure and interoperable manner, and the dataanalytics techniques for data processing.

The BRIDGE Data Management WG will continue to contribute to the ongoing activities of European Commission(EC) to deliver 'data interoperability implementing acts' as mandated in articles 23 and 24 of 2019/944 Eelectricity Market Directive[1] and Common Energy Data Space as foreseen in DESAP (Digitalising the Energy System - EU Action Plan[2]).

The objective of this report is to continue working on issues related to organising energy data exchanges on European level. The first version of EU data exchange reference architecture was defined in the BRIDGE Data Management WG report in 2021[3], the second version in the report of 2022[4] and the third version in the report of 2023[5].

The 2023 General Assembly identified possible activities related to data exchange reference architecture for 2023/2024:

- Action #2 EU data exchange reference architecture – 2023-2024
- Release BRIDGE Federated Service Catalogue tool and associated process – October 2023
- Release DERA interactive visualisation tool – July 2023
- Update recommendations to comply with DERA 3.0 – December 2023
- Develop / enhance the "data role model" – December 2023
- Foster implementation and deployment of DERA 3.0 inside and outside BRIDGE – Continuous

2023-2024 work and this report were based on the contributions of four sub-actions of Action #2 of Data Management Working Group (originally planned fifth sub-action 2.2 on DERA interactive visualisation tool was cancelled due to unavailability of resources):

- Sub-action 2.1: BRIDGE Federated Service Catalogue tool and associated process
- Sub-action 2.3: Updating recommendations to comply with DERA 3.0
- Sub-action 2.4: Development of the "data role model"
- Sub-action 2.5: Implementation of DERA 3.0 in BRIDGE projects (mapping to DERA)

Chapter 2 gives the overview of DERA, explains the content of each interoperability layer and presents some examples of instantiation of DERA in the projects. Chapter 3 summarises the feedback to data role model related questions from projects based on the survey and gives recommendations for modifications in the role model. Chapter 4 highlights the main outcomes of the projects' survey about DERA recommendations and provides the updated list of findings and recommendations. Chapter 5 concerns the work on BRIDGE federated catalogue. Chapter 6 outlines possible next steps.

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[1] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1593158348328&uri=CELEX:32019L0944

[2] European Commission, COM (2022)552, Digitalising the energy system – EU action plan. Available: https://energy.ec.europa.eu/communication-digitalising-energy-system-eu-action-plan-com20225522_en

[3] BRIDGE Data Management WG, European energy data exchange reference architecture, 2021. Available:https://energy.ec.europa.eu/system/files/2021-06/bridge_wg_data_management_eu_reference_architcture_report_2020-2021_0.pdf

[4] BRIDGE Data Management WG, European (energy) data exchange reference architecture 2.0, 2022. Available:https://data.europa.eu/doi/10.2833/142689
[5] BRIDGE Data Management WG, European (energy) data exchange reference architecture 3.0, 2023. Available: https://data.europa.eu/doi/10.2833/81504

2. DERA 3.1

2.1. Description of Reference Architecture

BRIDGE Data Management Working Group members active in Action #2, Data Exchange Reference Architecture (DERA), agreed to iterate the previous 3.0 version and, therefore, generate the new 3.1 version based on the following objectives:

- Solidify the approach presented in DERA 3.0, with its effort to **aggregate and simplify** the modules in every layer, grouping them in terms of similar approach/objective/functionalities. As a result, fewer and more high-level modules were presented in DERA 3.0 and further discussed in DERA 3.1.
- DERA 1.0 originated from the initial traction of BRIDGE DSO-TSO collaboration project identifying a set of vital function to address cross-sector data exchanges and in turn cross-sector coupling, providing specific recommendations to enhance the transversal interoperability in the energy domains. There, the data value and, generally, data exchanges based on interoperable data exchange platforms were identified. This was iterated in DERA 2.0 to introduce even more sector-agnostic approach, but still keeping much emphasis on including energy-specific modules as a starting point. Meanwhile, the **data space concept** arose in the research landscape,with very relevant associations and industry clusters pushing for it also from the ICT sector (such as Gaia-X[6], IDSA[7], DSBA[8], etc.). These initiatives are providing new reference architectures, frameworks, roles. DERA 3.1 continues to build on DERA 3.0 that tries to match also those new inputs, while keeping the essence of energy-related requirements as described in DERA 1.0 and 2.0.
- Additionally, the European Commission also published the **Digitalising the Energy System - EU Action Plan**[9] (DESAP) in October 2022. This action plan includes several sections, namely "Fostering the exchange of energy data", "Increasing investments", "Empowering citizens", "Cybersecurity and resilience", "Energy consumption of the ICT sector" and "An EU-wide coordinated approach". The first one ("Fostering the exchange of energy data") is especially relevant for this analysis. DERA 3.0 established the initial link with DESAP, by identifying reference modules to deliver requirements presented by the European Commission in this DESAP, and DERA 3.1 builds on that action and provides an updated representation. The requirements listed in the document are the following:
    - **Non-personal data**. Availability of non-personal/anonymised energy data (including protection, confidentiality and sovereignty requirements).
    - **Security/Resilience.** Cybersecurity and data protection.
    - **User Acceptance.** Reach consumer acceptance and empowerment.
    - **Sovereignty.** EU data sovereignty principles:
        - Data to flow within EU across sectors;
        - Access/es fair, practical and clear;
        - Trustworthy data governance;
        - Open approach to international data flows, based on EU values;
        - Data shared focused and containing essential elements for services;
        - Non-essential data stored and processed locally.
    - **Open Source.** Open-source solutions, open standards and data models, APIs.
    - **Interoperability.** Interoperable cross-sectoral solutions.

[6] Gaia-X, [online]. Available: https://gaia-x.eu/
[7] International Data Space Association, [online]. Available: https://internationaldataspaces.org/
[8] Data Space Business Alliance, [online]. Available: https://data-spaces-business-alliance.eu/
[9] European Commission, COM (2022)552, Digitalising the energy system – EU action plan. Available: https://energy.ec.europa.eu/communication-digitalising-energy-system-eu-action-plan-com20225522_en

In the following sections, DERA 3.1 is presented. As in DERA 1.0, DERA 2.0 and DERA 3.0, the approach of clustering modules based on SGAM[10] interoperability layers are maintained. Each layer is presented, with the descriptions of individual modules based on the following template:

- **Module description**. Why is it placed in the layer and what are the objectives?
- **Aggregation reasoning**. The new modules are grouping legacy modules from DERA 1.0 and 2.0, as depicted already in DERA 3.0. Here is a reminder on the motivation for grouping those modules together;
- **Link with DESAP[11]**. Each of the new modules should identify the relevance to DESAP requirements for data sharing. For those identified, a description regarding how the usage of appropriate technologies can contribute to fulfilling the DESAP requirement is provided;
- **Link with OpenDEI Data Space building blocks[12]**. In order to leverage the work done in previous iterations with data space related H2020 projects, it would also be very beneficial for DERA 3.1 to align with these building blocks,as ideally the new architecture should include them all.

Last but not least, it is important to stress that the DERA 3.1 differentiates between local platforms and federated data space stacks. They are both connected through a piece of software named **Data Space Connector**, allowing the interconnection and data exchange.

The Data Space Connector allows different IT systems/platforms and data using applications to connect and share data with each other. This can be useful for integrating data from different sources, or for allowing multiple applications to access the same data without having to duplicate it in multiple places. Data space connectors typically use standardised protocols to facilitate the transfer of data between different systems. This can help to ensure that the data remains consistent and accurate across all of the connected systems. Beyond trustworthy and interoperable data exchanges, it can provide a seamless service utilisation.

The local side of the architecture refers to (most likely already existing) data platforms, either from individual actors (e.g., the data platform from a retailer) or groups of actors (e.g., the data platform of an energy community) or energy market/system as whole (e.g., the data hub of metering data, the flexibility register, the SCADA, the ECCo SP platform from ENTSO-E and Transparency Platform from ENTSO-E). These platforms are already capturing and persisting their own data, which is usually fed into local services for tailored applications. The data space connector should be incorporated to these (pre-existing) platforms to enable identification, data harmonisation and brokerage towards Data Spaces.

The federated data space part of the architecture refers to where data is indexed, making it discoverable and providing a sort of marketplace for trading both data and data services. In order to do so, the Data Space will rely on multiple actors and data platforms (the previously described ones) federating through the Data Space Connectors andoffering their data under pre-recorded policies.

Figure 1 shows the DERA 3.1 layered architecture incorporating the elements that will be defined in the following sections, including their relationship with both the DESAP and the OpenDEI building blocks. This has no visual changes compared to DERA 3.0[13] but includes further explanations in this report.

Figure 2 recalls DERA 2.0 with more detailed visual description of DERA elements in each interoperability layer[14]. Versions 2.0 and 3.1 should be considered complementary. However, it is important to keep in mind that some

[10] CEN-CENELEC-ETSI Smart Grid Coordination Group, Smart Grid Reference Architecture, 2012. Available: https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN- CENELEC_Topics/Smart%20Grids%20and%20Meters/Smart%20Grids/reference_architecture_smartgrids.pdf

[11] European Commission, COM (2022)552, Digitalising the energy system – EU action plan. Available: https://energy.ec.europa.eu/communication-digitalising-energy-system-eu-action-plan-com20225522_en

[12] OpenDEI, Design principles for data spaces, [online]. Available: https://h2020-demeter.eu/wp-content/uploads/2021/05/Position-paper-design-principles-for-data-spaces.pdf

[13] BRIDGE Data Management WG, European (energy) data exchange reference architecture 3.0, 2023. Available: https://data.europa.eu/doi/10.2833/81504

[14] BRIDGE Data Management WG, European (energy) data exchange reference architecture 2.0, 2022. Available:https://data.europa.eu/doi/10.2833/142689

elements have been reclassified to different layers as described in this report.

Figure 3 extends the architecture to also link to the data governance modules and functionalities as described in previous DERA 3.0 report[15].

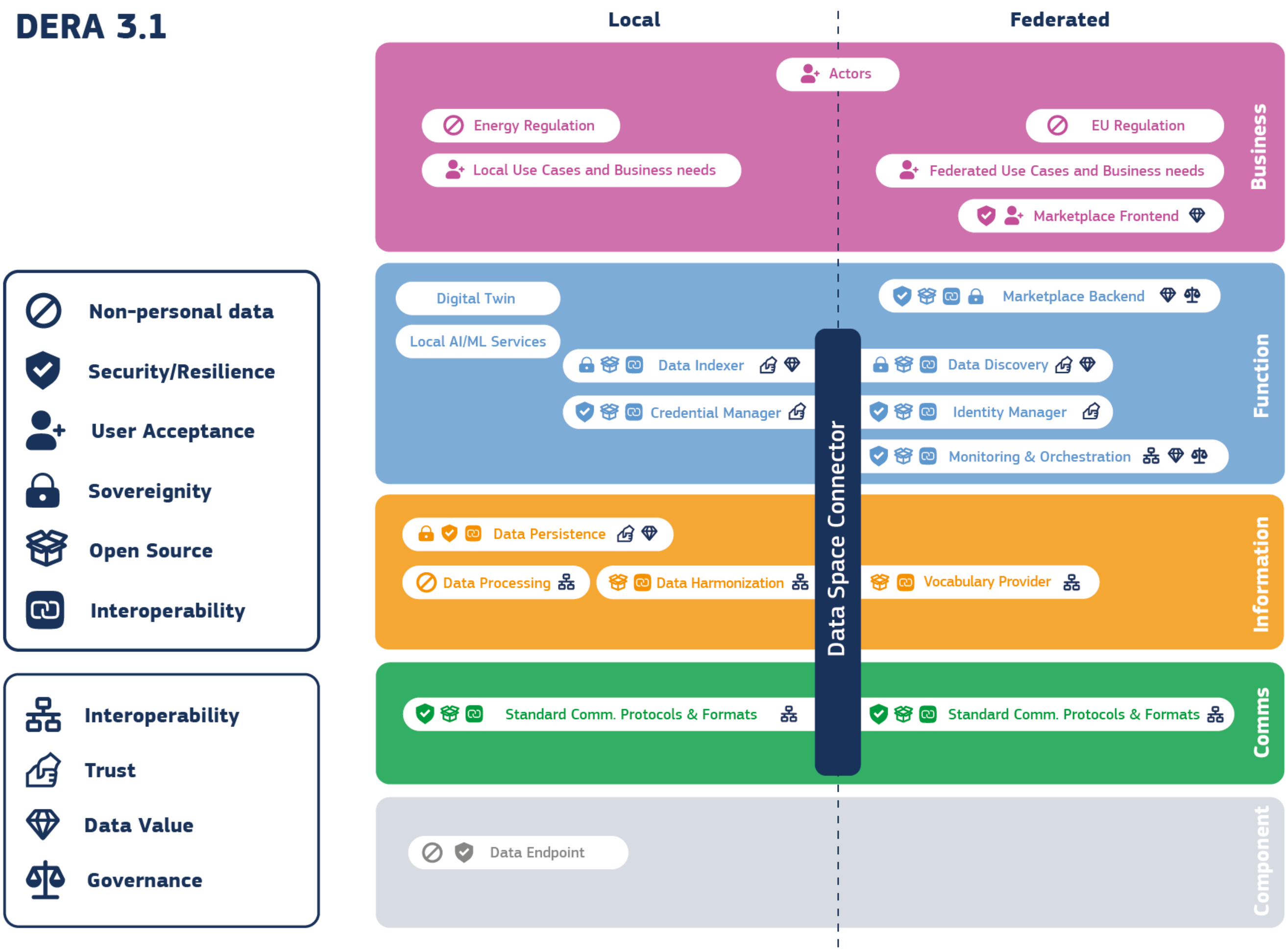

Figure 1. DERA 3.1 layered architecture and link to the DESAP and OpenDEI building blocks

[15] BRIDGE Data Management WG, European (energy) data exchange reference architecture 3.0, 2023. Available: https://data.europa.eu/doi/10.2833/81504

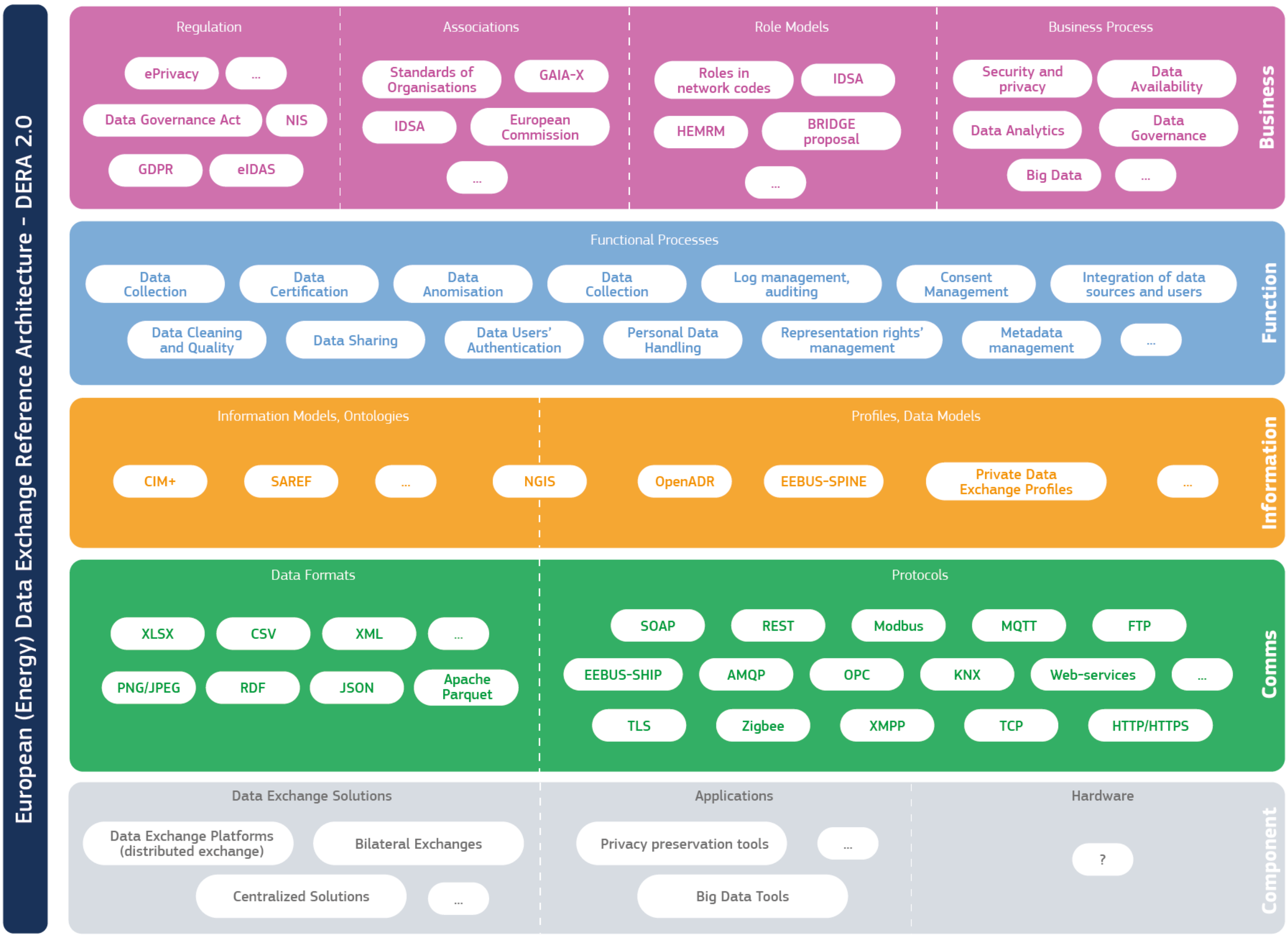

Figure 2. DERA 2.0[16]

[16] BRIDGE Data Management WG, European (energy) data exchange reference architecture 2.0, 2022. Available:https://data.europa.eu/doi/10.2833/142689

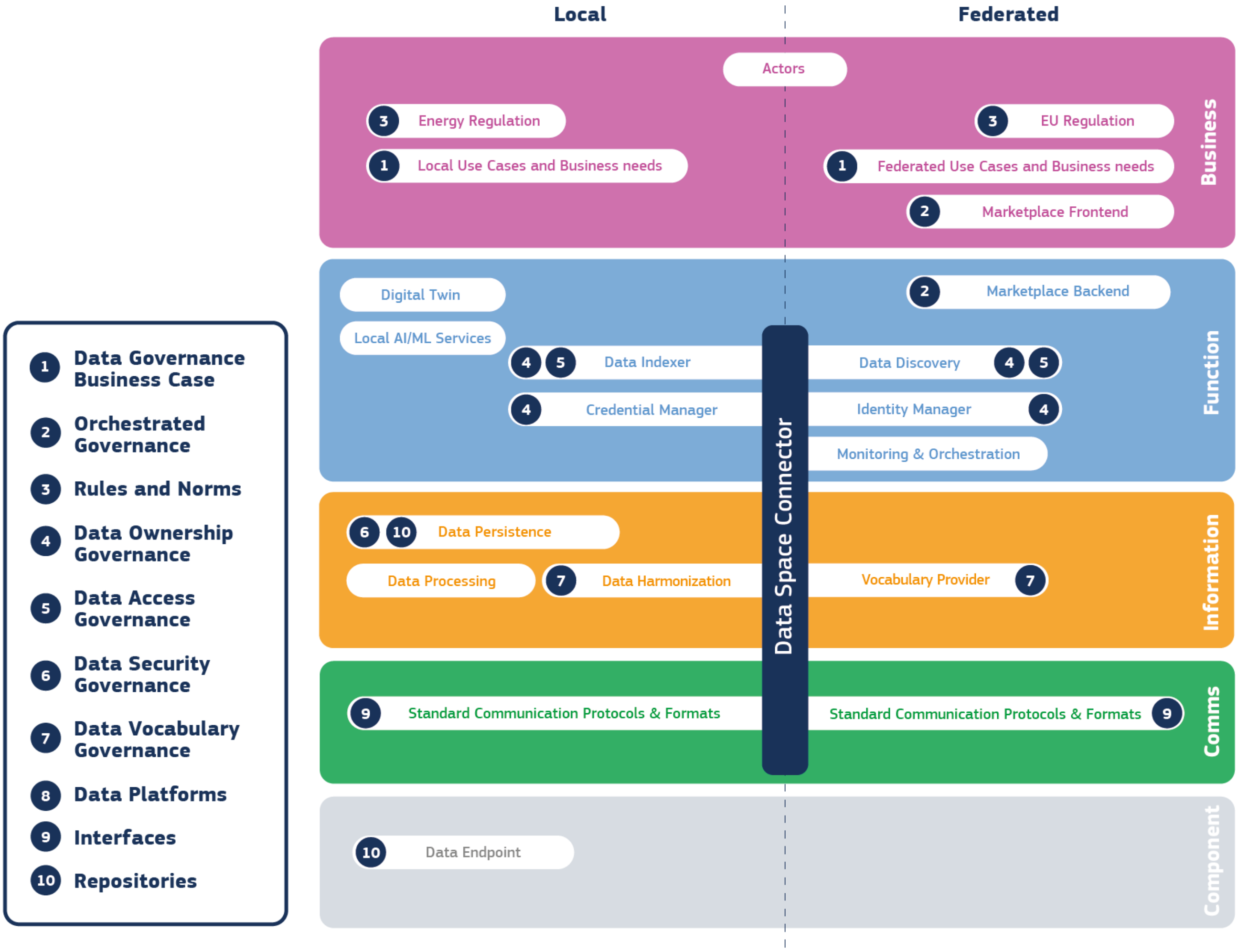

Figure 3. DERA 3.1 link to data governance

In an attempt to clarify and express the potential usage of connectors and interoperability between local and federated platforms, Figure 4 serves as an extension of Figure 1. This figure includes the cases of (1) data indexing of own data in a data space, (2) data discovery in a data space and (3) bilateral exchange of data.

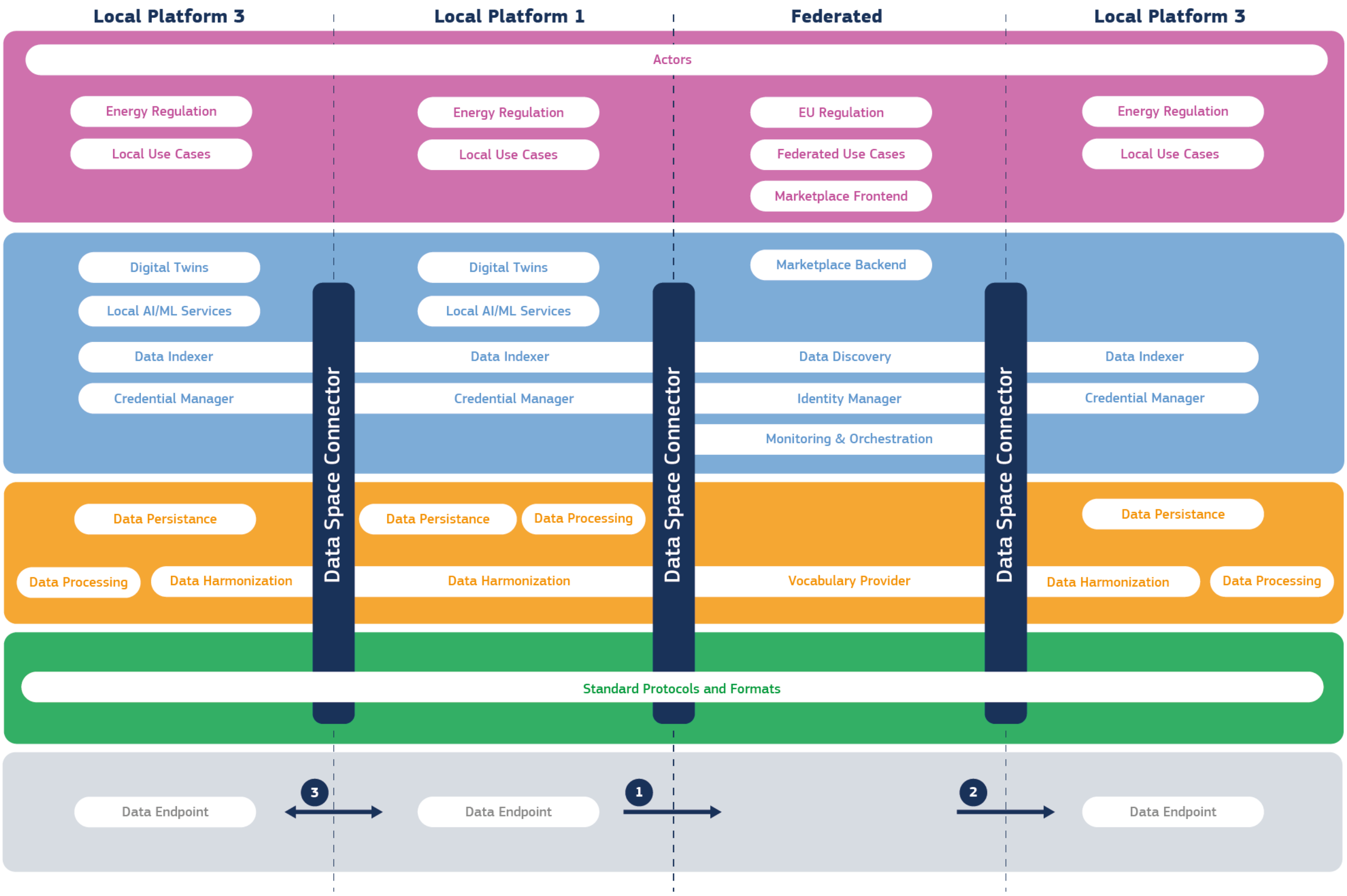

Figure 4. Interactions between Local platforms and the data space

2.2. Interoperability Layers of Reference Architecture

2.2.1 Component Layer

The component layer in the IEC 63200 (SGAM) reference architecture[17] is a logical layer that represents the different components or subsystems that make up a larger system. It is used to organise and structure the architecture of a system in a way that makes it easier to understand and work with. It helps identify and understand the relationships between them. This can be useful for identifying potential areas of reuse or integration, and for designing and implementing the system in a modular and scalable way.

For the purposes of data exchange realisation, this layer can be abstracted as the origin of the data being handled by the system. This way, whereas theoretically the layer should incorporate the physical components producing data and the ICT infrastructure for enabling its processing and transfer, for the sake of simplicity, DERA 3.1 will record here just a generic module for (energy) data sources.

[17] CEN-CENELEC-ETSI Smart Grid Coordination Group, Smart Grid Reference Architecture, 2012. Available: https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN- CENELEC_Topics/Smart%20Grids%20and%20Meters/Smart%20Grids/reference_architecture_smartgrids.pdf

Data Endpoint component

As DERA 3.1 is looking from the energy perspective, the data endpoints being considered are energy-related, but this component would be identical in functionality regardless of the vertical considered. This layer could equally consider any data source susceptible to be incorporated to the exchange.

It is important to note that these data sources are just available on the local (left hand) side of the architecture, as data sources and sinks are just considered in local data platforms. The federated part of the data space should just index these data sets, but never persist them.

With respect to DERA 2.0, this component is aggregating the following ones:

- Data exchange platforms (distributed exchange), as those are the ones covered by the previous definition and certainly are considered as data sinks, data providers or consumers.
- Centralised solutions, being those also a form of local data gathering frameworks.

This component is relevant for the following DESAP requirements:

- **Non-personal data**. Even though DESAP describes non-personal data only, the DERA should focus on personal data as well. As this is the entry point for data to the system, it is important to evaluate whether there is a critical need for using personal data or not. If it is critical, the data should be kept that way just on the local data gathering platform for specific and agreed purposes and in line with all the special GDPR regulationfor this kind of data. For this data to be exchanged in a data space, a form of consent and anonymization or aggregation, or consent management mechanism should be incorporated prior to their availability on the data space ecosystem.
- **Security/Resilience**. It is very important to identify directly at the origin potential business or operation critical elements. The data from those should be carefully handled and replicated just where and when it is strictly needed.
- **Interoperability**. The electrification of new sectors and applications leads to the interconnection, in the energy systems, of new devices and assets; their interoperability must be considered from the design phase of the physical components, ensuring alignment among manufacturers.

While the situation in DERA 3.0 implied there was no direct link with Open DEI building blocks, even though the data provided there constitutes the raw material used in all of them, it is worth noting that the introduction of the interoperability requirement in DERA 3.1 establishes a link with the “Interoperability” building block of Open DEI. Moreover, the building block "Trust" will be associated too, as it relates to the intention to maintain an overview, and eventually establish certain control, of the interconnected devices, at least from the pure electrical/physical perspective.

2.2.2 Communication Layer

The purpose of the communication layer in the SGAM reference architecture[18] is to provide a means for different components of the system to communicate with each other. This layer enables the different components to exchange information and coordinate their actions to achieve the overall goals of the system. It is an essential part of the architecture, as it allows the various components to work together and function as a cohesive whole.

As in the component layer, here the previous DERA 2.0 components have been aggregated into a generic protocol and format component, ensuring they are open and standard, as both local data platforms and data spaces should be protocol agnostic for communication purposes.

[18] CEN-CENELEC-ETSI Smart Grid Coordination Group, Smart Grid Reference Architecture, 2012. Available: https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN- CENELEC_Topics/Smart%20Grids%20and%20Meters/Smart%20Grids/reference_architecture_smartgrids.pdf

Standard communication protocols and formats component

As anticipated, this layer is unifying the DERA 2.0 components for communication protocols (perceived as the means to exchange data, either for local ingestion or for federated data sharing) and formats (meaning the concrete way to represent the data in the transfer).

On the local side, as the data is expected to be kept for the platform users, the requirements should not be too demanding. Each data platform administrator can select the most convenient option. Nevertheless, aligning with or integrating standard and open protocols/formats and specifically those selected in data spaces would greatly ease the process of federation.

On the other hand, making sure both the protocol and format used for communication are openly available and standard to pave the way to easy federation is critical at data space level. This can be achieved with the deployment of a data connector which would establish the communication with the data space ecosystem, ensuring the interconnectivity across different domains and sectors.

This component is grouping the following modules of DERA 2.0:

- All data formats (PNG/JPEG, XLSX, RDF, CSV, JSON, XML, Apache Parquet…)
- All communication protocols (AMQP, REST, OPC, ZigBee, SOAP, ModBus, XMPP, MQTT, KNX, TCP, Web-services, FTP, HTTP/HTTPS…)

Regarding DESAP requirements, this module is key for the following recommendations:

- **Security/Resilience**. The selection of the data format and protocol is not a matter of selecting the easiest to implement. It is rather based on guaranteeing the security needed for sensitive data sets being transferred. Therefore, the protocol selected should ensure the highest levels of cybersecurity needed for keeping those data sets sovereign and confidential, if applicable.
- **Open Source and Interoperability**. The usage of open standards, publicly available APIs and open source is key to make sure everybody who might be interested in federating or using the data space can easily do so. Vendor locking, proprietary protocols and logical black boxes should be avoided in data-sharing architectures.

This component is very important for the interoperability set of building blocks outlined from Open DEI. More specifically, this module is the basis and the essence of the “Data Exchange APIs” one. Selecting appropriate open communication protocols will inherently provide this building block to the architecture.

2.2.3 Information Layer

The purpose of the information layer in the SGAM reference architecture[19] is to provide a designated location for handling, managing, and storing data that is used by the various components of the system. This layer acts as a repository for information, allowing it to be accessed and used by different parts of the system as needed. It is an important part of the overall architecture, as it allows for the efficient and effective management of data, ensuring that it is available when and where it is needed.

This layer is very relevant for local platforms, as this is where data processing and persistence is occurring. Nevertheless, as the purpose of this document is to propose a data-sharing architecture, those functionalities will be presented but not with the detail level as in the data sharing related components.

Additionally, this layer also contains the harmonisation part, which is a cornerstone of semantic interoperability. This

[19] CEN-CENELEC-ETSI Smart Grid Coordination Group, Smart Grid Reference Architecture, 2012. Available: https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN- CENELEC_Topics/Smart%20Grids%20and%20Meters/Smart%20Grids/reference_architecture_smartgrids.pdf

comes as a duality in terms of modules to be placed both at local and federated level.

Data harmonisation (local) and vocabulary provider (federated) components

As anticipated, this pair of modules regulates the way data is presented and understood along the data sharing endpoints. Depending on which side of the architecture which is considered, the functionalities vary:

- Data harmonisation is the module to be placed in the local side. It can be either embedded into the connector or available data harmonisation services that can be found available on the DERA Marketplace, and its functionality is meant to ensure the sharing format and semantics are appropriate. This refers also to semantic correctness, in the sense that the elements listed mean what they are supposed to. In order for all data space actors to understand the data itself, a common vocabulary is used, making sure the data formatting is FAIR (Findability, Accessibility, Interoperability and Reusability). In the particular case of this BRIDGE DERA 3.1, this semantic correctness should link to energy ontologies.
- The vocabulary provider is the counterpart at federated data space side. This module, on the one hand, provides information about the ontology/language used for data and, on the other hand, checks that the data being indexed is compliant with the vocabulary provided. Again, this being an energy-oriented approach, IEC (CIM, 61850, COSEM), ETSI (SAREF) standards are what this vocabulary module is expected to be reliant on.

These two aforementioned modules take onboard the following set of legacy DERA 2.0 modules (and other standards not appearing here, such as MATTER, etc.):

- IEC CIM
- SAREF
- NGSI
- OpenADR
- EEBUS
- Private Data Exchange Profiles

The functionalities provided by these components are very relevant to the following DESAP requirements:

- **Open Source**. This will be a trend on this kind of dual side functional blocks. It is very important to rely as much as possible in open-source modules for this, as it will foster the scaleability of the approach, allowing any party interested in connecting to the data space, being able to understand the common language implemented through the data space as well as performing correct and meaningful data exchanges.
- **Interoperability**. Interoperability is particularly important in relation to the data semantic. There should be a consensus on the syntactic format for data exchanges and queries to the data space, allowing easy connection and even integration of data spaces from different verticals. Semantic interoperability is alsocrucial at local level, making sure the relevant data providers and users are aligned in the way data is presented. This includes the following:
    - Structured Data Sets: for these data set a validation process should exist according to the agreed common language. For instance, a CIMCGMES data set will be validated against a Certification Scheme associated to a CGMES data set.
    - Unstructured Data Sets
    - Private Data Set & Open Data Sets

As for the link with Open DEI building blocks, this module is closely linked to “Interoperability” group of blocks. There is one specific building block regarding “Data models and formats” which is precisely the functionality provided with thismodule.

IEC 63417 Guide and Plan to Develop Smart Energy Ontologies is referencing DERA 3.1, and is proposing some recommendations to support semantic interoperability.

Data processing module

As anticipated, this is a relevant module at local level, but not crucial for the data exchange. This module aggregates all those functionalities related to data security, data quality, data provenance, etc. This DERA 3.1 assumes that those functionalities are implemented at local level, making sure the data being ingested is compliant with all relevant regulations and standards applied to the vertical (in this case energy), so that data being used here is ready to be shared if needed. The other way around, for potential data sets being acquired/shared from the federated part of the data space, this module should make sure that they are again secured, with the level of quality needed and traceable before persisting them in the local database.

The module incorporates the legacy components of DERA 2.0 (where they were recorded on function layer) for:

- Data cleaning and quality
- Data collection
- Data anonymization
- Metadata management

Therefore, the functionalities provided by data processing module are linked to the DESAP requirement about **non-personal data usage**. This module oversees providing the needed anonymization or pseudo-anonymization as applicable by the regulation.

The module is also linked to the Open DEI building blocks in the "Interoperability" family, especially those listed as "Provenance and traceability".

Data persistence module

Similarly, to the previous module, it is assumed that local energy platforms will have their own means of persisting data. They will use these warehousing capabilities to store their own data sets and also potentially store some new data incoming from the exchanges made on the data space. Moreover, this module will make sure to keep data sovereignty, and involve in its operative means to provide an access control aspect which, in turn, will assure confidentiality.

The way this data persistence module is implemented is up to each local platform owner/operator, as long as it complies to the specifications of the data harmonisation/ vocabulary component and the data processing module. The requirements from the data exchange side are, as anticipated, making sure everything stored here that is to be shared at data space level is compliant with the semantic/ syntactic interoperability and data processing specifications.

This module is equal to the DERA 2.0 module named Data Storage (where it was placed on the function layer).

This way, the module is aligned with the DESAP requirements in regard to:

- **Security/Resilience**. The data persistence module must ensure, especially for those data sets received from other data providers in the data space and entailing potential non-disclosure clauses, a secure, trusted and sovereign storing. This can be achieved by deploying cybersecurity mechanisms to protect the data access and usage at local level.
- **Sovereignty**. As partially described in the previous point, sovereignty should be guaranteed at local storage level. This applies to those data sets owned by the Local platform owners/operators but also to those data sets received as part of a data exchange, that might be labelled for internal use but not able to be re-shared or disclosed.
- **Interoperability**. Also, in order to be compliant with each other's non-disclosure rules there is a need for interoperability in the definition of how the data accesses are specified.

As for Open DEI, based on the previous description, the functionality of the data persistence module links to both "Trust" and "Data Value". In the former case, it is linked to the "Access & Usage control/policies". In the latter, particularly to the "Data Usage Accounting" module.

2.2.4 Function Layer

The purpose of the function layer in the SGAM reference architecture[20] is to provide the actual functionality that is needed to support the goals of the system. This layer is associated to System Use Case Definition as described in IEC 62913-1. This layer contains the components that are responsible for carrying out the tasks and operations that are needed to achieve the desired outcomes. This may include functions such as analysis, and decision-making. The function layer is an essential part of the architecture, as it is where most of the work is done to support the system's objectives.

As in the previous layer and supported by the figure of the data space connector, this layer also has a lot of dualities, grouping functionalities that should match what is being done in federated infrastructures (the local data platforms) and the data space (the federated part).

This way, the layer contains the components in charge of managing the identification, allowing data indexing/discovering, monitoring the federation and potential digital services acting over the data.

Credential manager (local) and identity manager (federated) modules

These two modules regulate the access to the federation services in the marketplace, from both standpoints: data platforms, considered as nodes, and data spaces participants, who will act as the uses in this context. Again, the functionality can be split depending on the side of the architecture:

- Credential manager refers to the modules at the local part that allows the identification of that data platform as such, unequivocally, opening the door for data indexing of own data sets and potential acquisition of data space indexed external resources.
- Identity manager is the module to be placed at federated data space level to check identities of federated nodes when interacting with the federated services. This is, therefore, the prerequisite before starting any data indexing, discovery, or transaction.

The two modules incorporate this way the following set of legacy DERA 2.0 modules (some of them in business layer previously):

- Data user's authentication
- Integration of data sources and users
- Security and privacy

The functionalities provided by these components are very relevant to the following DESAP requirements:

- **Security/Resilience**. The identity provision and management are per definition one of the critical parts of a cybersecure system.
- **Open Source**. As most modules in this layer, the way to implement identification at any potential interested infrastructure should be kept as simple and as open as possible. Therefore, the usage of open source is strongly advised, and specially at federated level.
- **Interoperability**. It is very important not just to facilitate federation, but also to make sure the identification mechanism proposed is aligned at EU level, maximising the interoperability with other data spaces, either on the same or different sectors, towards the EU data single market.

As for the link with Open DEI building blocks, this module is closely linked to "Trust" group of blocks. There is one specific building block regarding "Identity management" which is precisely the functionality provided with this module.

[20] CEN-CENELEC-ETSI Smart Grid Coordination Group, Smart Grid Reference Architecture, 2012. Available: https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN- CENELEC_Topics/Smart%20Grids%20and%20Meters/Smart%20Grids/reference_architecture_smartgrids.pdf

Data indexer (local) and data discovery (federated) modules

These are the couple of modules making sure data is discoverable through the data space. For this purpose, the duties are broken down into two parts:

- Data indexing refers to the ability of local data platforms to push relevant data into the data space, so it can be discoverable. In order to do so, they have to rely on the data harmonisation modules of the information layer, making sure the data is in the format and semantics understood at data space level. The way to index data is commonlyapproached as a collection of metadata to be transferred, including self-descriptive pieces of information.
- Data discovery is the counterpart in data spaces. It also has a dual functionality. On the one hand side, it should gather and process the metadata being received from local data platforms, incorporating them to the catalogue, as long as it complies with the demands posed by the data persistence module. On the other hand, it should incorporate an engine allowing discovery of the already indexed datasets in the catalogue, allowing users to explore, search and select potential interesting pieces of information. All this, while the data discovery module adheres to the access policies applied over the data available in the catalogue.

These two modules are now grouping the previous DERA 2.0 components (some of them in business layer previously):

- Data certification, which is the module in charge of making sure the data indexed in the data space is compliant with the standards adopted;
- Metadata management, also covering the part of indexing and brokering at data space level;
- Data availability, in the sense of discoverability;
- Data Governance, making sure the indexing of data sets also incorporated the policies and conditions under which the data owner allows the exchange.

As per the DESAP links, these modules are especially relevant for:

- **Sovereignty**. They should clearly be indexed preventing its misuse or leaking.
- **Open Source**. The technology selected to implement those modules on both ends should be open enough to allow any interested party to federate in the data space with no major technical barriers. Open source is therefore a must on the federated part and highly recommendable for the local side.
- **Interoperability**. Linking also with the information layer, the usage of common ontologies and data models to capture and index the data is key to allow understandability and replicability.

This module is also aligned with Open DEI building blocks, both on “Trust” and “Data Value”. In the former case, it covers the building blocks for “Access and usage control / policies” (together with the previous credential/identity managers). On the latter, this is the core module providing the building blocks for “Metadata and Discovery protocol”.

Monitoring and orchestration module

The monitoring and orchestration module comprises the functionalities needed at the federated part of the data space to make sure the federated nodes connected and using the system are performing as expected, together with the needed ICT monitoring of the own resources for seamless digital operation.

The monitoring functionality of the module should provide transparency to the data space users about both the data and services offered on the marketplace and discoverable through the already described discovery module. This alignment relates to requirements such as security, encryption, interoperability, or privacy, among others, while at the same time provides a means to keep a traceability on data transactions taking place. Hence, this module will gather and record evidence proving the alignment of both service/data providers and users, as well as for the transactions made.

The orchestration side of the functionality should allow data space users to instantiate and manage potential infrastructure services that are selected through the data space portal. This orchestration provides a life-cycle management engine, together with standard APIs.

This module inherits the functionality of the following DERA 2.0 modules (in this case, most of the functionalities were not recorded in the previous version of DERA, so these modules will be combined with new onesinside the monitoring and orchestration module):

- Data sharing and bilateral exchanges (the latter being in component layer previously), so that the transactions can be tracked.

Regarding the alignment with the DESAP, the requirements this module will help cope with are the following:

- **Security/Resilience**. As indicated, especially for the monitoring part, cybersecurity is critical to this module, for guaranteeing privacy and sovereignty in the system.
- **Open Source and Interoperability**. Both the monitoring and orchestration functionalities of the module rely heavily in the openness of the technologies used not directly in this module but also regarding underlying ingestion, communication and formatting modules.

This module is pivotal with respect to Open DEI building blocks. As described above, the module provides a set of functionalities covering "Interoperability", "Data Value" and (especially) "Governance". The interoperability part is covered in the sense that it provides "Provenance and traceability", as part of the logging system. The data value side is given by the "Data Usage Accounting" functionality. Finally, the governance functionalities cover "Operational" and "Continuity model" blocks.

Marketplace backend module

The complete offer of the data space regarding both data and services available should be somehow prompted to users. The way data spaces envisage to do so is through digital marketplaces, indexing the data available and offering data services either as App Stores or using a SaaS (Software as a Service) approach.

In order for these marketplaces to work properly, a number of functionalities should be provided. Those, which are the ones unrelated to purely visual representation, are the ones covered by this marketplace backend module. These functionalities are, at least, the following:

- **Monetisation/payment** engine allowing data or service owners to obtain money/tokens based on what they offer and also users to pay for data or services.
- **Contracting/legal** modules to enforce bilateral contracts between data/service providers and users when certain pre-recorded conditions are made.
- **Clearing house**, for matching supply and demands, asking the previous modules to enforce the needed actions and verifying that all parties follow required procedures and contractual rules. If so, this module helps as well to settle the expected transactions.
- Potential **additional functionalities** helping users and providers to manage their interactions and provide added value functionalities, such as (but not restricted to) Data-as-a-Service, Machine-Learning-as-a-Service, ability to index models and libraries, compliance management, etc.

This module is completely new and, therefore, not considered in DERA 2.0.

As for the DESAP alignment, the marketplace backend will be relevant for fulfilling the following requirements:

- **Security/Resilience**. As this is the entry gate of both users and providers to the data space ecosystem, the marketplace backend should implement the highest standards of security. For this, it will also rely on certain modules such as the identity Management and the monitoring and orchestration.
- **Sovereignty**. Again, the backend for the marketplace is where the interactions and transactions between different parties are articulated and enforced. It is crucial to carefully implement those to make sure those exchanges will occur just under the circumstances and policies set by data owners.
- **Open Source and Interoperability**. As in previous modules, having the marketplace developer using open source, open standards and open APIs will foster its adoption and ease the interaction with all stakeholders, including not only providers/users, but also the interaction with other data space and other industries.

This module is also very relevant for Open DEI alignment on building blocks. As this module regulates the exchange of data (with smart contracts), it is the cornerstone for functionalities related to “Data Value” and “Governance”. In detail, the Data Value here concentrates on “Access and usage control policies” and “Trusted data exchange”, while the governance part focuses on “Overarching cooperation model”.

Digital twins and local AI/ML services

This is a generic placeholder for potential local services that might be hosted on the left-hand side of the architecture, that is, the local data platforms.

Those services could be local/pre-existing (those that were developed to use the own data in the platform) or can also be some additional ones purchased from the App Store of the Data Space Marketplace and then deployed locally.

Those services can be very different, but they are usually related to artificial intelligence (AI) and machine learning (ML), for data processing and valorisation, or digital twins, including system simulation.

There were several related modules on DERA 2.0 which are now grouped here, such as:

- Big Data (previously in business layer);
- Big Data tools (previously in component layer);
- Analytics (previously in business layer).

Being these modules oriented directly to data processing and valorisation, instead of being related to data exchange purposes, there are no specific DESAP requirements that they could help fulfil.

2.2.5 Business Layer

The purpose of the business interoperability layer in the SGAM[21] reference architecture is to enable different business units and systems to interoperate and exchange data in a consistent and standardised manner, supporting the flow of information across the enterprise and facilitating interoperability between different business processes. This layer is associated to business use case definition as described in IEC 62913-1. It involves business roles as defined in the HEMRM, or data related roles. The business interoperability layer is designed to be flexible and extensible, allowing organisations to easily integrate new systems and applications into the architecture and to adapt business processes to new regulatory requirements, for instance, impact of network codes and guidelines or data interoperability implementing acts on utilities.

As in the case of the component layer, this layer is populated by a number of highly relevant modules needed to articulate the end-to-end operation of both the local data platforms and the data space, but not that relevant when it comes to data sharing itself.

This is why the definition of those modules in this report might not be as detailed as the previous modules and also the links with both the DESAP and the Open DEI building blocks for data spaces are not relevant. Apart from the ones listed below, there should also be a mention of the possibility to incorporate an additional one that would focus its activity on the evaluation of compliance with certification & ethics aspects, helping participants to make decisions that create positive impacts and steering them, and the framework itself, away from unjust outcomes.

Moreover, and as a side note, recent studies hint that this business layer could even be split in two: the existing business layer plus an additional, 6th layer called "framework layer". In this layer, a broad range of stakeholder groups would need to be addressed, among those:

- Policy makers in politics and public authorities on multiple levels from national to municipal
- Regulatory bodies
- Market operators (from global to national to regional and local marketplaces)

[21] Data Space Business Alliance, [online]. Available: https://data-spaces-business-alliance.eu/

- Standardisation organisations (national and international)
- Supplier associations
    - for energy (e.g., ENTSO-E, EU DSO Entity)
    - for technology (e.g., T&D Europe, AIOTI)
- Consumption Associations
    - Industry and other business associations
    - Building associations
    - Consumer associations
- Research, innovation and other funding programs (national, transnational, international)
- Institutions for education and human capital development
- Infrastructure operators (e.g., for transport, health)
- Finance and investment institutions (e.g., ECB, EIB, EU facilities, EFRAG).

Even though they are not directly implemented in this DERA 3.1, it is worth noting as a proposal in this report.

Marketplace frontend module

The marketplace is broken down into two modules in the architecture. Its core functionality is described in the functional layer, such as the way data is contractually exchanged or the way services are published..

The business side of the marketplace is related to the marketplace user interface and actor access

As the backend part of the marketplace, this is a new module and isn't listed in DERA 2.0.

This frontend part of the marketplace has the following links with respect to the requirements of the DESAP:

- **Security/Resilience.** As in the backend part. In this particular case, the considerations are regarding the way actors are accessing the marketplace frontend.
- **User Acceptance.** As this part of the marketplace is seen and used by external actors (and potentially notfamiliar either with data exchange principles or Energy insights), it is important to make it as simple and as usable as possible in order to maximise its acceptance and engage potential users.

The frontend part of the marketplace is also aligned with the “Data Value” group of building blocks from Open DEI. It is mapping the functionalities regarding “Publication and Marketplace services”.

Local/federated use cases and business needs

This module indicates how local data platforms can make use of a collection of functional layer AI/ML services to build up a new use cases solving a specific problem at local level. This is what local data platforms have been doing sofar, collecting or acquiring data, storing it, applying AI/ML or big data analytics and producing a result or a model to be used locally. Those use cases can be, for instance, local energy services such as day ahead optimisation of a grid or forecasting of an energy source.

The federated side of this module is introduced to present one of the big values of the data space and data sharing usage. New federated use cases can be unlocked, combining both data and services that are not local. This way, combining data from other sources and using services provided by other parties (either in IaaS/SaaS model or downloading the service as an app to be used locally), new use cases such as benchmarking or multi-vector energy grid optimisation are enabled.

As anticipated, this module is not directly linked with any DESAP or Open DEI requirement/building block by itself, but it is somehow making use of those for its purpose.

Energy/EU regulation

This pair of modules is also highly relevant for the final operation of both local and federated sides of the data space. The functionality to support these regulations have been partially addressed both in Information and Functionallayers, making sure the data and usage of data is aligned with relevant regulation both related to energy and general data usage at EU level (including GDPR).

This module includes the following DERA 2.0 modules:

- Data Governance Act;
- GDPR (General Data Protection Regulation);
- eIDAS (EU regulation on electronic Identification, Authentication and trust Services);
- NIS (EU directive on security of Network and Information Systems).

As anticipated, this module is not directly linked with any DESAP or Open DEI requirement/building block by itself, but it is somehow making use of those for its purpose.

Actors

There are a number of relevant actors expected to use the underlying modules and functionalities in this DERA 3.1 architecture. These actors trigger and extract the information from both federated and local usecases, interacting with multiple of the modules compressed in the layers below.

This module aggregates some DERA 2.0 modules as listed below:

- Standards organisations;
- European Commission;
- Gaia-X;
- IDSA (International Data Spaces Association);
- Roles in Network codes;
- BRIDGE proposal;
- HEMRM (Harmonised Electricity Market Role Model).

As anticipated, this module is not directly linked with any DESAP or OpenDEI requirement/building block by itself, but it is somehow making use of them for its purpose.

2.3. Instantiation of DERA in Projects

Data Cellar

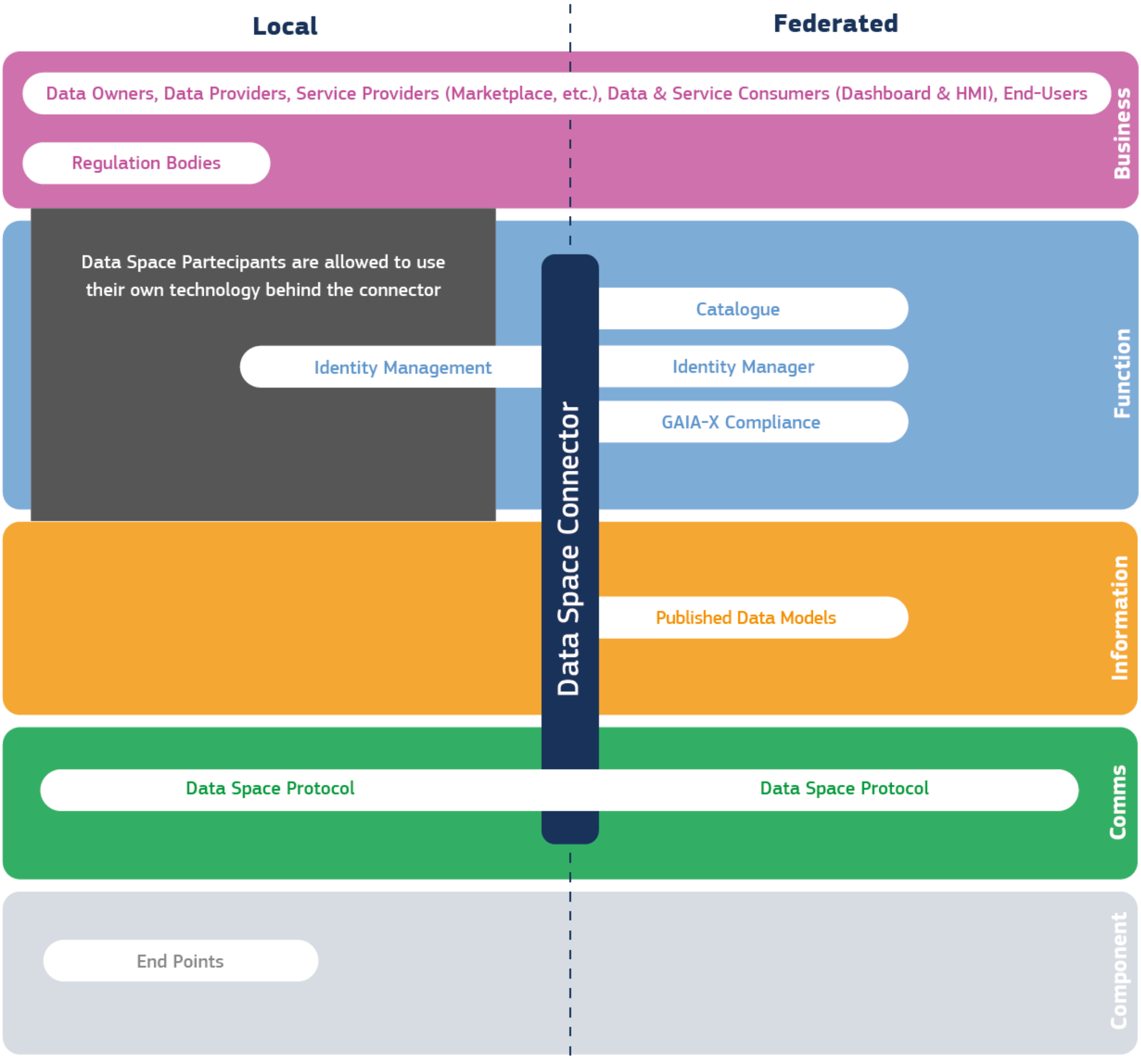

Figure 5. Instantiation of DERA in Data Cellar project

Ebalance-plus

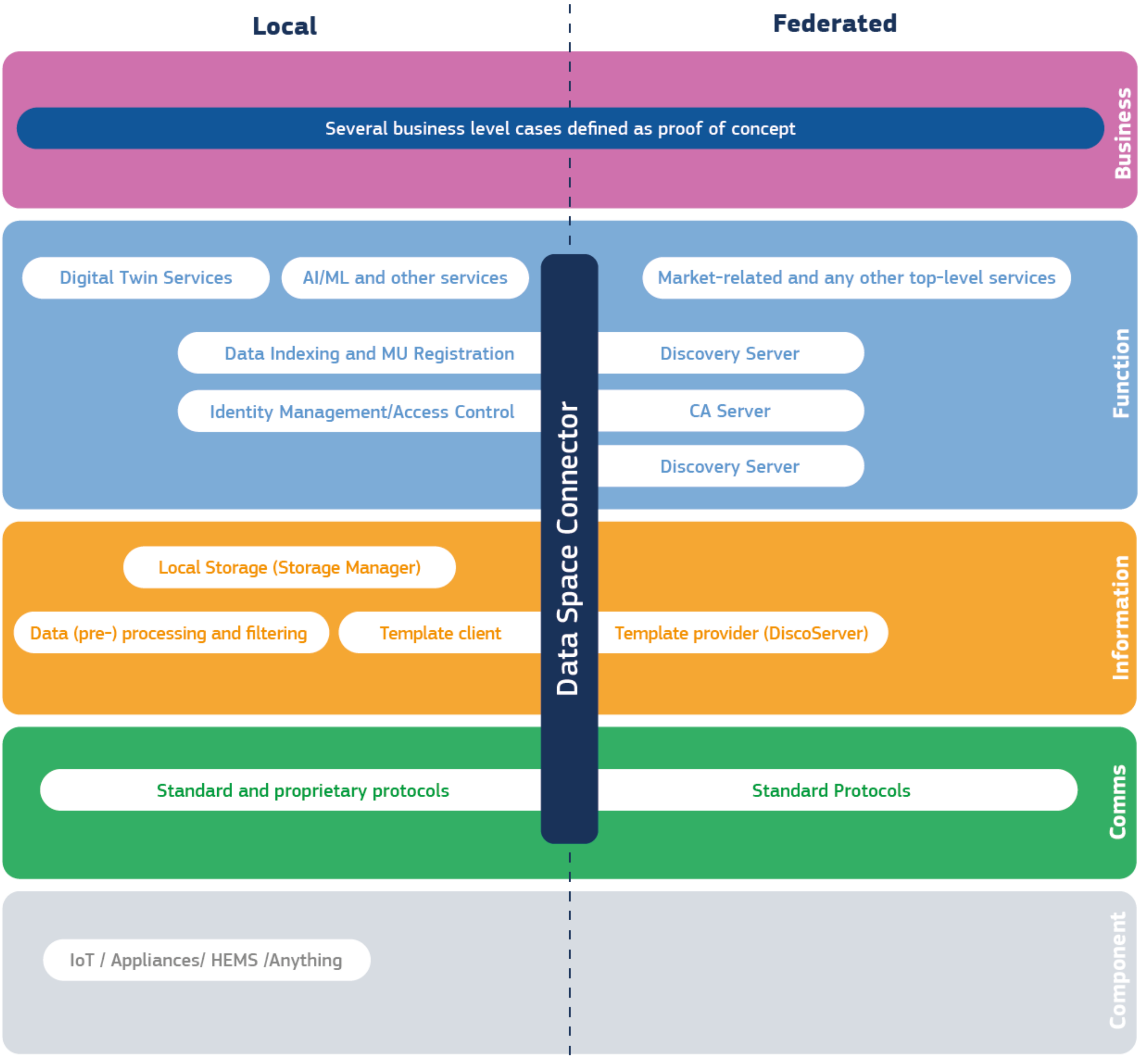

Figure 6. Instantiation of DERA in Ebalance-plus project

This diagram shows the case where the ebalance-plus platform operates in standalone mode. In this case it is responsible for the local as well as for the federated level. But it can also operate under a larger framework, being connected to an imperative federated level via some data space connector.

EDDIE

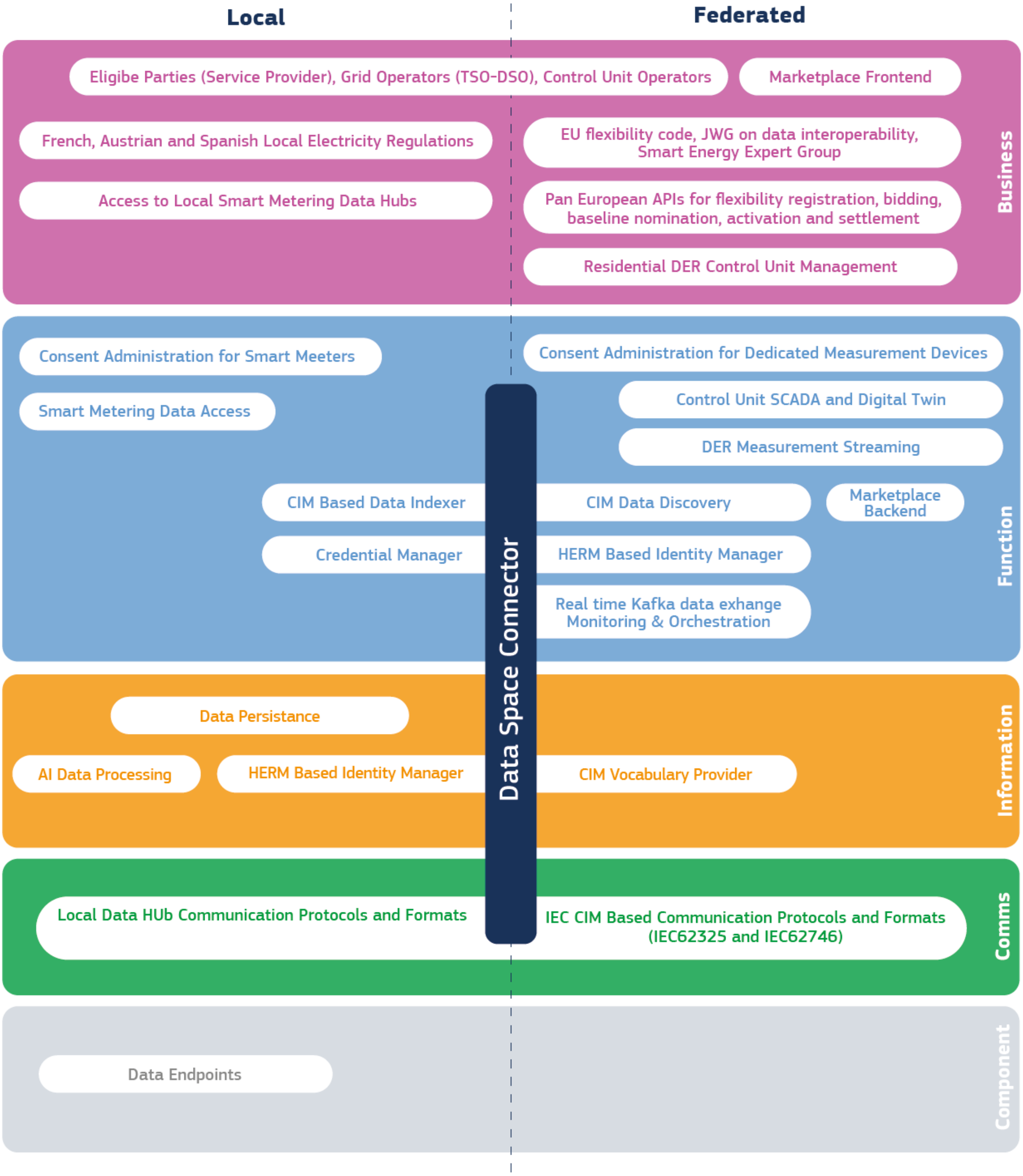

Figure 7. Instantiation of DERA in EDDIE project

InterConnect

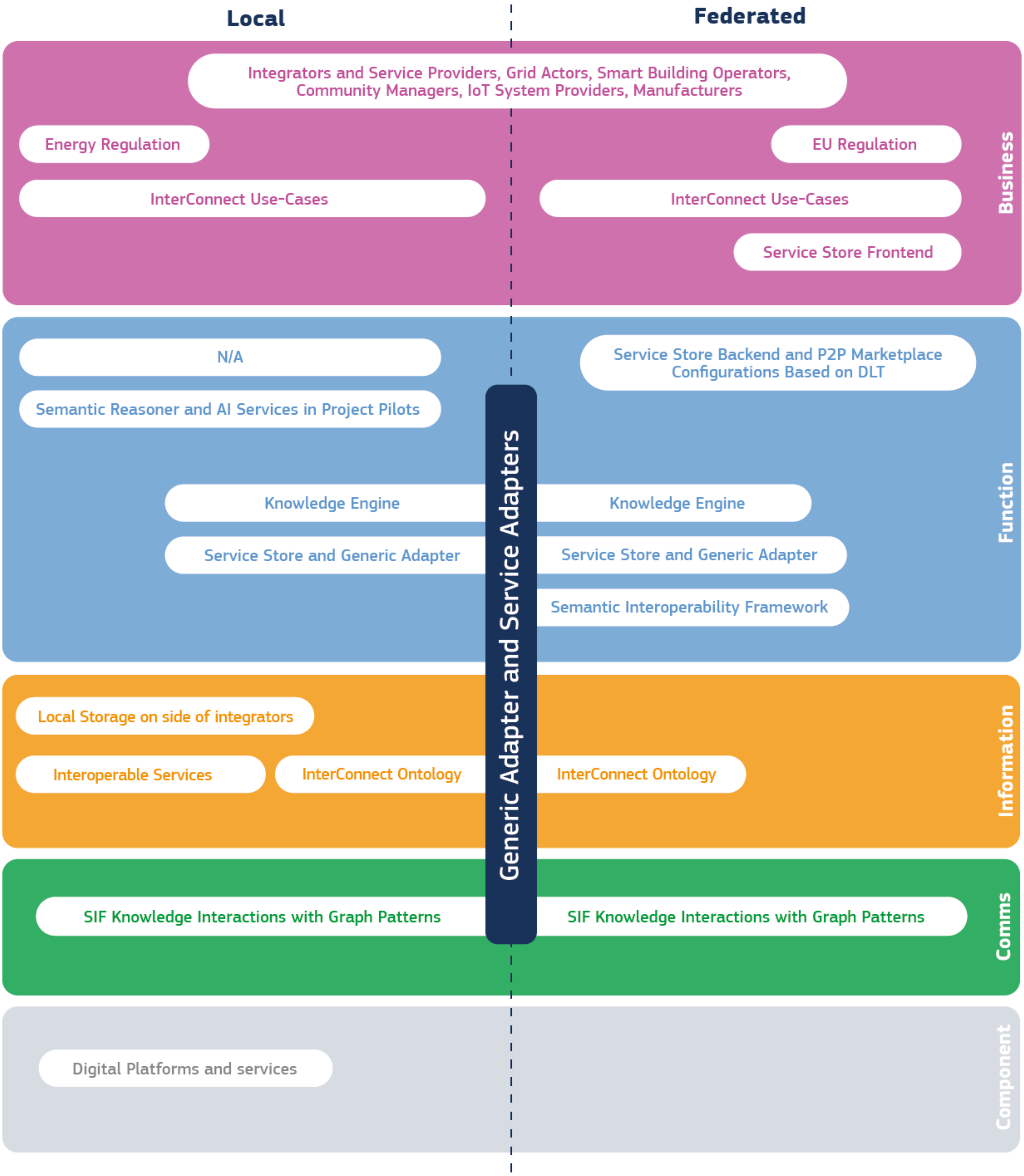

Figure 8. Instantiation of DERA in InterConnect project

OMEGA-X

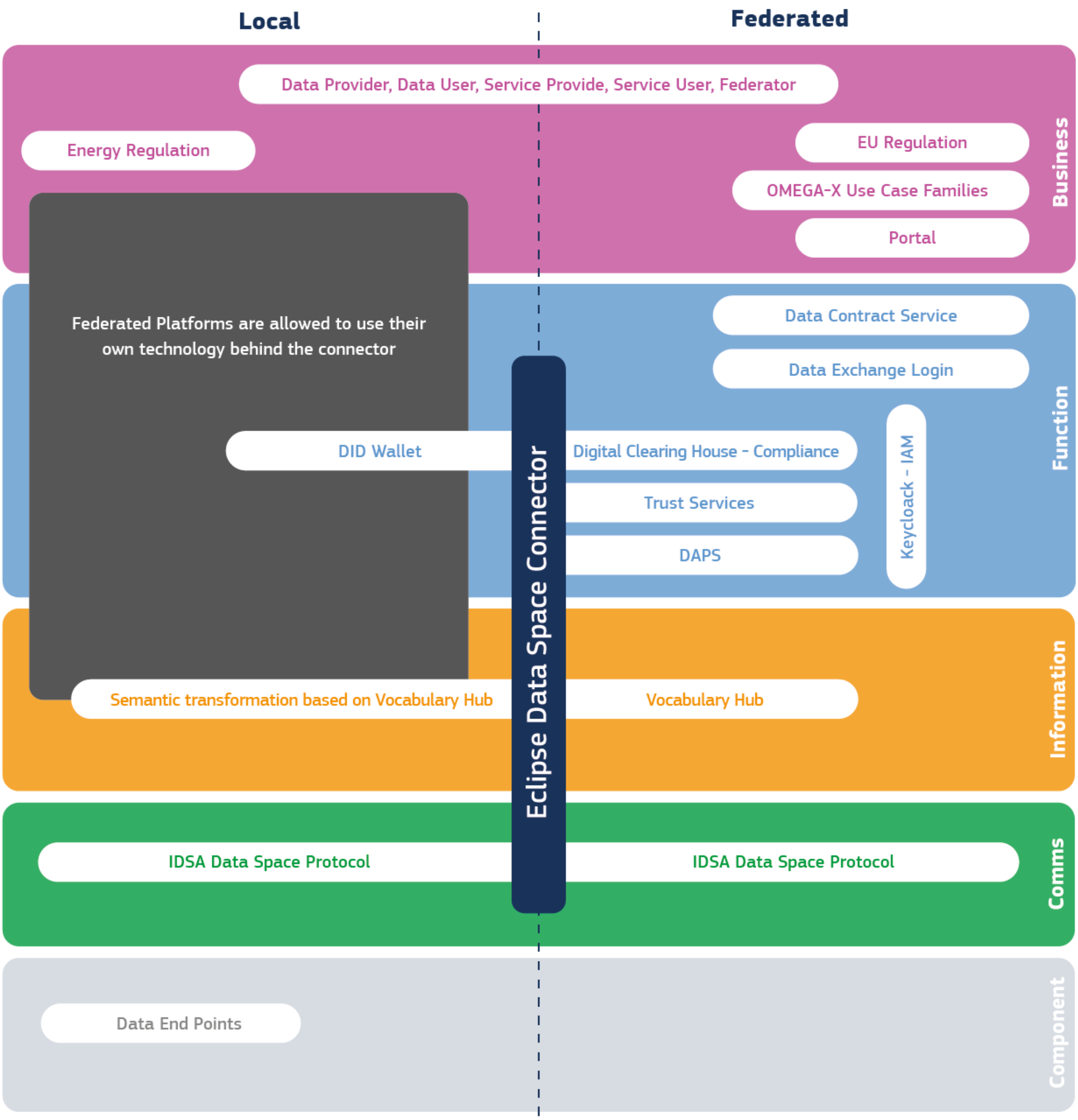

Figure 9. Instantiation of DERA in OMEGA-X project

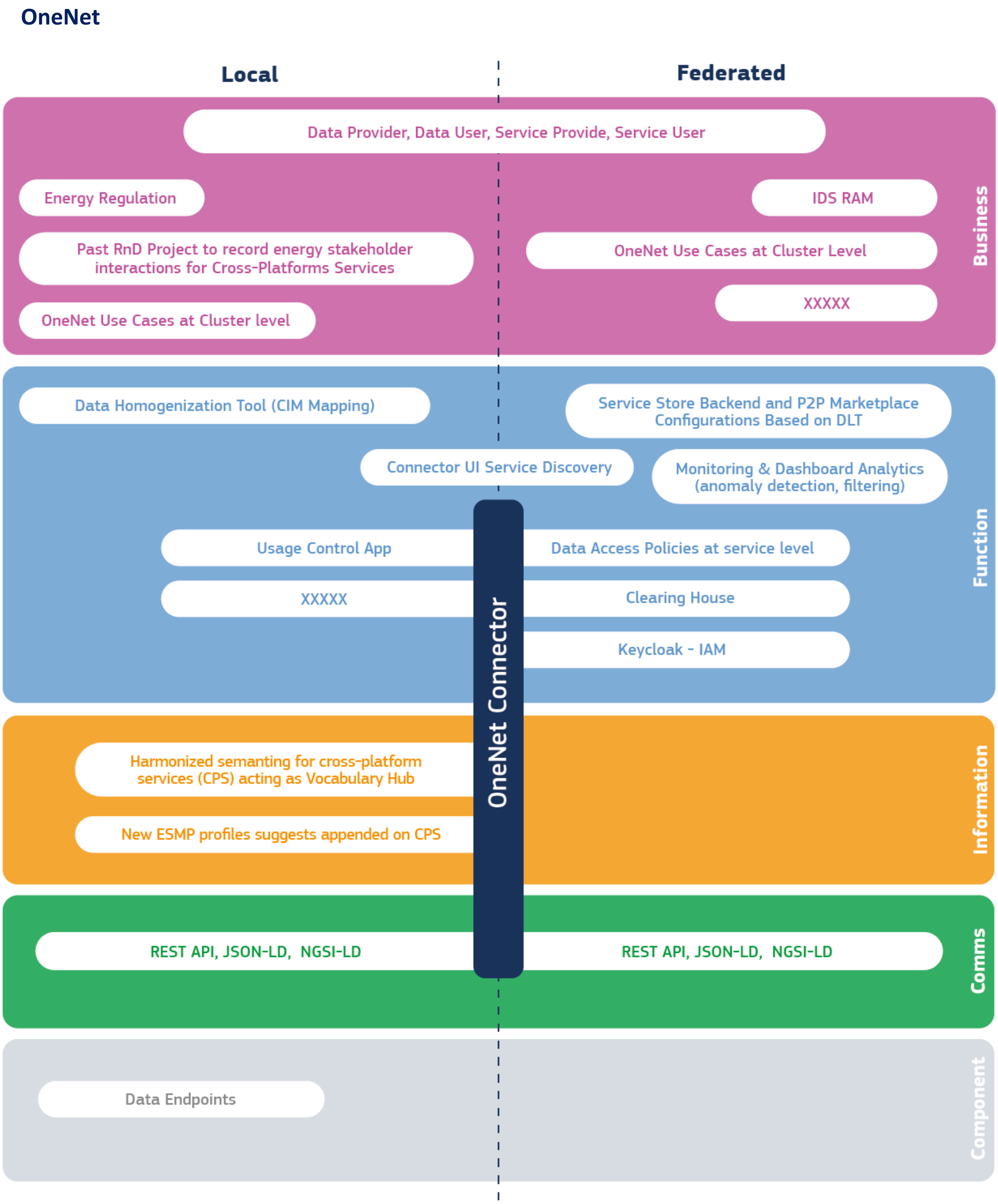

Figure 10. Instantiation of DERA in OneNet project

REEFLEX

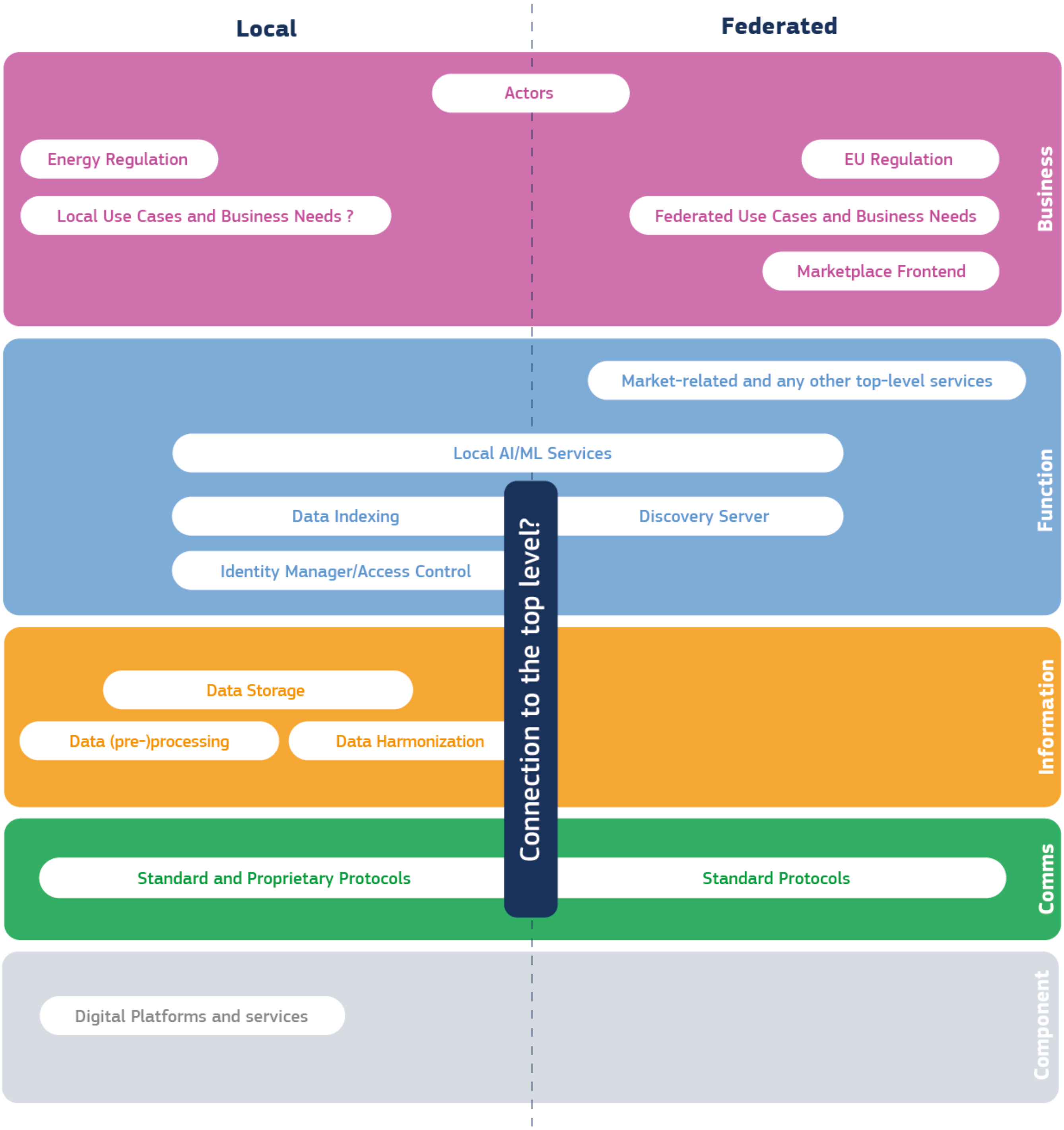

Figure 11. Instantiation of DERA in REEFLEX project

The diagram shows the case where the REEFLEX data platform operates in centralised mode. But it can also operate under a larger framework, being connected to an imperative federated level via some data space connector.

SENDER

CI: Control Interface

EVC EMS: Electrical Vehicle Charginh Energy Management System

RES: Renewable Energy Sources

UC: Use Case

EV: Electrical Vehicle

EVSE: Electrical Vehicle Supply Equipment

HWT: Hot Water Tank

DER: Distributed Energy Sources

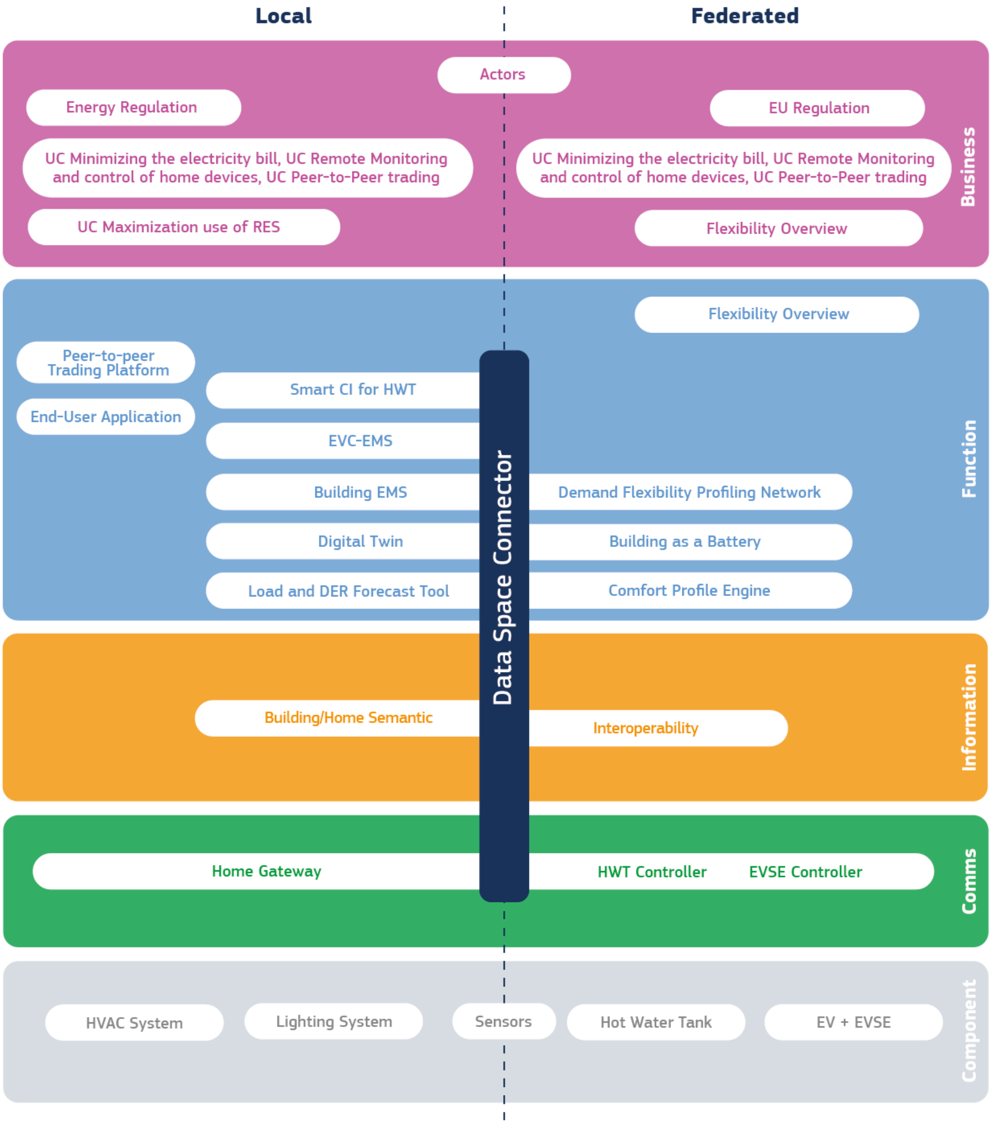

Figure 12. Instantiation of DERA in SENDER project

SINNOGENES

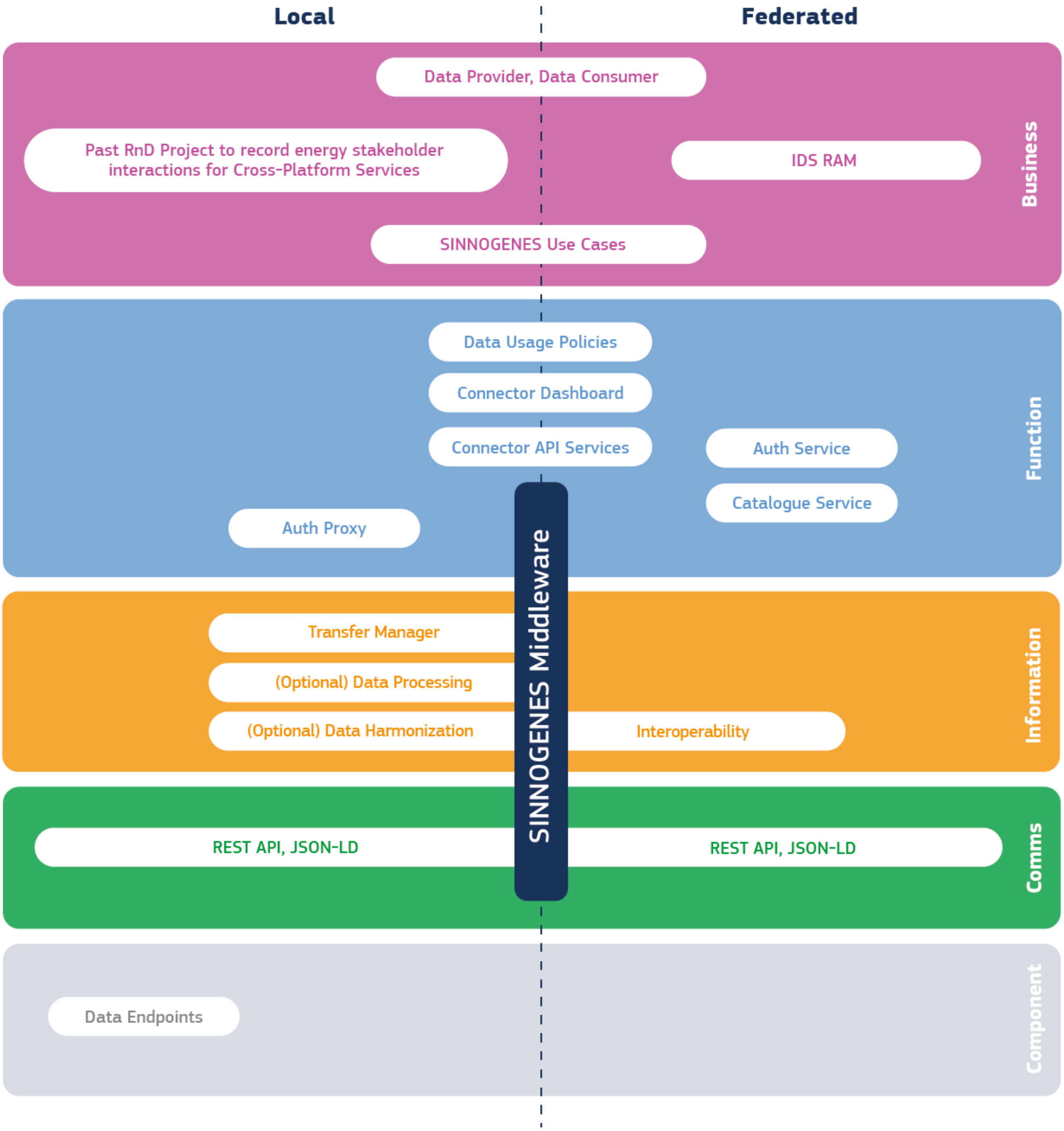

Figure 13. Instantiation of DERA in SINNOGENES project

SYNERGIES

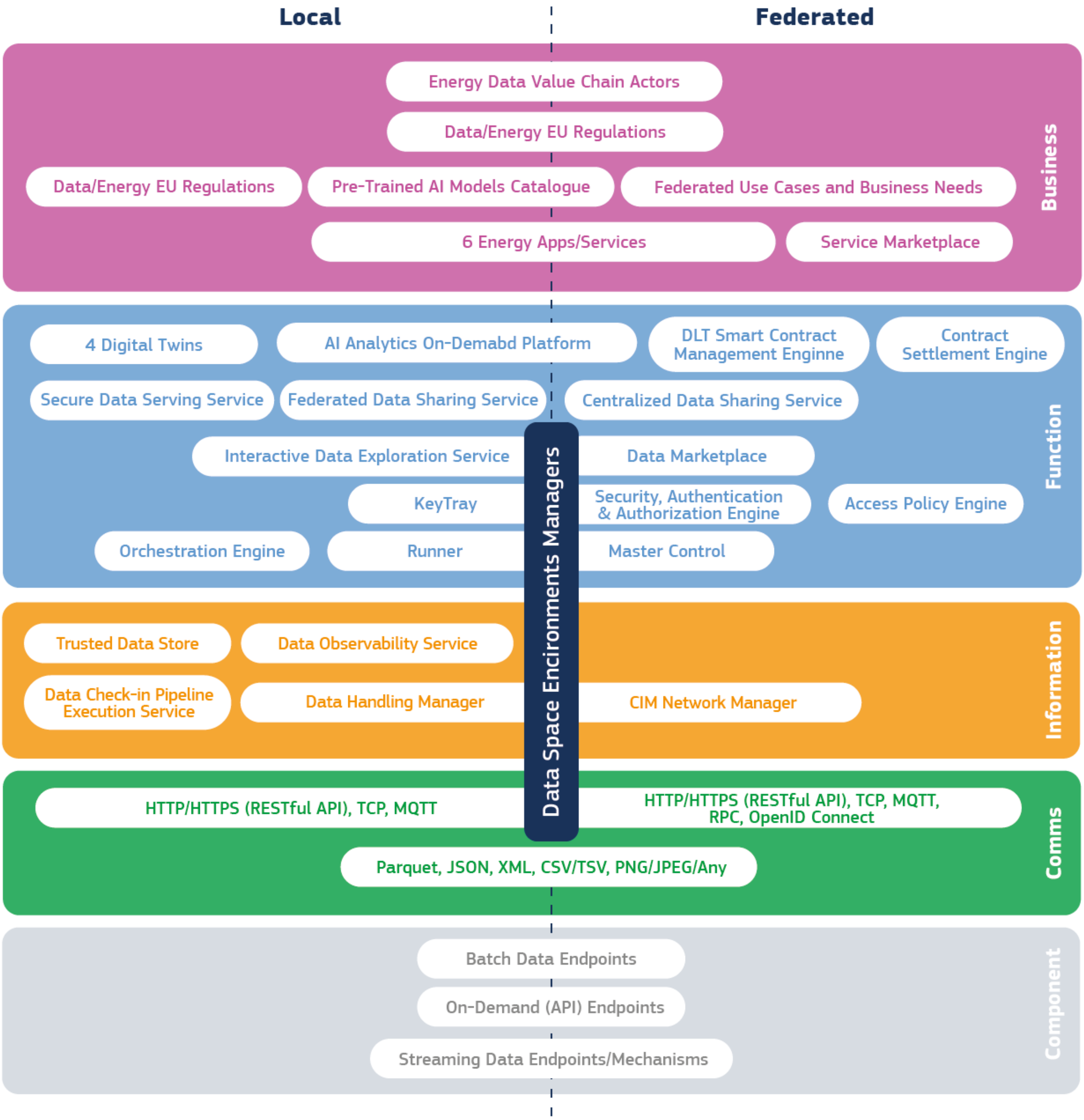

Figure 14. Instantiation of DERA in SYNERGIES project

3. Data Role Model

This chapter emphasises on the importance of the data governance layer in alignment with DERA. The chapter is structured into two distinct sections. The first section outlines the principal insights gleaned from members of the Data Management Working Group through a survey, regarding their interpretations of these components within the context of their individual projects. Drawing from the outcomes of the survey and ensuing further deliberations, the second section of the chapter consolidates recommendations pertaining to data role models.

3.1. Feedback from Projects Based on the Survey

The survey gathered insights from numerous projects concerning data role models and their respective strategies for addressing existing gaps. The primary focus was to elucidate how projects navigate consent procedures for near real-time data obtained from home area networks (HAN). Specifically, the survey aimed to ascertain the approach used for managing consent concerning data retrieved directly from meters or sub-meters within consumers' premises via the HAN (or P1) interface.

The majority of respondents either do not address permission procedures for real-time data access or do so through manual means, requiring data owners to sign consent forms in advance. Agreements in such instances encompass a spectrum ranging from joint controller agreements, controller-processor agreements, to specific user consent agreements. Responses received indicate that the management of consent for near real-time data is a relatively nascent area within several projects. In certain cases, responsibility for this falls to the service provider rather than being managed at the project level. Notably, two projects, OneNet and EDDIE, stand out for their dedicated mechanisms designed to handle consent for near real-time data. EDDIE, for instance, is in the process of developing a consent manager to operate within its administrative interface for in-house data access (AIIDA) instance. Conversely, in the case of OneNet, consent is managed through the registration of consumer consent in the flexibility register. Such consent is subsequently integrated into the agreement between the consumer and the FSP (flexibility service provider).

The subsequent question aimed to solicit the perspectives of projects regarding whether they believe the existing smart meter consent administrator role in HEMRM should be broadened to encompass consent from the HAN, including P1 interfaces. The role in question is highlighted with the help of Figure 15. Placement of the role "Consent Administrator" in HEMRM with updates proposed by BRIDGE previously (based on BRIDGE Data Management WG, European energy data exchange reference architecture, 2021.)

24 responses were received on this question where 13 were in favour of the expansion of the consent administrator role and 11 were against it. The percentage breakdown of the responses, illustrated in Figure 16, demonstrates a lack of consensus on the matter.

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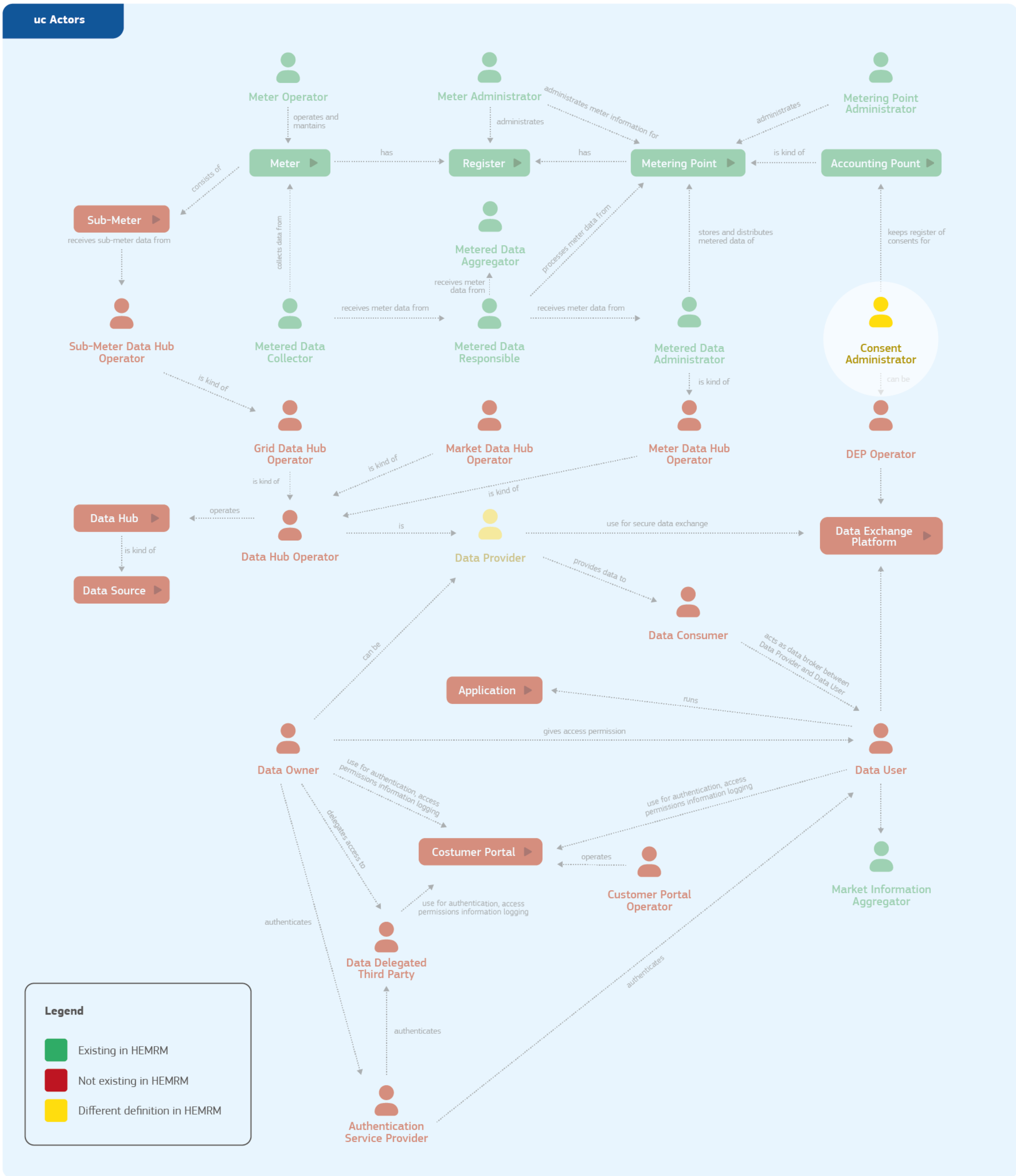

Figure 15. Placement of the role "Consent Administrator" in HEMRM with updates proposed by BRIDGE previously (based on BRIDGE Data Management WG, European energy data exchange reference architecture, 2021[22].)

24 responses were received on this question where 13 were in favour of the expansion of the consent administrator role and 11 were against it. The percentage breakdown of the responses, illustrated in Figure 16, demonstrates a lack of consensus on the matter.

[22] Available: https://energy.ec.europa.eu/system/files/2021- 06/bridge_wg_data_management_eu_reference_architcture_report_2020-2021_0.pdf

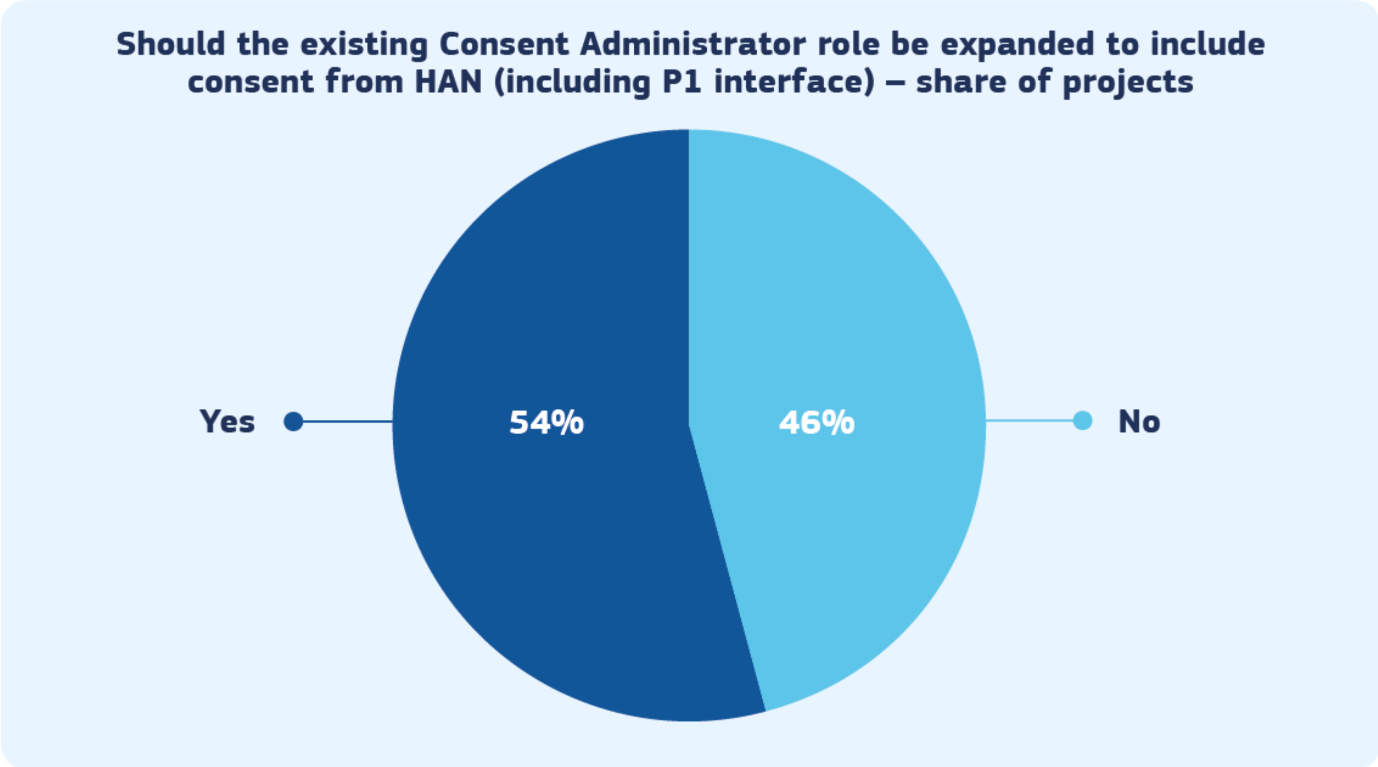

Figure 16. Should the existing Consent Administrator role be expanded to include consent from HAN (including P1 interface) – share of projects

Conversely, the third question sought to assess projects' perceptions regarding the necessity of introducing another role specifically for permissions and consents related to near real-time data access. Out of 23 responses, 14 opposed the idea, while 9 advocated for the introduction of a new role for managing near real-time data access permissions. When considering the responses from both the second and third questions, it becomes apparent that there is no clear consensus among projects on this matter.

The fourth question enquired about the appropriate nomenclature if a new role were to be introduced. Out of the responses received, 11 suggested the name "HAN Permission Administrator" as fitting, while one response opined that the decision regarding the name should rest with the coordinator.

The subsequent question in the survey centred on the necessity of a role for a "data space operator" or a similar position. The question posed was: "Do you feel the need for a role for a 'data space operator' (or similar)?" Out of the responses received, 14 indicated support for establishing such a role, while 10 recommended against introducing a new data role. These findings are shown in Figure 17

Figure 17. Do you feel the need of a role for “Dataspace operator” (or similar) – share of projects

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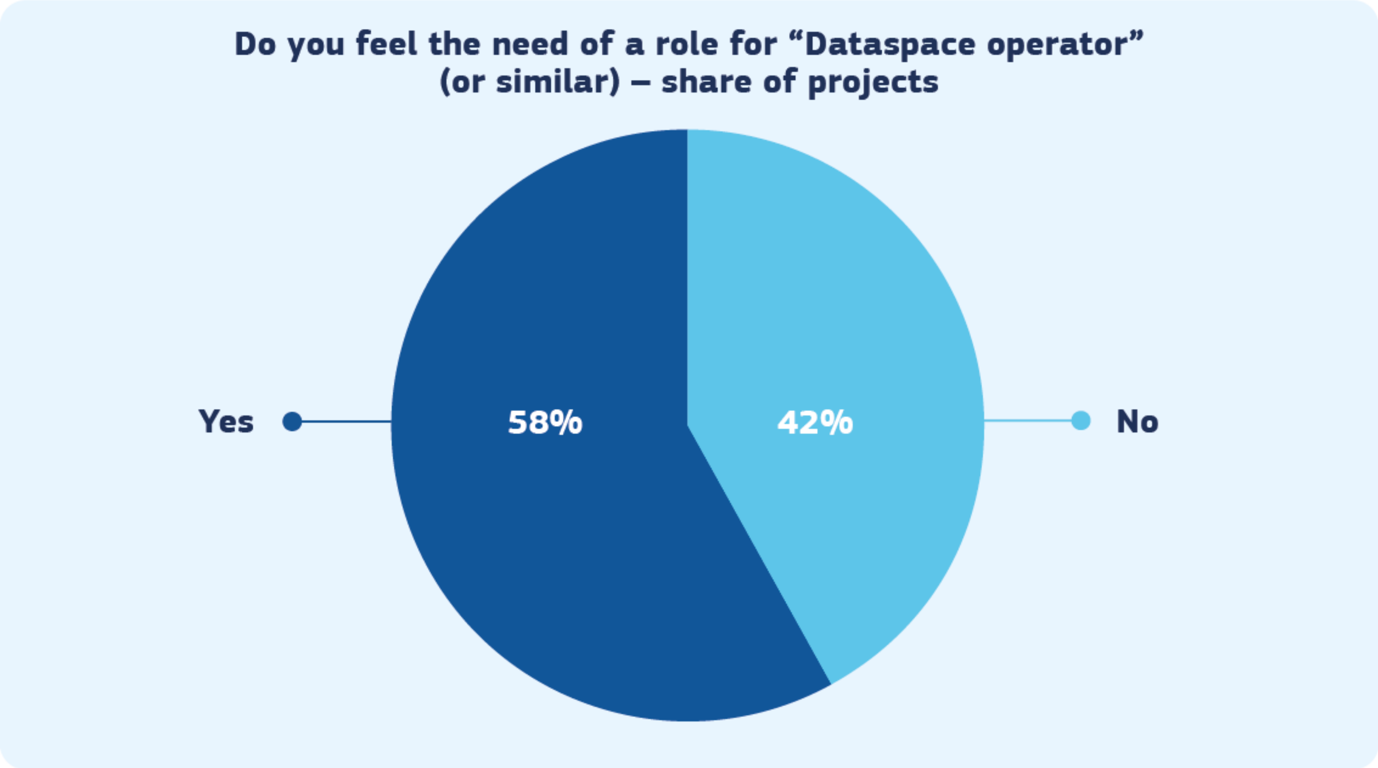


Figure 17. Do you feel the need of a role for "Dataspace operator" (or similar) – share of projects

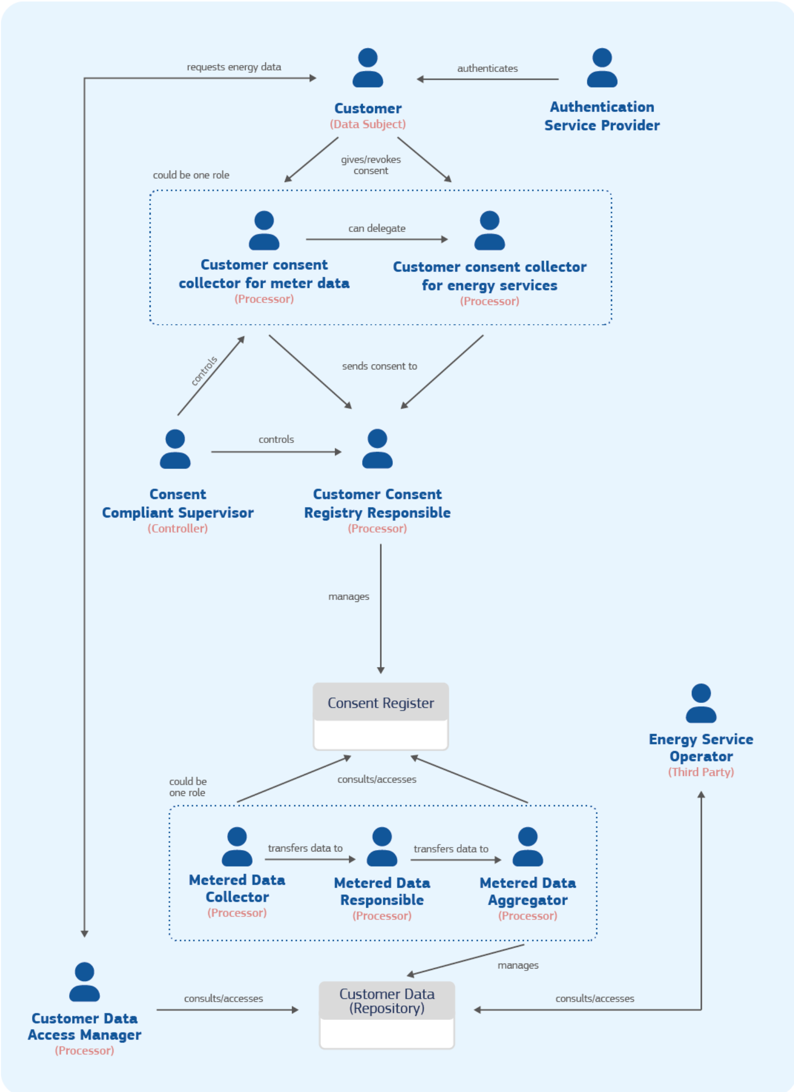
The last question for this section focused on understanding from various projects if there is a need of other data roles which they envision.

Most of the responses received can be grouped and summarised as under:

- *The roles should be simplified, merging some of them for clarity. Initial guidance for role definition should be drawn from the network code for demand response (NCDR), currently in progress, with additional detailing as necessary. Emphasis should be placed on expanding the handling of HEMRM to include DER measurements behind the primary meter.*
- *Compliance with data protection laws necessitates the appointment of a data controller when dealing with sensitive meter data. Sharing such data among project partners may require a joint data controller agreement, especially if multiple partners are involved in data collection, usage and storage. Defining the data controller and establishing data collection and storage protocols are essential.*
- *One of the responses suggested to have a new role of canonical data model administrator/manager. These roles can be adapted for cross-sector applications.*
- *Some of the roles provided in the figure could be generalised for the cross-sector case.*
- *As part of the Governance Body as described in data space reference architectures, to allow for agreement on: 1) determining the set of vocabularies to be used in the data space; 2) operating or delegating the vocabulary management processes; 3) providing a vocabulary hub component. It is probably something beyond one single role, as there is a need for a clearing house operator, marketplace operator as well.*
- *The "Data Exchange Platform" should be understood as "data space". Or maybe we should have separate roles for each if they are still different.*

3.2. Recommendations for Modifications in the Data Role Model

Topic	Synchronisation of Data Roles
Findings	The basis of the discussion for data role models was taken from the Recommendations for the [Harmonised electricity role model by OneNet project](). However, there have been some more developments in this regard over the time.
Recommendation	There is a need for reconciliation with other developments such as the Data Act and GDPR. An initial step in this journey could be to synchronise with My Energy Data illustration provided below[23]:



[23] European Smart Grids Task Force, "My Energy Data", 2016. Available: https://energy.ec.europa.eu/system/files/2016-11/report_final_eg1_my_energy_data_15_november_2016_0.pdf

Topic	Defining near real-time data permission administrator role under existing consent administrator
Findings	Managing consent or permissions for near real-time data at the consumer premises or within the HAN is still in its early stages and lacks consensus. There is currently no standard approach or unanimous agreement on how to manage consent specifically for near real-time data originating from the HAN.
Recommendation	To effectively manage near real-time data consent from HANs, it is essential to distinguish between the sub-roles of the existing consent administrator role. An inheritance relationship should be established from the consent administrator to explicitly define the role of the HAN Permission Administrator. Additionally, it should be noted that there can be multiple HAN permission administrators at a single consumer premises. When refining the existing consent administrator, the connection to the "accounting point" must be updated from "Keep a register of consents for" to "Might keep a register of consents for" to accurately reflect its function. These adjustments will ensure a more precise delineation of responsibilities and facilitate efficient management of near real-time data consent within the context of HAN.

Topic	Introduction of new roles associated with Dataspaces
Findings	Several roles related to data spaces are either missing or require explicit definition within the existing roles. Addressing these gaps is crucial for ensuring comprehensive coverage and clarity in the roles associated with data spaces.
Recommendation	It is recommended to wait for the finalisation of the description of certain data space roles by the int:net project before introducing the associated roles in HEMRM or in a separate data role model. This approach ensures alignment with ongoing developments and allows for a more informed integration of data space roles within the role model framework.

4. Findings and Recommendations

The first section of this chapter presents the outcomes of the survey. The second part of the chapter depicts the recommendations for DERA 3.0, which are based on the comments provided by the EU-funded projects.

4.1. DERA Recommendations Survey Outcomes

Based on the report from last year, a survey was conducted in the scope of sub-action 3 to get feedback from the different EU-funded projects. As part of this work, the first goal was to understand if the projects follow DERA 3.0 recommendations and how important they consider the recommendations for enabling cross-sector integration. Thequestions for the survey were created for the component layer (data exchange platforms, data applications), communications layer (protocols and data formats), information layer (canonical data model, data model and profiles), function layer and business layer (cooperation, process and data roles). The analysis presented in the following sections reflects the answers given to the survey by 28 EU-funded projects. Furthermore, the survey also allowed theparticipants to provide suggestions about DERA 3.0 recommendations.

The survey was conducted in a way to identify findings and gaps for the different layers of SGAM:

a. Component layer
    i. Data Exchange Platforms
    ii. Data Applications
b. Communications layer
    i. Protocols
    ii. Data Formats
c. Information layer
    i. Canonical Data Model
    ii. Data Models and Profiles
d. Function layer
e. Business layer
    i. Regulation
    ii. Cooperation
    iii. Processes
    iv. Data Roles

The survey's first question concerns the component layer, which addresses two aspects: data exchange platforms and data applications. According to the survey's outcomes, around 50% of the projects fully consider the first recommendation and around 36% partially (
Figure 18. Question 1 of the survey about component layer (data exchange platforms)
18); in turn, for the data applications, around 43% of the projects fully adopt this recommendation and the same percentage partially (**Errore. L'origine riferimento non è stata trovata.**19).

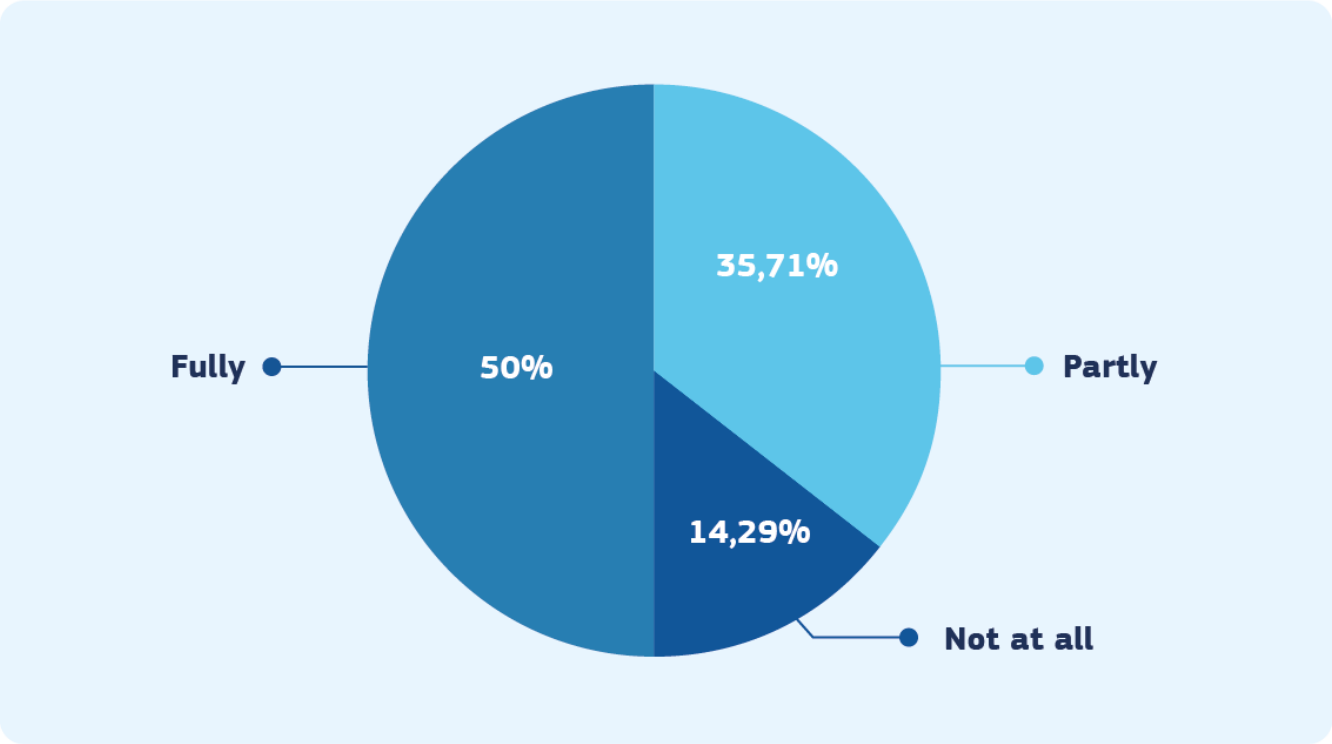


Figure 18. Question 1 of the survey about component layer (data exchange platforms)

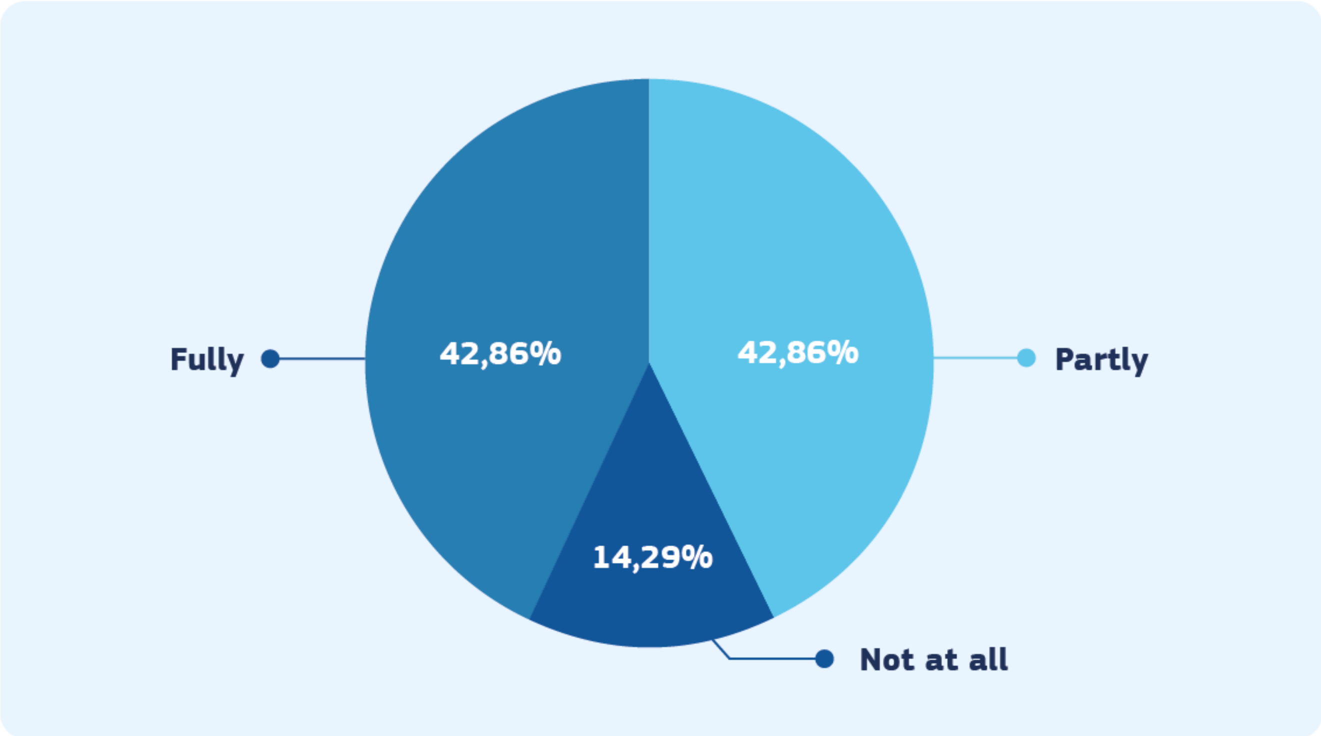


Figure 19. Question 1 of the survey about component layer (data applications)

Regarding the recommendations, some projects advocate for regulatory measures to compel technology providers to open their communication layers, facilitating data exchange. Additionally, they promote data sharing among users by providing incentives and a data monetisation marketplace. Also, the need to address concerns over data sovereignty is stated, particularly for 'data endpoints' in local environments, with proposed amendments to grant sovereignty to these endpoints, especially concerning real-time metering or measurements. This could be achieved through consent-based data sharing and adherence to agreed-upon data usage policies. Furthermore, there's a need to clearly specify components requiring real-time event-based data exchanges, especially in the energy sector, distinct from traditional REST API exchanges. For example, the EDDIE data space offers a solution for harmonised APIs across the energy value chain, compliant with industry standards such as CIM. Cross-sector APIs, including those for electromobility, should also be considered for smart home energy management. Key data applications such as ADMS, DERMS, EMS for pan-European balancing markets should be prioritised. Integration with other sectors like heat and transport is essential, incorporating weather and public transport data for precise forecasting. To achieve interoperability, data exchange platforms should be implemented as frameworks, using real-time messaging mechanisms. Lastly, data-driven applications should be focused on the function layer.

The second question was related to the communication layer, where around 48% of projects are fully adopting this recommendation while 44% partially (Figure 20. Question 2 of the survey about communication layer (protocols)20). Concerning the data formats, around 46% of the projects fully adopt the recommendation from DERA 3.0, while around 35% only partially do so (Figure 21. Question 2 of the survey about communication layer (data formats)
21).

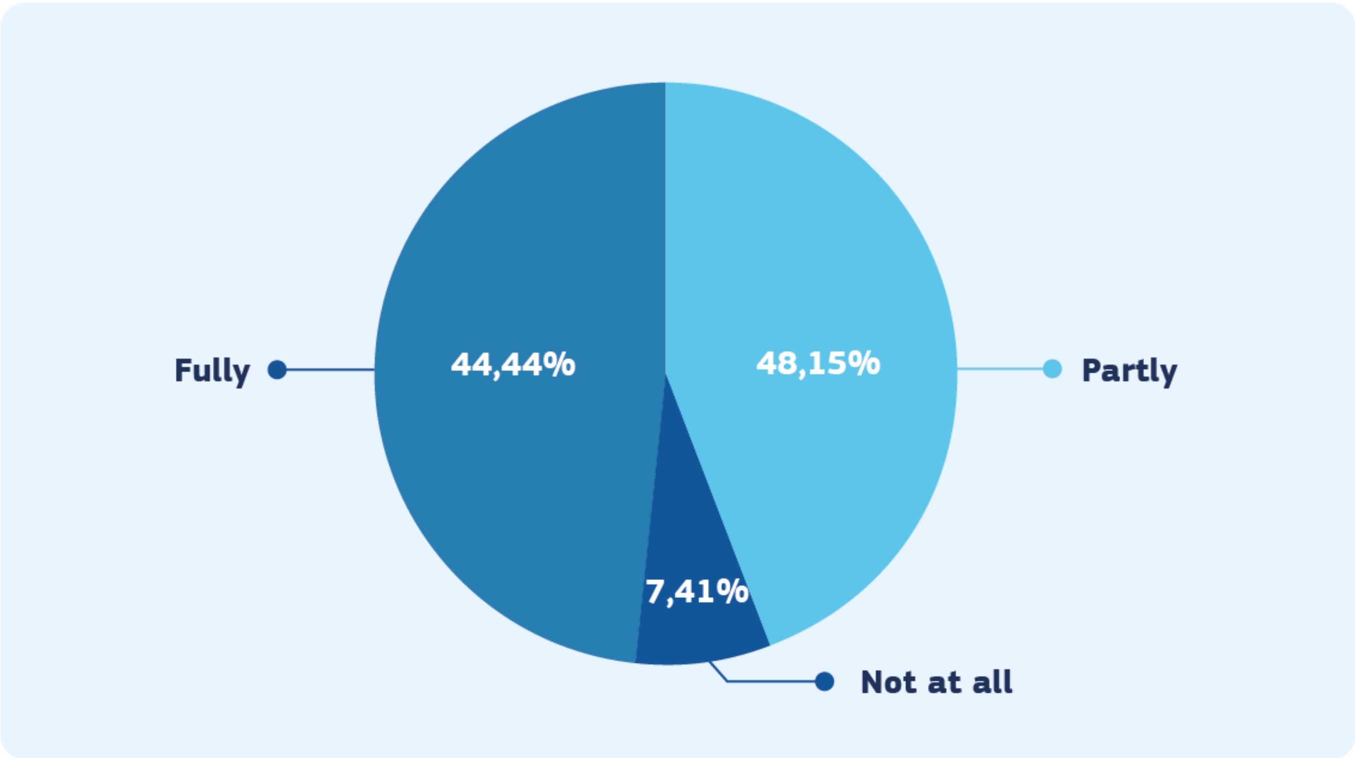


Figure 20. Question 2 of the survey about communication layer (protocols)

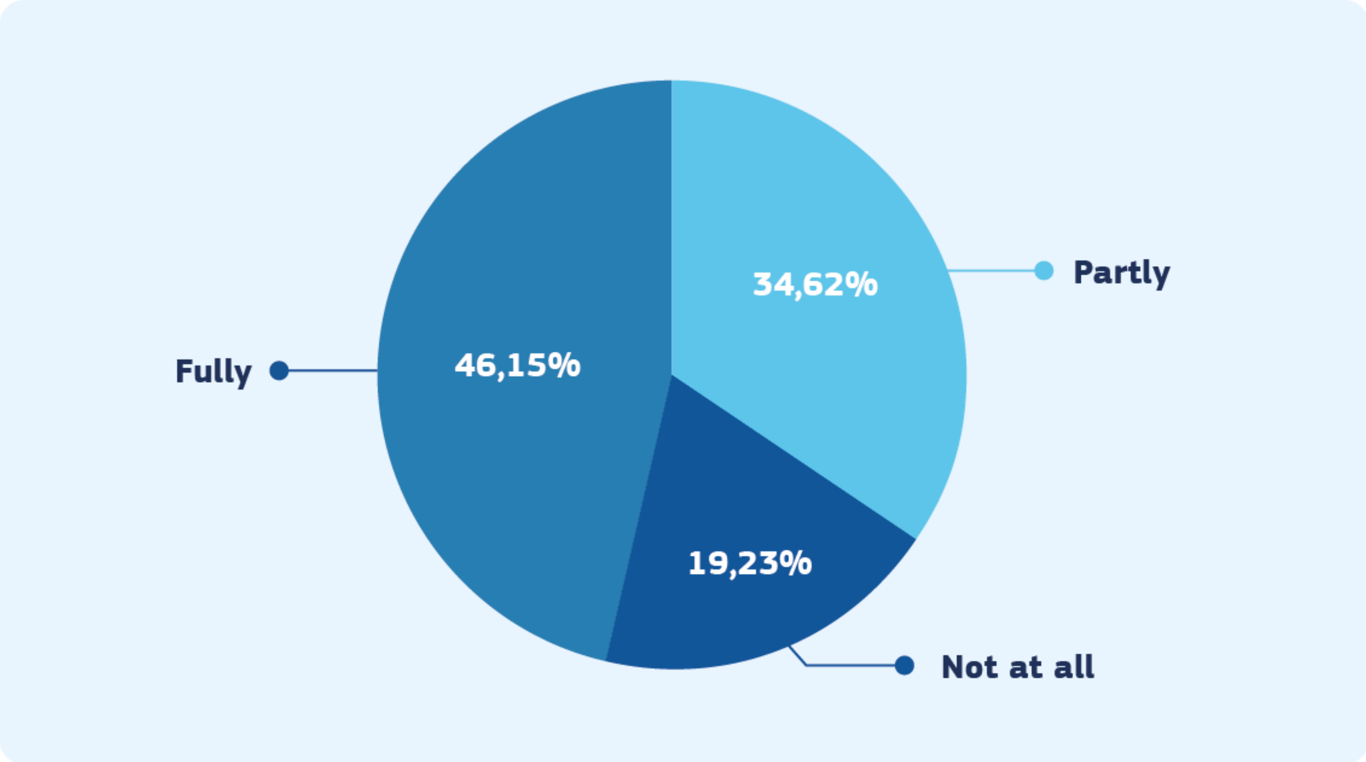


Figure 21. Question 2 of the survey about communication layer (data formats)

According to one project, there is a minor recommendation to include BLE Mesh for IoT and OCPP for charging stations. However, there's a need for explicit synchronisation between the technical layer and the business layer, particularly emphasising compliance with EU regulations. Key data exchange formats, especially those derived from CIM data exchanges, should be highlighted due to their significant use in electricity grid and market domains.

Consideration of reference models from the implementing act for demand side flexibility and flexibility network code is crucial for standardisation efforts. CIM emerges as a default option given its widespread deployment in ADMS, EMS and DERMS environments. Kafka and MQTT are notable industry standards for data exchanges, alongside CIM JSON files, which progressively replace XML message structures. A potential gap lies in the continuous evolution of new protocols and data formats, necessitating ongoing updates to the architecture. Implementing a dynamic framework to seamlessly integrate emerging technologies and standards can ensure the architecture remains future proof. Additionally, a clearer guideline on protocol and format selection based on security and interoperability criteria could enhance the architecture. The relation to key demand response standards such as EN 50491-12 and IEC 62746 standard families should be explored.

The InterConnect work, particularly its ability to bridge homes, buildings, and grid domains using semantic interoperability frameworks, should be incorporated into recommendations. Addressing the lack of a single standard for all data exchanges across sectors, reconciliation, and complementarity of standards need to be investigated. Furthermore, while a format-agnostic approach is ideal, it may not always be practical, as certain formats may be more suitable for specific cases. Finally, while agreement exists, establishing a common communication protocol, such as idscp2[24], could facilitate coupling across different sectors.

Regarding the survey questions related to the information layer, around 44% fully consider the recommendation on the canonical data model and 37% on the data models and profiles, as depicted in Figure 22. Question 3 of the survey about information layer (canonical data model)
22 and
Figure 23. Question 3 of the survey about information layer (data models and profiles)

[24] https://industrial-data-space.github.io/trusted-connector-documentation/docs/idscp_overview/

23, respectively.

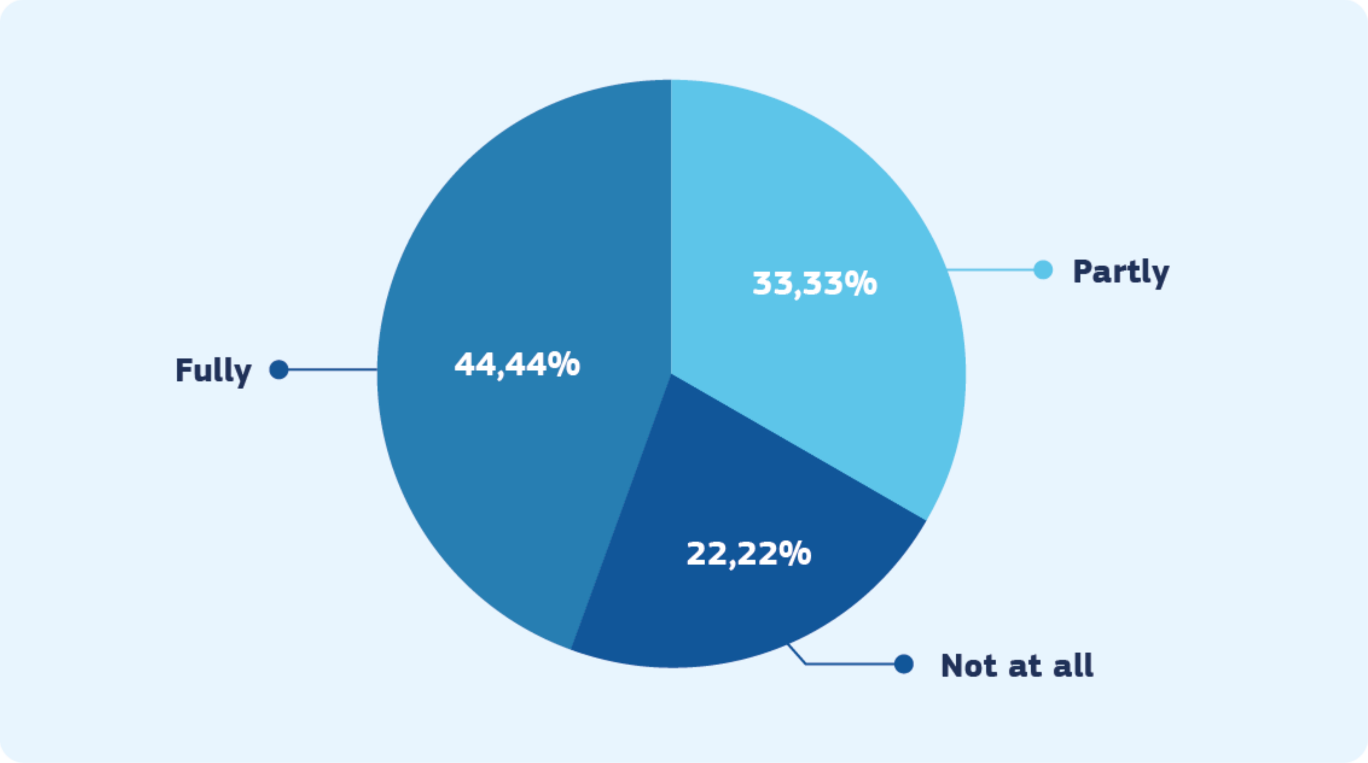


Figure 22. Question 3 of the survey about information layer (canonical data model)

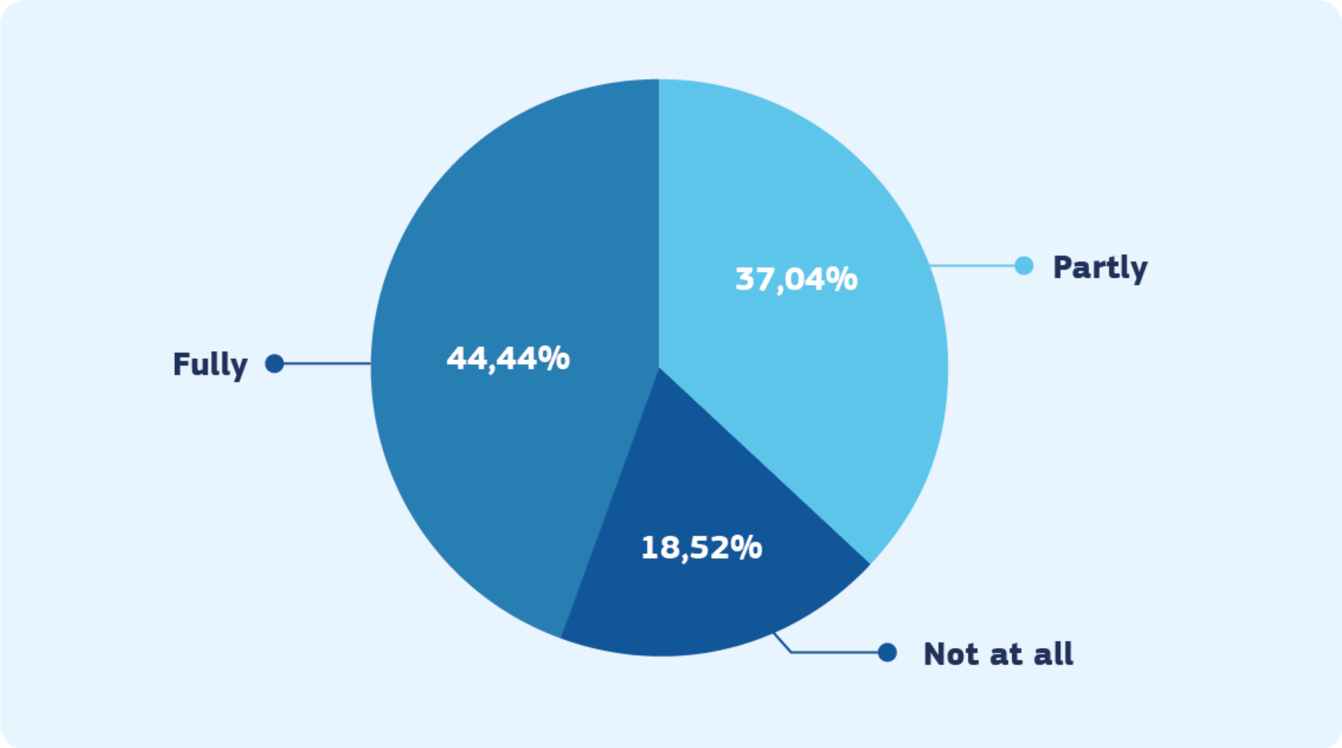


Figure 23. Question 3 of the survey about information layer (data models and profiles)

There is a recommendation to strengthen governance in data vocabulary to address conflicting terms, particularly within CIM, by amending attributes to include 'governance' for vocabulary providers. Concerns arise regarding the generic nature of terms in certain layers, raising questions about redundancy with embedded modules in data applications like DERMS or ADMS. Clarity is needed regarding the optional nature and specific use cases of certain layers, emphasising their value in information sharing across sectors.

Collaboration is encouraged to enhance mapping between CIM and SAREF at the home DER level, facilitating cross-sector profile exchange, especially in residential energy management and electromobility sectors. Investigation is suggested into integrating CIM-based data exchanges into key standards like OpenADR and OCPP for cross-sectorial integration, addressing the absence of reference data models. There is a need for clarification on the intention and domain of the data harmonisation component, specifically whether it harmonises metadata or data itself, and the requirement for prior knowledge of the harmonisation domain. The lack of abstraction and standards in communicating asset flexibility is highlighted, suggesting incorporation of concepts from CEN/CENELEC EN50491-12-2 and the management of a network of canonical models across different domains.

Emphasis is placed on the importance of a common and stable reference to data model descriptions for effective management and maintenance.

On the function layer, the survey outcomes show that around 38% of the projects have fully adopted the recommendation provided in the last report, while most (52%) have only partially considered it (Figure 24. Question 4 of the survey about function layer
24).

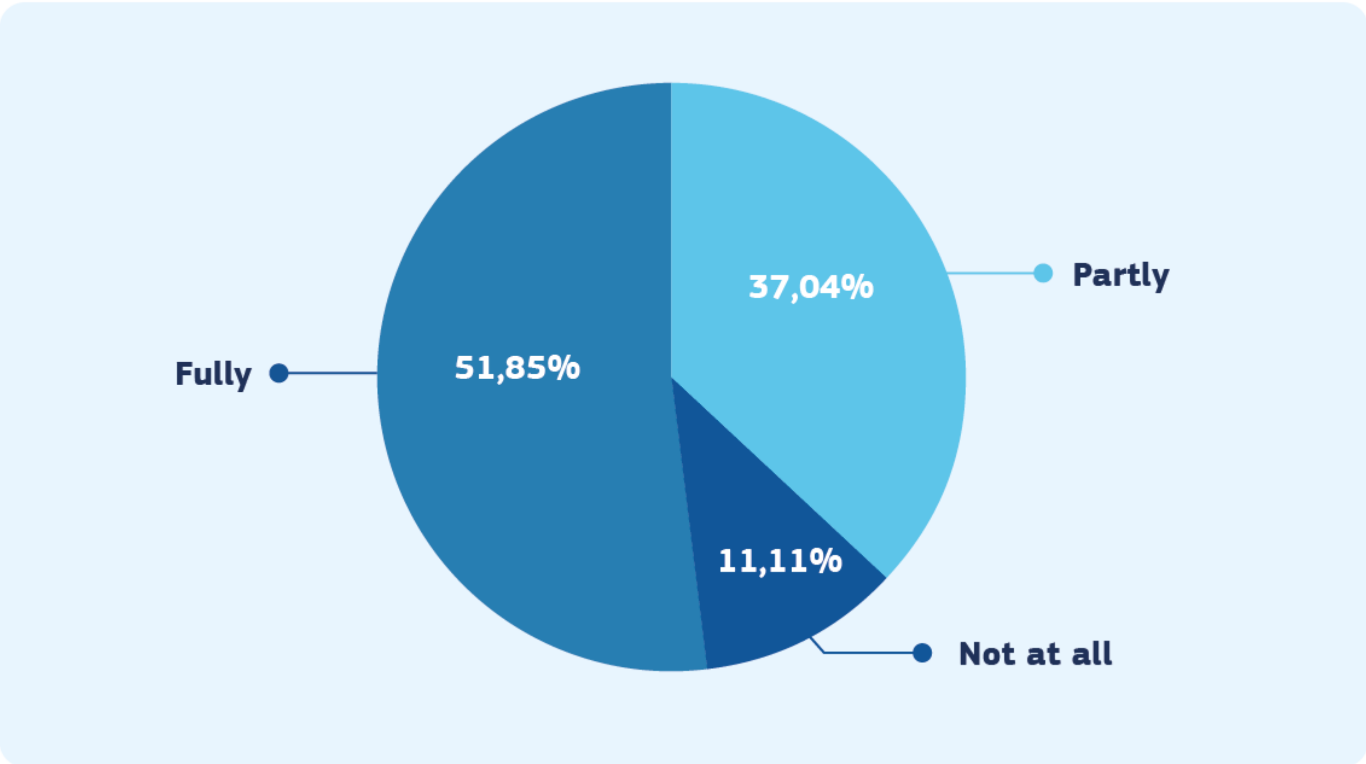


Figure 24. Question 4 of the survey about function layer

The respondents stated that the considerations for data analytics and decision support functions should acknowledge the existence of applications' digital twins and AI/ML service layers as distinct or complementary. The efficacy of the data discovery component relies heavily on agreed semantic models, which is a complex and ongoing process. Enhancements to data discovery could leverage location attributes for energy data until semantic agreements are finalised. Alignment with specific cross-sectorial use case needs is crucial, particularly for functions like monitoring and orchestration, which should prioritise compliance with agreed governance frameworks. The treatment of the marketplace backend and frontend as independent modules may be inappropriate, and emphasis on flexibility aspects is necessary. Ensuring real-time data processing capabilities, standardising protocols, and adapting frameworks for technological advancements are vital for immediate decision-making. Incorporating local AI/ML services with federated counterparts, addressing access policies, data provenance, bartering mechanisms, and metadata brokering functionalities within the framework are essential considerations.

For the business layer, the survey analysed adoption regarding three topics: regulation, cooperation and processes. From the survey outcomes, around 44% fully adopted the recommendation on regulation, 50% on cooperation, and 39% on processes. Around 45%, 39%, and 39% of the projects partially adopt the regulation, cooperation, and processes recommendations.

Regarding the business layer question (Figures 25-27), one may conclude that most of the projects adopt this recommendation and classify its importance on high level to enable cross-sector integration. Indeed, based on the feedback provided by the projects, a key point is the need to harmonise the use case repository. The projects suggest that the definition of the use cases should be compliant with IEC 62559-2/3 and the roles of the use cases must rely first on the HEMRM with additional roles created by some projects or roles coming from other associations (related to other sectors than electricity/ energy sector). For that purpose, it is proposed to open and promote the use case repository and align it with any potential peer repositories for other domains. As stated by one of the projects, as several initiatives are developing a use-case repository, interoperability between these repositories should be considered (e.g., based on 62559-3 XML serialisation but also by using common roles & information libraries). It is also suggested to develop a single-use repository for cross-sector data exchange use cases in Europe and create links between the use case repository, reference information model (IEC CIM), and reference role model (HEMRM).

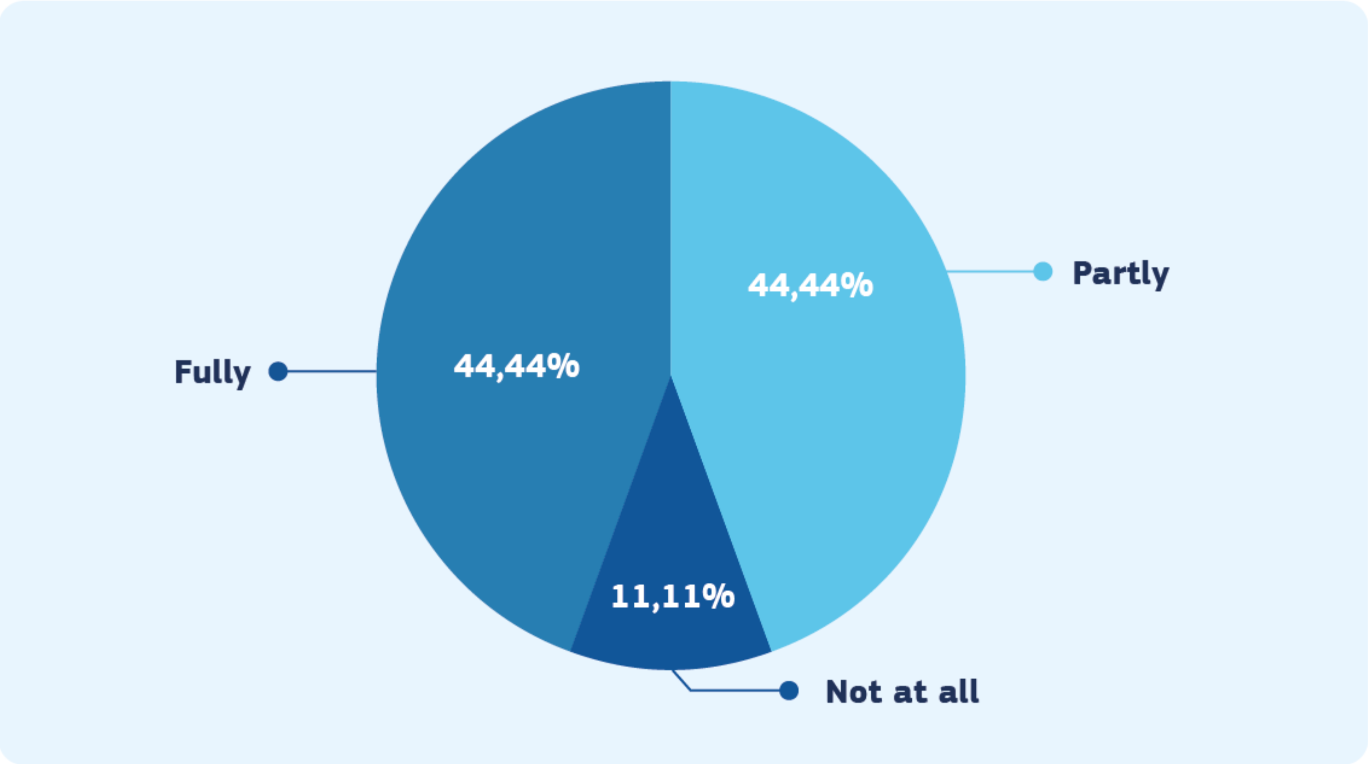


Figure 25. Question 5 of the survey about business layer (cooperation)

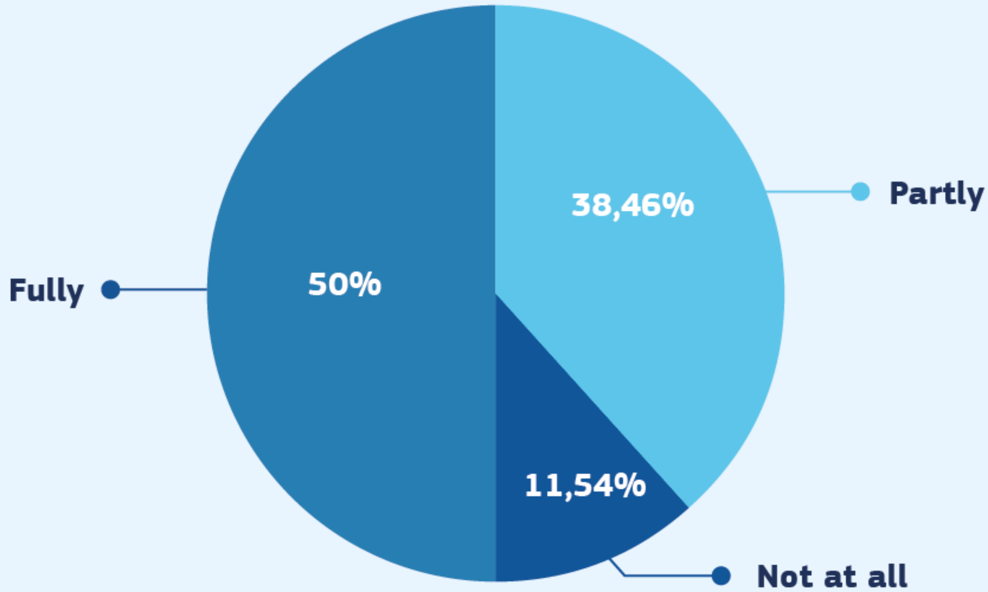


Figure 26. Question 5 of the survey about business layer (processes)

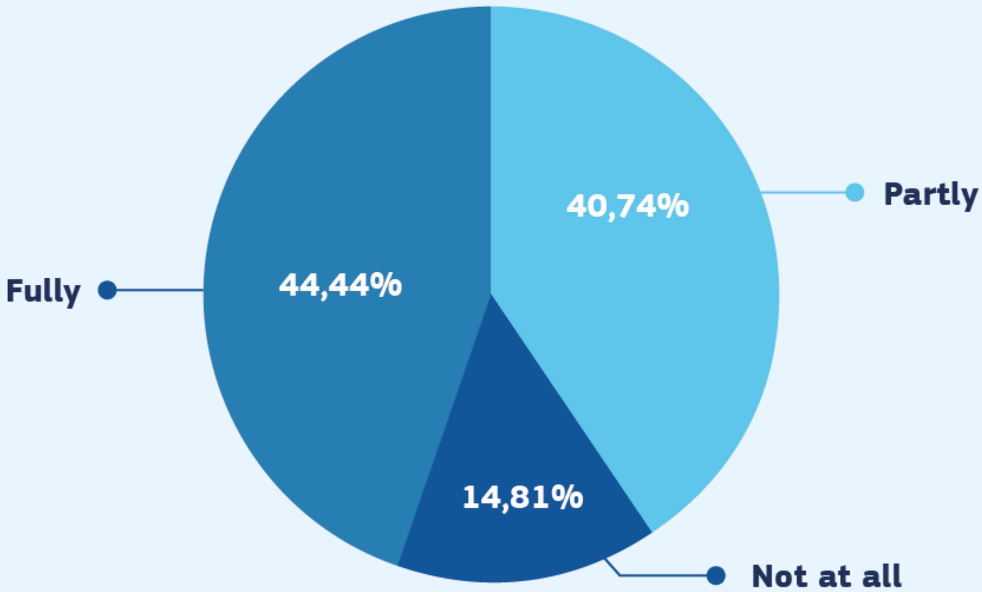


Figure 27. Question 5 of the survey about business layer (data roles)

Firstly, it's imperative to consider local and national laws and regulations. Secondly, clarification is required regarding whether the mentioned marketplace pertains to the electricity marketplace or an underlying data marketplace. If it refers to the electricity marketplace, recognition of the various existing marketplaces defined through the flexibility code is essential. Thirdly, within the context of the electricity market, actor roles should align with the HEMRM to maintain consistency with the European electricity market design.

Further collaboration with regulators and parties producing key regulatory text, such as ENTSO-E and EU DSO Entity, is necessary as they significantly influence associated use cases. Regular alignments with regulatory developments should be ensured. While the HEMRM should serve as the basis for the use case repository, it's vital to recognise that BRIDGE use cases should only provide high-level descriptions to allow for differentiation, innovation, and competition while complying with antitrust laws. Mentioning of the HGRM alongside the HEMRM is important.

Regular meetings between ENTSO-E and ENTSO-G to harmonise the HEMRM and HGRM towards a Harmonised energy role model (HERM) are crucial for consistency, according to the feedback provided by the projects. The HERM should be regularly updated with the latest developments from the data interoperability expert group for demand-side flexibility and should anticipate future regulatory deployments related to submetering and dedicated measurement devices.

The marketplace frontend should not operate as an independent component/module and should integrate cross-sector use cases and business needs. Additionally, it should be renamed to reflect a more business-oriented approach.

4.2. Recommendations

This section presents and upgrades the recommendations for implementing DERA 3.0. The upgrade of the recommendations takes the recommendations provided by the last version of the DERA . Then, the suggestions provided by the projects that answered the survey were considered to adjust the recommendations.

Topic	Component layer – data exchange platforms
Findings	BRIDGE projects are increasingly using business process agnostic data platforms such as ECCo SP, Estfeed, IEGSA, Atos FUSE, Enterprise Service Bus, and Cloudera. These platforms hold the potential to enhance data interoperability. Interoperable data exchange platforms encompass functionalities across all layers as defined in the SGAM framework. Connecting multiple data exchange platforms could unleash data-driven services among various stakeholders.
Recommendation	Promote business process agnostic data exchange platforms (DEPs) and ensure interoperability through the development of APIs (application programming interfaces). These APIs should facilitate easy connection for both data providers and users to any European DEP. This will create a seamless data exchange environment, aligning with the aim to push brands and technology providers through regulations to open their communication layers. DEPs should explore integrating data space connectors to enable connectivity with other DEPs, including cross-sector platforms, fostering a broader data ecosystem, and facilitating the exchange of data.

Topic	Component layer – data applications
Findings	Projects are using a wide range of existing and newly developed applications for data management. For instance, numerous applications are present in the realm of advanced distribution management systems (ADMS), capable of interpreting meter and sub-meter near-real-time data or historical data into actionable insights regarding the operational state of the power system.

Recommendation	Develop universal data applications capable of serving any domain, aligning with the push for regulations to open communication layers among brands and technology providers. Additionally, foster the development of open data-driven services that promote cross-sector integration. These services should be collectively available in application repositories, ensuring accessibility and facilitating the exchange of data across various domains.

Topic	**Communications layer – protocols**
Findings	Some communication protocols reported by the projects include HDFS (Hadoop Distributed File System) layered on top of TCP (Transmission Control Protocol) / IP (Internet Protocol). Internal data processes, such as data request and ingestion among services, predominantly use REST web services over secure HTTP connections. Additionally, IEC CIM XML files can be exchanged through the AMQP interface of ECCo SP.
Recommendation	Ensure a protocol agnostic approach to cross-sector data exchange by selecting standardised and open protocols. This entails emphasising interoperability and openness in protocol selection to facilitate seamless communication across sectors.

Topic	**Communications layer – data formats**
Findings	Data profiles use various formats like XSD and RDFS, often influenced by communication protocols and implementation considerations. IEC CIM XML stands out as a primary format across applications. Reference models from data interoperability implementing acts guide standardisation, with CIM widely deployed in energy environments. However, ongoing protocol and format evolution requires dynamic architecture updates. Clear guidelines for selection, considering security and interoperability, are necessary. Separate domains can be bridged with SAREF-based ontology, highlighting the need for the reconciliation of standards. A format-agnostic approach must recognise domains where specific formats are more suitable.
Recommendation	Ensure a data format agnostic approach, prioritising interoperability. Leverage IEC CIM and industry standards like Kafka and MQTT. Implement a dynamic framework for emerging technologies. Develop guidelines for format selection based on security and interoperability. Explore relationships with key demand response standards. Acknowledge cases where specific formats are necessary.

Topic	**Information layer – canonical data model**
Findings	The development of use cases according to IEC 62913-1 (Generic smart grid requirements) allows for the definition of business objects, which are exchanged between applications, systems, and functions providing interfaces. Business objects establish the semantics to be exchanged, and the Canonical data model defines these business objects for information exchange. There's a need to implement stronger governance in data vocabulary to resolve conflicting terms and ease the use of IEC CIM. Terms such as "power" and "active power" may point to the same concept in some cases, and there are discrepancies between terms used

	by the ENTSO-E CIM community and other IEC sources. Thus, amending attributes of 'vocabulary provider' to include 'governance' is recommended.
Recommendation	Define and maintain a common reference semantic data model, ensuring access to its model files for cross-sector data exchange. This involves leveraging existing data models like the Common information model (CIM) of the International Electrotechnical Commission (IEC) and ontologies like the Smart appliances reference ontology (SAREF). Incorporate mechanisms for life-cycle management of the canonical data model to facilitate enrichment with new concepts, extension to further domains, and relations' management. Collaborate with other projects to improve the mapping of CIM and SAREF at the residential energy resources level, enabling cross-sector profile exchange, especially in residential energy management and electromobility sectors. Investigate the possibility of integrating CIM-based data exchanges through key standards like OpenADR and OCPP for cross-sectorial integration. Address the lack of abstraction and standards in communicating asset flexibility, incorporating concepts as described in CEN/CENELEC EN50491-12-2. Consider the management and maintenance of a network of canonical models to address different domains, emphasising the importance of a common and stable reference to the data model descriptions.

Topic	**Information layer – data models and profiles**
Findings	The European electricity sector has established a robust methodology based on a system approach, emphasising interoperability through the use of standards such as use case definition, Harmonised electricity market role model, and canonical data models like IEC CIM and Smart grid architecture model. Extending this approach to other energy vectors and cross-sector domains would enhance data exchange between sectors. Profiling methodology, defined in IEC 62361-103, defines how the semantics of an interface relate to a common semantic data model, with IEC CIM and IEC 61850 serving as references for elaborating the profiling methodology. IEC is also going to publish in 2024 IEC 63417 “Guide and plan to establish smart energy ontologies” which proposes recommendations to support semantic interoperability.
Recommendation	Develop cross-sector data models and profiles, emphasising private data exchange and ensuring open access to model files. Adhere to robust methodologies, leveraging standards like IEC CIM and IEC 61850 and future IEC 63417. Address identified gaps by implementing stronger governance in data vocabulary, clarifying terms, and collaborating on mapping efforts. Investigate integration possibilities for CIM-based data exchanges through standards like OpenADR and OCPP. Emphasise the importance of maintaining a common and stable reference to data model descriptions for effective interoperability.

Topic	**Function Layer**
Findings	The transformation in both electricity domain and cross-sector domains hinges on effective data exchange and management. It's crucial to establish comprehensive functional data processes to facilitate data sharing, governance, and other functionalities necessary for cross-sector exchanges. These processes should align with the European Interoperability Framework and encompass standardised data governance blocks, including data source integration, handling, consent management, etc. Additionally, considerations for data analytics and decision support functions must acknowledge the existence of applications' digital twins and

	AI/ML service layers as distinct or complementary entities. The efficacy of the data discovery component heavily relies on agreed semantic models, presenting a complex and ongoing process. Enhancements to data discovery should leverage location attributes for energy data until semantic agreements are finalised. Alignment with specific cross-sectorial use case needs is crucial, particularly for functions like monitoring and orchestration, which should prioritise compliance with agreed governance frameworks. The treatment of the marketplace backend and frontend as independent modules may be inappropriate, and emphasis on flexibility aspects is necessary.
Recommendation	Establish and harmonise functional data processes for cross-sector domains, leveraging common vocabulary, templates, and repositories for describing respective use cases. Harmonisation efforts should encompass vocabulary provider, federated catalogue, data quality, data accounting processes, clearing process (audit, logging, etc.), and data tracking and provenance to ensure seamless interoperability and efficient data management across sectors. Furthermore, ensure real-time data processing capabilities, standardise protocols, and adapt frameworks for technological advancements to enable immediate decision-making. Incorporate local AI/ML services with federated counterparts, address access policies, data provenance, bartering mechanisms, and metadata brokering functionalities within the framework to support comprehensive cross-sector data management.

Topic	**Business layer – Cooperation**
Findings	The importance of TSO-DSO cooperation within the electricity sector is growing, extending into the realm of data management. European institutions such as the European Commission and standardisation organisations (CEN, CENELEC, ETSI) advocate for cross-sector coordination, a principle embraced by numerous BRIDGE projects. Bottom-up initiatives such as GAIA-X, FIWARE, IDSA, OPEN DEI, BDVA, and AIOTI are emerging to support cross-sector (and cross-border) data exchange. Additionally, associations from different sectors (e.g., ICT4Water) have the potential to collaborate and learn from each other, fostering further synergies, particularly in designing data exchange reference architecture. Orchestration at the European level could facilitate these efforts.
Recommendation	Ensure cooperation among appropriate associations, countries, and sector representatives to advance cross-sector and cross-border data management by establishing a European data cooperation agency. This entails ongoing empowerment of the BRIDGE Data Management Working Group to engage other sectors and expand cooperation with projects beyond EU funding. Collaboration with European standardisation organisations (CEN-CENELEC-ETSI) should also be prioritised.

Topic	**Business layer – Processes**
Findings	There are evident dependencies of the electricity sector with other energy vectors (e.g., gas, combined heat and power). Similarly, the water sector presents interdependencies with electricity due to the correlation between water usage and seasonal weather changes. Projects spanning health, manufacturing, and agri-food sectors highlight the feasibility and necessity of cross-sector business synergies. Common data management business processes, such as data security & privacy and data analytics, are shared across all energy vectors, including water, and in many

	aspects with other sectors such as health and transportation.
Recommendation	Harmonise cross-sector data exchange business use cases via the BRIDGE Use Ccase Repository, ensuring clarity on marketplace references and aligning actor roles with the HEMRM. Strengthen cooperation with regulators to align use cases with evolving regulatory frameworks. Base the repository on the HEMRM, acknowledging additional roles from other sectors like in the Harmonised gas role model (HGRM). Facilitate ongoing process harmonisation efforts through regular meetings, keeping the repository updated with the latest developments. Incorporate cross-sector needs into the marketplace frontend, renaming it to reflect a business-oriented approach, and ensuring it remains an integrated component.

Topic	**Business layer – Regulation**
Findings	The Electricity Market Directive holds significant relevance concerning meter data access and GDPR compliance for handling personal data. These regulations underscore the growing importance of private data in achieving interoperability within the electricity domain and across sectors. Projects emphasise the necessity of ensuring data owners' control over their data amidst evolving legislative frameworks. Moreover, the promotion of IEC CIM through electricity network codes and guidelines further accentuates the significance of standardised data models.
Recommendation	Facilitate a comprehensive European strategy and regulatory framework, including the harmonisation of national regulations, to support cross-sector exchange of both private and public data. This involves establishing reference models for data spaces, implementing common data governance practices, and promoting data interoperability through practical tools and guidelines.

5. BRIDGE Federated Catalogue

5.1. Reference Points

The practical implementation of DERA focused on the design and development of the BRIDGE data and services federated catalogue. The catalogue aims to be a central reference tool for establishing the interoperability data, services and applications. The insights and conceptualisation of the BRIDGE federated catalogue rely on extending the implementations of OneNet project that proposed cross-platform services (CPS) established for supporting the energy sector towards the instantiation of a wider energy data space[25]. The CPS were initially developed to help establish data and services interoperability among third party platforms, providing a formal definition and representation. A standardised process would define functional specifications, functional description, semantic definition and data quality requirements.

In BRIDGE, former DERA versions[26] addressed questions for the energy transition like:

- how to embody the demand side flexibility services derived from such new assets and actors into the energy market, utilising them for operational and ancillary services capable to tackle any technical issues ensuring resilience, efficiency and reliability for the modern power networks, spanning flexibility potential – even from residential consumers – in the foreground of system operation and planning,
- enabling data and services' marketplaces assuring cross-sector integration (i.e., beyond energy sector) exploring cross-sector flexibility sharing. All these solutions need to assess interoperability features also assuming comparability, appropriate standardisation and transversal governance.

Accordingly, there is need at least for a platform/framework/architecture that enables different applications and (energy) roles and actors to be modular enough to serve multiple objectives and possibly to be used in cross-sectoral applications. It should also be able to use existing data models, and map these to a higher level of abstraction and (semantic) interoperability. Data models and architecture should be open source. Using standards is preferred. Security and privacy are important, but still difficult to embed from the start in the architecture. As reflected in previous chapters, the adoption of data space approaches addresses conceptually such issues, yet the actual implementation of open tools and components to orchestrate domain agnostic data, services and applications. For instance, both FIWARE and IDSA propose the vocabulary hub/provider solution to provide a web-based vocabulary registry where all stakeholders can seek for data vocabularies relevant to the project/use case. This includes both standard vocabularies (i.e., ontologies like OEO (Open Energy Ontology) but also others like smart data models) and non-standard vocabularies (i.e., data models specifically for data from a certain use case in a pilot). Through the vocabulary hub, the developer of domain-specific vocabularies may access functions to create, improve, and publish their terms. While it is expected that these vocabularies follow the RDF pattern, further requirements like the linked data concepts or even formal ontologies are not enforced[27].

Another important component stemming from data space initiatives is the App Store/data apps that acts as a secure platform for both service providers and service consumers. For service providers it is important to register and maintain their applications, making them available (i.e., through the necessary metadata descriptions), whilst for service users to discover and then use new applications.

[25] OneNet D5.3, Data and Platform Assets Functional Specs and Data Quality Compliance, 2021. Available: https://onenet-project.eu/wp-content/uploads/2022/12/OneNet-D5.3-v1.0.pdf

[26] BRIDGE Data Management WG, European energy data exchange reference architecture, 2021. Available: https://energy.ec.europa.eu/system/files/2021-06/bridge_wg_data_management_eu_reference_architcture_report_2020-2021_0.pdf / BRIDGE Data Management WG, European (energy) data exchange reference architecture 3.0, 2023. Available: https://data.europa.eu/doi/10.2833/81504

[27] International Data Space Association, [online]. Available: https://docs.internationaldataspaces.org/ids-ram-4/layers-of-the-reference-architecture-model/3-layers-of-the-reference-architecture- model/3_5_0_system_layer/3_5_6_vocabulary_hub

5.2. Current State of Play

The data space use case involves establishing, connecting, and ensuring interoperability among the EU data spaces. A data space can be understood as a network of data-sharing services within a specific industry sector. These data spaces consist of multiple distributed actors, each holding a portion of data in a decentralised manner. These actors can opt to share their data with other participants in the data space, thereby becoming data providers within that space. Data consumers within a data space can then search for and access data from these providers, subject to compliance with the policies and agreements set forth by the data provider.

Following the latest Data space Protocol 2024-1, terminology as reflected in the IDSA Information model[28], the *connector* is the core technological building block of data spaces. It is a dedicated software component allowing *participants* to exchange, share and process digital content (i.e., unstructured, semi-structured or structured), ensuring the data sovereignty of the *data owner*. A connector is typically owned by a *participant agent,* who is a technology system that performs operations on behalf of a *participant* that offers a *data set*. Connectors may expose an arbitrary number of *resources* that provide or consume digital content (i.e. resources) via the data catalogue (*DCAT*) (
Figure 28. Relationships between data space Participant Agent types

28). A *catalogue service* is a participant agent that makes a DCAT catalogue available to other participants. A catalogue contains one or more data sets, which are DCAT data sets. A catalogue also contains at least one *DCAT data service* that references a connector where data sets may be obtained.

[28] International Data Space Association, [online]. Available: https://docs.internationaldataspaces.org/ids-knowledgebase/v/dataspace-protocol/overview/model

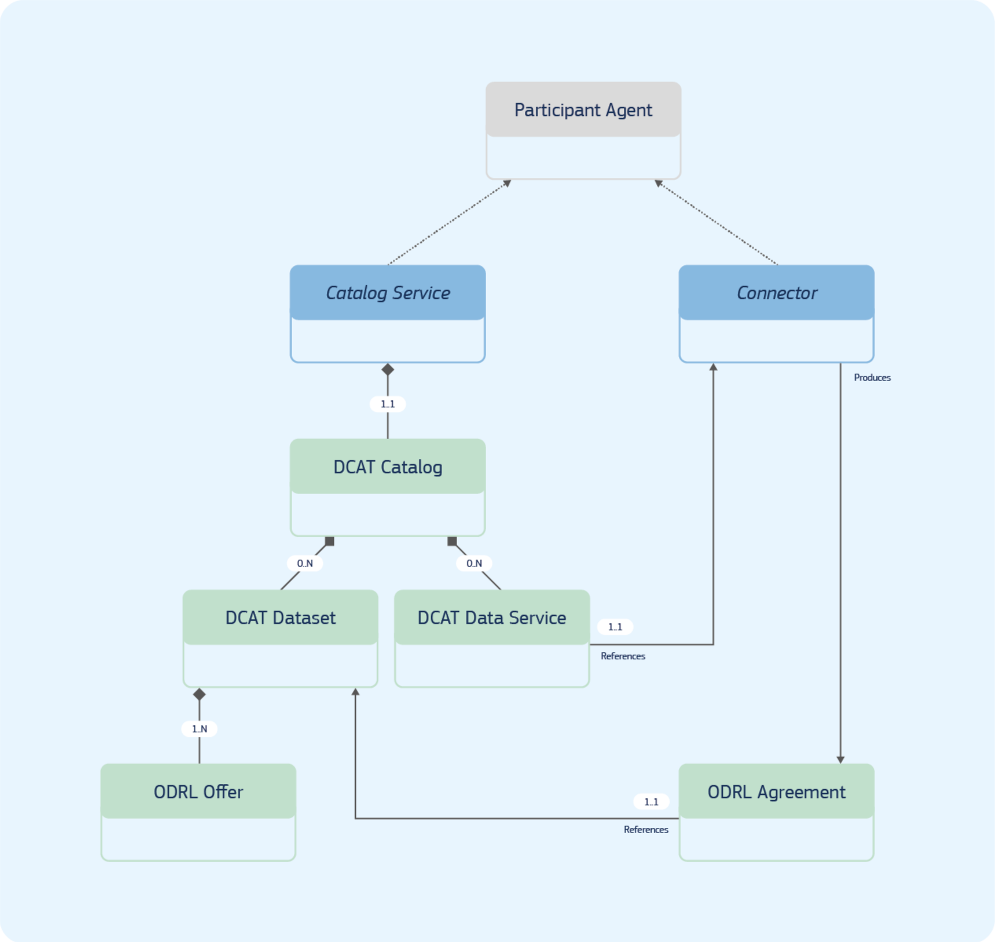


Figure 28. Relationships between data space Participant Agent types[29]

The challenge arises because of a trend towards the development of numerous instances of sector-specific data spaces, which raises concerns over silos among data space instances. Concurrently, with the continuous exponential expansion of data, there exists an urgent requirement within the European Union to ensure resilient and competitive access to storage and processing capabilities for data, catering to both the private and public sectors. The European Commission's objective is to establish sector-specific EU data spaces, such as an energy data space, agriculture data space, health care data space, or mobility data space. An important concern is to facilitate the establishment of these EU data spaces by offering a suite of common services and avoiding the emergence of silos between data spaces. Therefore, to establish interoperability among EU data spaces, ensuring that users are not confined within a single data space, proper universal tools/framework are deemed vital. In a high-level abstraction, the metadata operation on DCAT data set are performed as in Figure 29. Typical interaction of participant agent via the central metadata broker
9.

[29] International Data Space Association, [online]. Available: https://docs.internationaldataspaces.org/ids-knowledgebase/v/dataspace-protocol/overview/model

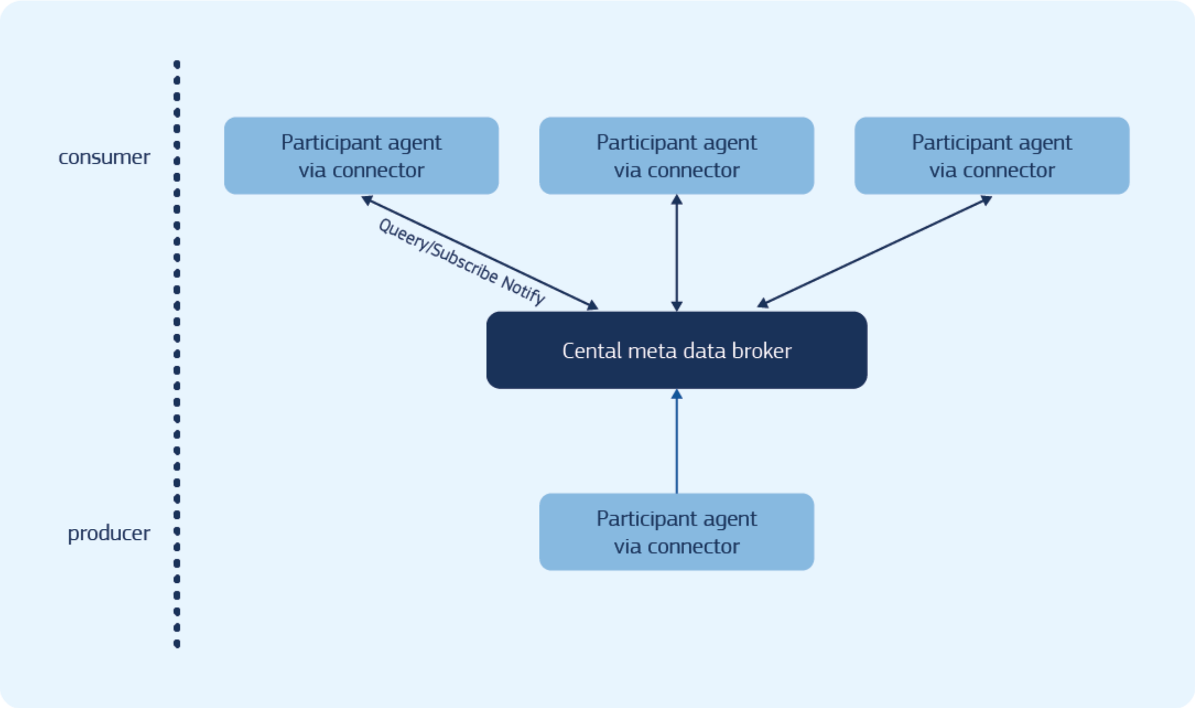


Figure 29. Typical interaction of participant agent via the central metadata broker

In the centre of the figure, a central/core metadata broker stores for context producers (`update process`) context information on connectors' self-descriptions, context information on available DCAT data services, data sets, and for potential context consumers (`query, subscribe, notify process`). Potential data users/participant agents have access to the metadata information available on the metadata broker about how data sets are deployed as DCAT catalogues, offering on usage control, referring to a rather technical standpoint of the data. As available data sources are increasingly developed, proper data indexing and data labelling needs to be applied to streamline the querying and discoverability of data.

5.3. BRIDGE Federated Catalogue

The rationale of proposing the BRIDGE federated catalogue relies on creating a reference tool that would support the creation and formalisation of interfaces for third party platforms from any sector (as a matter of fact supporting cross-sector linkages) as illustrated in Figure 30. The idea originates from the OneNet project's CPS that were developed to facilitate data exchanges among existing platforms, services, applications, and devices, to ensure system requirements' IEC standard formats (i.e., IEC 62325, 61970 etc.), standardised file formats, metadata, vocabularies and identifiers[30].

[30] OneNet D5.3, Data and Platform Assets Functional Specs and Data Quality Compliance, 2021. Available:https://onenet-project.eu/wp-content/uploads/2022/12/OneNet-D5.3-v1.0.pdf

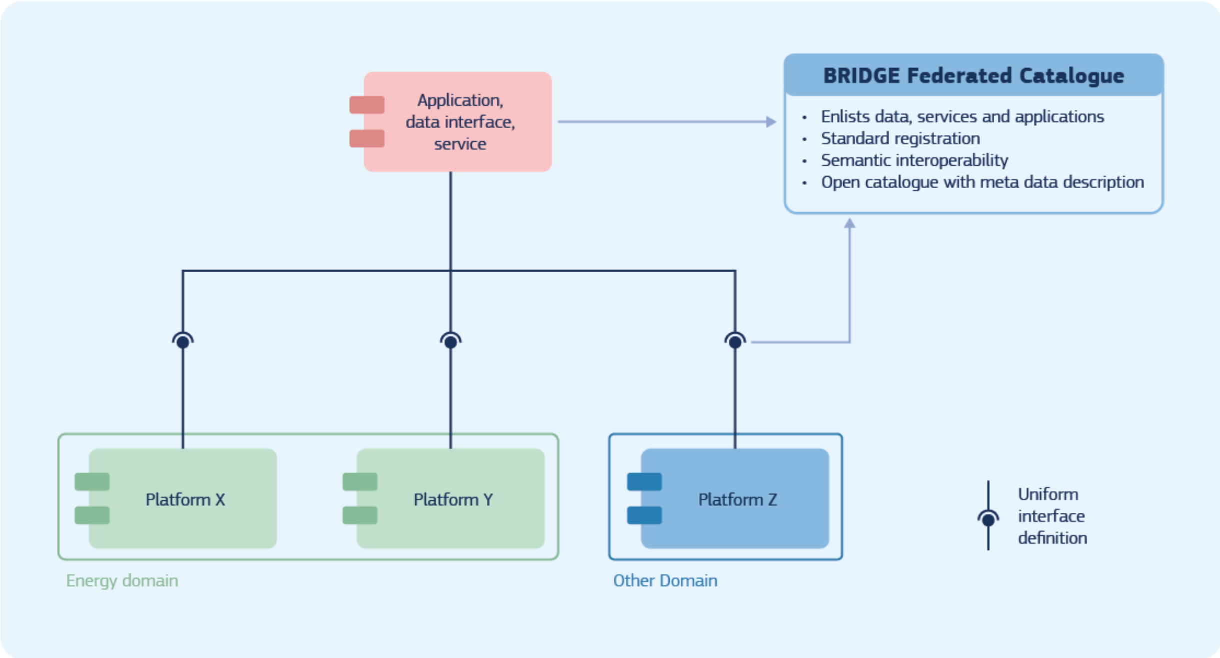


Figure 30. Federated cataloguing of services, data and applications' interfaces[31]

The BRIDGE federated catalogue aims to propose a standard form to register data (business objects) and apply data indexing/labelling, services and applications (data-driven applications that transform data sources). These, in turn, are useful for data exchanges among different actors, systems, platforms assuming the technical specification of those interfaces, which are independent of any implementation or application. The actual realisation of these interfaces, meaning the operational realisation, including the communication protocols (e.g., APIs), can be based thereafter at any open specification and it is not part of this cataloguing process.

The proposed BRIDGE federated catalogue aims to leverage data, services and applications from different domains, including the cross-sector ones, and most importantly to federate data and services stemming from different data spaces, fact which justifies the term of federation. It is assumed to be a web-based tool, which would allow users to openly view, register and propose improvements in existing business objects, services and applications. The conceptual view of the BRIDGE federated catalogue is on Figure 31.

[31] BRIDGE Data Management WG, European (energy) data exchange reference architecture 3.0, 2023. Available: https://data.europa.eu/doi/10.2833/81504

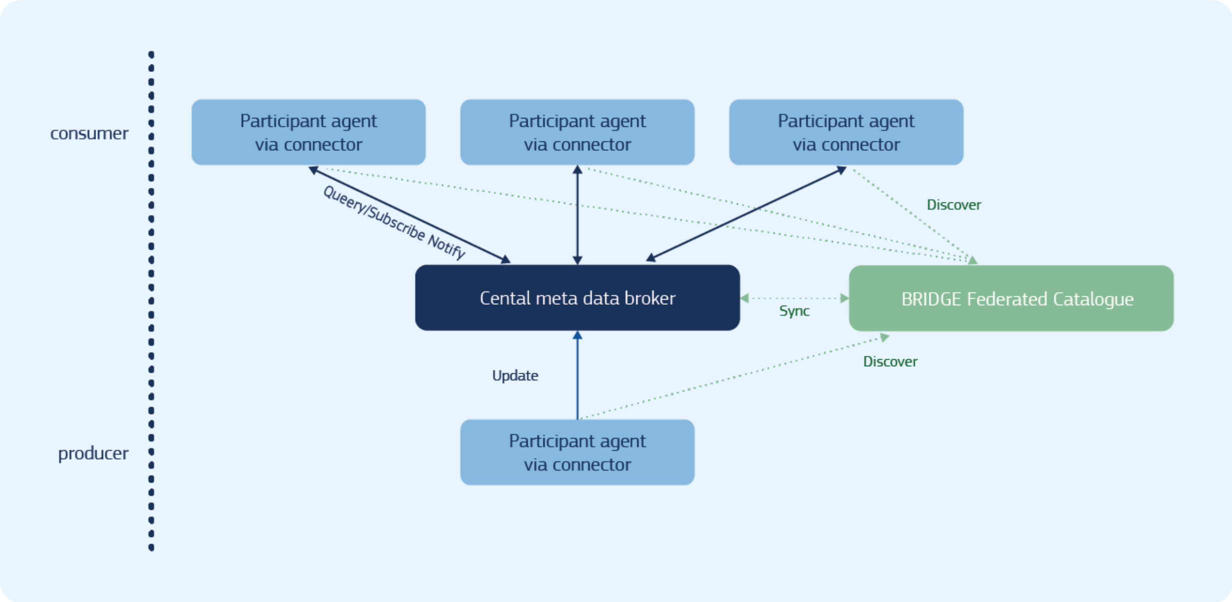


Figure 31. Proposal for registering new item in the BRIDGE federated catalogue

The catalogue is understood as an index and context registry for adhering factual metadata records from the participant agents' side, and not from the data sources themselves. Participant agents as consumers, can query, discover and subscribe to catalogue entries and context sources. The catalogue will be integrated to the metadata broker to push subscription requests to the corresponding context sources/DCAT services. The preliminary GUI (graphical user interface) features of the catalogue was presented in previous DERA report[32].

The proposed concept is expected to support the wider implementation of common European data spaces towards their federation. A view of the supporting operation of the Catalogue is given in Figure 32. BRIDGE Federated Catalogue on common European data spaces
2. The common European data spaces will to combine and integrate existing data space sector-specific instances, increasing the value of data economy. In this respect, the EC has funded the SIMPL[33] as smart middleware platform that will enable cloud-to-edge federations and assuming the creation of the common European data spaces. Within this extended data space ecosystems the federation of metadata brokers (i.e., those of individual data spaces), the smart middleware can play a pivotal role on their orchestration. To this end, the BRIDGE federated catalogue role is emphasised for the population and user-friendly metadata indexing towards easy-to-discover appropriate data set for end users.

The BRIDGE federated catalogue will be made publicly available for end users with the features of registering new objects and apply additional comprehensive label/indexes along with API endpoint to ease their integration with metadata brokers of evolving data spaces.

[32] BRIDGE Data Management WG, European (energy) data exchange reference architecture 3.0, 2023. Available: https://data.europa.eu/doi/10.2833/81504

[33] European Commission, Simpl: Cloud-to-edge federations empowering EU data spaces, [online]. Available: https://digital-strategy.ec.europa.eu/en/policies/simpl

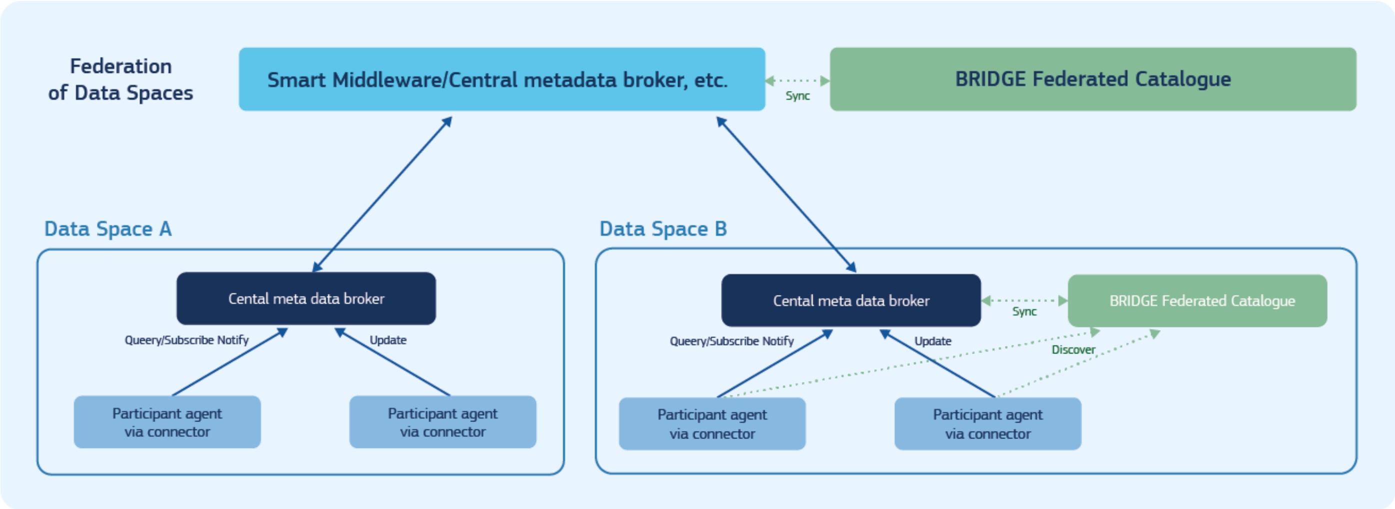


Figure 32. BRIDGE Federated Catalogue on common European data spaces

6. Next steps

Potential topics for 2024/2025:

a. Working on DERA version 3.2 with focus on SGAM compliance, business aspects and synergies with other vertical data spaces. Taking best parts from DERA 2.0 and DERA 3.1, potentially combining these two also visually.
b. Making sure that recommendations are still relevant and in line with DERA.
c. Elaborating further data role model, including with data space specific roles. Ensuring alignment with European initiatives and legislation – like Demand Response Network Code and data interoperability implementing acts.
d. Interface of the Federated Service Catalogue tool to be made available in 2024.
e. Implementing and deploying DERA based on concrete use cases. Cross-project demonstration of DERA, cross-project testing of data exchange use cases, in cooperation with int:net project.

Sub-actions for 2024-2025:

1. BRIDGE Federated Service Catalogue tool
2. Development of DERA 3.2
3. Implementation and deployment of DERA
4. Recommendations of DERA
5. Data role model

Annex I. Glossary

Term	Definition	Source
Architecture	Fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution.	CEN-CENELEC-ETSI[34] with reference to ISO/IEC/IEEE 42010
Canonical data model	A semantic model chosen as a common dialect for a data exchange.	
CIM standards ofIEC	IEC CIM standards aim to: • simplify integration of components and expand options for supply of components by standardising information exchanges; • reduce complexity with clear consistent semantic modelling among different points of integration; • clarify data mastership across any domain; • establish data flow between components without directly coupling their design.	Britton[35]
Data format	Data format in the meaning of file format is a standard way that information is encoded for storage on a computer file. It specifies how bits are used to encode information in a digitalstorage medium.	Wikipedia
Data model	An abstract model that organises elements of data and standardises how they relate to one another and to the properties of real-world entities.	Wikipedia

[34] CEN-CENELEC-ETSI Smart Grid Coordination Group, Smart Grid Reference Architecture, 2012. Available: https://ec.europa.eu/energy/sites/ener/files/documents/xpert_group1_reference_architecture.pdf
[35] Britton, J., Alstom Grid, Profiles vs the Canonical Model, Version Management in CIM Architectures. Available: http://www.ucaiug.org/Meetings/Austin2011/Shared%20Documents/CIMug/CIM%20University/Tutorial%20CIM%20Profiles%20and%20CIM%20Projects.pdf

Information model	A representation of concepts and the relationships, constraints, rules, and operations to specify data semantics for a chosen domain of discourse. Typically it specifies relations between kinds of things, but may also include relations with individual things. It can provide sharable, stable, and organised structure of information requirements or knowledge for the domain context.	Lee[36]
	An information model provides formalism to the description of a problem domain without constraining how that description is mapped to an actual implementation in software. There may be many mappings of the information model. Such mappings are called data models, irrespective ofwhether they are object models (e.g. using UML), entity relationship models or XML schemas.	Wikipedia
	The information model now serves two purposes. First, it aids future software design in creating robust data models, for example by supporting different customer address types.	McNamee[37]

[36] Lee, Y. T., Information Modeling: From Design to Implementation, National Institute of Standards and Technology, 1999. Available: https://tsapps.nist.gov/publication/get_pdf.cfm?pub_id=821265

[37] McNamee, K., Information model vs. data model, 2018. Available: https://blog.softwaresuperglue.com/2018/11/09/information-model-vs-data-model/

Term	Definition	Source
	Secondly, it enforces a common terminology across the system and in the documentation	
Interoperability	The ability of two or more devices to exchange information and use that information for correct cooperation to perform the required functions. In other words, two or more systems are interoperable, if they are able to perform cooperatively aspecific function by using information that is exchanged.	SGTF EG1[38], IEC 61850-2010[39]
Ontology	A representation, formal naming and definition of the categories, properties and relations between the concepts, data and entities that substantiate one, many or all domains of discourse.	Wikipedia
Profile	Specifies standards for particular business problems. Defines how the semantics of an interface relate to the Canonical Data Model.	Britton[40]
Protocol	Communication protocol is a system of rules that allow two or more entities of a communications system to transmit information via any kind of variation of a physical quantity. The protocol defines the rules, syntax, semantics and synchronisation of communication and possible error recovery methods. Protocols may be implemented by hardware, software, or a combination of both.	Wikipedia
Reference architecture	A reference architecture describes the structure of a system with its element types and their structures, as well as their interaction types, among each other and with their environment. Describing this, a reference architecture defines restrictions for an instantiation (concrete architecture). Through abstraction from individual details, a reference architecture is universally valid within a specific domain. Further architectures with the same functional requirements can be constructed based on the reference architecture. Along with reference architectures comes a recommendation, based on experiences from existing developments as well as from a wide acceptance and recognition by its users or per definition.	CEN-CENELEC-ETSI[41] with referenceto ISO/IEC42010

[38] European Smart Grids Task Force, Towards Interoperability within the EU for Electricity and Gas Data Access & Exchange, 2019. Available: https://ec.europa.eu/energy/sites/ener/files/documents/eg1_main_report_interop_data_access.pdf

[39] IEC 61850-10, Communication networks and systems for power utility automation - Part 10: Conformance testing, 2012. Available: https://webstore.iec.ch/publication/6008

[40] Britton, J., Alstom Grid, Profiles vs the Canonical Model, Version Management in CIM Architectures. Available: http://www.ucaiug.org/Meetings/Austin2011/Shared%20Documents/CIMug/CIM%20University/Tutorial%20CIM%20Profiles%20and%20CIM%20Projects.pdf

[41] CEN-CENELEC-ETSI Smart Grid Coordination Group, Smart Grid Reference Architecture, 2012. Available: https://ec.europa.eu/energy/sites/ener/files/documents/xpert_group1_reference_architecture.pdf

(Reference core) process model	A representation of harmonised processes for information exchange within the energy sector so that these processes may be implemented as such or as the basis for a customisedversion according to regional/national business needs.	SGTF EG1[42]
(Reference) information model	A representation of concepts and the relationships, constraints, rules, and operations to specify data semantics for the energy sector.	SGTF EG1[43]

[42] European Smart Grids Task Force, Towards Interoperability within the EU for Electricity and Gas Data Access & Exchange, 2019. Available: https://ec.europa.eu/energy/sites/ener/files/documents/eg1_main_report_interop_data_access.pdf

[43] European Smart Grids Task Force, Towards Interoperability within the EU for Electricity and Gas Data Access & Exchange, 2019. Available: https://ec.europa.eu/energy/sites/ener/files/documents/eg1_main_report_interop_data_access.pdf

Term	Definition	Source
Role model	A model representing core functions/responsibilities in the energy sector and their interdependence.	SGTF EG1[44]
Semantics	Understanding of the concepts contained in the message data structures. Understanding of the information that needs to be accessed/exchanged. The semantic aspect refers to themeaning of data elements and the relationship between them. It includes developing vocabularies and schemas to describe data exchanges, and ensures that data elements are understood in the same way by all communicating parties.	SGTF EG1[45], European Interoperability Framework[46]
Semantic model	A structured description of the semantics of a set of information, using some information modelling language (e.g. UML). A semantic model is 'metadata' – 'data about data'. Many different semantic models are possible for the same semantics, even within one modelling language. Semantic modelling only represents information content – it does not include formatting/encoding (syntactical) specifications.	Britton[47]
Semantic transformati on	A procedure for converting a given semantics from one semantic model representation to another. This should be distinguished from a syntactic transformation that converts from one format to another (e.g. CSV to XML).	Britton[48]
Syntax	Understanding of data structure in messages exchanged between systems. Technical aspects (e.g. formats, technologies used) of the information that needs to be accessed/exchanged. The syntactic aspect refers to describing the exact format of the information to be exchanged in terms of grammar and format.	SGTF EG1[49], European Interoperability Framework[50]

[44] European Smart Grids Task Force, Towards Interoperability within the EU for Electricity and Gas Data Access & Exchange, 2019. Available: https://ec.europa.eu/energy/sites/ener/files/documents/eg1_main_report_interop_data_access.pdf

[45] European Smart Grids Task Force, Towards Interoperability within the EU for Electricity and Gas Data Access & Exchange, 2019. Available: https://ec.europa.eu/energy/sites/ener/files/documents/eg1_main_report_interop_data_access.pdf

[46] European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, European Interoperability Framework – Implementation Strategy, 2017. Available: https://eur-lex.europa.eu/resource.html?uri=cellar:2c2f2554-0faf-11e7-8a35-01aa75ed71a1.0017.02/DOC_1&format=PDF

[47] Britton, J., Alstom Grid, Profiles vs the Canonical Model, Version Management in CIM Architectures. Available: http://www.ucaiug.org/Meetings/Austin2011/Shared%20Documents/CIMug/CIM%20University/Tutorial%20CIM%20Profiles%20and%20CIM%20Projects.pdf

[48] Britton, J., Alstom Grid, Profiles vs the Canonical Model, Version Management in CIM Architectures. Available: http://www.ucaiug.org/Meetings/Austin2011/Shared%20Documents/CIMug/CIM%20University/Tutorial%20CIM%20Profiles%20and%20CIM%20Projects.pdf

[49] European Smart Grids Task Force, Towards Interoperability within the EU for Electricity and Gas Data Access & Exchange, 2019. Available: https://ec.europa.eu/energy/sites/ener/files/documents/eg1_main_report_interop_data_access.pdf

[50] European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, European Interoperability Framework – Implementation Strategy, 2017. Available: https://eur-lex.europa.eu/resource.html?uri=cellar:2c2f2554-0faf-11e7-8a35-01aa75ed71a1.0017.02/DOC_1&format=PDF

Use case	A list of actions or event steps typically defining the interactions between a role (known in the Unified Modelling Language (UML) as an actor) and a system to achieve a goal. The actor can be a human or other external system.	Wikipedia

Annex II. Alignment with Gaia-X and IDSA reference architecture and modules

This DERA 3.0 is trying to perform a complex exercise of mapping very different yet relevant baseline architectures and modules coming from different backgrounds.

This DERA is the third iteration of an architecture coming from the energy industry and related to early data exchange projects under the umbrella of BRIDGE. The SGAM layering approach (intrinsically linked to the Energy world) and previous DERA modules and roles serve as a basis to build on.

In this exercise, a more vertical-agnostic and pure data exchange approach is introduced. For this, the most relevant sources of information are Gaia-X and IDSA. They both issue their own reference architectures, which are expected to converge in the future (through technical convergence tasks in the Data Space Business Alliance[51]) butare still separated and different in terms of maturity and component naming/functionality.

Therefore, it is not always easy to know whether one is referring to the same thing or something totally different when it comes to data sharing modules.

Figure 6 tries to map and group all these names and functionalities considered as equal (or at least covering the same functionality) with respect to DERA 3.0, Gaia-X and IDSA.

For the sake of completeness, Table 1 later summarises the links to Gaia-X, IDSA, DESAP, OpenDEI and previous DERA versions with respect to all listed DERA 3.0 modules. Those DERA 3.0 modules noted with **(C)** are those expected to be provided as part of the data space connector functionality.

[51] Data Space Business Alliance, Technical convergence document, [online]. Available: https://internationaldataspaces.org/dsba-releases-technical-convergence-discussion-document/

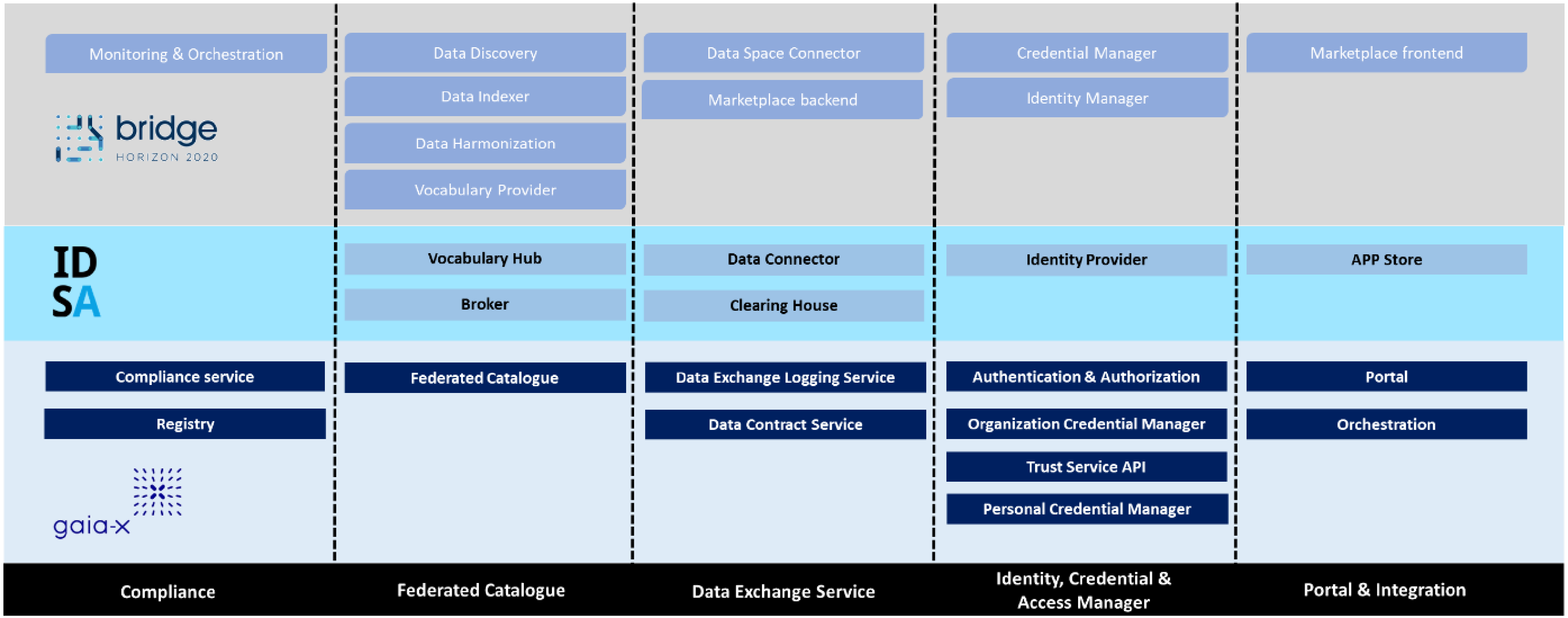


Figure 6. Alignment with Gaia-X and IDSA

Table 1. DERA 3.0 summary table

DERA 3.0	DERA 2.0	DESAP	OpenDEI	Gaia-X	IDSA
Energy Data Sources	Data Exchange Platforms (distributedexchange) Centralised solutions	Non-personal data Security/Resilience	N/A	N/A	N/A
Standard communication protocols and formats	All data formats (PNG/JPEG, XLSX, RDF,CSV, JSON, XML, Apache Parquet…) All communication protocols (AMQP, REST,OPC, ZigBee, SOAP, ModBus, XMPP, MQTT, KNX, TCP, Web-services, FTP, HTTP/HTTPS…)	Security/ResilienceOpen Source and Interoperability	Data Exchange APIs	N/A	N/A
Data Harmonisation (C) **Vocabulary provider**	IEC CIM, ETSI SAREF, NGSI, OpenADR, EEBUS, Private Data Exchange Profiles ...	Open-Source Interoperability	Data Models andformats	Federated Catalogue	Vocabulary Hub
Data Processing	Data cleaning and quality Data collection Data anonymization Personal data handling Metadata management	Non-personal data	Provenance and traceability	N/A	N/A
Data persistence	Data Storage	Security/Resilience Sovereignty	Access & Usage control/policies Data Usage Accounting	N/A	N/A

Credential Manager (C) **Identity Manager**	Data User's authentication Integration of data sources and users Security and privacy	Security/Resilience Open-Source Interoperability	Identity managem ent	Authentication and authorisation Organisation/Personal Credential manager	Identity Provider
Data Indexer (C) **Data Discovery**	Data certification Metadata managementData availability Data Governance	Sovereignty Open-Source Interoperability	Access and usage control / policies Metadata and Discovery protocol	Federated Catalogue	Broker
Monitoring and Orchestration	Data sharing and Bilateral exchanges	Security/Resilience Open-Source Interoperability	Provenance and traceability Data Usage Accounting Operational Continuity model	Compliance service Registry Orchestration	N/A
Marketplace backend	N/A	Security/Resilience Sovereignty Open-Source Interoperability	Access and usage control policies Trusted data exchange Overarching cooperation model	Portal Data Contract Service	APP store Clearing House
Digital Twins AI/ML services	Big Data Big Data tools Analytics	N/A	N/A	N/A	N/A
Marketplace frontend	N/A	Security/Resilience User Acceptance	Publication and Marketplace services	Portal	APP store

Local/Federated usecases and business needs	N/A	N/A	N/A	N/A	N/A
EU/Energy Regulation	Data Governance Act, GDPR, eIDAS, NIS	N/A	N/A	N/A	N/A
Actors	Standards organisations, European Commission, Gaia-X, IDSA, Roles in Network codes, BRIDGE proposal, HEMRM	N/A	N/A	N/A	N/A

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