Project deliverable D2.1

Requirements analysis of the technical infrastructure

Co-funded by
the European Union

Document information

Summary					
Grant Agreement	101123520	**Project short name**	deployEMDS		
Deliverable no.	D2.1	**Deliverable name**	Requirements analysis of the technical infrastructure		
Status	Final	**Due**	M5 – M6	**Date**	19/04/2024
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Dissemination level	PU – Public				
Document history	**Version**	**Date**	**Submitted**	**Reviewed**	**Comments**
	V1.0	13/03/2024	IMEC		/
	V2.0	25/03/2024	IMEC	By Implementation site representatives, associated partners	/
	V3.0	19/04/2024	IMEC	By advisory board, EC	/

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Project Executive Summary

The establishment of a common European mobility data space (EMDS) aims to accelerate the digital and green transformation of the European mobility and transport sector. The deployEMDS project contributes to the further development of the common European mobility data space announced in the European Strategy for Data and the Sustainable and Smart Mobility Strategy. It builds on PrepDSpace4Mobility, a Coordination and Support Action funded under the Digital Europe Programme and is the first deployment action foreseen under the EMDS initiative.

The deployEMDS project advances EU policy priorities by developing a technical infrastructure for an operational data space in the mobility sector. It aligns with the European Data Strategy's goal to facilitate data access, pooling, and sharing. The project supports the European Green Deal's aim to accelerate sustainable and smart mobility, contributing to a reduction in transport emissions. Further, it aligns with the Sustainable and Smart Mobility Strategy, ITS Directive, and MDMS initiative. The diverse consortium of partners implements 16 use cases across nine European cities and regions, aiming to create and deploy an operational data space with a common technical infrastructure. The project aims to make data available in machine-readable format, facilitating innovative services and applications while contributing to the development of a European mobility data sharing ecosystem.

Social Media links:

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For further information please visit **www.deployemds.eu**

Deliverable Executive Summary

This deliverable presents the analysis conducted to define the technical infrastructure requirements necessary for the deployEMDS project. Leveraging frameworks from the Open Data Product Specification (ODPS) and the Data Space Business Alliance (DSBA) Technical Convergence document, a bottom-up approach was adopted to address the diverse requirements of the nine implementation sites. This methodology emphasised a capability-driven design to establish a scalable, secure, and flexible data space, ready to meet the evolving needs of the European mobility sector.

Through an intake and mapping process, the essential technical, functional, and operational capabilities required by the data space to support use cases at various implementation sites were identified. This included specifying components such as data governance mechanisms, authentication, authorisation, and accounting protocols, along with interoperability standards crucial for the efficient management and exchange of mobility data. Additionally, requirements stemming from best practices and state of the art were added to reach the minimum viable capabilities for the data space. This process did not result in requirements for a specific data space standard, indicating that the methodology and results are implementation-agnostic. This supports a later decision that should be based on a hands-on feasibility study.

Key insights reveal that while most data products offered are open data, over half of the sites require access control and a revenue model, highlighting the need for further refinement in governance and business strategies. This has proven to be a challenge because 40% of the data products are owned by external stakeholders. Additionally, it was found that over 50% of the sites will operate a local data space alongside the deployEMDS data space, marking the first federation of its kind on this scale within the mobility sector. This finding underscores the need for detailed analysis in the subsequent project phase. Additionally, it was noted that 90% of data product offerings contain static or dynamic mobility data, with a major focus on public transport, road infrastructure, and shared mobility data; 9% of data product offerings contain environmental data; and 1% contain mobile phone data. Several implementation sites combine mobility data with environmental data, which highlights the importance of and opportunity for cross-domain interoperability, for example with other sectoral data spaces.

With the deployEMDS project consolidating over 100 data sources across nine regions, it is poised to play a pivotal role in standardising mobility data. This role is yet to be fully defined but potentially guided by sites with a strong standardisation vision. The experience from sites with existing local data spaces and the active involvement of a National Access Point highlight the collaborative potential within the deployEMDS project, which is critical for the future positioning of the EMDS relative to existing local platforms. Local data portals will be crucial in bridging data products to the deployEMDS data space, requiring either ad-hoc integration or the appointment of a deployEMDS data intermediary.

In conclusion, the deliverable presents a bottom-up, use case driven perspective on the technical capabilities of the data space needed for the deployEMDS project. These findings will be used to feed the implementation plans of the local sites and to design an architecture for the successful initial implementation of the common European mobility data space (EMDS).

List of abbreviations and acronyms

Acronym	Meaning
BB	Building Block
DID	Decentralised Identifier
DISP	Data Intermediation Service Provider
DP	Data Product
DPO	Data Product Offering
DRT	Demand-Responsive Transit
DSBA	Data Spaces Business Alliance
DSS	Decision Support System
DSSC	Data Spaces Support Centre
EC	European Commission
EDC	Eclipse Dataspace Connector
eIDAS	Electronic Identification, Authentication and Trust Services
EIT	European Institute for Innovation and Technology
EMDS	common European mobility data space
EU	European Union
FMD	Forfait de mobilité durable (Fr.) Sustainable mobility package (En.)
FTP	File Transfer Protocol
GBFS	General Bikeshare Feed Specification
GPS	Global Positioning System
GTFS	General Transit Feed Specification
HTTP(S)	Hypertext Transfer Protocol (Secure)
IDSA	International Data Spaces Association

ITS	Intelligent Transportation Systems
LBS	Location Based Services
LDES	Linked Data Event Streams
LPT	Local Public Transportation
MaaS	Mobility as a Service
MDS	Mobility Data Standard *or* Mobility Data Space
MMTIS	Multimodal Travel Information System
NAP	National Access Point
NAPCORE	National Access Point Coordination Organisation for Europe
NeTEx	Network Timetable Exchange
ODPS	Open Data Product Specification
OD	Origin-destination
ODT	On-Demand Transport
OSLO	Open Standards for Linking Organisations
PT	Public Transport
PTA	Public Transport Authority
PTO	Public Transport Operator
RAM	Reference Architecture Model
RAP	Regional Access Point
REST	Representational State Transfer
S3	(Amazon) Simple Storage Service
SAEi	Sistema d'Ajuda a l'Explotació i a la Informació (Ca.) Operation and Information Support System (En.)
SFTP	Secure File Transfer Protocol
SULP	Sustainable Urban Logistics Plan

SUMP	Sustainable Urban Mobility Plan
TOD	Transport-on-Demand
VC	Verifiable Credential(s)
WFS	Web Feature Service
WMS	Web Map Service
WP	Work Package

Glossary

Unless noted, these definitions follow those from the DSSC Blueprint v1.0, where applicable. Their full glossary is available here[1].

Term	Meaning
Certification body	As defined in the IDSA Rulebook: A governance body responsible for certifying components and/or entities seeking admission to a data space.
Connector	A technical component that is run by (or on behalf of) a participant and that provides connectivity with similar components run by (or on behalf of) other participants.
Control Plane	The Control Plane consists of components for handling data sharing agreements, and it is responsible to orchestrate the data transfer by delegating it to the right Data Plane. Control Planes could trigger business states and provide business insights (i.e., transaction logs).
Data Asset	Data sources that are implemented in a data product offering become a data asset with the data space.
Data Consumer	Participant engaged in data sharing in the International Data Spaces requesting and using data provided by a Data Provider. The very same concept has different naming between the DSSC Blueprint v1.0 (*Data Recipient*) and the Open Data Product model (*Data Consumer*).
Data Intermediary	A data intermediary supports and promotes voluntary data sharing practices between undertakings or facilitates data sharing in the context of obligations set by European Union or national law. They could become a tool to facilitate the exchange of substantial amounts of relevant data. Data intermediation services providers, which may include public sector bodies, that offer services that connect the different actors have the potential to contribute to the efficient pooling of data as well as to the facilitation of bilateral data sharing.
Data Intermediation Service Provider	The EU promotes, through the DGA a new class of market players with neutral, specifically imposed business models, namely the data intermediation service providers (DISPs). DISPs are services aimed at "e*stablishing a commercial relationship for the purpose of data sharing between an undetermined number of data subjects and data holders on the one hand and data users on the other through technical, legal or other means including for the purpose of exercising the rights of data subjects in relation to personal data*" [DGA[2] 5 Article 2 (11)]

[1] Introduction - Blueprint v1.0 - Data Spaces Support Centre (dssc.eu)
[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022R0868

Data Plane	A data space connector should implement both a "Control Plane" and a "Data Plane". The Data Plane performs the actual transfer of data from the data provider to the data consumer. Different Data Planes support different data transfer or communication protocols, such as HTTPS, S3 file transfer, REST, or messaging queues.
Data Product	Data Products are defined in the DSSC Blueprint v1.0 as follows: "*Data products bundle a set of resources (e.g., data sets and data services) into a consumable form to provide meaningful business value in data space use cases. Data products comply with a data product specification and are part of one or more data product offerings.*" The idea behind data products is to engage data space participants in developing the productification of data resources and creating data product offerings and their governance rules. Besides transactions of data products, non-productised data can also be operated in a data space.
Data Product Offering	The data product offering defines how the data source is published. More specifically, it defines the way the data is consumed, the non-functional restrictions (e.g. a download limit, access restrictions), the component that exposes the offering (i.e., the interface), and the effective mechanism to implement the data sharing. The data space connector implements the data offering.
Data Product Owner	A legal person, public body, international organisation, or a natural person (who could not be a data subject with respect to the specific data in question) which, in accordance with applicable law, has the right to grant access to or to share certain data.
Data Project	See *Final Product*.
Data Provider	Participant exposing Data Sources via a Connector; a Data Provider may be an enterprise or other organisation, a data marketplace, an individual, or a "smart thing".
Data Recipient	See *Data Consumer*.
Data Space Authority	The Data Space (Governance) Authority develops and maintains the governance framework, where the rules to be part of the data space are defined, together with the accepted Trust Anchors for the related attestations.
Data Source	Data sources provide data and metadata in its final form, but they are not yet integrated in the governance of the data space.
Decentralised Identifier	A Decentralised Identifier[3] (DID) is a globally unique identifier that identifies an entity in a verifiable manner. A DID does not require a centralised registry to be located. In its simplest form, it is an URL that points to a data document (i.e., the

[3] https://en.wikipedia.org/wiki/Decentralized_identifier

	DID Document). The latter describes the entity in a semantically interoperable format, and provides mechanisms to verify its credentials, like cryptographic keys.
Final Product	A *Final Product*[4] offers value for the end users of the data space use cases, for example, business apps that the data space participant compiles using one or more data products. The customers of the data projects do not need to be participants in the data space. The name *Data Project* has been extensively used during the intake analysis to align with the deployEMDS project charter, and it is mentioned for historical reasons.
ID Descriptor	The same concept of a *Self-Descriptor* but applied to a legal or natural person.
Identity Provider	Entity offering services to create, maintain, manage, and validate identity information of and for Participants in the International Data Spaces.
Metadata Broker	The combination of global Catalogue Services and lineage updates. The Metadata Broker supports global searching of data services and data service offerings based on discovery/crawling and indexing functions they implement. The Broker resolves linking to external metadata resources.
Participant	Stakeholder in the International Data Spaces, assuming one or more of the predefined roles; every Participant is given a unique identity by the Identity Provider.
Self-Descriptor	The combination of characteristics of Data Product, Service or Resource and credentials that determine its trustworthiness.
Simpl	Open source, smart and secure middleware platform that supports data access and interoperability among European data spaces[5]. Supported by the European Commission and currently in early development.
Trust Anchor	Trust Anchors, which can be either the direct controller of the Trusted Data Source or a Notary, are entities that have been approved by a recognised authority like Gaia-X. Although Ecosystems can choose their own Trust Anchors, the only cross-ecosystem trust is, now, provided by Gaia-X. The Gaia-X Registry stores the list of approved Trust Anchors.
Verifiable Credential	A Verifiable Credential (VC) is a bundle of claims and cryptographic material bound to services or Data Products. The claims are presented in a standard format and impose standardised rules on how parties can derive trust in claims of that bundle.

[4] DSSC 1.0 Blueprint definition https://dssc.eu/space/BVE/357074277/Data+Product+Development#Data-products-are-distinct-from-the-final-products-used-by-non-data-space-participants
[5] Simpl: Cloud-to-edge federations empowering EU data spaces**:** https://digital-strategy.ec.europa.eu/en/policies/simpl

Vocabulary Hub	The central repository for vocabularies and assets that semantically define a Data Service or Data Product. The Vocabulary Hub here proposed builds a graph of resources to enable semantic equivalence and localisation (language equivalence).

1 Purpose of the deliverable

1.1 Attainment of the objectives and further development

The following objectives related to this deliverable have all been achieved in full:

- Gather and analyse requirements from the use cases and overall smart and sustainable mobility policy perspective (e.g., stemming from local sustainable urban mobility plans (SUMPs)).
- Based on use cases in local implementation projects, derive a technical use case specification ("use case canvas").
- Identify different stakeholders and roles (e.g., data owners, providers, consumers, users) and respective information needs and processes.
- Derive functional and non-functional requirements (scalability, availability, reliability, usability, etc.) for the specification of the data space technical and soft infrastructure, as well as the different building blocks in close alignment with the technical partners from WP4.

The following objectives have yet to be achieved:

- Use the feedback from WP4 implementations to complement/expand technical requirements.
- Use the feedback from WP3 to complement/expand technical requirements.
- Establish a feedback loop from WP4 implementations and operations to evolve data and data space components requirements for engineering.

1.2 Intended audience

This is a public document. For the project consortium, this document outlines the requirements of the local implementation sites on various levels, and the capabilities the deployEMDS should address to meet these requirements. For interested stakeholders outside the consortium, it can give an idea in what direction the first deployment of the EMDS is heading and which role it can possibly play in the mobility ecosystem. The bottom-up approach that was used here to define the data space capabilities might inspire other projects and consortia to play close attention to the participants of the data space right from the start.

1.3 Structure of the deliverable and links with other work packages/deliverables

The goal of the deliverable is to report on the requirements of the local implementation sites, which were obtained through a bottom-up intake process. After an introduction, the methodology is outlined, with a focus on the intake process and the canvas which was designed to this end (sections 3.1 and 3.2), and the analysis that followed the intake process (section 3.3). The results are spread over three subsections: the use case requirements (section 4), the standards and data model requirements (section 5), and the technical requirements (section 6). Each subsection focuses on one specific perspective of the intake canvases, and provides learnings and next steps, to be taken up by the respective work package 2 (WP2; the deployment of an operational data space across borders) workgroups: 'use case workgroup', 'mobility data standards workgroup', and 'data space building blocks workgroup'. The 'use case workgroup' will make sure that the results of this deliverable flow back to work package 4 (WP4; the real-life implementation projects), while the 'data space building blocks workgroup' and the 'mobility data standards workgroup' will make sure that the results flow back to WP2. In WP4, the insights, takeaways, and defined capabilities of this deliverable, will

not only feed the local sites' implementation plans (deliverables D4.2 – D4.10), but can also be used to define workshops, cluster implementation sites (Milestone 24) and outline transversal use cases (Milestone 26). In WP2, the data space capabilities defined in this report will first and foremost form the baseline for the technical specifications report (D2.3) where specific data space building blocks and technologies will be outlined. Therefore, in the next phase of the project, the performance of different technologies will be compared by the 'data space building blocks workgroup'. A building block or capability that might need specific expertise of actors both within and outside of the project consortium is standardisation, as this is not only domain dependent, but also highly contingent on local, national and European regulations and practices. This role will be taken up by the 'mobility data standards workgroup'. In summary, the WP2 workgroups will make sure that the results of this deliverable are put to practice in the relevant work packages and tasks, and that they feed into the right deliverables and milestones.

2 Introduction

In an era marked by swift technological progress and changing societal demands, the concept of mobility extends well beyond mere transportation. It embodies a comprehensive understanding of movement that integrates a variety of transport modes, urban development strategies, environmental sustainability considerations, and individual preferences. The significance of mobility in moulding our communities and economic landscapes is widely acknowledged. Consequently, a pioneering initiative has been launched by the European Commission (EC) to develop a common European mobility data space (EMDS).[6]

As we advance towards the realisation of a more interconnected, sustainable, and resilient mobility ecosystem, the EMDS stands out as a symbol of collaborative innovation in data sharing. By embracing principles of data sovereignty, interoperability, and trust, the EMDS is poised to open new avenues in mobility data management. The EMDS is envisioned as a pioneering enabler that will facilitate the exchange of mobility data across various stakeholders, including government bodies, private companies, and the public, thereby improving the efficiency of transportation systems, reducing environmental impact, and enhancing the overall quality of life for citizens. By integrating data from diverse sources, such as traffic management systems, public transport networks, and user-generated content, the EMDS aims to offer a holistic view of the mobility landscape. This comprehensive perspective will facilitate better decision-making and encourage innovative solutions to mobility challenges.

Moreover, the initiative underscores the importance of data privacy and security, ensuring that the collection and sharing of data is conducted in accordance with the highest standards. The establishment of the EMDS is a testament to the EU's commitment to leveraging technology for the betterment of society, emphasising the role of data in crafting a future where mobility is not just about moving from one place to another but about doing so in a manner that is efficient, sustainable, and inclusive.

The deployEMDS project is the first step towards this common European mobility data space. This ambitious project is aimed at exploiting the potential of data to radically transform mobility throughout Europe. By establishing a cohesive, interconnected network of mobility-related data, the deployEMDS project aims to empower all stakeholders involved, stimulate innovation, and lay the groundwork for a mobility framework that is both sustainable and inclusive. At the heart of this initiative are the nine local implementation sites, where data-driven use cases will be implemented to tackle a broad spectrum of pressing issues, such as traffic congestion, environmental pollution, challenges in accessibility, and the sprawling growth of urban areas.

This deliverable is an exploration into the requirements necessary for the deployEMDS project, as an initial stage for the establishment of the EMDS, providing detailed insights into the use cases of the participating implementation sites. An exhaustive analysis of the technical and use case requirements of each local implementation site is conducted with the objective of illuminating the desired capabilities of the deployEMDS project which will contribute to the further development of the broader EMDS. Additionally, the document identifies both the prospects and the hurdles associated with the deployment of an operational data space across borders, offering practical guidance to stakeholders for effectively manoeuvring through this dynamic terrain.

[6] Communication on the creation of a common European mobility data space (COM/2023/751): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A751%3AFIN

3 Methodology

3.1 Canvas design

To collect input from the local implementation sites on their requirements for deployEMDS, a canvas was developed for each local consortium to fill in. The DSSC blueprint[7] lends the concepts and terminology used in the canvas, while the intake questions are organised following the model provided by the Open Data Product Specification[8].

The canvas was designed to:

1. Identify the most relevant patterns of technology, data sharing protocols and their related access control mechanisms.
2. Define a set of bottom-up or use case driven business and technical requirements for the deployEMDS project.
3. Survey the expectations of data space participants about the use cases they want to implement.
4. Assemble these current practices, requirements, and expectations to provide a selection of data space capabilities that implement the most sustainable and fit-for-purpose data space architecture.

Four core concepts are at the foundation of the canvas (Figure 1):

- ***Data source***
  Data sources provide data and source metadata that is not yet integrated in the governance of the data space.
- ***Data product***
  A data product is a standardised data unit that packages relevant data resources and improves the utility of data by providing metadata, related policies, and support elements in the same package.
- ***Data product offering (DPO)***
  A data product offering defines how the data product is offered to the data space. The data space connector implements the data offering, and handles usage control, formats, data assets publication, data asset catalogue etc.
- ***Data project***
  Data projects offer value for the end users of the data space use cases, i.e., business apps, training models etc.

[7] https://dssc.eu/space/BVE/357073006/Data+Spaces+Blueprint+v1.0
[8] https://open-data-product-initiative.github.io/open-data-product-spec-2.1/#open-data-product-specification-2-1

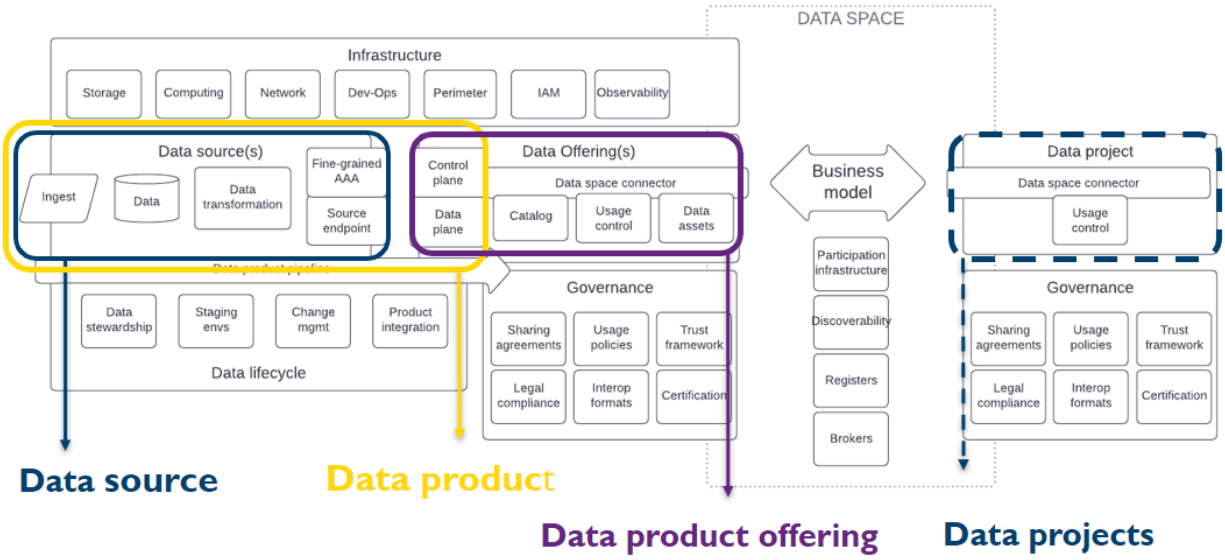


Figure 1 - Canvas core concepts outlined on the Open Data Product Specification model

In a first stage, a comprehensive reference canvas was designed, including questions in seven categories:

- ***Infrastructure***
  The underlying technical stacks that host data sources and data space components of a participant.
- ***Data sources and data transformations***
  The data source becomes the asset that is published in a data space.
- ***Data product offerings***
  The data space connector implements the data product offering.
- ***Governance***
  We distinguish between the micro-governance of the data offering (i.e., the data management and quality parts) and the macro-governance, that is, the compliance with shared/domain governance frameworks, or data-related laws.
- ***Business Models and Stakeholders***
  The business model defines how the data product is consumed, paid for and what value it delivers to the data projects. It defines the value of data products for the customers and if external resources are needed.
- ***Lifecycle***
  The lifecycle of a data product defines the long-term implementation and the mechanisms that are needed for change management. Data product development testing and integration fall in this category.
- ***Data space federation***
  A data space federation is a collaborative network where diverse data spaces, typically owned and managed by different organisations, are interconnected to enable secure and efficient data sharing and interoperability. This section is particularly relevant for participants that manage an existing data space with an indigenous governance.

The reference canvas was reviewed by WP2 partners in December 2023, and in a next phase a derivative of the reference canvas was made – the intake canvas – to start the intake process. The intake canvas is less extensive than the reference canvas and contains a subset of questions that are relevant or pertinent in this stage of the project in four remaining categories: data product offering, governance, business model and

data space federation. Additionally, the questions were rephrased to make them as intuitive and as clear as possible, and customised example answers were added for each implementation site.

The canvas design resulted in an intake canvas with 25 questions in the categories of data product offering, governance, business model and data space federation, which is added to Annex 1.

3.2 Intake process

For each implementation site two canvas sessions were organised between January 11 and February 16, 2024:

- ***The canvas go-through session***
  In this session the core principles and content of the canvas was explained to the local consortium in detail. The questions of the canvas were discussed one by one, in order to give the local consortium the opportunity to ask questions to the interviewers. Additionally, the process was outlined and deadlines were set.
- ***The canvas follow-up session***
  This session took place one or two weeks after the go-through session to discuss the input of the local consortium in the canvas. Once again, the questions were discussed one by one, but this time the focus lay on the answers of the local consortium, giving the interviewers the opportunity to ask questions. During this session, the deadline was set for final changes.

The local consortium was instructed to identify all the data products that they want to offer to the deployEMDS data space, and subsequently to fill in the canvas for each of these data product offerings or DPOs. The local consortium could choose their own strategy to distinguish between different DPOs, but if the following aspects significantly differed, they were advised to create separate DPOs:

- ***The scope of the data product***
  e.g., air quality data versus real-time bus positions for travellers
- ***The governance of the data product***
  e.g., open data versus access control required
- ***The transferring protocol***
  e.g., API versus SFTP
- ***The consumption pattern***
  e.g., real-time bus positions accessed every 20 seconds versus static infrastructure accessed once every week.

The intake process resulted in 43 canvases, filled in by the implementation sites, for the 43 DPOs they identified in their use cases.

3.3 Canvas analysis

This section presents the practical approach that was taken to identify the necessary requirements and components for the EMDS in the context of the project, based on the data product offerings that were proposed by the implementation sites to be published within it. By utilising the intake canvas described in section 3.1, the different stakeholders were offered a structured method to articulate their data sharing intentions. This approach, which enabled them to provide detailed descriptions of the data products they plan to offer on the deployEMDS data space, is designed to be straightforward and to not presuppose any specific architecture or framework of the data space. Therefore, it ensures that the outcomes are sufficiently flexible to adapt to changing contexts and novel use cases that may emerge during or after the deployEMDS project timeline.

For the analysis of the canvases, three different perspectives were used: the use case perspective, the data model perspective, and the components perspective, each resulting in different requirements.

For the first two perspectives, an abstraction of the canvases was made, which can be found in Annex 2 and Annex 3. Annex 2 presents an overview of the different data sources that are included in the DPOs, while Annex 3 presents an overview of the DPOs. The results of the analysis of these two overview tables can be found in sections 4 and 5.

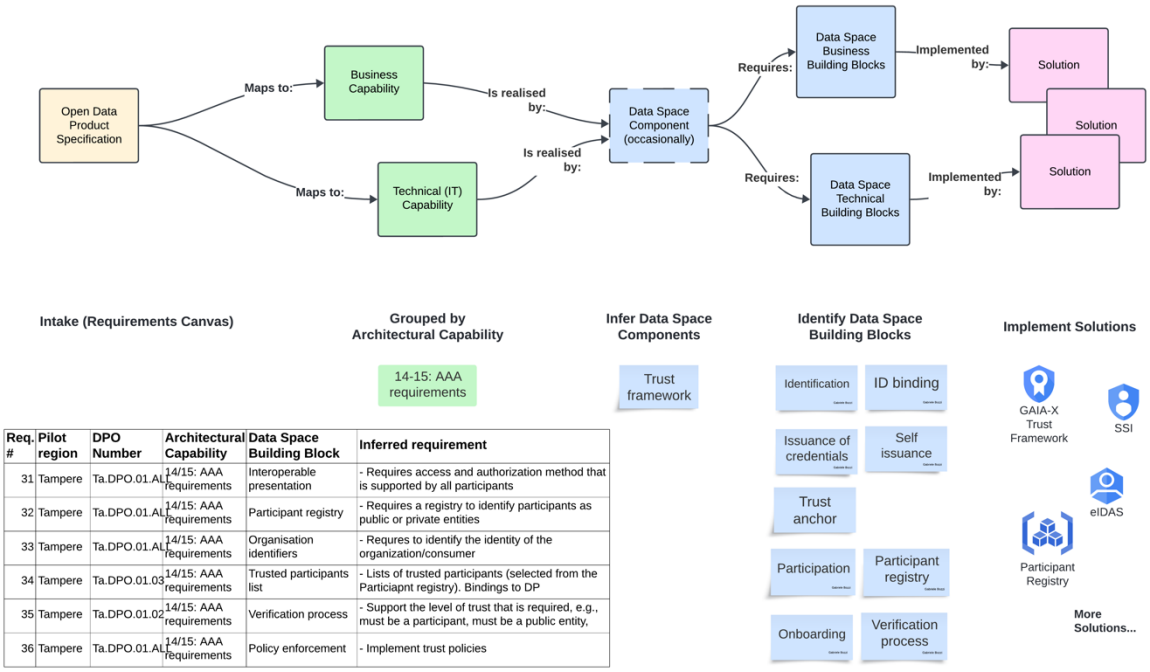
For the component's perspective, the technical requirements were evaluated to identify the minimal, viable set of data space building blocks that realise a functional and efficient data space. To sanity-check requirements with the state of the art of data spaces, we assessed each requirement's feasibility against a group of selected data spaces initiatives and frameworks (see Table 2). Both coverage data and feasibility assessments might be useful in the later implementation stage to prioritise components that deliver more shared value. The approach for the technical requirements (section 6) is outlined in the next subsections.

3.3.1 From technical capabilities to data space building blocks

We have strategically chosen to map the canvas questions to technical capabilities, aligning them as closely as possible to the building blocks (BBs) defined in the DSSC 1.0 blueprint. This approach of using a common language facilitates comprehension and enhances alignment. While we may deviate from the DSSC in how these capabilities are clustered and their interrelationships drawn, we have strong justifications for maintaining the organisation of the capabilities as it is:

- Some use cases demand that existing/legacy data-sharing ecosystems have a role in the participation and governance of the deployEMDS data space. By assuming a "pure-player" approach to data spaces, the DSSC building blocks do not fully support cross-cutting requirements, forcing us to add capabilities and split the clusters to preserve domain encapsulation, such as the Trust and Sovereignty clusters.
- The other way around: the intake has produced insufficient requirements for clusters of capabilities like Value-Added Services. The result is that some capabilities have been repositioned in different clusters from those where the corresponding DSSC building blocks are.
- Last, but not least: the canvas sessions have catalysed a data product offering maturation process that is now assumed across the projects, underscoring the value of our approach.

The schema below guides the mapping process, illustrating how each stage maps or produces specific artifacts. It provides a tangible representation of our approach, aiding in understanding the mapping process.



Req. #	Pilot region	DPO Number	Architectural Capability	Data Space Building Block	Inferred requirement
31	Tampere	Ta.DPO.01.AL	14/15: AAA requirements	Interoperable presentation	- Requires access and authorization method that is supported by all participants
32	Tampere	Ta.DPO.01.AL	14/15: AAA requirements	Participant registry	- Requires a registry to identify participants as public or private entities
33	Tampere	Ta.DPO.01.AL	14/15: AAA requirements	Organisation identifiers	- Requres to identify the identity of the organization/consumer
34	Tampere	Ta.DPO.01.03	14/15: AAA requirements	Trusted participants list	- Lists of trusted participants (selected from the Particiapnt registry). Bindings to DP
35	Tampere	Ta.DPO.01.02	14/15: AAA requirements	Verification process	- Support the level of trust that is required, e.g., must be a participant, must be a public entity,
36	Tampere	Ta.DPO.01.AL	14/15: AAA requirements	Policy enforcement	- Implement trust policies

Figure 2 - The components' mapping process and its artifacts

As the data space building blocks in DSSC 1.0 relate primarily to data space capabilities, the mapping process will produce requirements with no gaps.

Adopting a capability-driven design[9] approach in the implementation phase is possible with the requirements organised this way. The reason for this choice was to maximise the opportunity to prioritise the capabilities that put the deployEMDS data space off to a quick start.

A detailed list of technical capabilities is available in Table 1, where we indicate if the capability is equivalent to a DSSC building block. In Table 2 we list the selected data space initiatives that were used to assess the feasibility of the required capabilities.

Table 1 - List of technical capabilities

Cluster	Building-Block / Capability	Synopsis
Trust	ID binding	The relationship that a participant in a data space must be an entity, or a group of entities, in the real world. Bindings are linked with exclusive (self-)identifiers.

[9] https://www.researchgate.net/publication/272357275_Capability_Driven_Development_An_Approach_to_Designing_Digital_Enterprises

	Identification, authorisation (DSSC 1.0)	The capacity to distinctly identify participants and verify their claims to provide a service or grant access to a data product.
	Trust anchor (DSSC 1.0)	The authoritative entity for which trust is assumed and not derived. In practice, the Trust Anchor is represented by a public key and associated data. The public key is used to verify digital signatures, and the associated data is used to constrain the types of information or actions for which the trust anchor is authoritative.
	Onboarding and participation (This capability regroups DSSC 1.0's governance building blocks and Data Space Registry in Trust)	The capability that creates a participation relationship with a data space, and that screens participants' eligibility to data space's business or governance criteria.
	Authorisation and Credentials Interoperable Presentation (The capability regroups several DSSC 1.0 building blocks)	The capacity to issue and verify credentials to data space participants. The capacity to expose a credentials' amount of information that is just needed, by using an interoperable format that every participant can verify.
Data sovereignty	Jurisdiction	Capabilities (or building blocks) that satisfy the

	(Capabilities that support Cross Cutting Legal Frameworks, as defined in DSSC 1.0)	requirements derived from the extension of a local legal authority, or an overarching institution bound to a domain of activity.
	Data residency	Local or data space requirements that define rules on data storage, encryption, transmission, and cross-border transaction.
	Access and Usage Policies enforcement (DSSC 1.0)	The definition, negotiation, and enforcement of a usage contract of a data product. Control can rely on legal means (i.e., binding documents) or technical (i.e, an attestation engine capable of contract interpretation)
	Federated algorithms	Federated algorithms preserve sovereignty by triggering partial computation in the same governance realm of a data product; they federate non-confidential outcomes in a central processing entity.
Data services	Data and data services offering (DSSC 1.0)	Data space mechanisms to describe and publish a data product, associate a usage contract.
	Publication and discovery (DSSC 1.0)	Mechanisms to publish, announce and discover data products and services in a data space.

	Data Interoperability: semantic framework and semantic equivalence (DSSC 1.0)	As part of a wider data interoperability topic, the capability implements semantic description and mechanisms to correlate concepts and shapes of data products having diverse formats and languages.
	Business observability / audit	Data offering and product transaction tracing and services to perform counting, rating and clearing.
	Provenance and traceability (DSSC 1.0)	As data and data products evolve over time, how do we keep up with change? How has a data product been built? From whose data? Under which conditions?
	Supported data models and formats (DSSC 1.0)	Common data models deal with the shape and syntactic understanding of data; they provide a consistent interface that exchanges information via shared vocabularies.
	Metadata and vocabulary services (Regroups several DSSC 1.0 building blocks)	The association of metadata to a data product provides the ability to extract unambiguous interpretation of data across different formats.
Value Added Services	(Environment-agnostic) deployable components	Services and middleware that uses a technology stack compatible with most actual execution

		environments, public clouds, in-house infrastructure, operating systems, and deployment orchestrators.
	Flexible data planes (DSSC 1.0, Data Plane definition)	Data plane that executes the data exchange under a certain protocol or implements the methods of a non-trivial interface.
	Autonomous data services	The capacity to automatically publish a data product from its data sources. Also refers to the adaptive interface that producer and consumer can use to exchange data with no configuration involved.
	Marketplace (DSSC 1.0)	A service where participants can create and exchange value from their data products. The marketplace facilitates the value exchange by providing services like rating, billing, invoicing, etc.
	Marketplace-oriented data sharing negotiation (DSSC 1.0)	Formats and services that standardise business transactions for the exchange of data services and data products.
	Billing and payments (DSSC 1.0)	Enablement of billing from rating services and payment providers and clearing houses.

	Data intermediaries (DSSC 1.0)	The DGA definition of intermediaries is: “Neutral third parties that connect individuals and companies with data users. While they may charge for facilitating the data sharing between the parties, they cannot directly use the data that they intermediate for financial profit.”

Table 2 - Data space frameworks, standards and initiatives that served as references to assess the feasibility of the technical requirements

Initiative / Framework	Synopsis
IDS RAM[10]	The International Data Space (IDS) initiative defines a high-level reference architecture (the RAM) that describes a model for secure and trusted data exchanges in a data space. The IDS RAM describes the end-to-end stack that constitutes a data spaces, organised in layers: Business layer, Functional, Information, Process and System Layers.
Data Space Protocol 2024-1[11]	IDS also provides a set of specifications that enable interoperable data sharing and usage control governance that rely on open Web standards. The specifications define schemas and protocols to publish data, negotiate data sharing agreements, and access data as part of an IDS data space.
IDSA Rule Book[12]	The IDSA Rule Book is an aid to the development and operation of data spaces. It describes which rules are mandatory and which are optional guidelines on functional, technical, operational, and legal dimensions. In this analysis the impact of the Rule Book is quite limited, it primarily serves as a repository of definitions and a metric to ascertain the extent to which trust-related requirements encompass the obligatory provisions stipulated within the it.
Eclipse Dataspace Components (EDC)[13]	The EDC project provides a flexible, adaptable, data space connector that implements the IDS protocol as its primary standard.

[10] https://docs.internationaldataspaces.org/ids-knowledgebase
[11] https://docs.internationaldataspaces.org/ids-knowledgebase/v/dataspace-protocol
[12] https://github.com/International-Data-Spaces-Association/IDSA-Rulebook/tree/main
[13] https://github.com/eclipse-edc

	The connector has a modular architecture with a control plane (data sharing negotiation and usage control) and a data plane (data transfers on multiple protocols). At the time of writing this document, the EDC team is adding compatibility with Verifiable Credentials, integration with GAIA-X compliance and the ability to federate the data catalogues of each connector in a data space.
Fiware[14]	Fiware is a European initiative to build data sharing components for industry and services domains. Fiware has just launched the second iteration of the Fiware Connector[15], that closely abides to the Data Space Business Alliance technical convergence[16]. Fiware also provides domain specialised data models[17], and it implement ready-to-use services to support a data ecosystem, like an identity provider, a specialised time-organised data server (called the Context Broker), and catalogue and marketplace services.
iSHARE[18]	iSHARE is a collaborative effort to facilitate data-sharing for organisations aiming to collaborate in a data space. The functional scope of the iSHARE Trust Framework focuses on identification, authentication, and authorisation. iSHARE and Fiware have recently presented a joint architecture for data spaces[19].
GAIA-X[20]	GAIA-X provides common governance and the basic level of interoperability across individual ecosystems at service level. GAIA-X can co-exist with Fiware or IDS, as it uniquely provides EU-wide verification of trust and participants compliance.
European Digital Identity[21]	Through the eIDAS Regulation, the European Digital Identity initiative improves certainty on the legal validity of electronic identity and trust services for business and citizens alike.

[14] https://www.fiware.org
[15] https://github.com/FIWARE/data-space-connector
[16] https://data-spaces-business-alliance.eu/wp-content/uploads/dlm_uploads/Data-Spaces-Business-Alliance-Technical-Convergence-V2.pdf
[17] https://www.fiware.org/smart-data-models
[18] https://dev.ishare.eu/index.html
[19] https://github.com/i4Trust/building-blocks
[20] https://gaia-x.eu/gaia-x-framework
[21] https://digital-strategy.ec.europa.eu/en/policies/eidas-regulation

3.3.3 Mappings and requirements inference

To infer requirements based on the questions that were posed in the intake canvases, a set of mappings was developed that match each of the 25 canvas questions to one or more of the capabilities outlined in section 3.3.1. The intake canvas questions were meticulously mapped to these capabilities and consequently to technical requirements for the data space that will be deployed in this project (see section 6) via a four-step process outlined below:

1. ***Initial mapping***
   An initial mapping of intake canvas questions to all capabilities mentioned in Table 1 was performed. The outcome of this mapping is shown in Annex 4 until Annex 7, displaying the mappings towards capabilities in the trust framework, data sovereignty, data transactions and lifecycle, and product-enabling capabilities, respectively. These diagrams show questions in green boxes, capabilities in blue boxes and the corresponding links between questions and capabilities indicate potential requirements that can be inferred from the content of the intake question. Arrows in red show potential links that cannot be inferred from the intake canvas directly, and which might require a second iteration of requirements gathering once the pilot sites are further along with their implementation plans and have more insight in their technical infrastructure.

2. ***Refined mapping***
   In a second phase, the mappings were further improved and refined to tailor them to the intake canvases. Mappings that cannot be inferred from the intake canvas (red arrows) were omitted in this phase. In order to make the preceding mapping diagrams easier to grasp for the reader, an interactive diagram was prepared. It has all the canvas questions (Q1-Q25) in the middle (green boxes), with the capabilities on either side (blue boxes). In this interactive diagram[22], each question can be highlighted individually to see only those arrows showing what deductions can be made based on the answers to a single DPO question. Two examples are given in Annex 8 and Annex 9, showing the potential requirements that can be inferred for capabilities from question 17 on the business model of a DPO, and those that can be inferred from questions 14 and 15 on the authentication, authorisation, and accounting requirements, respectively.

3. ***Initial requirements analysis***
   After the mappings were completed, an Excel worksheet was prepared to form an overview of all the requirements that are inferred by the different data product offerings. While the capabilities describe what the data space can provide, highlighting its functions and features, the requirements detail what it must do, specifying the necessary functionalities and performance criteria it needs to fulfil. Requirements guide the development process to achieve the desired capabilities, serving as a blueprint for what needs to be built and how it should perform. The worksheet where these requirements were gathered contained the following information per requirement, in separate columns to support easy filtering and analysis. Each row in this worksheet therefore represents a distinct requirement derived from specific questions or identified needs within certain capabilities or processes. This structure facilitates the systematic identification, categorisation, and management of requirements across different pilot regions and components of the data space. Figure 3 shows this worksheet in action.

[22] Due to the constraints of a printed format, which prevent the demonstration of the interactive diagram, the mappings are accessible through Excalidraw at the following URL: https://link.excalidraw.com/l/3LTvDsL35LL/2hBDChKe0p9

a. *Req. Number*
   A unique identifier assigned to each requirement for easy tracking and referencing.
b. *Pilot region*
   The specific geographic or organisational area (implementation site) where the requirement has been identified, indicated the context or particular needs of different areas.
c. *DPO number*
   Short for "Data Product Offering number," this identifier references a specific offering that the requirement pertains to. It serves to categorise and organise requirements within specific data product offerings.
d. *Question number*
   A reference to a particular question from the intake survey that led to the identification of the requirement. This column links the requirement back to specific questions.
e. *Capability identifier*
   Identifies the functional area, system component, or capability related to the requirement. This helps in understanding which part of the system or process the requirement aims to address.
f. *Inferred requirement*
   Contains the detailed description of the requirement as deduced from responses or observations related to the *Question number*. This column includes the actual statements of requirement, specifying actions, considerations, or improvements needed in relation to the common European mobility data space.

The initial analysis yielded a total of 450 inferred requirements from *federation with existing local data spaces* to *product-granular access control*. On average, each implementation site contributed roughly thirty requirements.

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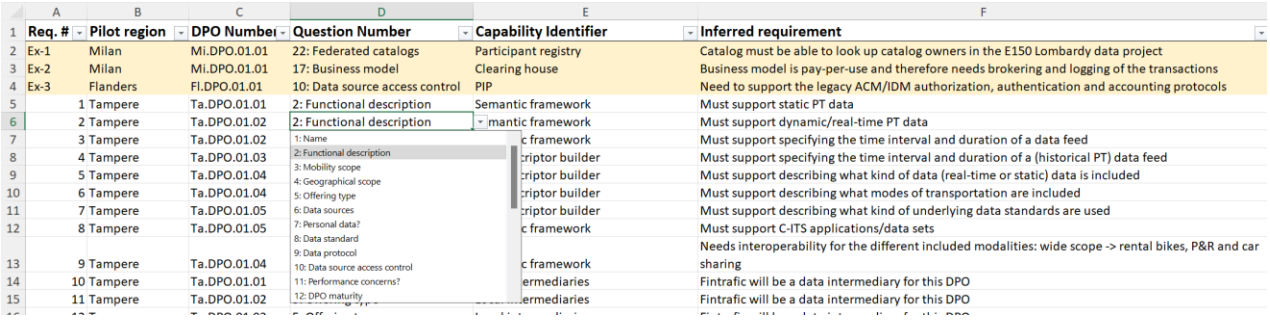
4. ***Refined requirements analysis***
   Finally, to further refine the process, several internal workshops were organised. The primary objective of these sessions was to consolidate the gathered list of requirements into a format that is both comprehensible and practical for implementation. This effort ensured that the requirements were not only systematically categorised but also summarised for easy understanding, actionability and conversion into user stories and for re-use in the data space architecture deliverables that will follow later in the project. The result of this process is detailed in section 6.



Req. #	Pilot region	DPO Number	Question Number	Capability Identifier	Inferred requirement
Ex-1	Milan	Mi.DPO.01.01	22: Federated catalogs	Participant registry	Catalog must be able to look up catalog owners in the E150 Lombardy data project
Ex-2	Milan	Mi.DPO.01.01	17: Business model	Clearing house	Business model is pay-per-use and therefore needs brokering and logging of the transactions
Ex-3	Flanders	Fl.DPO.01.01	10: Data source access control	PIP	Need to support the legacy ACM/IDM authorization, authentication and accounting protocols
1	Tampere	Ta.DPO.01.01	2: Functional description	Semantic framework	Must support static PT data
2	Tampere	Ta.DPO.01.02	2: Functional description	mantic framework	Must support dynamic/real-time PT data
3	Tampere	Ta.DPO.01.02	1: Name	c framework	Must support specifying the time interval and duration of a data feed
4	Tampere	Ta.DPO.01.03	2: Functional description	criptor builder	Must support specifying the time interval and duration of a (historical PT) data feed
5	Tampere	Ta.DPO.01.04	3: Mobility scope	criptor builder	Must support describing what kind of data (real-time or static) data is included
6	Tampere	Ta.DPO.01.04	4: Geographical scope	criptor builder	Must support describing what modes of transportation are included
7	Tampere	Ta.DPO.01.05	5: Offering type	criptor builder	Must support describing what kind of underlying data standards are used
8	Tampere	Ta.DPO.01.05	6: Data sources	c framework	Must support C-ITS applications/data sets
9	Tampere	Ta.DPO.01.04	7: Personal data?	c framework	Needs interoperability for the different included modalities: wide scope -> rental bikes, P&R and car sharing
10	Tampere	Ta.DPO.01.01	8: Data standard	ermediaries	Fintrafic will be a data intermediary for this DPO
11	Tampere	Ta.DPO.01.02	9: Data protocol	ermediaries	Fintrafic will be a data intermediary for this DPO
			10: Data source access control		
			11: Performance concerns?		
			12: DPO maturity		

Figure 3 - View of the initial requirements analysis worksheet.

4 Use case requirements

In this section, the results of the use case-oriented analysis of the canvases are presented to illustrate the diverse landscape of mobility use cases. The goal of this analysis is to give insight into the goals, value propositions and stakeholders of the different use cases. This will not only foster cross-border collaboration between consortium partners but will also highlight common requirements that are related to the scope of the use cases. This section is presented in a sequential format, starting with a comprehensive summary of the use cases for each implementation site. Accompanying each case is a delineation of its data product offerings, to set the scene for further analysis. Second, a global view of the business requirements inferred by these use cases is presented and to conclude this section, takeaways are listed.

4.1 Use cases

In this section, a high-level overview of the local implementation sites, their use cases and respective DPOs is presented. The goal is to give a high-level impression of the use cases, to set the scene for the requirements. More details on the local implementation are out of scope for this deliverable, but can be found in the local implementation plans (deliverables D4.2 – D4.10). For each local use case, section below presents its title, description, involved actors and stakeholders, a context diagram detailing how the different stakeholders interact with the deployEMDS data space, and a description of the DPOs involved in the use case.

4.1.1 Barcelona

4.1.1.1 Use case 1

- ***Use case title:*** Evolve regional multi-operator data governance platform for bus fleets to support new transport models such as On-demand Transport (ODT) and Demand-Responsive Transit (DRT), and interconnect operator ecosystem with third-party services.
- ***Use case description:*** The use case establishes a data space to manage diverse bus tracking and monitoring data across public transport operators (PTOs), as well as complimentary data sources and added-value service providers. This data management occurs across a regional, multi-operator Operation and Information Support System (SAEi) provided by the local public transport authority (PTA), designed to improve the digitalisation and operational efficiency of PTOs while maintaining their autonomous fleet management. Primary use case goals include:
    - Better integrate ODT and DRT and its diverse data sources and operator systems to complement fixed route transport.
    - Improve quality monitoring standards for related mobility services and target scalability, standardisation and harmonisation of data governance and technology including data, concepts, and indicators between the different modes of the regional bus system (i.e. fixed routes, ODT and DRT).
    - Provide data usage control for participating PTOs beyond the SAEi platform for third-party services. Of the latter, Nommon is an example of a third-party platform that will participate in the pilot, providing data services and a decision-support tool that also incorporates added-value complimentary data such as Floating Mobility Data (anonymised mobile phone data from mobile network operators).

- ***Use case actors:***

Table 3 - Barcelona Use case 1 – Partners

Partner	Role
i2CAT	Local coordinator, use case leader, implementation partner
ATM	PTA, public stakeholder, data provider (directly and through their operator network)
EIT Urban Mobility	Local public-private stakeholder network
Nommon	Data analytics solution provider and Decision-Support Tool developer

Table 4 - Barcelona Use case 1 – Additional stakeholders

Stakeholders to collaborate	Role
PTOs	Bus operators that use the PTA SAEi platform to help manage their fleet and will benefit from the third-party digital services exploiting PTO and PTA data under their usage policies.
Regional government, municipality, and other public actors	Additional end-users of the digital services and decision-support tools developed in the project. Public sector stakeholders of the targeted use case benefits (i.e. improved bus services and overall regional mobility) and for extensibility and scalability of data space
Additional digital service providers (like Nommon) to explore use case extensibility	Private sector stakeholders that could act as additional data consumers / service providers, to engage for potential extensibility and scalability of the use case.

- ***Context diagram:***

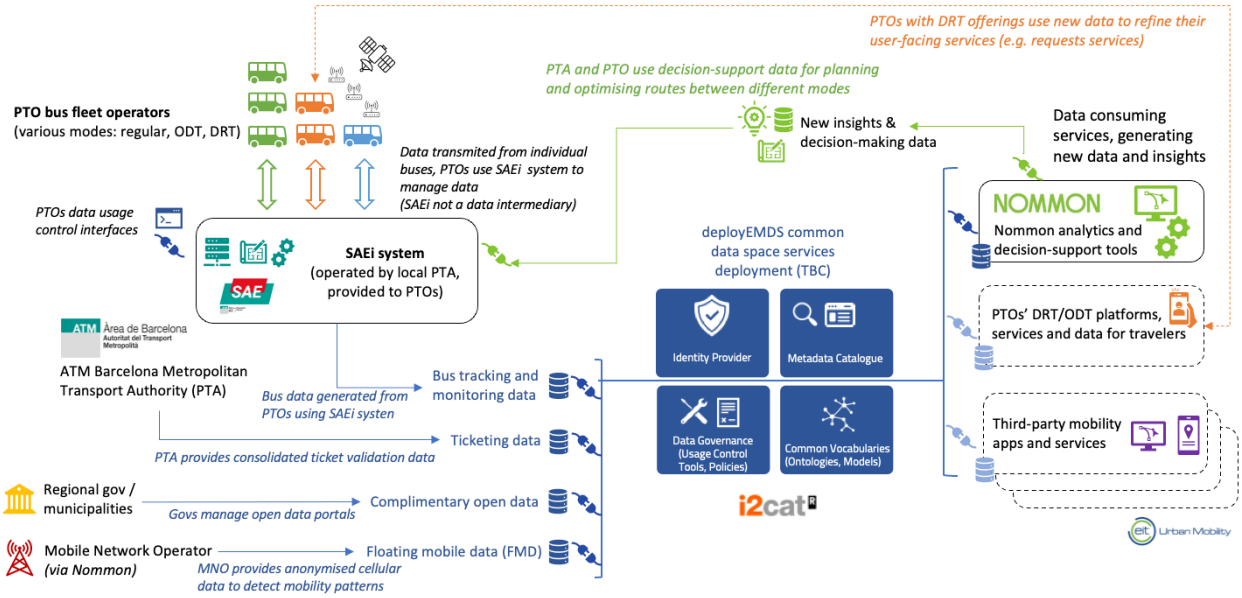


Figure 4 - Barcelona Use case 1 – Context diagram

- ***Data product offerings:***

Table 5 - Barcelona Use case 1 – Data product offerings

DPO Nr.	Name	Description
Ba.DPO.01.01	Bus services available	Routes, stops and timetables of the bus services available, for both fixed routes and on-demand transport (ODT). Complimented by vehicle info data.
Ba.DPO.01.02	Passenger boarding	Passengers boarding per stop measured by ticketing system (validations). This system is connected to the SAEi by a dedicated protocol between the onboard equipment.
Ba.DPO.01.03	Passengers drop off	Passengers dropped off per stop measured by state-of-the-art counting sensors, gathered from the Fleet Management System (SAEi/AVL).
Ba.DPO.01.04	General mobility indicators from mobile network data	Origin-destination (OD) matrices obtained from anonymised mobile phone records.

4.1.1.2 Use case 2

- ***Use case title:*** Forecasting system to optimise traffic, based on vehicle flow and air quality.
- ***Use case description:*** Traffic analysis through different variables.
    - Traffic prediction model
    - Incident detection model
    - Effect of weather on traffic
    - Impact of traffic on air quality
- ***Use case actors:***

Table 6 - Barcelona Use case 2 – Partners

Partner	Role
Eurecat	Traffic use case leader, implementation partner, data solution provider.

Table 7 - Barcelona Use case 2 – Additional stakeholders

Stakeholders to collaborate	Role
Barcelona city council's traffic operations	Data owner
Catalonia regional government	Data owner

- ***Context diagram:***

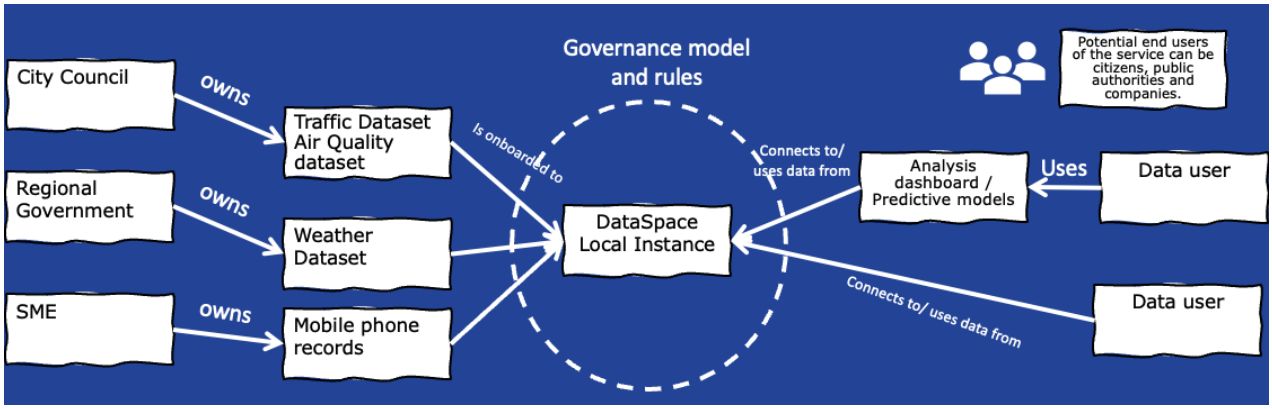


Figure 5 - Barcelona Use case 2 – Context diagram

- ***Data product offerings:***

Table 8 - Barcelona Use case 2 – Data product offerings

DPO Nr.	Name	Description
Ba.DPO.02.01	Traffic data	Traffic information from sensors. This is the number of vehicles detected every 15 min in the position where the sensor is located.
Ba.DPO.02.02	Street characterisation regarding mobility sensors	Data product offering that provides data of the devices that make up the equipment for measuring the street characterisation of the city of Barcelona.
Ba.DPO.02.03	Meteorological data	Statistical resources detail the meteorological stations of Barcelona. Each station shows the information captured by the different sensors.
Ba.DPO.02.04	Air quality data	Air quality data from the measure stations of the city of Barcelona. This dataset contains data of the contaminants measured in the stations of the city of Barcelona. The update is carried out in intervals of one hour indicating whether the value is validated or not.

4.1.2 Budapest

4.1.2.1 Use case 1

- ***Use case title:*** Multimodal connectivity and route planning integration
- ***Use case description:*** We will expand the current route planning system into a multimodal system by implementing UrbanPulse open data platform linking data from different sharing transport operators and other service providers with the FutarApp of the public transport system of Budapest. Special care will be placed on assisting people with reduced mobility to travel.
- ***Use case actors:***

Table 9 - Budapest Use case 1 – Partners

Partner	Role
BKK: Centre for Budapest transport	The integrated mobility manager of Budapest
ui! - Urban institute Hungary	Smart City solution provider of Budapest
ui! - Urban software institute	The strategic mobility advisor of Budapest city

Table 10 - Budapest Use case 1 – Additional stakeholders

Stakeholders to collaborate	Role
MOL Bubi	Shared mobility operator and data owner
Lime	Shared mobility operator and data owner
Greengo Car	Shared mobility operator and data owner

- ***Context diagram:***

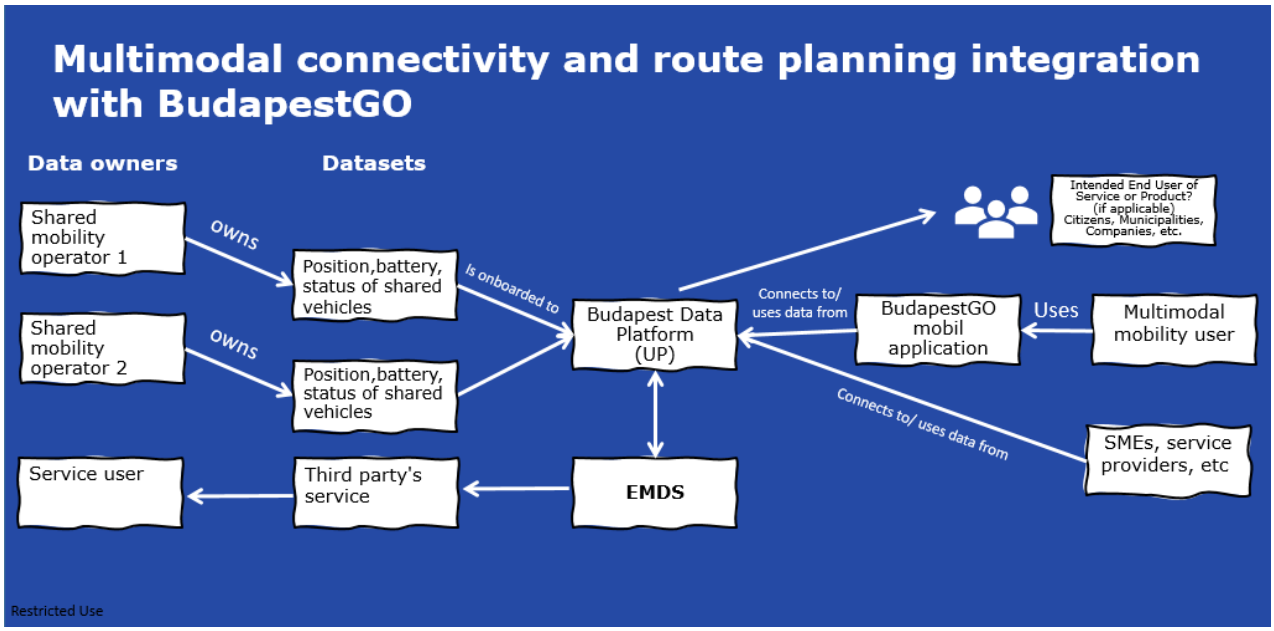


Figure 6 - Budapest Use case 1 – Context diagram

- ***Data product offerings:***

Table 11 - Budapest Use case 1 – Data product offerings

DPO Nr.	Name	Description
Bu.DPO.01.01	Public transport traffic data	The data product offering is designed to provide plan and real-time traffic data across various modes of transportation.
Bu.DPO.01.02	Shared mobility vehicle data	It collects the data of shared mobility provider's vehicles static data

4.1.2.3 Use case 2

- ***Use case title:*** MaaRLiM – Mobility as a Right for people with Limited Mobility
- ***Use case description:*** Support of vulnerable people in their mobility by Professionals (employees of transport companies) and Volunteers (Social Services, Charities, Private Persons).
- ***Use case actors:***

Table 12 - Budapest Use case 2 – Partners

Partner	Role
BKK: Centre for Budapest transport	The integrated mobility manager of Budapest
ui! - Urban institute Hungary	Smart City solution provider of Budapest
ui! - Urban software institute	The strategic mobility advisor of Budapest city

- ***Context diagram***

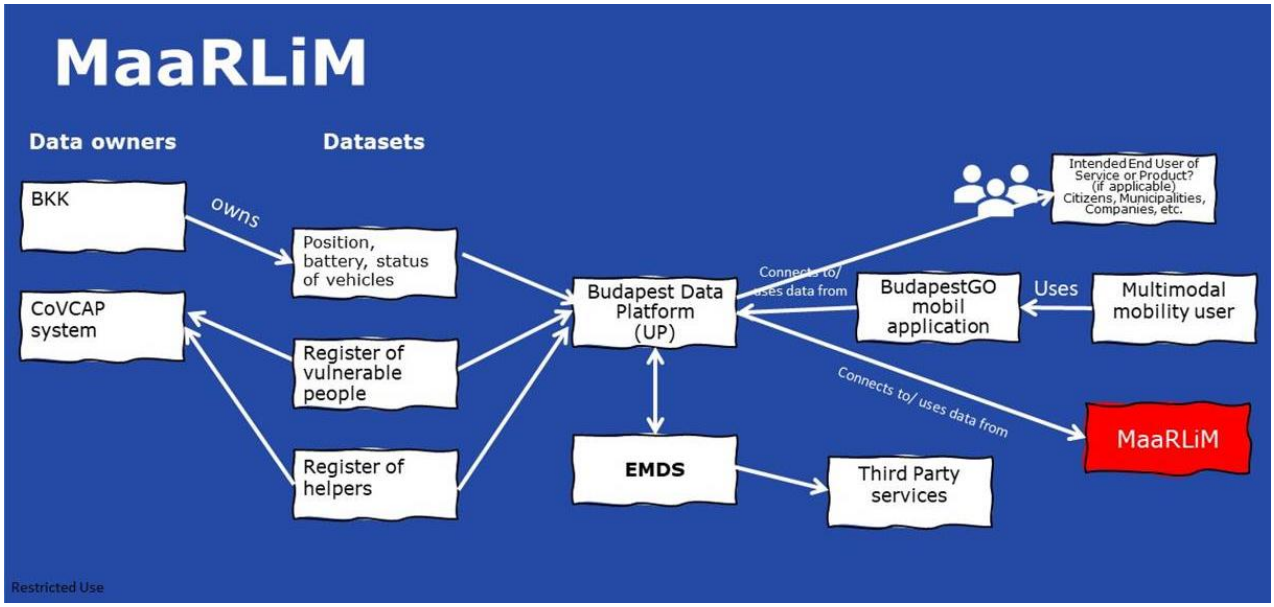


Figure 7 - Budapest Use case 2 – Context diagram

- ***Data product offerings:***

Table 13 - Budapest Use case 2 – Data product offerings

DPO Nr.	Name	Description
Bu.DPO.02.01	**MaaRLiM Registry**	The data product offering provides information about special functionalities in public transport vehicles for aiding persons with limited mobility. This is a collection of registered vulnerable persons and volunteers.

4.1.3 Flanders

4.1.3.1 Use case 1

- ***Use case title:*** Optimising the (re)-use of traffic measurements
  Use case description: Today, many different ways (and standards) exist to exchange data, but most of them are bilateral and ad hoc or through a centralised hub. For traffic measurements specifically, this means that the data is locked up within silos: more than 500 entities use traffic measurements based on different technologies with their own protocols, which limits data re-use. The value chain from sensor producer to data analysis is linear and closed. Within this use case, we want to make the exchange of traffic measurements understandable, exchangeable, re-usable and future proof; by using standards, linked data, data space technology, building an ecosystem and a clear governance. Our goal is to exchange traffic counts through Linked Data Event Streams (LDES) across different countries, so that concepts and definitions have the same meaning in those countries.
- ***Use case actors:***

Table 14 - Flanders Use case 1 – Partners

Partner	Role
Digitaal Vlaanderen	Implementation
imec	Technical lead

Table 15 - Flanders Use case 1 – Additional stakeholders

Stakeholders to collaborate	Role
Data owners, providers, and consumers	Participants in the data space

- ***Context diagram:***

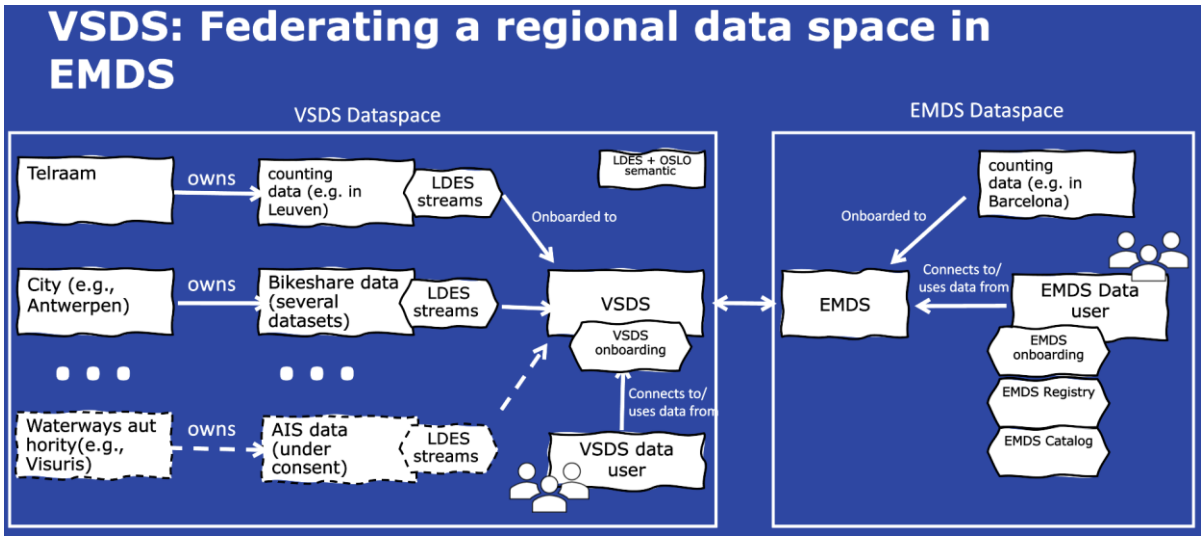


Figure 8 - Flanders Use case 1 – Context diagram

- ***Data product offerings:***

Table 16 - Flanders Use case 1 – Data product offerings

DPO Nr.	Name	Description
Fl.DPO.01.01	Multimodal Traffic Counts	"Multimodal Traffic Counts" is a data product offering designed to provide comprehensive, integrated traffic data across various modes of transportation (foot, bike, car, truck and potentially ship) for traffic managers, city administrations, researchers, and other stakeholders. The offering contains nine data sources on traffic counts (including vehicular (cars, buses, trucks), pedestrian, and bicycle traffic). This data is gathered through a mix of sources such as sensors, cameras, both temporary as permanent.

4.1.4 Île-de-France

4.1.4.1 Use case 1

- ***Use case title:*** MaaS for Companies
- ***Use case description:*** A MaaS solution for enterprises:
  - Facilitates management of companies' mobility policy ("Forfait de mobilité durable (FMD)" - mobility credits management)
  - Room for improvement in terms of data provided to respond to the Île-de-France's employers' challenges (need for EV charging stations, traffic information...)
- ***Use case actors:***

Table 17 - Île-de-France Use case 1 – Partners

Partner	Role
Instant System	Passenger App, Ticketing integrator and MaaS solutions provider
Eona-X	Mobility Transport Data Space Partner
enRoute	Mobility Data Management Platform Partner

Table 18 - Île-de-France - Use case 1 – Additional stakeholders

Stakeholders to collaborate	Role
Île-de-France Mobilités	Public transport authority in Île-de-France with access to the public transit data
Private transport operators	Traffic data owners
Companies interested in MaaS for employees	Data consumers

- ***Context diagram:***

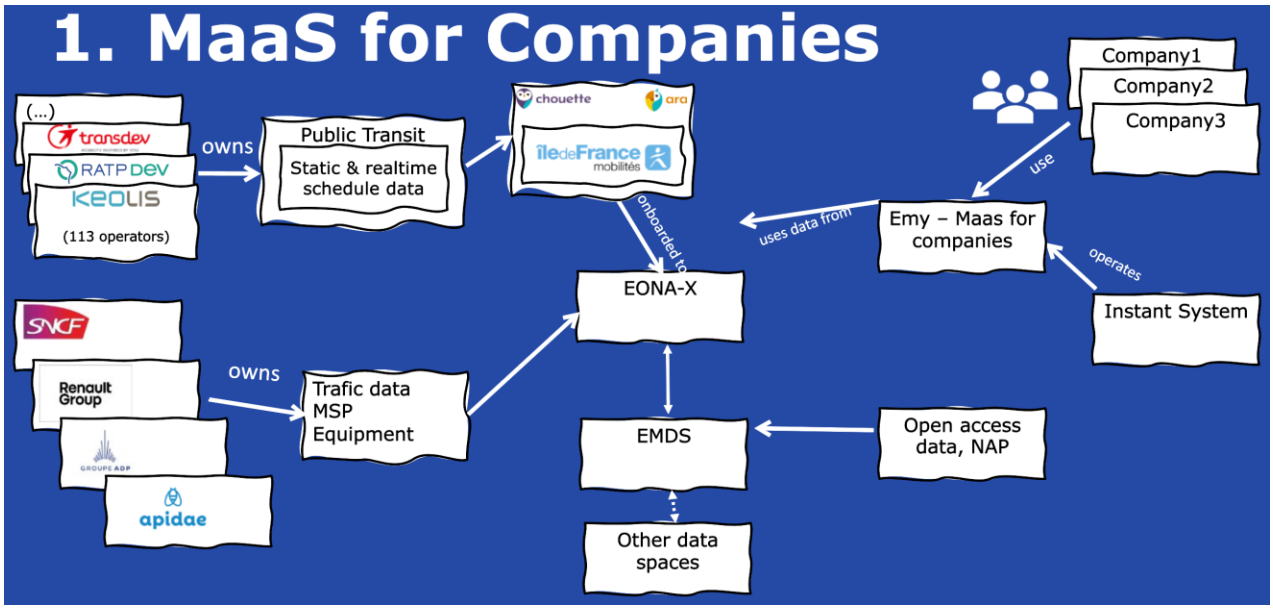


Figure 9 - Île-de-France Use case 1 – Context diagram

- ***Data product offerings:***

Table 19 - Île-de-France Use case 1 – Data product offerings

DPO Nr.	Name	Description
II.DPO.01.01	IDF Static Transit Dataset	The datasets contain information for describing public transport networks (stops location, routes, schedules etc...)
II.DPO.01.02	Charging point usage	Holds data on charging points in a geographic perimeter about the availability and quality of each charging point.
II.DPO.01.03	Location of infrastructure POI	This dataset is a selection of relevant static points of interest and their location (EV charging stations or mobility services).

4.1.4.2 Use case 2

- ***Use case title:*** Journey planner optimisation
  Use case description: Optimise the journey planner by feeding the algorithm with MaaS usage data to optimise the results of the itinerary research based on user behaviour.
- ***Use case actors:***

Table 20 - Île-de-France Use case 2 – Partners

Partner	Role
Instant System	Passenger App, Ticketing integrator and MaaS solutions provider

Table 21 - Île-de-France Use case 2 – Additional stakeholders

Stakeholders to collaborate	Role
Île-de-France Mobilités	Public transport authority in Île-de-France with access to the public transit data
Cities	Data providers

- ***Context diagram:***

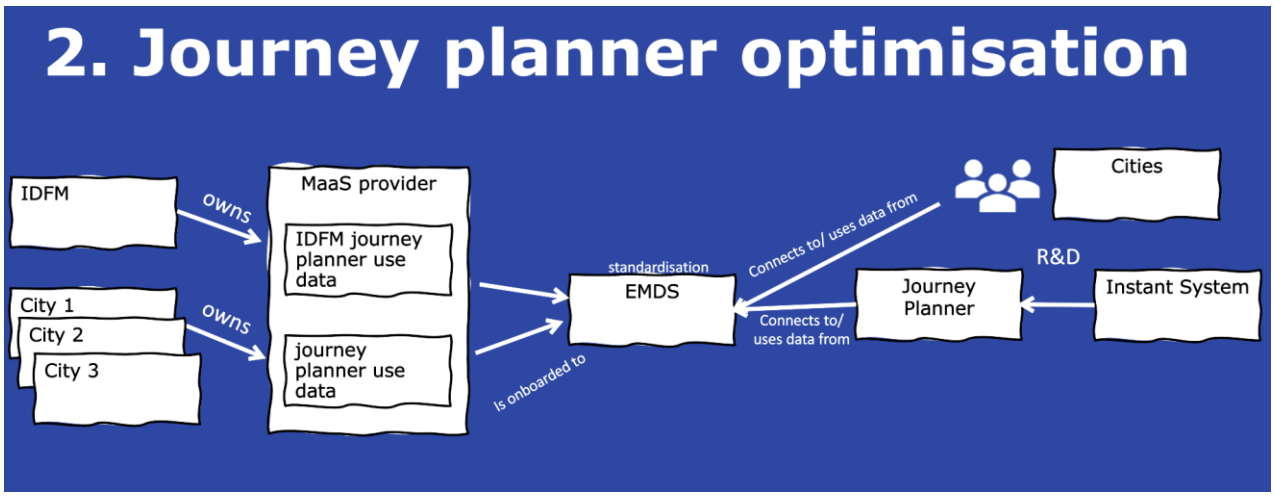


Figure 10 - Île-de-France Use case 2 – Context diagram

- ***Data product offerings:***

Table 22 - Île-de-France Use case 2 – Data product offerings

DPO Nr.	Name	Description
II.DPO.02.01	MaaS usage data	It is a product offering data about user travel habits and preferences. It allows city or transportation provider to understand the usage of public transport by the end users as well as the travel preferences. These preferences may include OD request (i.e. user searching itinerary from origin and destination), itineraries suggested by an itinerary planner using public transport and user favourite transportation modes (i.e. modes selected by the users among those suggested by the itinerary planner).

4.1.5 Lisbon

4.1.5.1 Use case 1

- ***Use case title:*** Enhancing seamless route planning
  Use case description: Untapping data that will contribute to door-to-door reliable route planning for people with reduced mobility (PMR) and for decision-makers to plan interventions in the public space:
  - real-time accessibility barriers identification.
  - verified information on accessibility of mobility services.

- ***Use case actors:***

Table 23 - Lisbon Use case 1 – Partners

Partner	Role
EMEL	Lisbon's Municipal Company for Mobility and Parking

Table 24 - Lisbon Use case 1 – Additional stakeholders

Stakeholders to collaborate	Role
NGOs representative of people with reduced mobility	Identification of the specific needs of this population
Lisbon City Council	Holds data on public space (traffic signs; bus stops, streetlights etc.)
JC Decaux	Holds data on its outdoor advertising equipment (public space barriers) in the city of Lisbon

- ***Context diagram:***

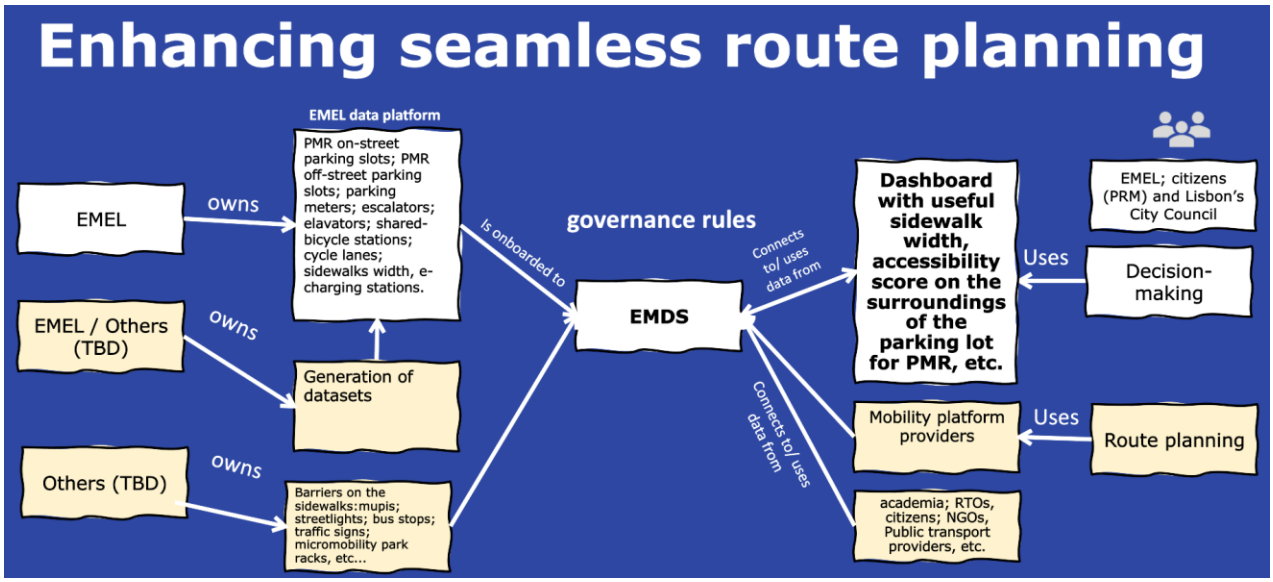


Figure 11 - Lisbon Use case 1 – Context diagram

- ***Data product offerings:***

Table 25 - Lisbon Use case 1 – Data product offerings

DPO Nr.	Name	Description
Li.DPO.01.01	Data on pedestrian accessibility	Harmonisation of available data & generation of new data sources focused on accessibility (e.g., people with reduced mobility)

4.1.5.2 Use case 2

- ***Use case title:*** Increasing the attractiveness of alternative mobility solutions
  Use case description: Identify opportunities to:
  - improve the provision of mobility services;
  - foster a more accessible data ecosystem;
  - enable the creation of a MaaS solution with focus on the corporate segment.

  The aim is to reduce car use in work commuting and business travel.
- ***Use case actors:***

Table 26 - Lisbon Use case 2 – Partners

Partner	Role
EMEL	Lisbon's Municipal Company for Mobility and Parking

Table 27 - Lisbon Use case 2 – Additional stakeholders

Stakeholders to collaborate	Role
Mobility services providers	Data owner
MaaS platform provider	Technical MaaS solution
Payment service provider	Payment services
Corporations with the headquarters in Lisbon	Users of the MaaS application

- ***Context diagram:***

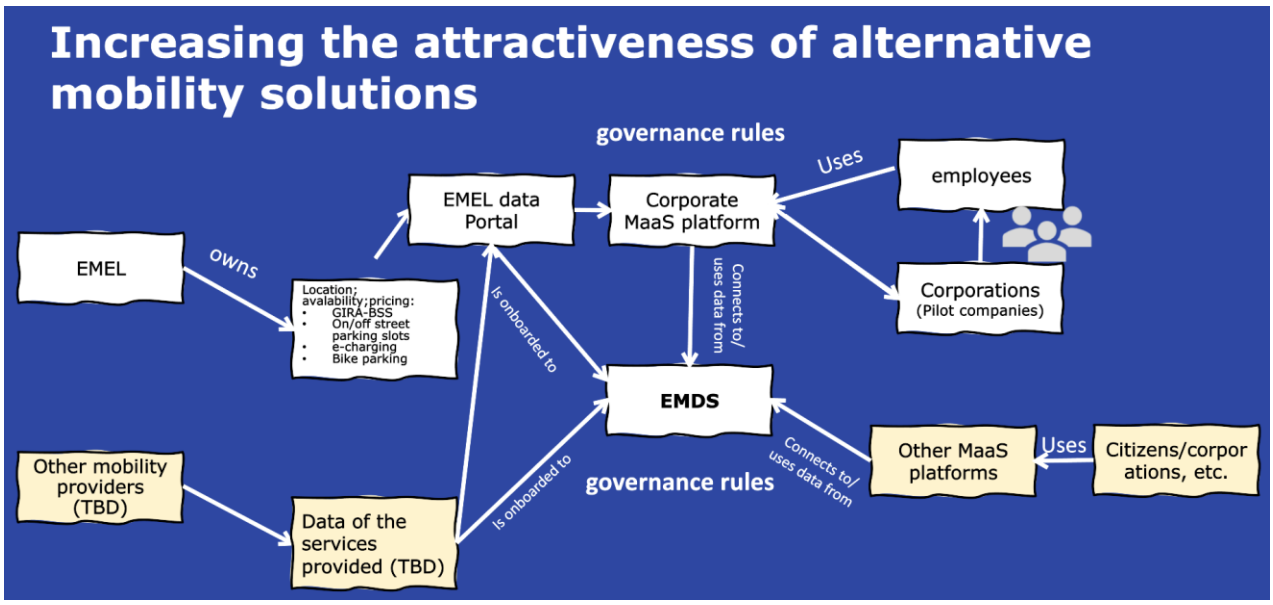


Figure 12 - Lisbon Use case 2 – Context diagram

- ***Data product offerings:***

Table 28 - Lisbon Use case 2 – Data product offerings

DPO Nr.	Name	Description
Li.DPO.02.01	Data on pricing of mobility services provided in the MaaS solution	Data sources of location; pricing of the selected mobility services provided in the MaaS solution

4.1.5.3 Use case 3

- ***Use case title:*** Increasing schedule reliability and/or commercial speed of buses
  Use case description: Map and characterise (most) critical public transport route paths, where different modes of transport conflict, resulting in particularly low bus speeds and/or bus traffic disturbance. Publish machine-readable data (e.g., specific locations where vehicles flow can be improved) to help for the improvement of bus operation efficiency and minimise impacts on passengers.
- ***Use case actors:***

Table 29 - Lisbon Use case 3 – Partners

Partner	Role
TML	the PTA of the intermunicipal bus operation

Table 30 - Lisbon Use case 3 – Additional stakeholders

Stakeholders to collaborate	Role
BUS Operators and Municipalities/PTA	Data owners and data consumers
3rd party Apps	Data owners and data consumers

- ***Context diagram:***

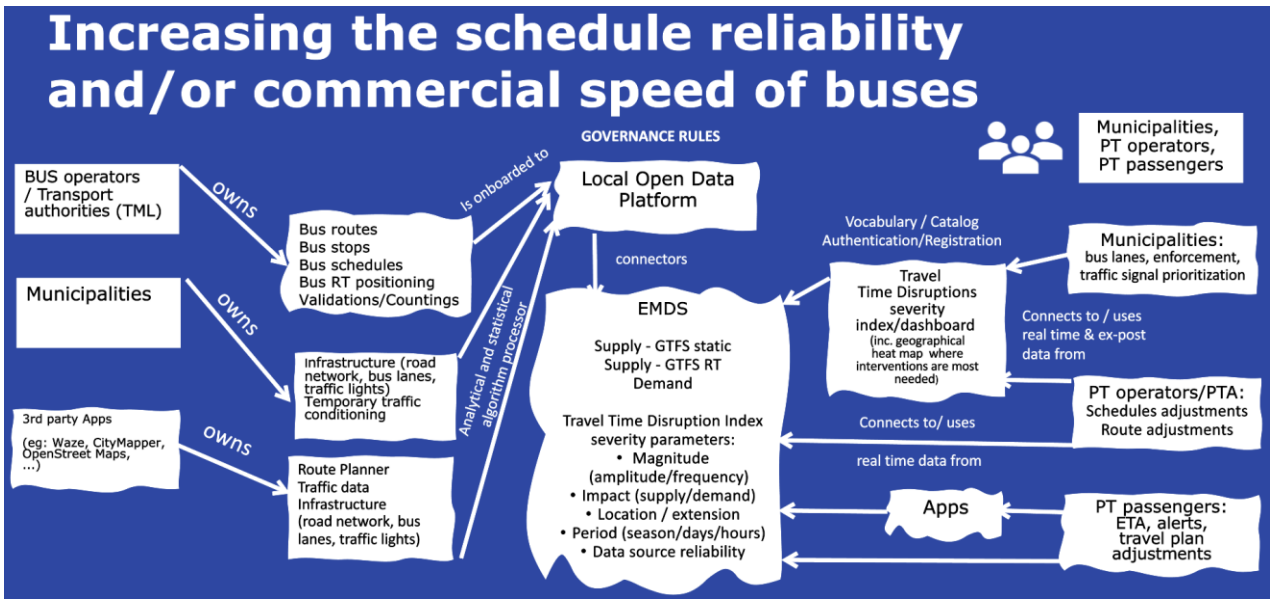


Figure 13 - Lisbon Use case 3 – Context diagram

- ***Data product offerings:***

Table 31 - Lisbon Use case 3 – Data product offerings

DPO Nr.	Name	Description
Li.DPO.03.01	Travel time disruption severity index	"Travel time disruption severity index" is a data product offering designed to provide comprehensive information, real time, and ex-post, about disruptions in the bus services to transport authorities, transport operators, and passenger. The offering contains geographic based and time-based data in different types of dashboards and channels, according to its usage context. This data is gathered through a mix of sources and processed through algorithms under development or still to be designed and developed.
Li.DPO.03.02	Non real time supply and demand data	"Non real time supply and demand data" is a data product offering designed to provide comprehensive information about planned public transport services, as also its level of usage.
Li.DPO.03.03	Real-time bus positioning and estimated time of arrival (to each stop)	Nearly 1500 data sources of GPS traces, 1 for each different selected buses in Lisbon metropolitan area & Nearly 10k data sources, 1 for each different selected bus stop in Lisbon metropolitan area, with a time interval of 10/20 seconds and going back X month(s) in time (still evaluating how many are feasible).
Li.DPO.03.04	Infrastructure data (road network, signalling, ...)	Road geospatial data sets, with street infrastructure position and characterisation (number of lanes, lane widths and length, turn permissions, signalling).

4.1.6 Milan

4.1.6.1 Use case 1

- ***Use case title:*** Decision support system for local public transport (LPT) services planning
- ***Use case description:*** A decision-support system (DSS) to optimise the public transport network and services through the integration of multiple data sources. The aim is to foster building algorithms and analysis models that will allow the evaluation of the efficacy and the efficiency of LPT planning alternatives against a set of identified objectives.

- ***Use case actors:***

Table 32 - Milan Use case 1 – Partners

Partner	Role
Cefriel	Local coordinator, use case alignment within deployEMDS & Centre of excellence in innovation, research, and training in the ICT sector.
ATPL	The Public Transport Agency of the Metropolitan City of Milan

Table 33 - Milan Use case 1 – Additional stakeholders

Stakeholders to collaborate	Role
LPT operators	Data providers & consumers (through DSS)
Area and corporate mobility managers	Data providers
Universities and educational institutions	Data providers
Cities, Public transport authorities	Data providers & consumers (through DSS)

- ***Context diagram:***

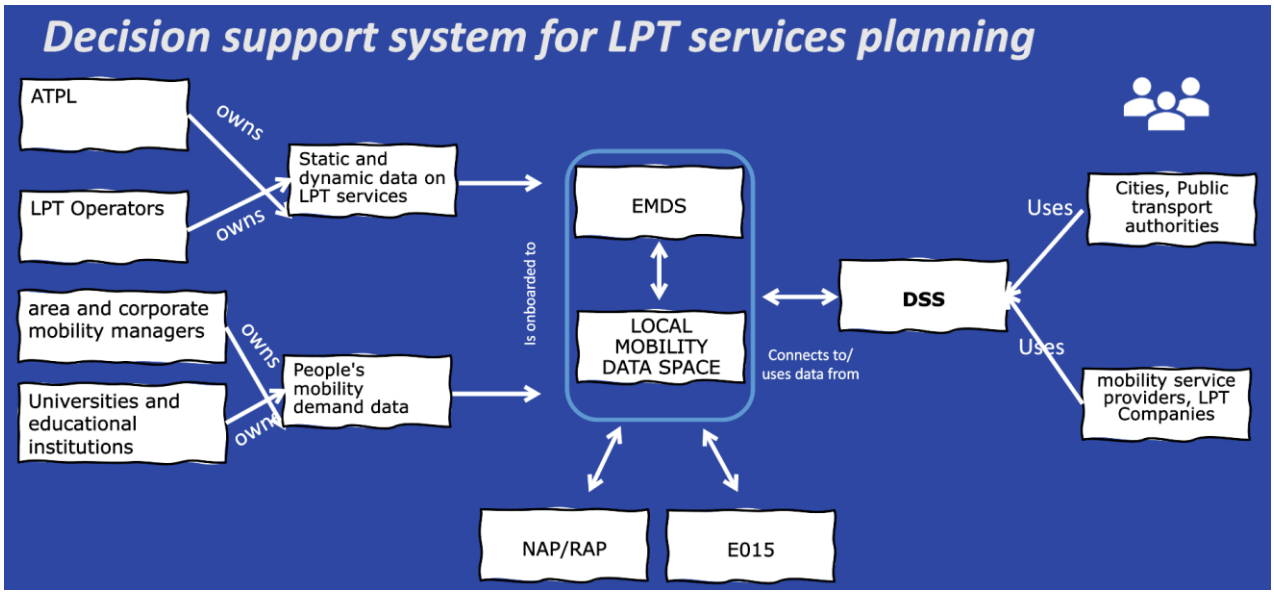


Figure 14 - Milan Use case 1 – Context diagram

- ***Data product offerings:***

Table 34 - Milan Use case 1 – Data product offerings

DPO Nr.	Name	Description
Mi.DPO.01.01	Scheduled LPT service	A data product offering designed to provide comprehensive public transport data about the routes followed, individual trips and timetables in the geographical area of the Metropolitan city of Milan. This data product offering is intended to provide information to transport authorities and passengers.
Mi.DPO.01.02	Realtime LPT service	A data product offering designed to provide stream of real-time data for LPT services, including service alerts, trip times updates and the locations of vehicles.
Mi.DPO.01.03	LPT demand data	A data product offering designed to provide transportation demand data collected by on-board and in-station surveys and from automated passenger-counting systems.
Mi.DPO.01.04	Metro lines status	A data product offering designed to provide information about metro lines status and timeliness of Milan and Metropolitan area of Milan.

4.1.6.2 Use case 2

- ***Use case title:*** MaaS-based mobility scenarios
- ***Use case description:*** Modelling future mobility scenarios targeting carbon neutrality based on the potentialities that arise from a fully developed MaaS. An interactive exhibition will be realised to present and gather feedback on MaaS-based future mobility scenarios.
- ***Use case actors:***

Table 35 - Milan Use case 2 – Partners

Partner	Role
Cefriel	Local coordinator, use case alignment within deployEMDS & Centre of excellence in innovation, research, and training in the ICT sector.
AMAT	The agency of mobility, environment, and territory in Milan

Table 36 - Milan Use case 2 – Additional stakeholders

Stakeholders to collaborate	Role
Municipality of Milan	Interested in the scenarios result
Sharing mobility operators	Data providers
LPT operators	Data providers

- ***Context diagram:***

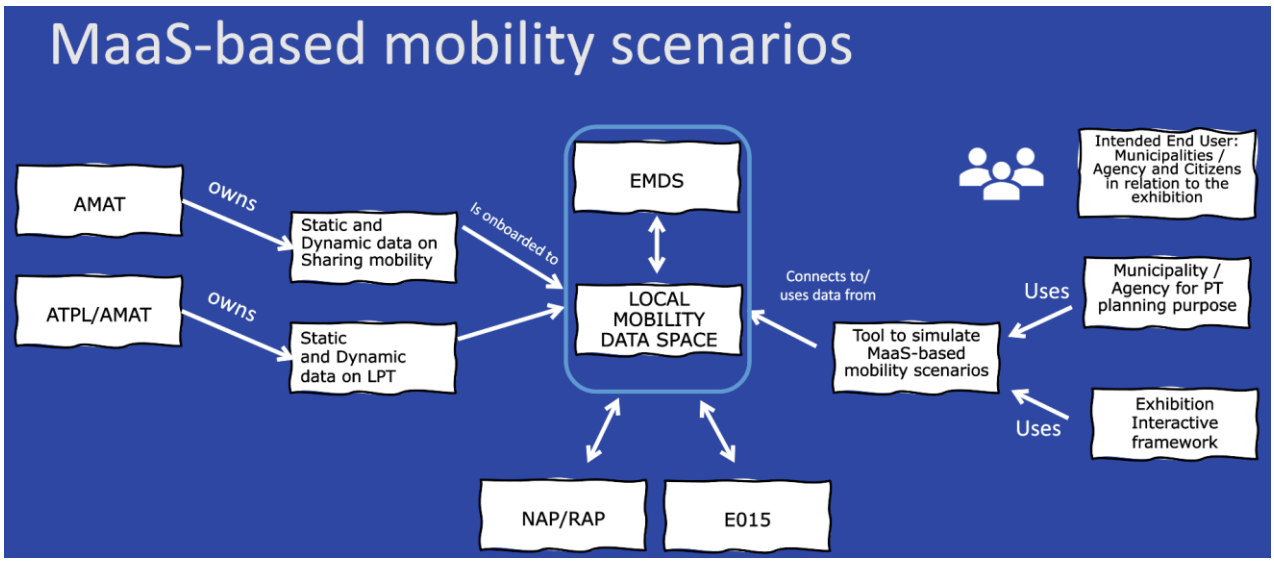


Figure 15 - Milan Use case 2 – Context diagram

- ***Data product offerings:***

Table 37 - Milan Use case 2 – Data product offerings

DPO Nr.	Name	Description
Mi.DPO.02.01	**Shared Mobility data**	A data product offering designed to provide aggregated data related to different shared mobility modes. A heatmap of the different shared systems will be provided covering transport mode availability, trip origin, trip destination with time and spatial granularity to be defined.
Mi.DPO.02.02	**Mobility demand data**	Mobility demand data collected through surveys and calibrated with different data source (road camera, LTP counting, etc.)

4.1.7 Sofia

4.1.7.1 Use case 1

- ***Use case title:*** Connected Green & Shared Mobility Journeys (GreenMob)
- ***Use case description:*** The use case aims to deliver MaaS by implementing a multimodal mobility solution involving public transport and green on-demand mobility services. A new mobility app/service for journey planning will be developed based on data sharing by Sofia Urban Mobility Centre and shared mobility providers of e-scooters, e-cars, e-bikes, etc. The buffer parking zones around the metro stations will be considered to deliver a service for both Sofia's citizens and those living outside but working in the city.
- ***Use case actors:***

Table 38 - Sofia Use case 1 – Partners

Partner	Role
GATE	Local consortium coordinator, Research centre in AI & Big Data
Sofia Urban Mobility Centre (SUMC)	Managing centre of public transport in the city of Sofia
Sofia Municipality	The local administrative unit

Table 39 - Sofia Use case 1 – Additional stakeholders

Stakeholders to collaborate	Role
Public transport providers	Data providers
Shared-mobility providers	Data providers
NIMH	Data providers
Citizens	Data consumers
Start-ups	Data consumers

- ***Context diagram:***

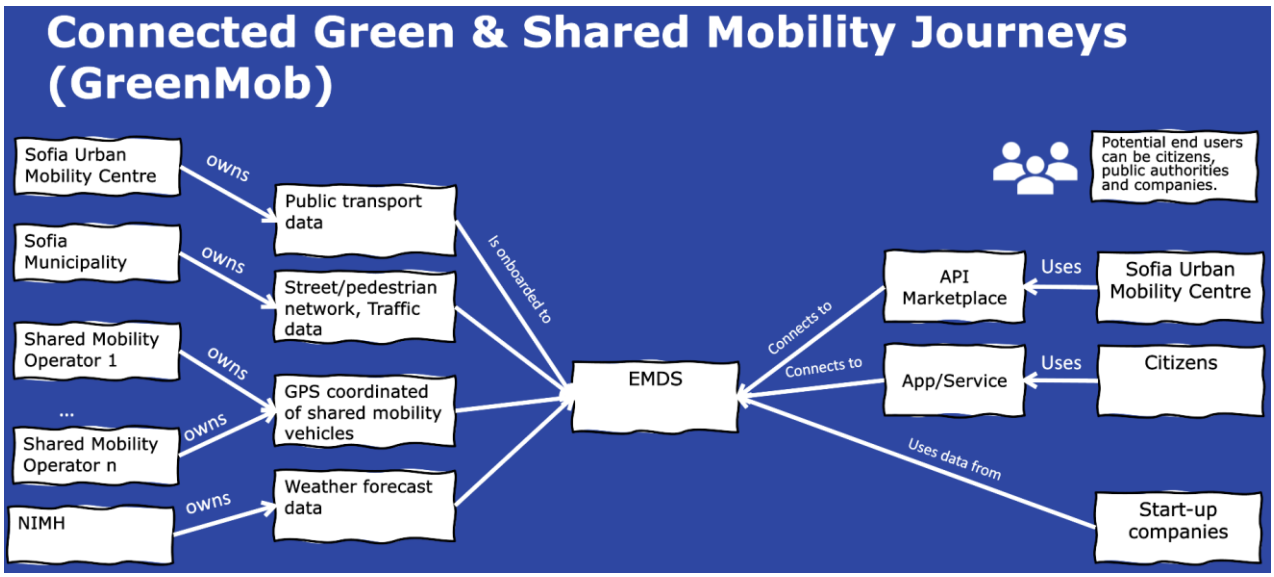


Figure 16 - Sofia Use case 1 – Context diagram

- ***Data product offerings:***

Table 40 - Sofia Use case 1 – Data product offerings

DPO Nr.	Name	Description
So.DPO.01.01	Real-time public transport vehicles positioning and estimated time of arrival (to each stop)	It is a data product offering GTFS static and real-time information on public transport routes, stops, location, occupancy and many more.
So.DPO.01.02	Mobility demand data	Mobility demand data collected through surveys and calibrated with different data sources (road camera, LTP counting, etc.)
So.DPO.01.03	Static data of geospatial location of short-term paid parking zones	It is a data product offering geographical coverage of the two short term paid parking zones - blue and green –and location of parking spaces in short-term parking zones - available parking spaces at 6 locations in the blue zone.
So.DPO.01.04	Shared Mobility data	This data product offers dynamic aggregated data related to different shared mobility modes.
So.DPO.01.05	Air quality data	This data product is offering air quality data measured by 21 sensor stations, part of the AirThings monitoring platform of Sofia. Air quality data, measured by 5 sensor stations of Bulgarian Executive environment agency.
So.DPO.01.06	Static infrastructure data	Geospatial data for street network and pedestrian network, including characteristics like number of lanes, lane widths and length, and availability of sidewalks.

4.1.8 Stockholm

4.1.8.1 Use case 1

- ***Use case title:*** Implementing and monitoring zero emission zones and reduction of car traffic.
- ***Use case description:*** The Stockholm Mobility Data Space (SMDS) will serve as the central platform for sharing and visualising data related to the zero-emission zone and reduction of car traffic. It will monitor the impacts of measure taken based on environmental data, traffic count data, bicycle usage and pedestrian counts, etc.
- ***Use case actors:***

Table 41 - Stockholm Use case 1 – Partners

Partner	Role
City of Stockholm	Data provider
RISE	Local coordinator, use case leader
Trafikverket	Swedish Transport Administration, NAP implementation partner

Table 42 - Stockholm Use case 1 – Additional stakeholders

Stakeholders to collaborate	Role
Sensor data providers	Data providers
Samtrafiken	Provider of public transport data

- ***Context diagram:***

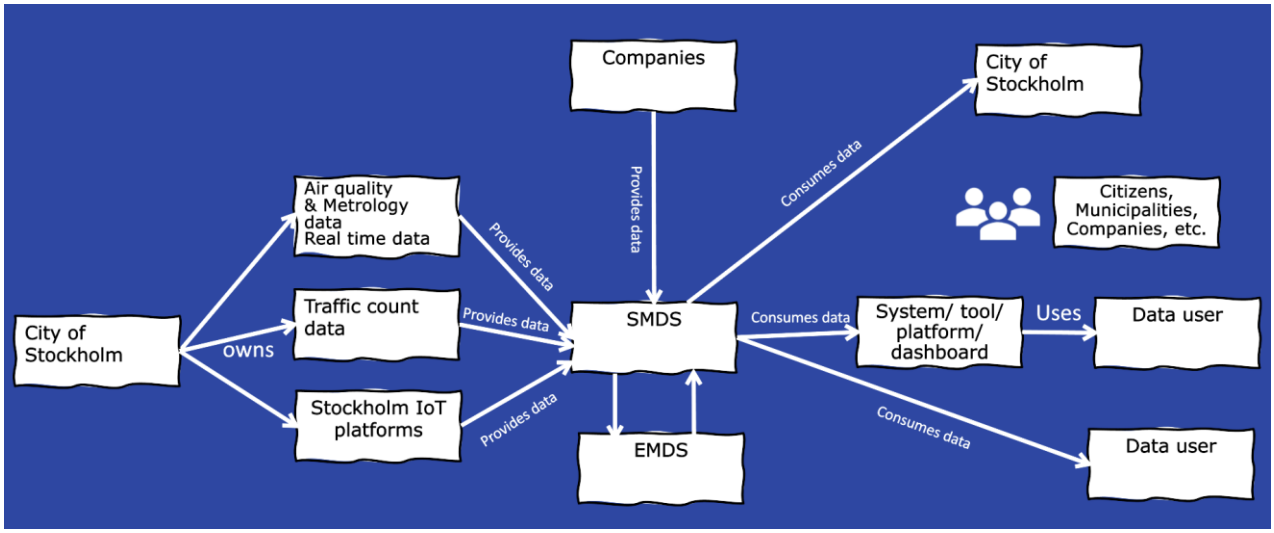


Figure 17 - Stockholm Use case 1 – Context diagram

- ***Data product offerings:***

Table 43 - Stockholm Use case 1 – Data product offerings

DPO Nr.	Name	Description
St.DPO.01.01	Static road and traffic regulation data	It is a data product offering datasets that describe the road network and traffic regulations within the city of Stockholm
St.DPO.01.02	Environmental data for zero emission zone	It is a data product offering data on traffic count, air quality and noise measurements from within Stockholm.
St.DPO.01.03	Micromobility and car sharing	It is a data product offering statistics and information on shared micromobility, charging infrastructure and car sharing within the city of Stockholm
St.DPO.01.04	Public transport data	This data product offers detailed public transport data sets for Stockholm.

4.1.9 Tampere

4.1.9.1 Use case 1

- ***Use case title:*** Collection of data, mandated by the Intelligent Transport Services (ITS) Directive, and interface to NAP.
  Use case description: Foster the availability of data, including commercial data, in an interoperable way, which will allow them to meet the requirements of the EU directives, and allows to develop services for improving situational awareness. Improve the readiness to assess the impact of measures to achieve the SUMP targets.
- ***Use case actors:***

Table 44 - Tampere Use case 1 – Partners

Partner	Role
VTT	Research organisation
City of Tampere	Organisation of public transport
Fintraffic	Fintraffic provides and develops traffic control and management services in all traffic forms as well as ensure safe and smooth traffic. Fintraffic also collects, administers, and published open data
Tampere public transport authority (Nysse)	Owned by the City of Tampere

Table 45 - Tampere Use case 1 – Additional stakeholders

Stakeholders to collaborate	Role
Data set owners	Data providers
ITS factory, traffic data ecosystem	Dissemination

- ***Context diagram:***

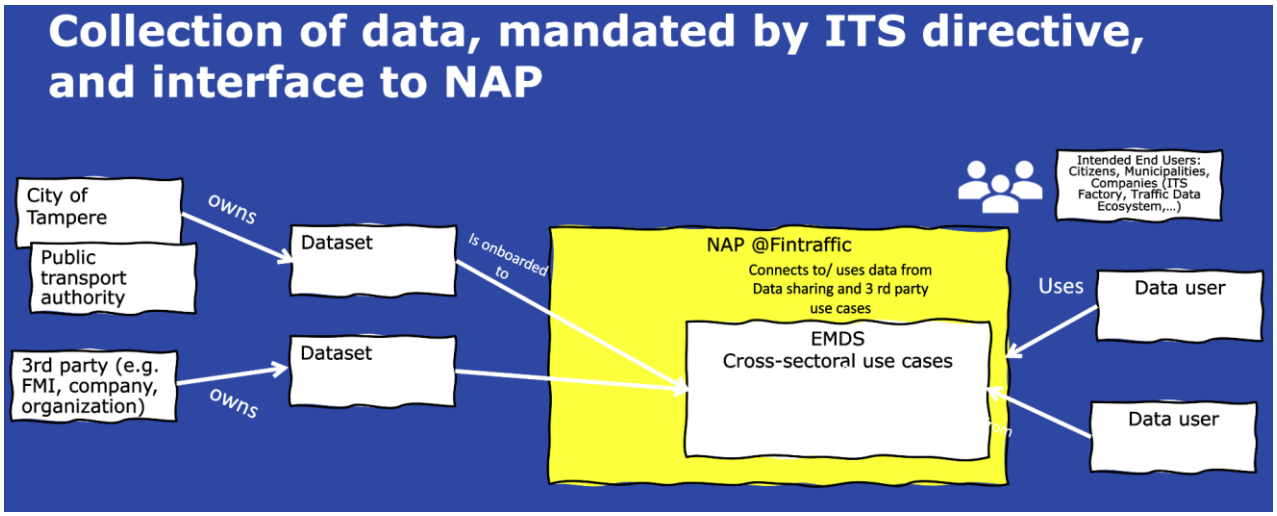


Figure 18 - Tampere Use case 1 – Context diagram

- ***Data product offerings:***

Table 46 - Tampere Use case 1 – Data product offerings

DPO Nr.	Name	Description
Ta.DPO.01.01	Public transport static data	Static data related to public transport collected by Tampere public transport authority
Ta.DPO.01.02	Public Transport Real time data	Real time information of public transport data, coming from GNSS devices in the vehicles (every second). Output in standardised format: SIRI
Ta.DPO.01.03	Tampere public transport history data	Historical data of public transport, based on the Real time data
Ta.DPO.01.04	Multimodal information for Tampere	This product contains both static and dynamic information related to multimodal transport, such as P&R, bike parking, e-scooters, …
Ta.DPO.01.05	Dynamic incidents and roadworks	Tampere City RTTI information

4.2 Requirements

The analysis in this section is based on Annex 3, which is an abstraction of the information in the canvases. The granularity of the reports in this section relates to DPOs, in line with the intake granularity. We remind the reader that a DPO can contain multiple data sources, and that DPOs are packages or data products that are offered to the data space. They are unique in scope, transferring protocol, governance, or business model. The data products in a DPO can be shared under the same contract, with the same policy.

Figure 19 shows the number of DPOs per implementation site, which ranges from one in Flanders to eight in Barcelona, and Figure 20 shows the number of data sources per use case and per implementation site. It is important to keep the difference between data sources and DPOs in mind while interpreting the results of the analysis. This difference becomes clear when we compare the Flanders and Tampere sites, for example, who each have one use case. The Flanders implementation site has one DPO, but this DPO entails nine distinct data sources, as can be seen in Figure 20. These data sources have different owners and providers, but they are shared under the same conditions. In Tampere, 5 DPOs are listed, but together they contain 8 data sources. Therefore, the number of DPOs gives an idea of the diversity of data products that will be offered to the data space, rather than the volume of data.

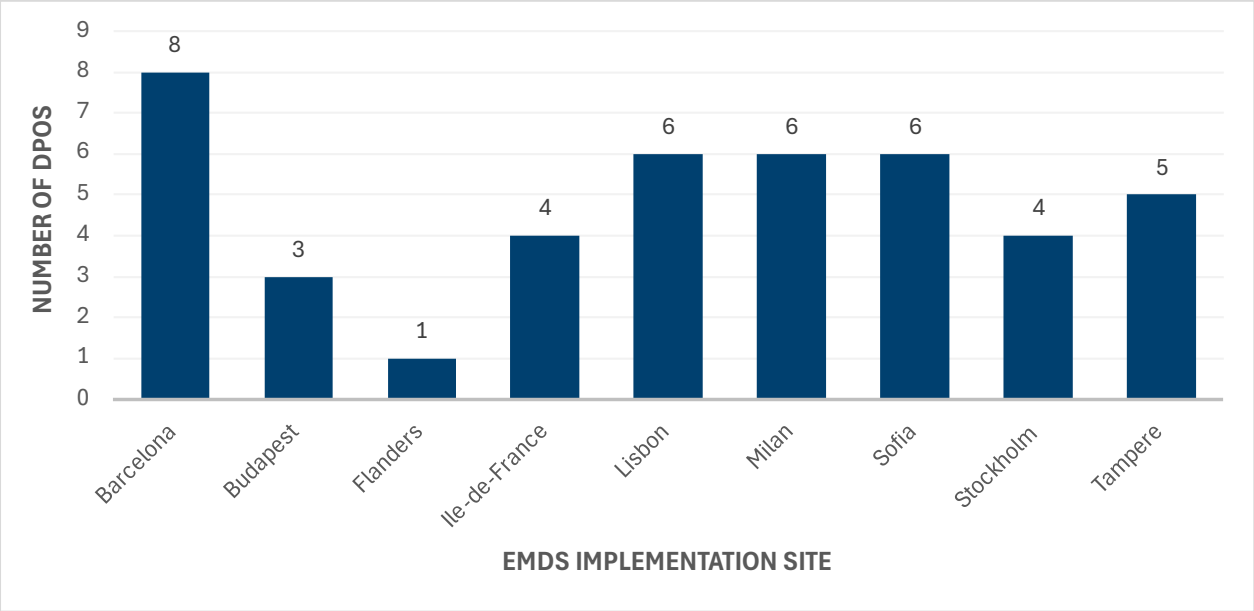


Figure 19 - Number of DPOs per implementation site

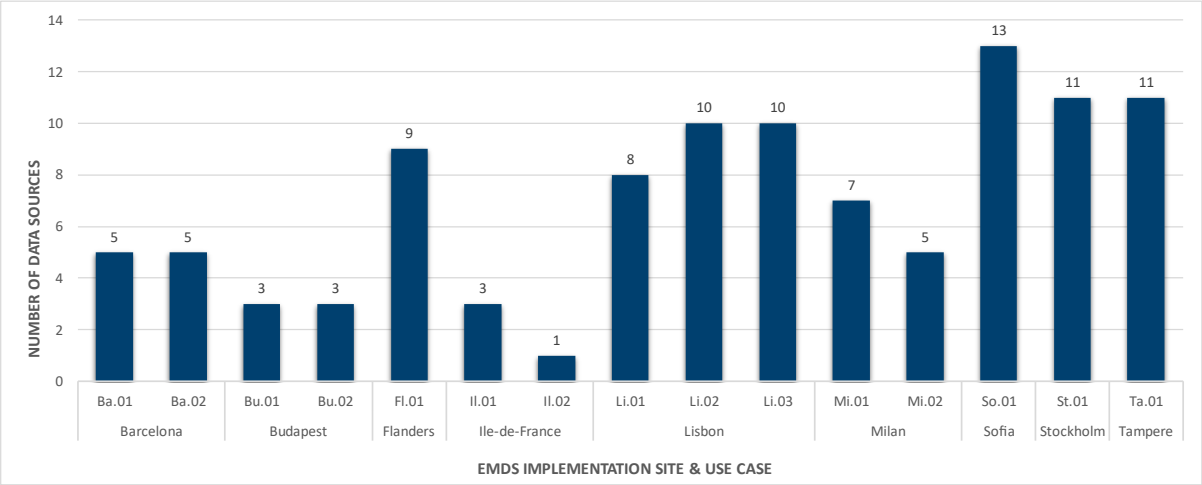


Figure 20 - Number of data sources per use case and per implementation site

4.2.1 Governance and business model

This section shows the analysis of questions 14, 15 and 17 in the intake canvas on governance and business models of the DPOs. Figure 21 shows the different governance models that are considered by the consortium partners during the intake process, a distinction is made between open data[23] (labelled as 'Open') and data that requires access control (now or in the foreseeable future). A relevant share of submitted DPOs contains open data, which means that a very permissive governance is implemented as there are no limiting requirements in terms of access and consumption of the information they provide. Some DPOs have yet to define a governance model, especially when third parties own the data sources and have yet to provide their usage policies.

Open data DPOs are found the most in this phase of the project for several reasons. First of all, open data products, which are shared with minimal restrictions and in a highly intuitive manner, represent the most widely shared type of data products today (see for example PrepDSpace4Mobility[24]). As the conditions for exchange are already clear, they are easily added to the intake canvases. Second, in the mobility domain a substantial share of the data being generated is open data (partially stimulated by the ITS Directive[25] for example), to optimise transportation networks, reduce emissions, and promote modes of transport that are environmentally friendly. The commitment of both public and private stakeholders to share information, and hence the large amount of open DPOs in this project, should be commended, as open data can act as a catalyst for innovation within the mobility sector. At first sight, the merit of a data space for open data could be questioned, as it requires no specific trust framework. However, although the data products are openly available today, they are not necessarily being exchanged across different countries. This could mean that the data today is not discoverable or usable to enable cross-border use cases, which could be solved by several data space building blocks, such as data interoperability and value creation. Therefore, ample opportunities and data space innovations can be identified for the DPOs with an open governance model in this project.

[23] The definition of data.europa.eu is used: https://data.europa.eu/en/dataeuropa-academy/what-open-data.
[24] https://mobilitydataspace-csa.eu/
[25] https://transport.ec.europa.eu/transport-themes/intelligent-transport-systems/road/action-plan-and-directive_en

Although most submitted DPOs have an open character, nine DPOs will need access control in the data space (for seven of them access control is already implemented outside of this project), and for seven DPOs the governance is unknown. The implementation sites that require access control for at least one DPO are Barcelona, Budapest, Stockholm, Ile-de-France, Sofia, and Flanders, which means that more than half of the implementation sites have this requirement, and this number will likely grow as the use cases are further developed. Based on this analysis, it can be concluded that the data space will need to facilitate both open data exchange and access control. Moreover, the data space will need the capabilities to easily adapt the governance model of a DPO, as this might evolve not only during, but also after the project.

The large amount of open data is also reflected in Figure 22, where the business model without revenue scheme is the most common one. While the governance models were not specified beyond data usage control, there is more detail and clarity for the business models. Besides the open business model, the consortium partners selected a variety of revenue schemes, such as subscription, value exchange, pay-as-you-go and one-time payments, and only for four DPOs it is not defined yet. The data space thus needs to support a variety of revenue schemes, and like the governance model, needs to support switching between revenue schemes in a user-friendly and intuitive way. In summary, consortium partners in first instance, and data providers in general need to be able to set the policies of their DPOs and adapt them at any time they seem fit.

Furthermore, the results might indicate that it is slightly easier for partners to specify the business model of a DPO than the governance model, as the canvas input is more detailed for the first than for the second. Therefore, an important first conclusion is that the consortium partners need assistance from work package 3 (WP3; deployment of common governance mechanisms) to further specify the governance models of their DPOs. The intake canvases provide a good base for further workshops and policy labs on this specific aspect.

Most DPOs contain open data, but more than half of the implementation sites imply some kind of access control and revenue scheme, making these necessary capabilities of the data space. The governance and business model need further refining for a lot of DPOs.

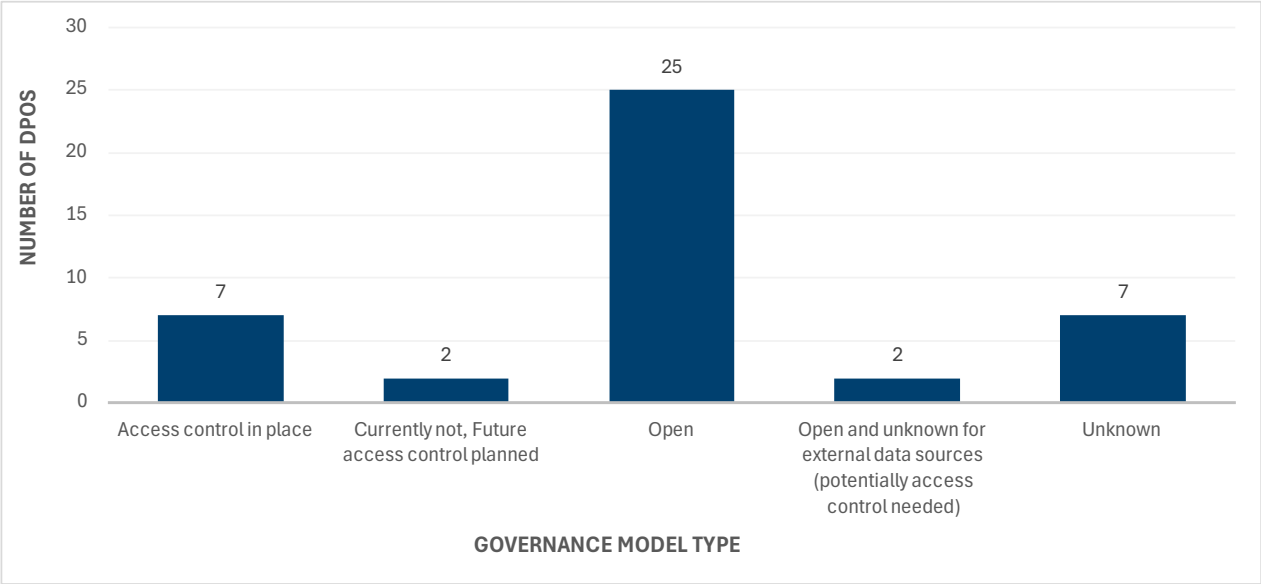


Figure 21 - Number of DPOs per governance model type

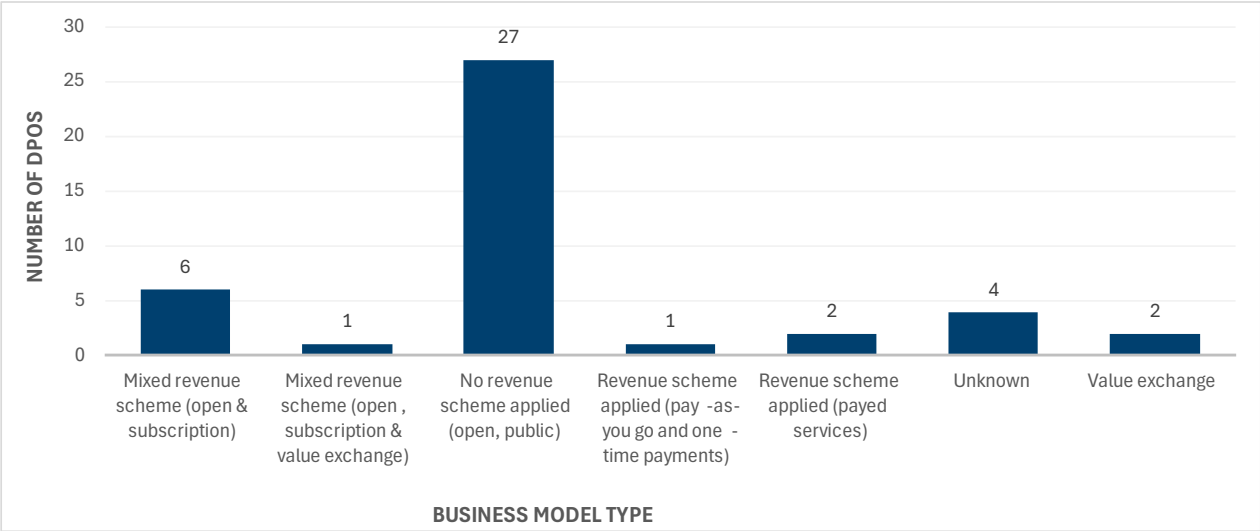


Figure 22 - Number of DPOs per business model type

4.2.2 Data space federation

If a local data space was deployed or considered, the data space federation section of the canvas had to be filled out (questions 21-25). The results show that two implementation sites already have a local data space in place (Flanders and Île-de-France), and three implementation sites are considering creating one within the timeframe of this project (Sofia, Stockholm, Tampere) (Figure 23 and Figure 24). This means that half of the consortium sites will be implementing use cases where at least two data spaces are involved. In other words, DPOs there will be offered and accessed through at least two data spaces: the local data space and the deployEMDS data space. This means that this project must ensure that the future EMDS is able to talk to at least six other data spaces, if the existing German Mobility Data Space is taken into consideration as well. This requirement is at the same time a huge opportunity for the EMDS, as it will be the first data space federation at this scale in the mobility domain. Therefore, an important next step is to have a closer look at the architecture, technologies, and functionalities of these local data spaces. deployEMDS should look at other projects and examples of data space federation for this[26].

More than half of the implementation sites will have a local data space in place besides the deployEMDS data space, which will be the first data space federation at this scale in the mobility domain. This requirement needs to be analysed in detail in the next phase of the project.

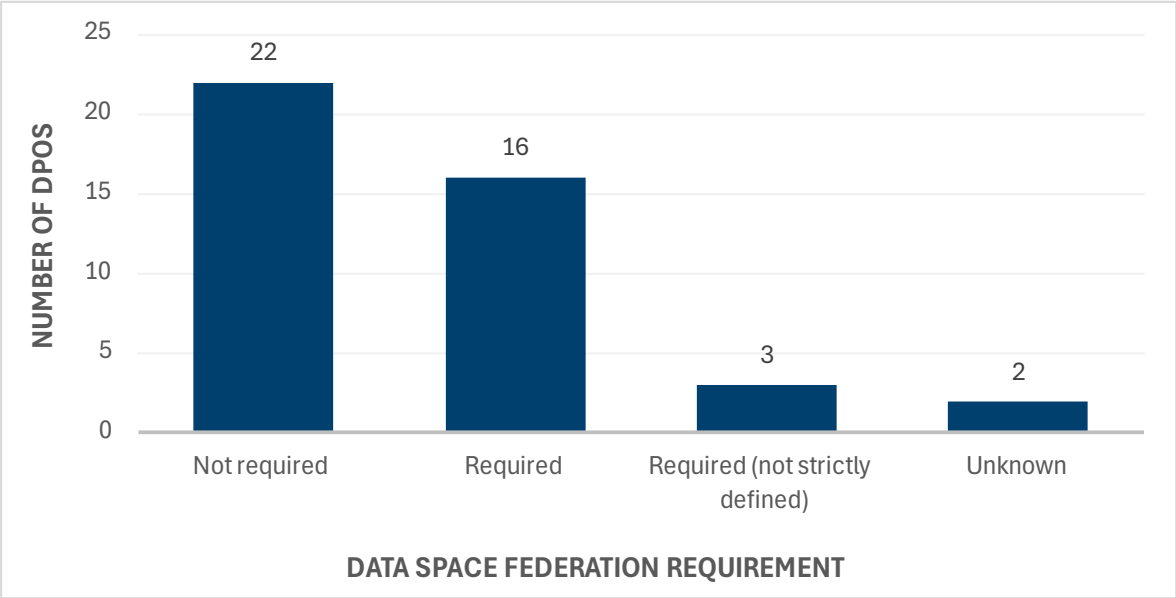


Figure 23 - Number of DPOs per data space federation category

[26] For example: https://internationaldataspaces.org/connected-data-spaces-we-let-data-spaces-talk-to-each-other

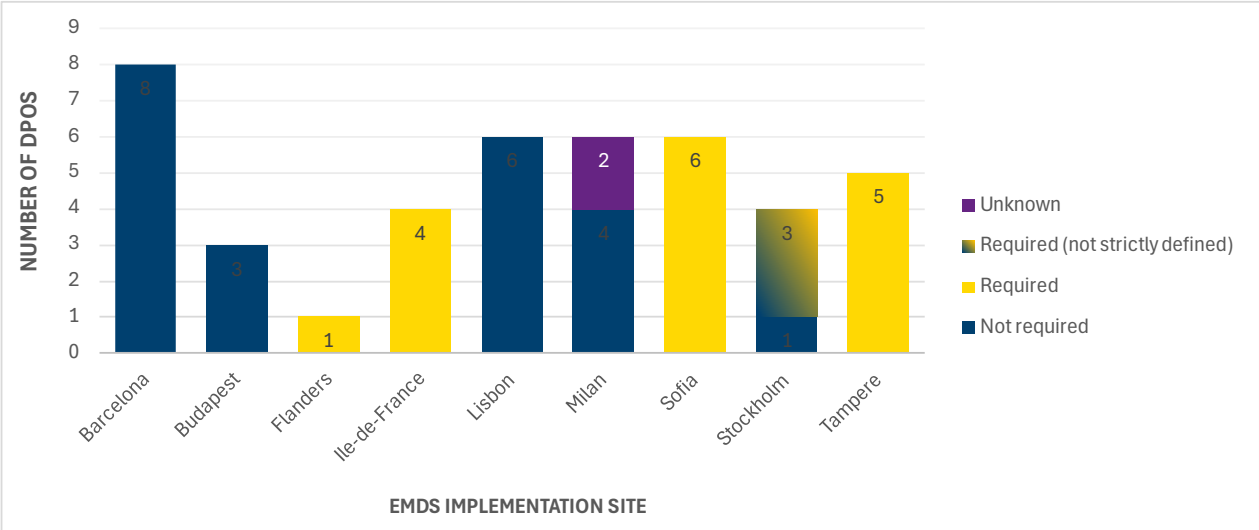


Figure 24 - Number of DPOs per implementation site for the data space federation requirement

4.2.3 Scope

In a next step the DPOs were categorised based on questions 1, 2, 3 and 6 of the intake canvas, regarding the scope and content of the data products. Four main categories were defined, each with their own subcategories (Table 47).

Table 47 - Scope categories

Scope category	Subcategory	Definition	Example
Static mobility related data product offering	Static public transport	It refers to information about transportation services that remain relatively unchanged overtime and it is used for planning and scheduling purposes rather than real-time tracking.	Static data on PT schedules, data on PT routes, fares, stops & accessibility information. Also, data on PT fleet and/or historical PT data.
	Travel demand	It refers to information that reflects the patterns and preferences of travellers in terms of their transportation needs and choices within a specific area of transportation network.	Origin-destination (OD) data, Socio-demographic data, Trip generation and distribution data etc.
	Road transport infrastructure	It refers to information about the physical characteristics and	Road network geometry data, road names and classifications, bridges

		attributes of road networks and associated facilities that do not change frequently.	and tunnels data, geospatial data, traffic control devices, emergency services infrastructure etc.
	MaaS usage	It refers to information collected from users of MaaS platforms or services regarding their transportation behaviours, preferences, and interactions with the MaaS ecosystem.	Data generated by MaaS platforms such as: user profiles, OD patterns data, trip duration and mode choice data, fare payment data, feedback & ratings data.
	Shared Mobility	It refers to static information about the usage, availability, and characteristics of shared transportation options such as car-sharing, bike-sharing, scooter-sharing, ride-hailing, and shared micro transit services.	Data on shared vehicle station locations (bike-sharing locations), vehicle inventory data, maintenance data, historical usage data etc.
	Static parking management	It refers to information that remains unchanged within time and it is collected and analysed to effectively manage parking facilities and resources within a given area.	Parking facility location data, parking zone destinations data, parking infrastructure data, EV charging stations, parking rates & fees data etc.
	Public transport accessibility	It refers to the ease and convenience with which individuals can access and utilise public transportation services within a given area or region. It encompasses various factors that influence the availability, affordability, and convenience of public transportation options for residents, visitors, and commuters. These	Accessibility features data (wheelchair, ramps, lifts etc), accessible fare options data (reduced fares, discounts, free travel scheme etc), station and stops accessibility data (platforms height &boarding areas) etc.

		factors may include the proximity of public transit stops or stations to residential areas, workplaces, commercial centres, and other destinations, as well as the frequency, reliability, and coverage of public transportation routes and services	
Dynamic mobility related data product offering	Real-time public transport	It refers to dynamic information about the status, location, and performance of public transportation services.	Data on vehicle location, arrival & departure time of PT fleet, occupancy levels data, service alerts & notifications data etc.
	Traffic data	It refers to the collection and analysis of information about the volume and flow of vehicles on roads, streets, highways, and other transportation corridors.	Traffic flow data, traffic speeds data, data on congestion levels, real-time incidents & accidents data etc.
	Multimodality	It refers to real-time information that captures the usage, interactions, and integration of multiple modes of transportation within a transportation network.	Real-time transit updates, bikeshare availability, rideshare availability, real-time trip planning etc.
	Parking management	It refers to dynamic information about parking availability, pricing, regulations, and enforcement, all presented in real-time	Parking availability, EV charging stations availability, dynamic pricing, parking reservations, parking facility status, parking violations alerts etc.
	Road transport infrastructure	It refers to dynamic information about the condition, operation, and performance of roadways and associated	Roadways conditions, incident reports, work zone alerts, road weather information, bridge and tunnel status

		infrastructure, presented in real-time.	information, traffic signals & signs etc.
Environmental related data product offering	Air quality	It refers to information collected and analysed to assess the level of pollutants and other contaminants present in the atmosphere. This data product offering includes measurements of various air quality parameters such as concentrations of pollutants coming from transport modes.	Air quality index (AQI) data, Particular matter (PM10, PM2.5) data, Volatile Organic Compounds (VOCs) data etc.
	Noise measurements	It refers to information collected through monitoring and measuring the levels of noise generated by transportation activities such as road traffic, railway operations, aircraft movements, and maritime vessels.	Traffic noise levels data, rail noise level data, noise mapping data, noise standards and regulations compliance data etc.
	Meteorological data	It refers to information related to weather conditions and atmospheric parameters that can impact transportation operations, safety, and infrastructure.	Temperature data, precipitation data, wind spread and direction data, humidity and visibility data, thunderstorm activity data etc.
Mobile phone data product offering	Mobile phone data	It refers to information collected from mobile devices such as smartphones and tablets that can provide insights into travel behaviour, transportation patterns, and mobility trends.	GPS data, Cellular network data, App usage data, mobile payment data, location-based services (LBS) data etc.

About 90% of the DPOs in this project will offer mobility related data, which is not surprising for a mobility data space. The bigger part of the DPOs covers static data, while a slightly smaller part covers dynamic data (Figure 25). The data space will thus need capabilities to handle both data types. Especially the dynamic DPOs might entail specific requirements. The Lisbon implementation site, for example, will need a high update frequency for their use case (each 10 to 20 seconds). Both the static and dynamic mobility related DPOs cover a wide range of subdomains, but in both cases the public transport data has the biggest share, followed by road infrastructure and shared mobility (Figure 26).

The second category is environmental data, which aptly reflects the link between the mobility and environmental domain and the impact these two domains can have on each other. The efficient movement of people and goods, when optimised, can significantly reduce carbon emissions, improve air quality, and contribute to a more sustainable and liveable planet. Data space technology plays a pivotal role in strengthening this link by enabling the analysis of travel patterns, optimising routes to minimise fuel consumption and emissions, and facilitating the development of eco-friendly public transportation systems. Barcelona, Sofia, and Stockholm will implement at least one use case that combines data products with a mobility and environmental scope (Figure 26).

90% of DPOs contain either static or dynamic mobility related data, of which public transport data has the biggest share, followed by road infrastructure data and shared mobility data. Several implementation sites combine mobility data with environmental data, which stresses the need and opportunity for cross-domain interoperability, for example through other sectoral data spaces.

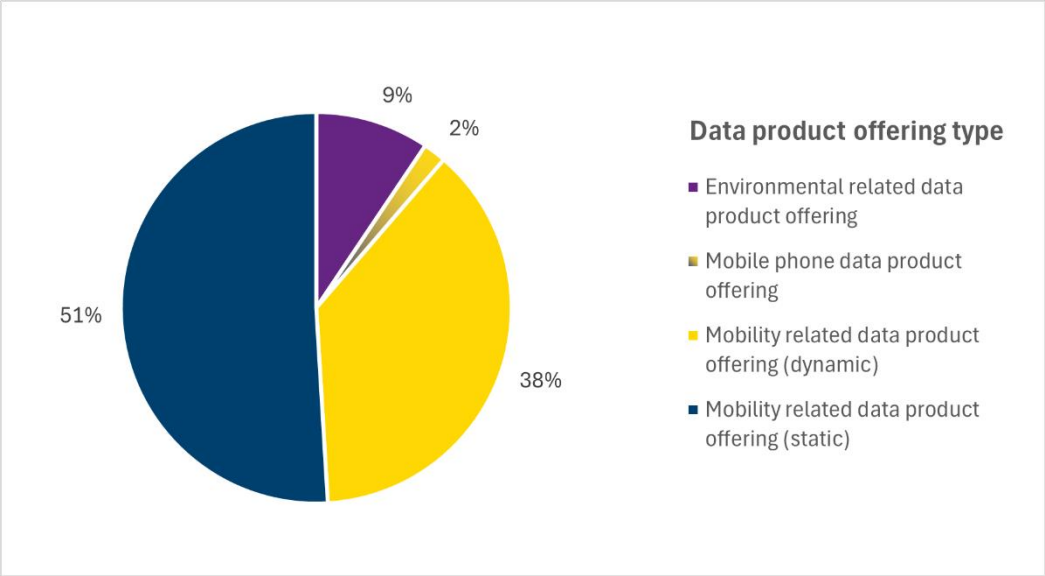


Figure 25 - Percentage of DPOs per scope category

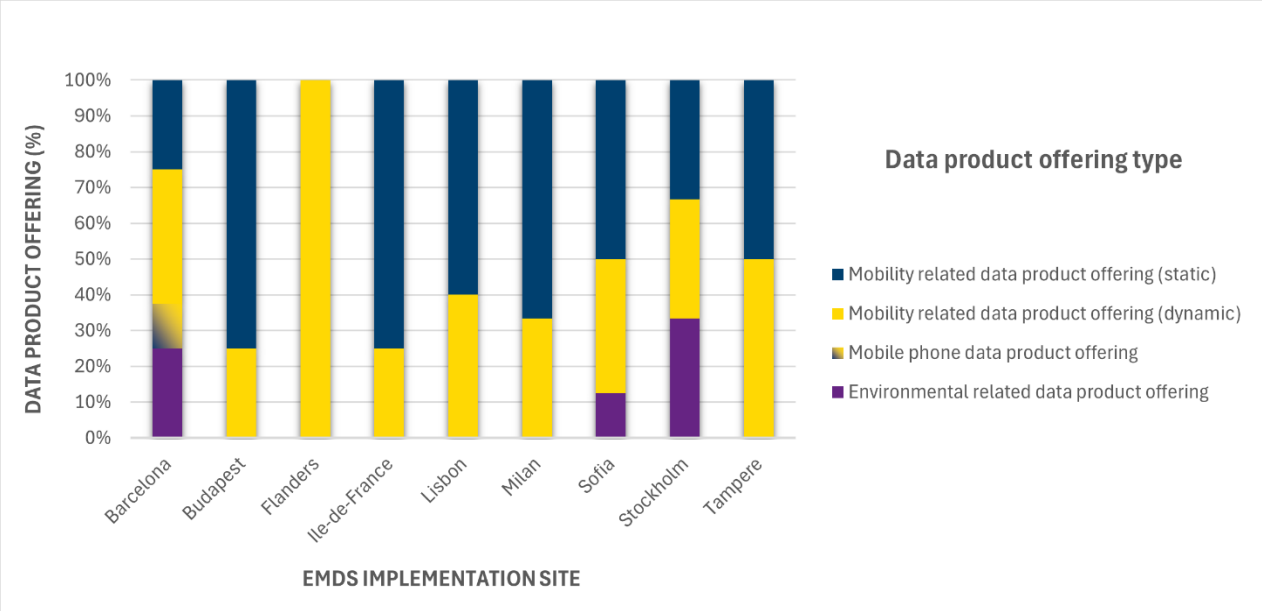


Figure 26 - Percentage of DPOs per scope category and implementation site

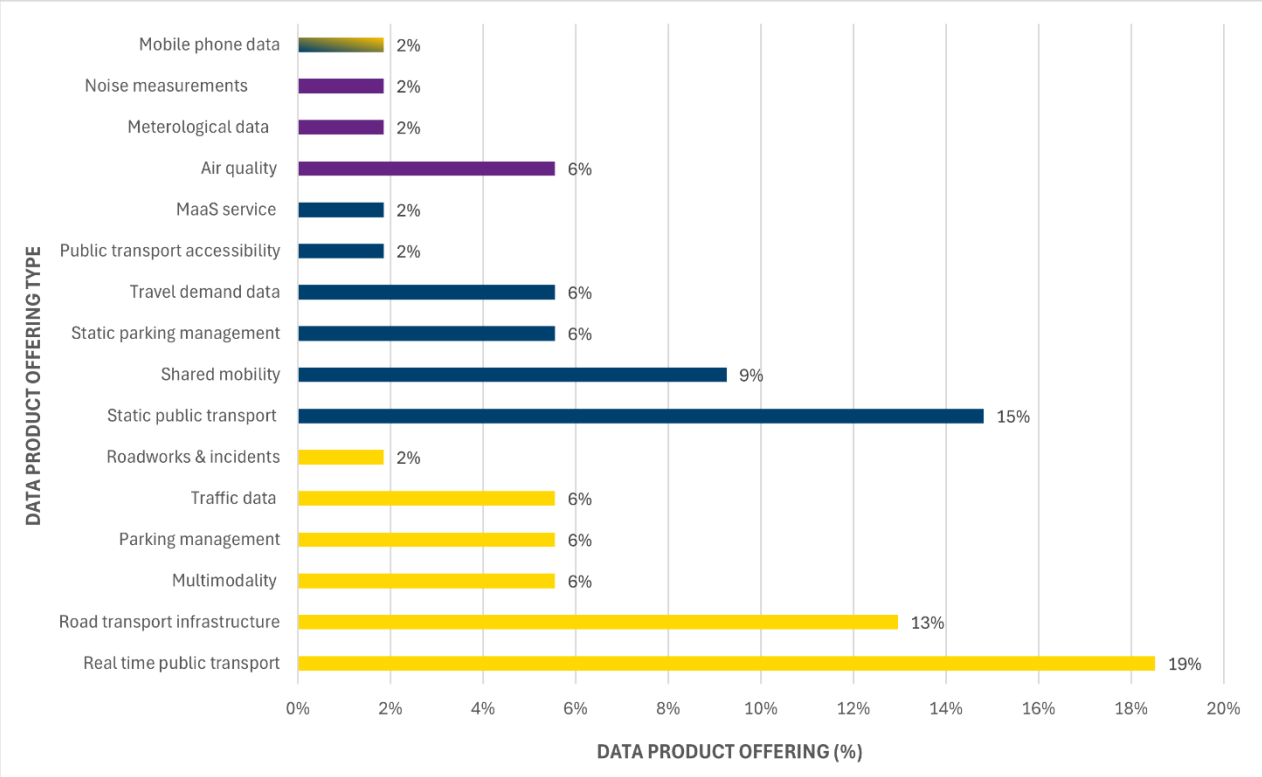


Figure 27 - Percentage of DPOs per scope subcategory

4.2.4 Ownership

A final aspect that was analysed with regard to the use case requirements is who owns the data. This analysis is, unlike the previous sections, not done on the level of DPOs, as one DPO can contain multiple data sources and thus also multiple data owners. Therefore, this analysis is on the level of data sources and the full data source overview can be found in Annex 2. The ownership of data is an important aspect for use case requirements as it determines the ecosystem that is involved in the project. In this deliverable, the analysis is limited to the question whether the data owner is a partner in the project consortium. The deployEMDS project consortium consists of almost 40 partners, but according to Figure 28, these partners only own around half of the data that will be onboarded in the data space. In Figure 29 we can see that all implementation sites must deal with external stakeholders; and in some cases, i.e., Flanders and Ile-de-France, the data is exclusively owned by external stakeholders. This means that all implementation sites must invest time and resources in external stakeholder management in the subsequent phases of the project.

The involvement of external data owners will also have an impact on the governance and onboarding of the DPOs in the data space. In section 4.2.1 it was already mentioned that it is challenging for the local consortia to define the governance model of the DPOs, which can be explained by the high involvement of external stakeholders. For the onboarding, this means that a lot of consortium partners will act as a data intermediary and onboard the data to the data space on behalf of the external data owners. Therefore, both in WP2 and WP3, extra attention should be devoted to the involvement of external stakeholders in this project.

The involvement of so many external stakeholders can have multiple benefits that align perfectly with the communication, dissemination and exploitation strategy goals (see deliverable D5.1):

- Increase impact by raising awareness and understanding of the project goals and achievements among stakeholders.
- Ensure engagement and adoption of results by different stakeholders.
- Pave the way for the exploitation of the solutions developed and validated within the project by disseminating information to the wider public.
- Promote deployEMDS as a reference project in the field of the EU Sustainable and Smart Mobility Strategy, especially where real-life implementation of data spaces is concerned.
- Stimulate dialogue in the community, as well as build on other large undertakings in mobility data and smart cities.

To reach these goals, findings from the present deliverable should be disseminated to external stakeholders. The communication activities (via project website, social media, newsletters, etc.) carried out as part of work package 5 (WP5; activities on communication, dissemination, exploitation and stakeholder engagement), and especially workshops and webinars at implementation site level, will be useful in this regard. Similarly, WP3 activities around developing sustainable stakeholder collaboration models and governance mechanisms can help achieve the goals listed above.

Almost 40% of the data sources is owned by external stakeholders, which entails consequences for DPO governance and onboarding, but also for communication and dissemination.

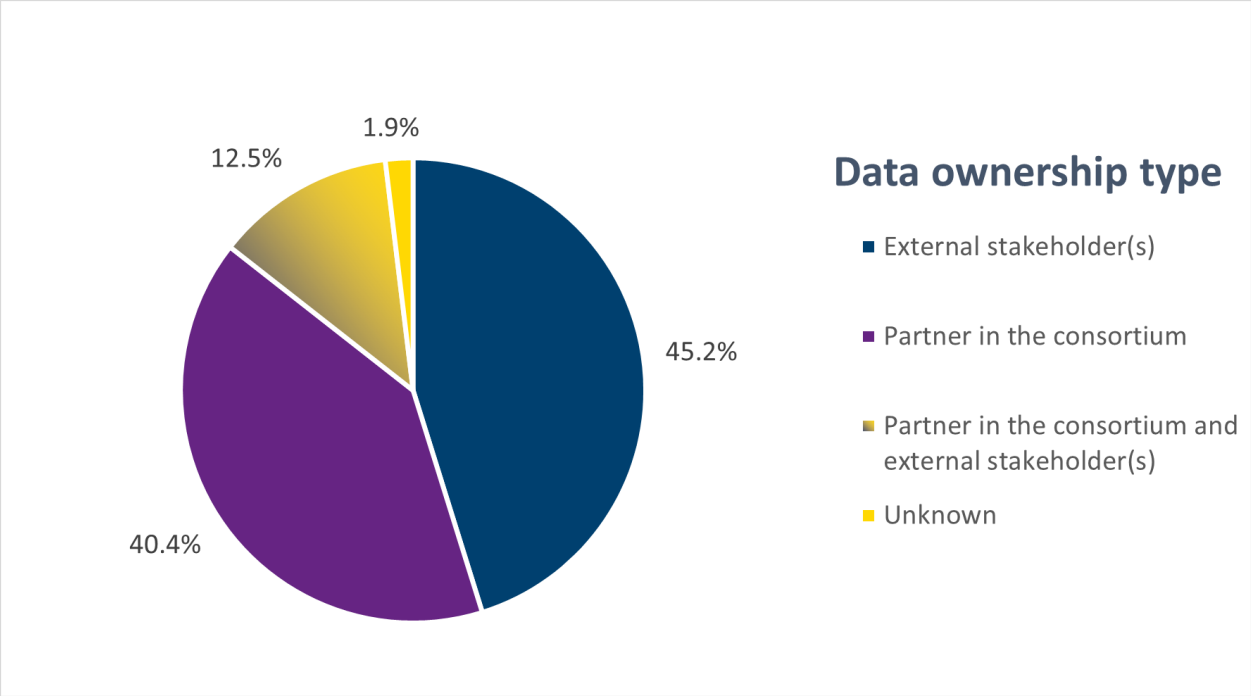


Figure 28 - Percentage of data sources per data ownership type

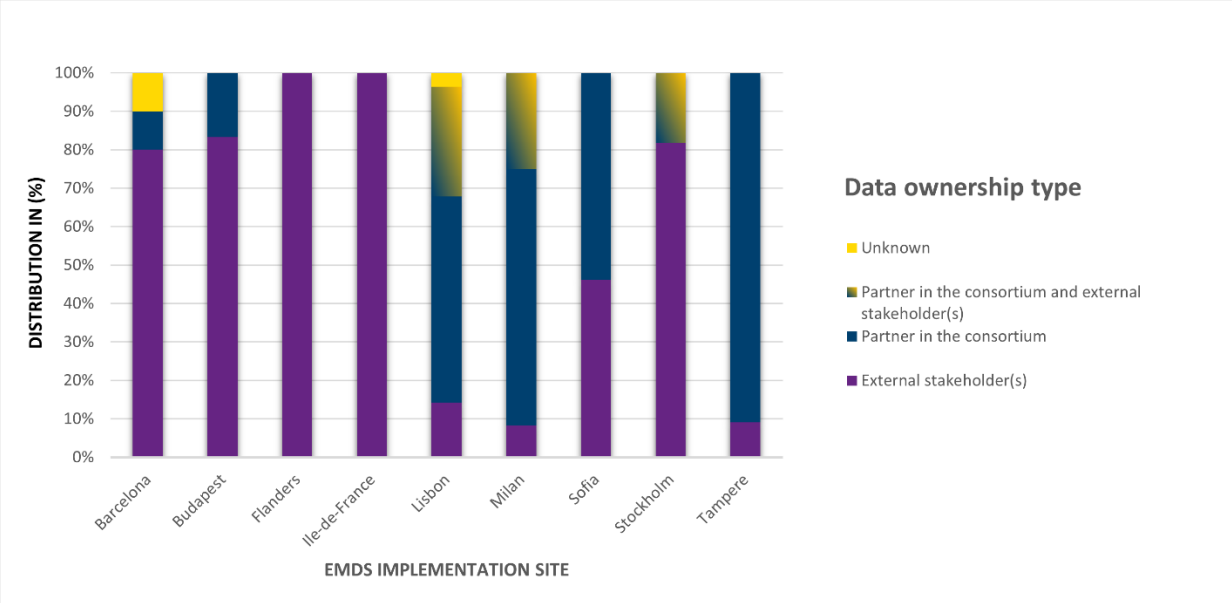


Figure 29 - Percentage of data sources per data ownership type and implementation site

4.3 Takeaways from the intake canvas process

This section highlights the practices and achievements recognised during the canvas sessions across various local implementation sites, showcasing the competence and dedication within this project, but also highlighted risks and dependencies. These insights are presented as takeaways to inspire the consortium and underscore the innovative potential present in the project's community.

4.3.1 Use case refinement

As became clear in the requirements section, the use cases and their DPOs will need further refinement in the next phases of the project. The canvas intake practice at times kickstarted that refinement process. Local consortia were stimulated to set objectives, sort out their data sources, contact external stakeholders and identify risks. The intake process particularly challenged the local consortia to think of their use cases in data space terms and sometimes to rethink their component architecture. In Barcelona, for example, the canvas intake process ignited the consortium partners of use case 1 to re-evaluate their approach towards a local implementing of the deployEMDS data space. These revisions prompted adjustments in the local implementation strategy and fostered a renewed perspective on the interaction between deployEMDS and local stakeholders. Consequently, partners revised their context diagram to reflect these changes, establishing a new blueprint for their local architecture. This instance illustrates how the canvas sessions were instrumental in enhancing their understanding of EMDS's potential impact on the local implementation.

4.3.2 Value proposition

The canvas exercise showed that every site is different from one another in many aspects; however, Lisbon, Stockholm, and Budapest all share a common approach to deployEMDS that is worth noting in this takeaway section. All three are planning to share besides readily available data products, including data products or services that they generate themselves (based on other data products that might be offered in the deployEMDS data space). In the case of Lisbon, a travel time disruption severity index will be calculated for use case 3, based on the real-time bus position and the timetables (also DPOs in the deployEMDS data space). Lisbon will use this index in its own platform and will also publish the index on the data space as an open data product for other stakeholders to use. The Stockholm implementation site is conducting a study on the reusability of the intermediate data transformations that make their data products. The goal is to publish the intermediate data sets on the data space to create a mobility ecosystem where start-ups enjoy the same data inclusiveness as institutional participants. In the Budapest implementation site, they are not only looking towards the data space to publish custom data products, but also to scale up their service offering. In their third use case, they will develop the MaaRLiM platform, which uses information about special functionalities in public transport vehicles to generate routes for people with limited mobility. What makes this use case interesting is the vision of providing the same service(s) to other interested cities in the EU or in the deployEMDS consortium, provided the latter can feed them the data. An example would be to ingest data from for example Barcelona via the data space and output back a route via the data space again. All three implementation sites show how value can be added to the data space, either by offering data products that are customised for the deployEMDS data space and ecosystem or by offering services through the data space, that cannot be found through other data sharing initiatives. These examples will enrich the data space and distinguish it from other data sharing initiatives, making it interesting for other participants to join.

4.3.3 Data models

In this deliverable a considerable amount of attention is paid to data models and standardisation (see section 6), as the EMDS might be an enabler for standardisation. Interoperability is an important building block of any data space, but in the mobility domain, several specific initiatives exist that aim to foster interoperability, such as the ITS Directive (see also section 6). As the deployEMDS project brings together more than 100

data sources from nine regions in this domain, it can play a significant role in the standardisation of mobility data. This role has not been defined yet, but the EMDS might be inspired by the implementation sites in this first deployment project. Additionally, metadata and information model standardisation should also be considered, as technical interoperability is often driven by metadata and information model mapping, especially when connecting multiple different data platforms or data spaces with each other. The re-use of existing European metadata model standardisation efforts that have been executed by NAPCORE, such as MobilityDCAT-AP,[27] might facilitate this technical interoperability. Flanders, in particular, stands out for its proactive approach to building a local mobility data space (as part of the Flanders Smart Data Space) with a keen focus on standardisation. Recognising early on the necessity of standardisation for effective data exchange, Flanders concentrated efforts on establishing data models and standardised transmission protocols as core components of their local data space. This endeavour involved significant effort in defining specifications and application profiles for traffic count data, which was previously unstandardised in Flanders. Through initiating discussions to categorise transportation modes, directions, locations, etc., they developed the OSLO traffic measurements data model, now essential for integration into the data space. Opting for a linked data transferring protocol (LDES) ensured consistent data exchange. Flanders' strategic approach shows that standardisation does not have to be an obstacle but can also serve as a catalyst for innovation. The mobility standards working group within deployEMDS will have to refine these data model requirements in the subsequent project phase, in close cooperation with NAPCORE, stakeholders from the different implementation sites and the WP3 on governance.

4.3.4 Peer learning

As section 4.2.2 showed, several implementation sites (will) have a local data space in place. Consequently, these sites have a good understanding of the data space concepts and terminology, but also about the possibilities and risks. Flanders was already mentioned, but also the Sofia implementation site had already initiated a local data space through GATE. This clearly gave Sofia an advantage during the canvas intake process, as many answers were readily available. Additionally, Île-de-France has quite a strong position in the map of the deployEMDS project as one of the sites that had already embraced data spaces. Having Eona-X as a technical actor clearly gives them an advantage related to the technical implementation process. During the canvas intake Eona-X assured the other partners of the local consortium to assist them in their digitalisation process and with a smooth federation of the data product offerings from their local data space to the European mobility data space. In addition, because of the established reputation of Eona-X as a deployed data space, they can attract promising private sector stakeholders, such as Renault group. The experience of these implementation sites can aid other implementation sites in understanding the value of data spaces. Moreover, the capabilities of the deployEMDS data space may be more impactful when demonstrated by peers (such as fellow public transport authorities, city administrations, service providers, etc.) who have firsthand experience with the challenges, rather than when explained by data space technology providers. Eona-X gave an inspiring webinar in the first month of the project, and this way of knowledge sharing and building between implementation sites should be continued throughout the project.

4.3.5 Other data sharing initiatives

Not all implementation sites may have a local data space, but all of them have some kind of data sharing platform, hub, or initiative in place. These initiatives were not considered during the intake process, but they play an important role in the local ecosystem and often form the base of data exchange today, especially for open data. While it is not strictly defined how the future EMDS should interact with these existing platforms, the local consortia need to take this into account and must be able to position the data space developed as

[27] https://mobilitydcat-ap.github.io/mobilityDCAT-AP/releases/1.0.0/index.html

part of deployEMDS in relation to these platforms. The Milan implementation site provided a notable example of a local digital sharing initiative (E015), which supports the publication of data source descriptions in a shared catalogue and already has been fostering the creation of data exchange relationships between data owners. Hence, the Milan site enthusiastically looks forward to having the governance of deployEMDS consider the availability of this initiative and of the Italian MMTIS RAPs/NAP (Regional/National Access Points) related to the Commission Delegated Regulation (EU) 2017/1926 and its revision recently published (2024/490 of 29 November 2023). The main goal – as the Milan implementation site states – is to avoid duplication of effort in different data-sharing initiatives related to the same data sources. This concern lives in several implementation sites and must be addressed in the next phase of the project.

4.3.6 National Access Points

A specific example of data sharing initiatives are the National Access Points (NAPs), which need to be provided by the EU member states as a provisioning point for mobility and traffic data under the ITS Directive. NAPs play a crucial role in the mobility sector by facilitating access, seamless exchange, and reuse of transport-related data. This support is vital for offering EU-wide interoperable travel and traffic services to end-users, making NAPs significant for mobility data spaces and, by extension, the EMDS. Although the deployEMDS project has not fully delineated the involvement of NAPs or engaged all relevant NAPs at the time of writing this deliverable, Tampere's implementation site is a notable exception. Three NAPs are actively involved in the project. *Fintraffic*, the Finnish NAP, and *Trafikverket*, the Swedish NAP, actively participate in the project, and influence the local implementation strategies for Tampere and Stockholm, respectively. On the other hand, *BASt*, responsible for the German NAP, follows the project's progress as an associated partner to ensure the link with NAPCORE, and will co-organise workshops on European-wide governance of mobility data in WP3. This active involvement not only demonstrates the initiative NAPs can exhibit in the digital transformation towards data spaces but also highlights how diverse mobility stakeholders can converge within these data spaces.

5 Standards and data models

In this section the current (Figure 30) and future (Figure 31) data models of the data sources are analysed, which relates to questions 8 and 13 in the intake canvas. This analysis, similar to the one on data ownership (section 4.2.4), is performed on data source level instead of DPO level, as a data model is inherent to the data source. This section considers the specific data models mentioned in the canvas, while the next section looks at the general building blocks needed to accommodate these data models. Figure 30 shows that the majority of data sources that will be onboarded are not standardised yet. The data model that occurs most frequently is GTFS and GTFS-RT, which can be explained by the high occurrence of public transport data, followed by DATEX-II, GBFS, WMS/WFS and NeTEx. Several implementation sites plan to implement a data model or convert to another data model within the next five years. Although for most data sources the future data model is unknown, the DATEX-II and NeTEx models are gaining significance. Additionally, new data models will be introduced, such as OSLO, SIRI, Fiware Smart Data Models and OpRa. The Sankey diagram of the data model conversions (Figure 32) shows that four data sources from GTFS and one from Liipi will be converted to NeTEx. Four data sources will be converted from GTFS-RT to SIRI and one to OpRa. Twenty data sources that now have no standard will be converted to OSLO, DATEX-II, GBFS/MDS, and Fiware Smart Data Models.

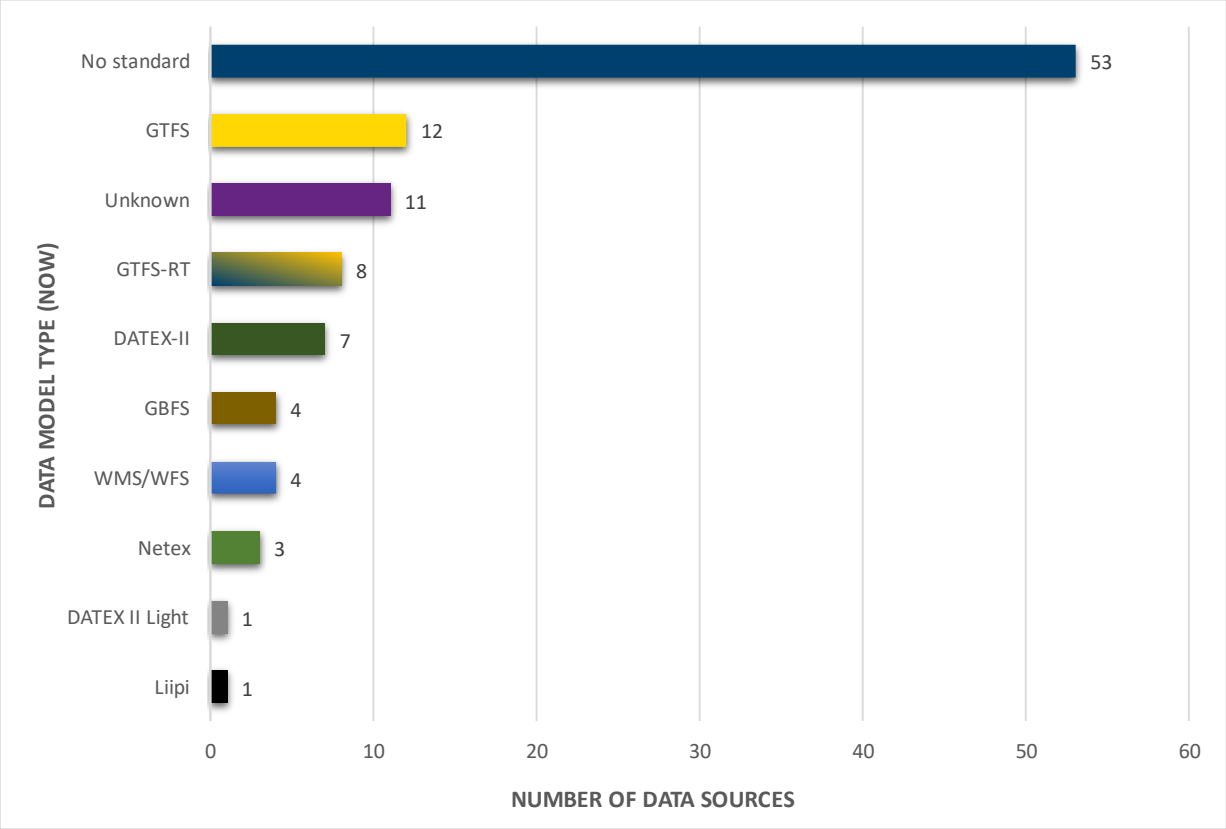


Figure 30 - Number of data sources per data model type as of today

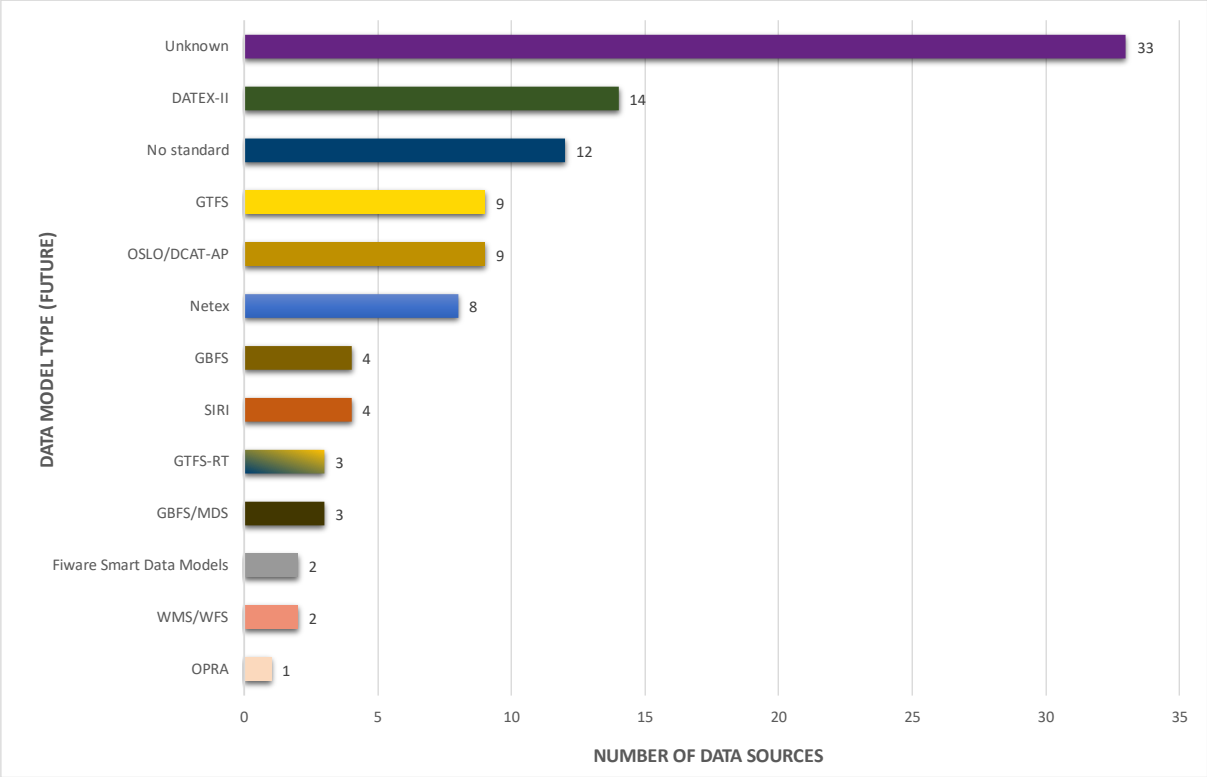


Figure 31 - Number of data sources per data model type as planned (within 5 years)

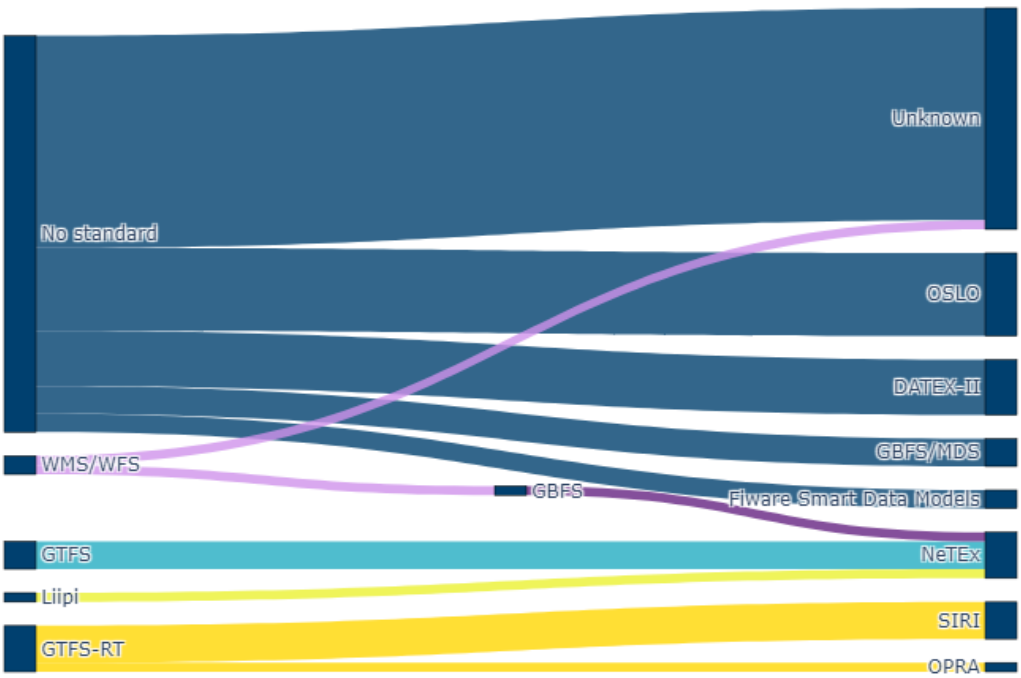


Figure 32 - Sankey diagram of the planned data model conversions

To organise and describe the standards and data formats mentioned by the implementation sites in their intake canvases, they have been divided into categories based on their primary focus or application domain. Some of these standards are specifically recognised as European standards under the Intelligent Transport Systems Directive (ITS)[28] or its Multimodal Travel Information Services (MMTIS) delegated Regulation[29]. An overview of these standards and data formats is available in Table 48, along with indications on whether they are specifically listed in the ITS Directives and its Delegated Regulations. Note that this is not meant to be an exhaustive list of data models, standards, and formats in the wider mobility domain. The list merely aims to offer more context to those presented as either a current or planned data format by the pilot implementation sites in their use case requirements canvases.

Table 48 - Overview of standards and data models mentioned by the implementation sites

Category	Abbreviation	Description	Listed in ITS Dir.
Traffic data	DATEX II	A European standard for the exchange of traffic and travel information in the transport domain. It supports ITS applications and is part of the ITS Directive. It is designed to facilitate the exchange of data between traffic management centres, service providers, and other information users.	**YES**
Public transport	GTFS	The General Transit Feed Specification is a common format for public transportation schedules and associated geographic information. GTFS enables transit agencies to publish their data and developers to write applications that consume that data in an interoperable way.	**NO**
	GTFS-RT	An extension of GTFS that allows public transportation agencies to provide real-time updates about their fleet to application developers.	**NO**
	NeTEx	Network Timetable Exchange is a European standard for exchanging public transport schedules and related information. It complements GTFS by offering more detailed data representations, especially for complex public transport systems.	**YES**
	SIRI	The Service Interface for Real Time Information is a European standard that defines a protocol to allow real-time information to be exchanged between different transport information systems.	**YES**
Shared mobility	GBFS	The General Bikeshare Feed Specification is a standardised data format for sharing information about the availability of bikes in bike-sharing systems. It enables users to find and use shared bikes and scooters.	**NO**

[28] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32010L0040
[29] Delegated regulation - 2017/1926 - EN - EUR-Lex (europa.eu)

	MDS	The Mobility Data Specification was developed by the Los Angeles Department of Transportation (LADOT). MDS is a set of data specifications and data sharing requirements for dockless (free-floating) scooters, bicycles, and car share systems. It is not a European standard but is influential in managing micromobility services worldwide.	NO
Parking management	HSL Liipi	Liipi is a service designed to support park and ride solutions in the Helsinki region. It provides important information about parking facilities near public transportation hubs. The service is utilised by HSL, parking operators, roadside displays, and third-party applications. The API supports various operations, including searching for facilities, getting facility details, and updating facility utilisation, making park and ride options more accessible and efficient for users.	NO
GIS & Mapping	WFS / WMS	The Web Feature Service and Web Map Service standards were defined by the Open Geospatial Consortium (OGC) for serving georeferenced map images and spatial data over the internet. They are not part of the ITS or MMTIS Directives but are widely used in various applications including mobility and logistics.	NO
	OSM	OpenStreetMap is a collaborative project to create a free editable map of the world. While not a standard per se, it is a widely used source of geographic data for various applications, including transportation planning and services.	NO
Generic data models	OSLO	Open Standards for Linked Organisations is an initiative by the Flemish government in Belgium, aimed at developing a set of open standards for data exchange and interoperability between organisations. It is not exclusively focused on transportation, but specific application profiles in the mobility domain exist, such as for traffic signs[30] or traffic counts[31].	NO
	Fiware Smart Data Models	Part of the Fiware ecosystem, these models provide a standardised way to describe smart city and IoT (Internet of Things) data, enabling interoperability among different systems and applications. While not directly under ITS or MMTIS Directives, they are still relevant for smart transport systems as several of the provided semantic models relate to the greater mobility domain, such as parking[32] or public transportation[33].	NO

[30] OSLO Standaardenregister – Applicatieprofiel Verkeersborden | Vlaanderen.be
[31] OSLO Standaardenregister – Applicatieprofiel Verkeersmetingen | Vlaanderen.be
[32] GitHub - smart-data-models/dataModel.Parking
[33] GitHub - smart-data-models/dataModel.UrbanMobility

Among these, DATEX II, NeTEx, and SIRI are explicitly recognised as part of the European ITS Directive and the MMTIS Regulation. These standards facilitate the exchange of transport, traffic, and travel information across various platforms and services within Europe, promoting interoperability and efficiency in public transport and mobility services. The others, while not explicitly part of these directives, play significant roles in the broader ecosystem of transportation and mobility data sharing, geographic information systems, and smart city applications. Nevertheless, all of these will have to be supported by the data space in some way.

Most data sources are not standardised today; the GTFS(-RT) data model has the highest occurrence. Data models that are explicitly recognised as part of the European ITS Directive and the MMTIS Regulation (DATEX-II, NeTEx and SIRI) will gain weight in the next five years, but also new data models will be introduced (e.g., OSLO and Fiware Smart Data models). The data space needs to accommodate these changes.

6 Technical requirements

6.1 Preliminary remarks

The requirements for the deployEMDS data space are derived from two primary sources: specific needs highlighted through the data product offering intake surveys and the adoption of best practices from other projects within the European data space realm. When needs are identified via intake surveys, the coverage is measured by their impact on the number of data products described by the local consortia. The coverage might be useful in a later stage to prioritise requirements that can accelerate the deployment of EMDS. In addition to the intake surveys, existing data space frameworks and similar implementations were examined to identify *best practices*. Therefore, these complementary requirements were not quantitatively assessed and can be distinguished into two categories:

- “State-of-the-Art", which refers to the implementation of best practice solutions and workflows from data space projects of a similar breadth of scope.
- "Best-Fit" acknowledges that not all advanced solutions from other projects will be suitable for deployEMDS. It focuses on selecting approaches that, while not necessarily ground-breaking or proven in other contexts, are deemed the most appropriate for meeting the unique challenges and objectives of the European Mobility Data Space.

The column “Rationale” in the requirements specification tables of Section 6.2 below summarises this by either showing the coverage in percentage or showing how many of the submitted DPOs supported this requirement. For the complementary requirements that have no measured coverage, the column indicates which of the two aforementioned categories (“State-of-the-Art” or “Best-Fit”) they belong to.

Together, these strategies for incorporating direct requirements from DPO intake surveys and adopting best practices from the broader data space ecosystem form a comprehensive framework for ensuring the continuous improvement of the European mobility data space.

6.2 Requirements specification

6.2.1 ID Binding

This section gathers the requirements for unique participant identification. An ID Binding is the relationship that a participant in a data space has to an entity or a group of entities in the real world. Bindings are linked with exclusive self-identifiers.

#	ID binding	Requirement	Rationale
IDB.1	ID binding	Every Participant must have, at least, one identifier.	25% coverage
IDB.2	ID binding	Participants can unequivocally establish the real-world entity bound to an identifier via a mechanism provided by the data space.	48% coverage

IDB.3	ID Binding: Legal person identifiers	Identifiers are attributed to a legal person (i.e., an organisation or company), or natural person as a legal representative or legal representative without legal entity (i.e., public administration employees).	48% coverage
IDB.4	ID Binding: Organisation identifiers	Data intermediaries have unique identifiers. The identifier is legally associated to the DISP[34] that provides data intermediation services.	38% coverage
IDB.5	ID Binding: EU standards	Identifiers must have legal and contractual value. The identity issuing authority(-ies) must be recognised cross-border for the whole participating demographic.	12% coverage

6.2.1.1 ID Binding notes:

- IDB.1: Not enough information about uniqueness of identifiers. This is likely a choice for the data space governance workgroup.
- IDB.2: The Trust Framework provides such a mechanism.
- IDB.3: No requirement exists, to date, to allow end-users or natural persons to directly participate to the data space.
- IDB.4: Not enough information to restrict use to EU's registered DISPs.[35]

6.2.2 Identification and authorisation

This section present the requirements for self-description, including the minimal set of characteristics that need to be defined in a Self-Descriptor. Identification and authorisation refer to the capacity to univocally identify participants and verify their claims to provide a service or grant access to a Data Product.

#	Identification and authorisation	Requirement	Rationale
IDC.1	Identification: Self-descriptors	Participants describe themselves using standardised, machine comprehensible metadata (self-descriptor) in their Identifiers. Self-Descriptors comprise one or more Verifiable Credentials.	85% coverage
IDC.2	Identification: minimal Self-Descriptors	Self-Descriptors should contain at least: 1. Organisation legal name. 2. A list of common names (FQDN) of the Connectors' endpoints. (at least one resolvable address must exist). 3. Country of registration.	48% coverage (cumulative)

[34] https://digital-strategy.ec.europa.eu/en/policies/data-governance-act-explained#:~:text=The%20DGA%20defines%20a%20set,the%20common%20European%20data%20spaces.
[35] https://digital-strategy.ec.europa.eu/en/policies/data-altruism-organisations

		4. Country of operation. 5. City of operation. 6. E-mail or contact. 7. Issuance of identity (e.g., issuer, CA, validity, ...) 8. A list of Credentials.	
IDC.3	Interoperable presentation	Identifiers should support existing identity frameworks that are in use by some Participants: EONA-X interoperability (SSI/VC) VSDS interoperability (SSI/VC) GAIA-X compliance registry	18% coverage
IDC.4	Interoperable presentation	Self-Descriptors and their Issuance and Verification mechanisms must support best practices like: 1. Avoid information leakage when presenting authorisation claims. 2. Provide nonrepudiation. 3. Use well known mechanisms to implement presentation and authentication flows. 4. Use well known mechanisms to avoid identification misconfiguration in connectors and data space components. 5. Provide identity provisioning and lifecycle, including deprovisioning.	State-of-the-Art
IDC.5	Participant Registry	Participants' Self-Descriptors must be discoverable and consultable through a global addressing mechanism. Depending on the implementation of Trust Framework, the Participant Registry might take the form of: 1. A DID network de-referencing DID Documents stored on a trusted medium (e.g., a blockchain, an IDP, or a federation of Identity Hubs) 2. A federation of registries, binding the descriptors to their local IDPs, as iSHARE does. 3. A centralised IDP	State-of-the-Art

6.2.2.1 Identification and authorisation notes:

- IDC.2: The list is not extensive and is limited to a non-representative group of use cases. The Identifier definition should be extensible to avoid refactoring.
- IDC.3: Another relevant framework is that of the German MDS (IDA IdentityProvider/DAPS). It is not mentioned in the intake canvases, as MDS did not participate, but will be considered.
- IDC.4: Required by two projects (Île-de-France and Flanders)

- IDC.5: The requirements we gathered are not sufficient to determine whether the Participant Registry will be a full-fledged building block or if it will be embedded in a technology implementation of decentralised credentials. Whatever the choice, one must consider the interoperability of identifiers, given that the deployEMDS data space aims to be compatible with other data spaces. Option 1 is the most likely choice.

6.2.3 Trust Anchor

This section presents the requirements on the certification authorities. The Trust Anchor is the authoritative entity for which trust is assumed and not derived.

#	Trust Anchor	Requirement	Rationale
TA.1	Data Space Trust Anchor	The deployEMDS data space requires at least one Trust Anchor as the authority that signs Verifiable Credentials or certificates used to sign Verifiable Credentials. The Data Space Trust Anchor is maintained by the data space authority.	State-of-the-Art
TA.2	Interoperable Presentation	The Trust Anchor must support SSI/VCs. The Trust Anchor should be endorsable by GAIA-X (federation).	18% coverage
TA.3	Trusted Issuers certificates	The Trust Anchor validates the certificates that Trusted Issuers use to sign Verifiable Credentials on behalf of other Participants.	State-of-the-Art

6.2.3.1 Trust Anchor notes:

- TA.1: We didn't find compelling requirements to either centralise or de-centralise the Data Space Trust Anchor(s). Instead, we have chosen to define a root Trust Anchor that delegates to other Anchors for purposes of issuance and validation.
- TA.2: We haven't gathered enough information to single out the framework to implement the Data Space Trust Anchor. However, considering that interoperability with EU Data Spaces is a requirement, we advise choosing a Trust Anchor scheme that supports SSI/Verifiable Credentials[36].

[36] https://en.wikipedia.org/wiki/Verifiable_credentials

6.2.4 Onboarding and participation

This section presents the requirements on the application and certification of participants and describes the necessary steps in the registration process. This is the capability that creates a participation relationship with a data space, and that screens Participant´s eligibility according to the data space's business or governance criteria.

#	Onboarding and participation	Requirement	Rationale
ONB.1	Application Process	Aspiring Participants are required to undergo an application process (i.e., submit a Participation Request to the data space), before receiving an Identifier. The aspiring Participant must provide enough trustable information to build a Self-Descriptor.	74% coverage
ONB.2	Application Process	Data intermediaries act on behalf of their Data Product Owners, onboarding them on the data space and requesting for them an Identifier.	74% coverage
ONB.3	Application Process	The Participation Request is carried out on an Onboarding Portal that provides an interactive user interface and an API with equivalent capability to allow orchestrated onboarding. The Onboarding Portal should not be open, rather it requires a Participation Request subscription account, to avoid spurious usage or DoS attacks. The Onboarding Portal is maintained by the data space authority.	State-of-the-Art
ONB.4	Verification Process	During onboarding, at least the following verifications must take place: 1. Identification of Data Product Owner. a. Verification of legal person i. Company registration number or VAT ii. Proof of registration of association/agency b. Verification of legal representative (if any). c. Verification of Connector's availability. 2. Country of operation. 3. Purpose and nature of Participation.	48% coverage
ONB.5	Verification Process: Cross-	Verification of the Participation Request requires interaction with national bodies to verify a legal person's existence and eligibility.	State-of-the-Art

	border verification	Either deployEMDS delegates verification to a cross-border entity, or it delegates national deployEMDS representative to carry out verification within their national border. Solutions that implement a cross-border verification might be: 1. GAIA-X Compliance within GAIA-X Framework 2. EIDAS Digital identity with Advanced Electronic Signature.	
ONB.6	Participant registration	Once the verification steps are completed, the Onboarding Portal delegates a trusted service to: 1. Create a new Self-Descriptor, provide the necessary cryptographic material. 2. Store the Self-Descriptor in the Participant's deployEMDS Wallet or IDP (depending on the implementation of Trust Framework). 3. A new record in the Participant Registry is created, de-referencing the newly crafted Self-Descriptor of the Participant. The Onboarding Portal must return both the Self-Descriptor reference and signature certificate to the Participant.	State-of-the-Art
ONB.7	Participant Registry: Connector binding	The Participant Registry is used to resolve the Participant's connector instances.	Best-Fit
ONB.8	Simplified Trust of Participants	Participants that successfully registered are automatically considered as Trusted Participants.	Best-Fit

6.2.4.1 Onboarding and participation notes:

- ONB.1: Not enough information to ascertain who will define and manage the Application Process. It is likely part of the deployEMDS governance work package.
- ONB.2: For this requirement, the implementation of the Legal Representative Identifier is a core requirement.
- ONB.3: The mechanisms to provide access to the Onboarding Portal are out of scope here; they are rather defined in the implementation phase.
- ONB.4: The exact mechanisms required for verifying the legal representative are as yet unknown and require further investigation in the implementation phase.
- ONB.5: Almost all Projects designate national Participants.
- ONB.6: Details of these steps depend on the implementation choice of Trust Framework.
- ONB.7: For instance, if DID is chosen as the URI scheme to resolve identifiers, there will be a DID for each connector.
- ONB.8: Not enough quantitative information to ascertain if implementing the infrastructure to support Trusted Issuers would bring enough return of investment.

6.2.5 Authorisation and Verifiable Credentials

This section presents the requirements necessary for the capacity to issue and verify credentials to data space participants and the capacity to expose only the required amount of information from credentials using an interoperable format that every participant can verify.

#	Authorisation and Verifiable Credentials	Requirement	Rationale
AVC.1	Issuance of credentials	Data Product Owners or intermediaries are allowed to issue Credentials to grant access to their products and manage such credentials during their lifetime. In the case of intermediaries, the Data Product Owner delegates the intermediary as Trusted Issuers to issue Credentials.	48% coverage
AVC.2	Proof of Issuance (Trusted Issuers)	For those use cases where access is restricted by consumer (e.g., subscription), we recommend the introduction of Trusted Issuers notion, to verify that a Participant is entitled to issue credentials that have contractual value when consuming a data product.	60% coverage
AVC.3	Trusted Issuers List	The Trusted Issuer List binds Producers and Consumers when a data sharing agreement has been fulfilled, so that selective access control can be implemented. The Trusted Issuer List contains also trusted public entities which can issue Verifiable Credentials related to a given domain or capability (e.g., a list of Meta Data Brokers). There might be more Trusted Issuer lists in deployEMDS.	45% coverage
AVC.4	Trusted Issuers - Scope of Issuance	A Participant looks up a Trusted Issuer when: 1. Receives a request for a Data Product that they own. 2. Acts as intermediary, looking up the Trusted Issuers list of the Data Product Owner. 3. Provides access services for deployEMDS, like Data Catalog or Clearing House.	Best-Fit
AVC.5	Trusted Issuers - Registration lifecycle	Data Owners (or Producers) have control over: 1. Registration of Trusted Issuers 2. Renewal of credentials 3. Revocation of credentials 4. Retirement of cryptographic keys	State-of-the-Art

AVC.6	Interoperable Presentation - Verification	Credentials must be verifiable across borders, that is: the verification process has no dependencies on Trust Anchors that act solely within a geographic boundary. ID bindings must always be resolvable during the verification of a credential.	State-of-the-Art
AVC.7	EU Standards	The technology stack that implements credentials and their mechanisms should be interoperable with evolving frameworks that support the EU Identity framework: EIDAS credential attestation[37] EBSI VC framework[38] N.B.: Both standards promote Verifiable Credentials.	State-of-the-Art
AVC.8	Interoperable Presentation - Legacy credentials	Projects that implement Data Portals require the following credentials to access their Data Products: 1. Proof of processing data in the country of origin of Data Product. 2. Proof of processing data in the EU. 3. Proof of governmental organisation. 4. Proof of recognised mobility operator. 5. Proof of local account on the legacy system (registration)	48% coverage

6.2.5.1 Authorisation and Verifiable Credentials notes:

- AVC.1: The Data Owner is not necessarily the Producer. A hypothetical example of this could be as follows: one needs a membership to MyCountry's NAP trusted partners to access My Country NAP core data. However, the Data Product is exposed by MyCountry Institute of Innovation. The NAP issues credentials that attest who is a trusted member.
- AVC.4: In practice, all Data Owners should be Trusted Issuers. What changes are: the scope of Issuance (i.e., the Data Products for which a Trusted Issuers has faculty of Credentials issuance), and Self-Issuance or delegation of Issuance to an intermediary.
- AVC.7: Although we don't have access to this information, it's highly likely that the SIMPL[39] initiative will produce deployable components that use these specifications.

[37] https://digital-strategy.ec.europa.eu/en/library/european-digital-identity-wallet-architecture-and-reference-framework
[38] https://hub.ebsi.eu/vc-framework
[39] https://digital-strategy.ec.europa.eu/en/policies/data-spaces

6.2.6 Data sovereignty

This section gathers the requirements that deal with usage control, data sovereignty in general and with policy enforcement.

#	Data Sovereignty, Usage Control	Requirement	Rationale
UC.1	Data Residency	There are no specific requirements for data locality, although the EU regulation for free flow of non-personal data[40] makes clear that national authorities might restrict the flow of non-personal data for security reasons. We advise to localise data as much as possible, and keep its storage and archival on infrastructure that is owned and governed within EU boundaries	State-of-the-Art
UC.2	Access and usage control (and enforcement) policies	A Usage Control Policy framework is required to describe policies, negotiate them, and enforce them upon data usage.	40% coverage
UC.3	Access and usage control policies: Standard formalism	Choose a Policy Definition Language that has sufficient expressivity to cover most of the Usage Control use cases. Two examples: 1. ODRL has been touted as the standard policy language by IDSA. Its model is semantic-aware and is being extended to vertical domains, like Big Data[41]. 2. iSHARE uses “Delegation Language” and XACML (as Fiware does) to implement equivalent levels of control and extensibility.	State-of-the-Art
UC.4	Usage control and enforcement - Standard formalism	A Control Policy language that allows to embed domain extensions is desirable, to implement consistent and auditable Data Usage Control Policies for mobility governance.	Best-Fit
UC.5	Access and usage control policies:	Independently from the Policy formalism, the deployEMDS data space Connector must implement the functionality of a Policy Decision Point (PDP)[42].	State-of-the-Art

[40] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32018R1807
[41] https://w3c.github.io/odrl/profile-bigdata
[42] https://en.wikipedia.org/wiki/XACML

	Policy runtime (PDP)		
UC.6	Access and usage control policies: Policy Enforcement Points (PEP)	Implement policy enforcement points at: 1. Metadata discovery (Selective meta data publication). 2. Data sharing agreement negotiation (Pre-condition auditing and enforcement). 3. Data sharing execution (Transfer request enforcement or auditing).	48% coverage
UC.7	Access and usage control policies: Policy Information Point (PIP)	Choose a framework that can integrate a PIP. A PIP is a source of attributes that the Policy Mechanism uses to complement its rules. Attributes might come from an external system (e.g., an IP geolocation service to ascertain if a Participant is EU-based). The PIP is not a mandatory component, but it might play a role to integrate existing portals, and their usage policies, in deployEMDS. A PIP might come in the form of Credential Verifier to integrate foreign credential formats (see UC.10)	31% coverage
UC.8	Access and usage control policies: Data Usage Control Policy Repository	Participants can re-use templates of Data Usage Control Policies that are available in a shared library or stored in a repository like GitHub. The goal is to provide a common framework that can, for instance, facilitate governance changes stemming from upcoming EU Directives on mobility data.	State-of-the-Art
UC.9	Usage control and enforcement – Local observability	Results of policy negotiation and enforcement are stored in a local log to allow debugging and business observability. No specific format is mandated; we suggest, ad-interim, to dump the output of the Policy Runtime and Policy Enforcement Points. Data space-wide Observability and clearing house role are discussed further. Requirements like retention or log detailed views are out of scope for this analysis.	State-of-the-Art
UC.10	Usage control and enforcement - Polyglot Policies	While not a current requirement, the Integration of existing or future local mobility data spaces could require compatibility with Usage Control Policies expressed in multiple formalisms (e.g., ODRL and XACML).	22% coverage

		The suggested approach is to port and test such policies on deployEMDS via ad-hoc policy translators (inspiration here[43]). The main motivation is preserving the same grade and accuracy of transparency and observability in how deployEMDS Data Products Offerings are consumed and used.	
UC.11	Access and usage control policies: Identified Usage Policy Patterns so far (reference[44].)	The following Usage Control Policy Patterns have been identified: 1. Allow access (trusted Participants) 2. Location / Regional restriction 3. Access Count 4. Rate Limit 5. Rating count (Data Product sharing value) 6. SLA acceptance (commercial agreement)	62% coverage

6.2.6.1 Data Sovereignty notes:

- UC.1: Whenever NAPs might become active participants of deployEMDS, locality of data might be crucial.
- UC.2: Usage Control Policies are different from access control because they regulate the intended usage of data.
- UC.3: The formalism serves as commonly adopted language to define Usage Control and Enforcement of data, however the service that interprets the policies might use another language. There might be diverse policy interpretation services, but the outcome of the policy should be the same as defined in the formalism.
- UC.4: See ODRL Profiles as an inspiration.
- UC.5: There are no strict requirements to implement an XACML-compatible model. We take the freedom to use the XACML terminology to express a functional description.
- UC.6: Not enough information to identify more Policy Enforcement Points. Some might be part of an analogue process.
- UC.10: The requirement stems from the demand of integrating existing portals in deployEMDS without losing the transparency of Usage Control in the data space. If Usage Control is enforced in a system upstream, it becomes invisible to the data space and requires double effort to enforce it.
- UC.11: Policy n.5 infers from a reward model where a Participant that (also) shares data receives more credits than one that purely consumes data. Policy n.6 infers from a private service delivery to paying customers.

6.2.7 Data Offering

This section gathers the requirements for data self-descriptors, the metadata that must be provided when creating a data product offering.

[43] https://pdfs.semanticscholar.org/f673/fe5776990824f9cbbe5e292fa88678855cba.pdf
[44] https://arxiv.org/pdf/2309.11289.pdf

#	Data Offering	Requirement	Rationale
DOF.1	Data Offering: Data Self-Descriptors	Data Products implement technology-agnostic description of the Data Offering. Self-Descriptors are the exclusive responsibility of the Data Product owner or intermediary that publishes Data Products on the deployEMDS data space.	State-of-the-Art
DOF.2	Data Offering: Data Self-Descriptors minimal requirements	1. Data Self-Descriptors must contain the following information: 1.1. Semantic references (e.g., used vocabulary, ontology, etc.) 1.2. Product identification information. 1.3. Product ownership. 1.4. Product type (e.g., data set, model, service, etc.). 1.5. Human-readable product description. 1.6. Mobility domain. 1.7. Associated Usage Control Policies. 1.8. Product access information (e.g., endpoint or call-back, protocol, auth, etc.) 2. Data Self-Descriptors should contain: 2.1. Intended purpose of Product usage. 2.2. Language profiles. 2.3. Data provenance information. 2.4. SLA of service (e.g., update frequency...) 2.5. Data quality (e.g., accuracy, timeliness...)	State-of-the-Art
DOF.3a	Semantic Framework: Identified Mobility domains	Not sorted: Traffic, Counting, Sensors, Ticketing, Infrastructure, Parking, Incidents and works, Public transport (static), Public transport (RT), Occupancy, Shared mobility, Accessibility, EV Infrastructure.	N/A
DOF.3b	Semantic Framework: Identified Other domains	Not sorted: Air quality, Noise pollution, Meteorology, Public Advertising, Telecom, Cartography, Points of Interest	N/A
DOF.4	Semantic Framework	Self-Descriptors must embed or link to semantic information on the model they use: 1. Must have:	State-of-the-Art

		1.1. Schema of the Data Product. 1.2. Vocabulary description of the concepts in the schema. 2. Should have: 2.1. Machine-readable upstream ontology (either proprietary or part of an existing standard).	
DOF.5	Semantic Framework	Data Products Descriptors that use a local language, other than English, must at least support an English profile. Data Products should support multiple language profiles.	29% coverage
DOF.6	Semantic Framework: Semantic equivalence	Data Descriptors support established formats of metadata and methodologies like: • Linked Data • OSLO • GAIA-X Schema The Data Product Publisher that adopts a semantic framework on Data Products should provide documentation or semantic resources to facilitate format interoperability. All Data Product Publishers should strive to provide semantic material to improve interoperability.	18% coverage
DOF.7	Publication and discovery: Vocabulary Hubs	Vocabulary Hubs are repositories of vocabulary definitions, they also provide semantic resources, like Ontologies that are needed to infer meaning from the different Data Products. Vocabulary assets and semantic resources are presented as Linked Data. Vocabulary Hubs neither implement Semantic Equivalence nor verify inference of linked resources, this is left to the Participant or a semantic translator (not in scope). We recommend that the Vocabulary Hub Component implement a graph traversal mechanism to support Linked Meta Data, independently from the Connector's protocol implementation.	State-of-the-Art
DOF.8	Data Offering: Self-Descriptor Builder	Must have a comprehensive framework that satisfies DOF.1 - DOF.7 and provides tools to validate Self-Descriptors.	State-of-the-Art
DOF.9	Data Offering: Self-Descriptor Builder	Must have a system to create and maintain Self-Descriptors, as well as keeping track of their changes. The system must be capable of creating and updating in a trusted way repositories of embedded resources (e.g., Vocabulary Hubs, Linked Ontologies...)	State-of-the-Art

6.2.7.1 Data Offering notes:

- DOF.All: Interoperability seems to be a challenge in the Mobility domain, hence the focus on Data Product Discovery and Selection. Although most of the requirements come from best practices and value building, rather than from the single intakes.
- DOF.4: Although most data spaces lean towards the use of Linked Data Standards to implement semantic metadata, we have no conclusive information that this is an exclusive requirement. A LOD model of DATEX-II has been presented recently[45], but its implementation requires extra work.
- DOF.5: This is a minimal requirement that takes only account of the machine-readable-ness of metadata. The requirement might be extended to other languages if deployEMDS governance decides so.
- DOF.7..9: The systems should have programmatic and U/X interfaces.
- DOF.7: IMEC has conducted studies on how a Linked Data Provider and LDES are the best-fit candidates to expose semantic resources and keep track of their lineage.

6.2.8 Publication and Discovery

This section gathers the requirements on the publication of data product offerings in the catalog.

#	Publication and Discovery	Requirement	Rationale
DIS.1	Publication and Discovery: Local Data Product Catalog	Each Participant exposes a Local Catalog of Self-Descriptors. Data Owners have the facility to make their Self-Descriptors public or to protect them via an access policy. The Local Catalog is accessible through a standardised Catalog API hosted on Participant's Connector. Intermediaries publish a Local Catalog of their subscribers' Products.	State-of-the-Art
DIS.2	Publication and Discovery: Metadata Broker[46]	A Metadata Broker is a special Participant that publishes Self-Descriptors data-space wide. Publication to a Metadata Broker is not mandatory, but it's key to increase Data Product discoverability. There can be more than one Metadata Brokers in deployEMDS. The Connectors must implement a method to identify and find Metadata Brokers. For instance, they could be searchable in a Trusted Service Providers registry (see IDC.5). Metadata Brokers can integrate non-standard catalogs (see DIS.3 and provide associated semantic resources from the	85% coverage

[45] Semantic Modelling Approach for Safety-Related Traffic Information Using DATEX II
[46] An example of Metadata Broker definition (IDSA): https://github.com/International-Data-Spaces-Association/IDS-RAM_4_0/blob/1fcdec06a36296e322f66a5daf934f9617a4da4e/documentation/3_Layers_of_the_Reference_Architecture_Model/3_5_System_Layer/3_5_4_Metadata_Broker.md?plain=1

		Vocabulary Hub to translate them to deployEMDS Catalog Standard Format (see DIS.3) Metadata Brokers implement a trusted protocol for the publication of Self-Descriptors and linked resources. The core deployEMDS Metadata Broker is maintained by the data space authority.	
DIS.3	Publication and Discovery: Data Product publication on Metadata Broker	Participants subscribe their Catalog entries to the Metadata Broker by granting the latter access credentials to their Local Catalog. Synchronisation of Local Catalogs is orchestrated automatically (the mechanism depends on the implementation). Data Product Owners must be able to prevent synchronisation of assets they don't want to be listed publicly. The preferred mechanism is to implement the Usage Control Policy on Catalog Synchronisation.	85% coverage
DIS.4	Publication and Discovery: Catalog Standard Format	DCAT-AP Mobility DCAT-AP	Best-Fit
DIS.5	Lineage and provenance: Self-Descriptor lineage	The Metadata Broker hosts a versioned registry of changes of Self-Descriptors. The Metadata Broker doesn't implement analysis or advertising of changes. Use of Metadata Lineage for impact analysis or compliance reasons is left to the Participant.	State-of-the-Art
DIS.6	Publication and Discovery: Lineage (and provenance of metadata)	The Metadata Broker hosts a versioned registry of changes of Technical Metadata (e.g., a change in Metadata schema, an additional service extending the Metadata, etc.)	State-of-the-Art
DIS.7	Publication and discovery: Data and Data Service Discovery	As mentioned in DOF.7, the Vocabulary Hub is a service that provides a graph of referenced vocabularies and linked semantic resources. The Vocabulary Hub tracks changes to the Meta Data so that data lineage is available. The Vocabulary Hub must implement a discovery and linkage mechanism, so that the Data Service Discovery tool can leverage it.	Best-Fit

DIS.8	Publication and discovery: Discovery Portal	Integrate a data discovery tool in a web portal. The discovery tool queries the Metadata Broker, the Vocabulary Hub and the Participant Registry. The tool allows deployEMDS users to explore data space's content and Participants. 1. Ad-hoc solution, eventually sharing resources with the onboarding portal. 2. Existing EU initiative, like https://euhubs4data.eu/ 3. Host an open-source tool, like https://datahubproject.io	45% coverage

6.2.8.1 Publication and Discovery notes:

- DIS.1: The Eclipse Connector implements a local catalog which is consulted via a standard IDS Protocol message. Fiware's Connector uses a detached component to provide a federated catalog.
- DIS.3: Discoverability of data space assets happens via the Metadata broker. Each Data Product is associated with an identifier of the Data Owner/Producer and the instance of the Connector where it's hosted.
- DIS.5: Because Self-Descriptors have contractual value, we must preserve their change history and, possibly, trigger contractual actions through a clearing house if certain conditions are met.
- DIS.7: The recommendation to use LDES stems from best practices and efficiency, as well as providing an immutable registry of lineage built-in the technology itself.
- DIS.8: There can be multiple tools, or none if the components expose a documented API. In the latter case, each node implements the discovery tool of convenience.

6.2.9 Business Observability and Audit

This section gathers the requirements to enable business observability and auditing capabilities.

#	Business Observability / Audit	Requirement	Rationale
OA.1	Data services: Observability, Local logs	Participants' Connectors store logs of the following business information: 1. Data Products publication and change (see DIS.5 also) 2. Data sharing agreements, request, negotiation outcome, sunsetting. 3. Data transfer requests, outcome, Data Product version. 4. Changes to Participants' descriptors. Logs entries must be machine interpretable. Logs must implement a mechanism of integrity control.	State-of-the-Art

		Persistency stack (e.g., DB or Object Storage), retention, information detail, and adherence to certain observability standards are out of scope for the time being. See OA.4	
OA.2	Data services: Observability – Data space log collector	A data space-wide log collector and storage enables observability services. Logs are collected from: 1. Participants' Connectors 2. Participant Registry (or Onboarding Services) 3. Metadata Broker Log collection is not mandatory, however it is required to enable value-driven services, like a clearing house, quality of service, or a marketplace. The log collection mechanism must be consistent across services participating in deployEMDS. Given the diversity of sources, the notion of deployable log collection agent might be needed. Log collection is secured, implements transport and storage integrity control, and it is stored on audited storage (or DB). The log collector is maintained by the data space authority.	State-of-the-Art
OA.3	Data services: Observability – Technical logs	All deployEMDS components emit technical logs in a common format that can be read and analysed by state-of-the-art monitoring and observability tools. Example: Open Telemetry -> Prometheus -> Elastic and Grafana	State-of-the-Art
OA.4	Data services Observability – Audit and review	The deployEMDS governance team must establish the basic requirements for auditing and operations review. It must take in account the quality of service that the data space authority is ready to provide for the shared components, and the obligations from auditing and technical support standpoint that Participants must abide to.	State-of-the-Art

6.2.9.1 Business Observability and Audit notes:

- OA.1: Observability is part of governance requirements that might evolve during this analysis.
- OA.3: Technical monitoring should be E2E, i.e., from containerisation to application stack. It is dependent on the supported Connector stack, nevertheless, sticking to commonly supported formats like OpenTelemetry is strongly advised.

6.2.10 Value-added services

This section gathers the requirements for several additional services that enable trusted computing, ease of deployment, data integrity and cyber security in general.

#	Value-added services	Requirement	Rationale
PEC.1	Deployable components	Data space components should be deployable in an actual, technical environment. The underlying operational mode, namely, in-house infrastructure, managed services, Cloud IaaS, Cloud PaaS, and SaaS (if the stack choice is provided as a service), should not be restricted. Core functionalities can rely on the unique features of currently maintained, Open-Source products. Conversely, no core functionality should rely on the unique features of a vendor's or cloud's product. Deployment and configuration mechanisms must minimise dependencies on frameworks and components. Nevertheless, this principle must not be detrimental to convenience and security (i.e., deployment by building inherits configuration and security risks).	State-of-the-Art
PEC.2	Deployable Components: Technology risk assessment	Choice of components should undergo a risk analysis based on section 3R.1...3R.7 of the ENISA Cloud Computing Risk Assessment.[47]	State-of-the-Art
PEC.3	Deployable Components: GDPR compliance	The setup of data space components should comply to GDPR ruling in terms of processing personal information. The fields where specific controls must be implemented are: • Security of infrastructure. • Data classification. • Data protection. • Data retention. • Access to privileged identities and operational processes. • Processes to safeguard citizens' rights (e.g., right to be forgotten). • Logging and traceability.	State-of-the-Art
PEC.4	Deployable Components: Trusted	Components that store or process Participants' data should support execution in a trusted environment that preserves runtime integrity. For instance:	State-of-the-Art

[47] https://www.enisa.europa.eu/publications/cloud-computing-risk-assessment

	execution environment	1. Azure Confidential Computing with Application Enclave[48]. 2. Kubernetes instance running on Intel GSX extensions[49].	
PEC.5	Deployable Components: Criteria for runtime and perimeter security	deployEMDS components should be risk-assessed following the requirements of section 3.8..3.20 and 3.25..3.32 of the ENISA Cloud Computing Risk Assessment (see reference on PEC.2)	State-of-the-Art
PEC.6	Deployable Components: Secure Software Development vetting of Open-Source components	It is advisable to assess how Open-Source components embed best practices of secure development in their software development lifecycle. A tentative assessment following the NIST 800.218 (SSDF)[50] specification has been recently drafted on the EDC Connector by the author of these requirements.	State-of-the-Art
PEC.7	Flexible data planes: Protocols	1. Connector data planes should support the following protocols and interfaces: HTTPS – Interactive interfaces (e.g., REST, GraphQL, URIs...). 2. Kafka streams (Pub-Sub). 3. Microsoft Queue Service (MSMQ). 4. DATEX Information Delivery EP (to be confirmed). 5. Batch file transfer (SFTP). For a list of supported data formats, please refer to the section 5.	100% coverage
PEC.8	Flexible data planes: Observability	Connector data planes should emit metrics relative to: 1. Data Sharing initiation and termination 2. Protocol specific metrics, like GraphQL error type	State-of-the-Art
PEC.9	Flexible data planes: Credential transfer	Connector data planes transfer identity and access claims to the data sources, so that the latter can rely on the Trust Framework of the data space to align access control and auditing.	45% coverage

[48] https://learn.microsoft.com/en-us/azure/confidential-computing/trusted-execution-environment
[49] https://intel.github.io/intel-device-plugins-for-kubernetes/cmd/sgx_plugin/README.html
[50] https://csrc.nist.gov/pubs/sp/800/218/final

PEC.10	Data Intermediaries: Data Ownership	Data Intermediaries are Participants that bring Data Products to deployEMDS on behalf of Data Owners. Data Intermediaries represent a significant portion of the use case taking part in this project. Data Owners are not exempt from registering to deployEMDS, but they rely on a Data Intermediary Connector. The deployEMDS data space must provide the necessary tools to maintain this separation of concern, where the Data Owner has control over the Data Product, independently from the Data Intermediary operation.	45% coverage
PEC.11	Data Intermediaries: EU DGA roles	Define and map roles of Data Intermediaries within the Data Governance Act definition and their certification. A useful starting point is provided by the recent report of the Joint Research Centre on intermediaries and data altruism[51].	State-of-the-Art

6.2.10.1 Value-added services notes:

- PEC.6: DATEX Information Delivery EP defines a complex Pub-Sub process that requires some effort to embed in a Connector. Further analysis is needed to ascertain if the Information Delivery process is in use and to what extent it can be replaced by the data space protocol.

[51] https://publications.jrc.ec.europa.eu/repository/handle/JRC133988

6.3 Capabilities and implementations

The following matrix maps the coverage of capabilities to capability-driven analysis to the reference data space frameworks that we used for the feasibility analysis of the requirements.

The analysis is presented here as complementary information for the (upcoming) implementation phase and must be validated by direct testing.

Capability	Req. #	(IDS) Data Space Protocol on EDC components	Fiware	GAIA-X	iSHARE
ID Binding	**IDB.1**	Decentralised Identifiers (DIDs) on web or consensus network.	Decentralised Identifiers (DIDs) on IDP.	Decentralised Identifiers, GAIA-X Trust framework	iSHARE Identity Provider
	IDB.2				
	IDB.3				iSHARE Satellites
	IDB.4				
	IDB.5	Ad-hoc eIDAS Trust Anchor	eIDAS Trust Anchor. iSHARE Trust Anchor (where recognised)	Built-in eIDAS providers, GAIA-X register.	eIDAS providers lists
Identification and authorisation	**IDC.1**	IDS Connector Descriptors	Identity Manager	GAIA-X descriptors	OpenID Connect UserInfo
	IDC.2	Supported (Descriptor schema)	Supported (Keyrock)	Supported, but can break compliance	
	IDC.3	EONA-X VSDS GAIA-X (compliance required)	EONA-X, GAIA-X (compliance required)	GAIA-X	Unknown, but likely possible with customisation
	IDC.4	Y	Y	Y	Y
	IDC.5	DID:Method	DID:	DID:Method	OpenID?
Trust Anchor	**TA.1**	Various GAIA-X Trust Anchors	Various iSHARE Satellite GAIA-X	GAIA-X Trust Anchors (see GAIA-X Trust framework)	iSHARE network, eIDAS Authorities

	TA.2	Y	Y	Y	When Integrated with Fiware
	TA.3	Y	Y	Y	iSHARE Satellites
Onboarding and participation	**ONB.1**	Onboaring API	Onboarding Provides onboarding API + verification	Custom development	iSHARE onboarding
	ONB.2				
	ONB.3	N (custom development)	N (custom development)	N (custom development)	iSHARE console
	ONB.4	GAIA-X compliance + integration national registries	Integration with iSHARE or GAIA-X Clearing House	GAIA-X Clearing House	Configuration + integration national registries
	ONB.5				
	ONB.6	Y	Y	Y	Y
	ONB.7	No Registry at the moment, Federated Catalog provides resolution.	M2M binding, Participant List	N/A	Service
	ONB.8	Trust is managed P2P	Participant List	Y	Y
Authorisation and Credentials Interoperable Presentation	**AVC.1**	Y	Y	Per Service	Y
	AVC.2	No ready-made mechanism. It can be implemented in a Clearing House however.	Trusted Issuers List Service	GAIA-X compliance	iSHARE Satellites
	AVC.3-4		Y	N	Y
	AVC.5	Y As part of self-issuance model of the EDC.	Y	N	Y
	AVC.6	Federation of TAs or cross-border TA with SSI/VCs	Use of cross-border TA with SSI/VCs	By design, GAIA-X is cross-border and integrates with SSI/VCs	Requires iSHARE Satellites can be trusted across borders.

	AVC.7	eIDAS VCs	eIDAS EBSI Registry VCs	eIDAS VCs	eIDAS
	AVC.8	Y	Y	Customisation possible but might break compliance	Y
Data Sovereignty	**UC.1**	N/A	N/A	N/A	N/A
	UC.2	IDS Policy Enforcement	Fiware ABAC	Descriptor support only	Delegation
	UC.3	ODRL	XACML	Formalism agnostic (no implementation	XACML
	UC.4	ODRL Profiles	?	N	?
	UC.5	EDC Policy engine	Fiware DBSA PDP	N	iSHARE Delegation Endpoint
	UC.6	EDC Policy engine	iSHARE plugin for API-Gateway	N	See Fiware integration No Metadata-discovery
	UC.7	EDC Policy Extension	N	N	N
	UC.8	External	External	N/A	External
	UC.9	Custom development	Custom development	N	?
	UC.10	N/A	N/A	N	N/A
	UC.11	Y	Y	N	See Fiware integration
Data Services Offering	**DOF.1**	Data Asset	Data Product	GAIA-X Service	N/A
	DOF.2	Customisation	Customisation	Customisation	N/A
	DOF.3a & DOF.3b	N/A	N/A	N/A	N/A

	DOF.4	Customisation	Customisation	Customisation	N/A
	DOF.5				N/A
	DOF.6				N/A
	DOF.7	Y	N	N/A	N/A
	DOF.8	N (Custom development)	N (Custom development)	N (Custom development)	N/A
	DOF.9	N (Custom development)	N (Custom development)	N (Custom development)	N/A
Data Discovery	**DIS.1**	Y	Partial	N	N/A
	DIS.2	Partial	N	N	N/A
	DIS.3	Y	N	N	N/A
	DIS.4	Extend DCAT	Extend DCAT	N	N/A
	DIS.5	Requires versioning development	N	N	N/A
	DIS.6		N	N	N/A
	DIS.7	N/A	N/A	N/A	N/A
	DIS.8	N/A	N/A	N/A	N/A
Business Observability	**OA.1**	Upcoming Observability protocol	Only logging	Computational Contracts	?
	OA.2	Extend EDC + collector	Extend Connector + collector	Data Contract Services	?
	OA.3	Y	Y	N/A	Y
	OA.4	Y	Y	N/A	N/A

7 Recommendations & lessons learned

This section summarises the recommendations and lessons learned from the use case requirements (section 4), standards and data model requirements (section 5), and technical requirements (section 6).

7.1 Use case requirements

- Most DPOs contain open data; however, over half of the implementation sites imply an access control and revenue scheme. The governance and business model need further refining for many DPOs, which must be a capability of the data space.
- More than half of the implementation sites will have a local data space in place in addition to the deployEMDS data space, representing the first data space federation at this scale in the mobility domain. This requirement needs detailed analysed in the next phase of the project.
- 90% of DPOs contain either static or dynamic mobility related data, of which public transport data holds the largest share, followed by road infrastructure data and shared mobility data. Several implementation sites combine mobility data with environmental data, underscoring the need and opportunity for cross-domain interoperability, for example through other sectoral data spaces.
- At least 40% of the data sources are owned by external stakeholders, which entails consequences for DPO governance and onboarding, as well as for communication and dissemination.
- Although the intake process already helped refine the use cases, they will need further refinement during the project, especially concerning the integration of the deployEMDS data space in the local infrastructure in a meaningful way.
- Some implementation sites plan to share not only readily available data products but also data products or services that they generate themselves (based on other data products that might be offered in the data space). In this way, they do not only add value to the data space but also incorporate deployEMDS as an inherent part of their processes, which can be considered a best practice.
- As the deployEMDS project brings together more than 100 data sources from nine regions in this domain, it can play a significant role in standardisation of mobility data. This role has not yet been defined, but the EMDS might be inspired by the implementation sites in this first deployment project.
- The experience of implementation sites that have a local data space in place can aid other implementation sites in understanding the value of data spaces. This peer learning process should be fostered in the project.
- All implementation sites have a data sharing platform, hub, or initiative in place, which plays an important role in the local ecosystem and often forms the base of data exchange today. The EMDS should be positioned in relation to these existing platforms.
- One National Access Point is actively involved in the project, which not only demonstrates the initiative NAPs can exhibit in the digital transformation towards data spaces but also highlights how diverse mobility stakeholders can converge within these data spaces.

7.2 Mobility data model & standards requirements

- Most data sources are not standardised today; the GTFS(-RT) data model has the highest occurrence. Data models that are explicitly recognised as part of the European ITS or MMTIS Directives (DATEX-II, NeTEx and SIRI) will gain weight in the next five years, but new data models will also be introduced (e.g., OSLO and Fiware Smart Data models). The data space needs to accommodate these changes.
- Some of the emerging European standards in the mobility domain are insufficiently familiar to the implementation site stakeholders and are therefore underrepresented in their data product offerings.

7.3 Technical requirements

- Our intake sessions have defined no exclusive requirement for the choice of data space standard. Therefore, the technical specifications are implementation-agnostic, supporting a later decision that, we suggest, should be based on a hands-on feasibility study.
- The “E” in the EMDS name (European) is only partly represented, since most projects support local stakeholders and lack a defined plan to craft data products for cross-border consumption. We suggest looking beyond the actual requirements, designing a best-of-breed scheme for a cross-border trust framework and pushing for international profiles in datasets. As the mobility sector is undergoing extensive regulation in terms of digital strategy, resources should be allocated to quickly analyse the upcoming regulation and come up with a future-proof design.
- There is a significant expectation that local data portals will be crucial in connecting data sources to deployEMDS. For instance, some portals require a data consumer to prove their existence by contacting the data portal administrative contact. Transferring existing portals’ governance and selection criteria to a purely deployEMDS environment is only possible by building ad-hoc integration or by appointing a deployEMDS data intermediary. The consortium should decide if ad-hoc integration is the way forward or if the role of EMDS data intermediary can be standardised to one operational and governance model, reinforcing its value in our operations.
- We discovered a significant need for semantic standards in the defined data products. This inadequate semantic lattice hinders interoperability, especially in a fragmented data landscape like the Europe’s. However, we see this as an opportunity rather than a setback. We suggest implementing mechanisms to reward the building of a semantic-aware data ecosystem, perhaps through research-grade innovation to overcome this issue.
- A relevant part of the requirements (Discoverability and Business Observability, for instance) stems from best practices rather than explicit requests. Nevertheless, the current requirements describe the minimal viable capabilities to make the deployEMDS value proposition attractive enough to justify its deployment. This initial deployment will pave the way for creating more value in the subsequent stages.

Annex

Annex 1 - Canvas intake template

2. Data Product Offering					
Background	The data product offering is the implementation of the data product in the deployEMDS and determines how a data product becomes a data asset. The data offering could be implemented in the data space connector, and handles usage control, formats, data assets publication, data asset catalogue, ... In other words, it defines how the data product is offered to the data space. The information we request here might not be immediately available during the intake phase of the project, but many "horizontal components" of the deployEMDS data space depend on these answers. Our main goal is to define a prioritised roadmap for implementing data products in the data space.				
No	**Question to be answered**	**Answer**	**Example answer**	**Context**	**Canvas reference**
1	Can you provide a name for your data product offering?		*Multimodal Traffic Counts*	Define/specify the data product offering being analysed in this sheet.	Do0
2	Can you provide a functional description of your data product offering?		*"Multimodal Traffic Counts" is a data product offering designed to provide comprehensive, integrated traffic data across various modes of transportation for traffic managers, city administrations, researchers, and other stakeholders.*	Functional description of the data product offering.	Do4
3	What is the scope of the data offering in terms of transport modalities?		*Truck, car, bicycle, pedestrian*	Used for grouping and quantitative analysis.	Do3
4	What is the geographical data product offering scope?		*Flanders*	Used for grouping and quantitative analysis.	Do3
5	What is your data product offering type?		*3) For a federated data space structure, we provide an intermediary service to link VSDS with EMDS*	1) The data owner publishes the data product offering in the data space (without intermediary service) 2) The data owner onboards the data product on an intermediary offering 3) You are yourself a data intermediary (see glossary)	Do1
6	What are the data sources that will use this kind of data product offering?		*Fl.01.01 - Fl.01.09*	A data product offering can be an aggregation of more than one data source (and a data source can have multiple data product offerings), therefore it's best to standardise the data product offering in a way that it can be reused. To answer this question, please refer to the dataset Nr. in the overview excel.	

7	Is there personal data involved in your data product offering or are there any ethical considerations?		*No personal data involved.*	Determine if mechanisms for consent or traceability are required when the data product includes personal data.	Do16
8	Is your current data model (if any) in conformance with existing standard(s)? If yes, which?		*OSLO Verkeerstellingen, DCAT-AP*	This question refers to the conformity of the data sources at present. Possible answers are for example: OSLO, MMTIS, MDS, DATEX-II, TOMP, GTFS, GTFS-RT, NeTEx, … or there is no standard used now. If there are any current metadata standards (DCAT, DCAT-AP, Mobility DCAT-AP, DOI, ...) in use, you may also list them here.	Do12
9	What is the underlying protocol used to transfer your data product?		*LDES*	We need to know which network protocols are used to infer which data planes will be necessary in deployEMDS. Examples are Kafka topic, LDES, HTTP, TSP, Websocket API, FTP, SSH, SFTP etc...	Do10
10	When integrating a data product (back end) with a connector, are there specific access control mechanisms or workflows needed to publish the data product?		*A system that provides data on demand must register a specific query for a specific data product offering in the back end (e.g., KBO)*	We need to know which access control mechanisms (which might be specific for your organisation) are needed to decide how the control plane (see glossary) should look like.	Do11
11	Are there performance concerns about your data product such as latency, high volumes, certain service level agreement(s)?		*Some traffic count data products have a volume > 100 GB*	The current SOTA of data space connectors is that they are vertically scalable, but they are not designed to manage hyperscale architectures. An out of band data plane overcomes scalability issues. We need to understand the effective needs or if there are sufficient reasons for more experimentation and testing.	Do9
12	Self asses your data product offering maturity.		*5: We have already built a VSDS connector.*	We would like you to think carefully on the maturity of the data product offering and to indicate this on a scale from 1 (not discussed yet) to 5 (all partners agree on the roadmap). Please also elaborate on why you chose this number. This self-assessment will allow us to identify mature and early-stage components of the data product offering. The results can be used to prioritise certain building blocks, organise trainings, cluster implementation projects, etc.	

3. Data product governance

Background	The information in this section will help identify standard practices in data management and product compliance, including industry/domain standards and governance models relevant for various use cases. Data product owners should outline their trust-building processes, which will guide our decision on supporting identity management and data sovereignty, and to see if a fully managed trust model is needed by the data space.

No	Question to be answered	Answer	Example answer	Context	Reference
13	Which data model (if any) would you like to use?		*OSLO Verkeerstellingen, MobilityDCAT-AP*	This question refers to the desired conformity of the data sources. Possible answers are for example: OSLO, MMTIS, MDS, DATEX-II, TOMP, GTFS, GTFS-RT, NeTeX, … or none.	Dp1
14	Are there any requirements for authentication and identification of participants?		*Participants registered to VSDS must be able to claim EMDS data products without re-registering. If they are Flemish citizens, their identity must be linked to 'Mijn burgerprofiel'.*	We need to know if participants are bound to specific identity management governance or processes and verifications when they want to use the data product. Think of claims participants could need, specific identity standards they must adhere to (e.g., EIDAs), domain registries that can identify them (e.g., a company registration registry). Which certification bodies and identity providers are involved?	Dp5
15	Are there any requirements for access control to the data product?		*Participants that want to access the data product should prove they are European citizens or companies with a primary seat in a European country.*	We need to know which claims can be verified by which trust anchor.	Dp6
16	Self asses your data product governance maturity.		*3: up until now only open data in the VSDS, so little experience with governance, but the team agrees on the roadmap.*	We would like you to think carefully about the maturity of the data product governance and to indicate this on a scale from 1 (not discussed yet) to 5 (all partners agree on the roadmap). Please also elaborate on why you chose this number. This self-assessment will allow us to identify mature and early-stage components of the data product offering. The results can be used to prioritise certain building blocks, organise training, cluster implementation projects, etc.	

4. Business model(s)

Background	The information in this canvas will help determine how diverse the participants' business expectations are. Some business models require specialised components at data space level. We also want to determine if a shared business model is viable, or rather fostering an eco-system of value returns. The data space should provide the necessary building blocks to support this diversity.

No	Question to be answered	Answer	Example answer	Context	Reference
17	Can you specify your expected/intended business model for the data product offering and relevant restrictions?		*The data offering should be open and public for Belgian citizens, but European citizens outside of Belgium pay per volume.*	The goal is to determine specific supporting infrastructure for enabling the intended business model. Possible answers are open public, open subscription, value exchange, recurring time, period based, one-time payments, pay-as-you-go, revenue sharing, data volume, dynamic pricing, freemium, value-based, on Request, ...	Bu1, Bu3
18	Does the data product offering fall under local legislation that might differ from and/or precede over EU and foreign legislation?		*We are aiming to include ANPR data in the offering and 'de wet op het politieambt' applies in that case. This is controlled by the COC.*	The GDPR applies to the processing of personal data of living individuals in the EU, but the implementation might slightly differ in each member state (e.g., in Italy the heirs of a deceased person can request data erasure, in Belgium they cannot). Additionally, there might be rules in place in your country that differ from other countries (e.g., the age of legal majority). In other words, we need to know which local legislation is in place that requires specific data space functionalities.	Bu4
19	What is the value proposition (if any) of the data product offering?		*Multimodal traffic counts of different providers can be accessed through one endpoint, is standardised, and always up to date. This will make the work of traffic managers easier.*	Why is this data offering interesting for the community, what value does it bring to the ecosystem? Why will participants want this data offering?	Bu6
20	Self asses your business model maturity.		*1: this is unclear in the Belgian ecosystem.*	We would like you to think carefully about the maturity of your business model and to indicate this on a scale from 1 (not discussed yet) to 5 (all partners agree on the roadmap). Please also elaborate on why you chose this number. This self-assessment will allow us to identify mature and early-stage components of the data product offering. The results can be used to prioritise certain building blocks, organise trainings, cluster implementation projects, etc.	

5. Data space federation

Background	There are cases where data products are already part of an existing data space. The information must help us to find the most flexible and sustainable way to integrate them in the data space.

No	Question to be answered	Answer	Example answer	Context	Reference
21	In which other data space is your data product offering included?		*Flemish Smart Data Space*	Name the data space. Describe if managing or part of an existing data space. Describe the data space standard used.	Fd1
22	Does this data space have an asset catalogue? And if so, which technology does it use?		*Yes, REST API, DCAT format*	We need to ensure that existing asset catalogue technologies and standards can interoperate with the deployEMDS asset catalogue.	Fd2
23	Is there a data space mechanism to univocally identify participants? If so, which one?		*No*	We need to ensure that the mechanisms to identify participants in your existing data space can interoperate with the deployEMDS systems.	Fd3
24	How is trust established in this data space?		*No identity management yet*	We need to know if a trust anchor is involved, how credentials are issued, which authorities are involved, etc. This is to ensure that the data space can interoperate with these trust mechanisms.	Fd4
25	Does the data space implement data usage control policies and enforcement? Does it use standards?		*OSLO data models and LDES protocol standards are used for the assets, but no usage control policies are active at this moment.*	We need to ensure that the existing usage control policies and enforcement methods are compatible with the deployEMDS mechanisms.	Fd5

Annex 2 - Data sources overview

Pilot region	Use case NR	Data source NR	DPO NR	Data source NAME	Data owner	Data owner classification	Conformity NOW	Comformity LATER
Barcelona	Ba.01	Ba.01.01	Ba.DPO.01.01	Static bus network information	ATM-PTO	Partner in the consortium and external stakeholder(s)	GTFS	GTFS
Barcelona	Ba.01	Ba.01.02	Ba.DPO.01.01	Vehicle information	PTO	External stakeholder(s)	No standard	Unknown
Barcelona	Ba.01	Ba.01.03	Ba.DPO.01.02	Ticket validations (bus)	ATM	Partner in the consortium	No standard	Unknown
Barcelona	Ba.01	Ba.01.04	Ba.DPO.01.02	Ticket validations (web service)	ATM	Partner in the consortium	No standard	Unknown
Barcelona	Ba.01	Ba.01.05	Ba.DPO.01.03	Passengers drop off (counters)	PTO	External stakeholder(s)	No standard	Unknown
Barcelona	Ba.01	Ba.01.06	Not in the Canvas	SAEi / AVL predictive times of arrival	ATM-PTO	Partner in the consortium and external stakeholder(s)	SIRI	Unknown
Barcelona	Ba.01	Ba.01.07	Ba.DPO.01.04	Mobile phone data	Mobile phone operator	External stakeholder(s)	No standard	No standard
Barcelona	Ba.01	Ba.01.08	Ba.DPO.01.04	Land use	SIOSE	External stakeholder(s)	No standard	No standard
Barcelona	Ba.01	Ba.01.09	Ba.DPO.01.04	Population census	Instituto Nacional de Estadística (INE)	External stakeholder(s)	No standard	No standard
Barcelona	Ba.01	Ba.01.10	Not in the Canvas	Weather	Aemet	External stakeholder(s)	No standard	No standard
Barcelona	Ba.01	Ba.01.11	Not in the Canvas	Bus operational data	PTO	External stakeholder(s)	Unknown	No standard
Barcelona	Ba.01	Ba.01.12	Not in the Canvas	Transport on-demand (TOD) requests data	PTO	External stakeholder(s)	Unknown	N/A
Barcelona	Ba.02	Ba.02.01	Ba.DPO.02.01	Traffic information from sensors inside Barcelona	Barcelona City Council	External stakeholder(s)	No standard	No standard
Barcelona	Ba.02	Ba.02.02	Ba.DPO.02.01	Traffic information from sensors in Barcelona ring road.	Barcelona City Council	External stakeholder(s)	No standard	No standard
Barcelona	Ba.02	Ba.02.03	Ba.DPO.02.02	Street characterisation	Barcelona City Council	External stakeholder(s)	No standard	No standard
Barcelona	Ba.02	Ba.02.04	Ba.DPO.02.03	Meteorological / weather data	Regional Government	External stakeholder(s)	No standard	No standard
Barcelona	Ba.02	Ba.02.05	Ba.DPO.02.04	Air quality data	Barcelona City Council	External stakeholder(s)	No standard	No standard
Budapest	Bu.01	Bu.01.01	Bu.DPO.01.02	GEO location of free bicycle	Sharing service provider (MOL)	External stakeholder(s)	No standard	GBFS/MDS
Budapest	Bu.01	Bu.01.02	Bu.DPO.01.02	GEO location of free scooters	Sharing service provider (Lime)	External stakeholder(s)	No standard	GBFS/MDS
Budapest	Bu.01	Bu.01.03	Bu.DPO.01.02	GEO location of free cars	Sharing service provider (GreeGo Car)	External stakeholder(s)	No standard	GBFS/MDS
Budapest	Bu.02	Bu.02.01	Bu.DPO.02.01	Register of volunteers	MaaRLiM operator	External stakeholder(s)	No standard	Unknown
Budapest	Bu.02	Bu.02.02	Bu.DPO.02.01	Register of vulnerable persons	Associations, healthcare (Budapest Association for Disabled People)	External stakeholder(s)	No standard	Unknown
Budapest	Bu.02	Bu.02.03	Bu.DPO.01.01	UP database	BKK	Partner in the consortium	GTFS	GTFS
Flanders	Fl.01	Fl.01.01	Fl.DPO.01.01	Permanent Traffic measurements Motorway	Traffic Centre Flanders	External stakeholder(s)	No standard	OSLO/DCAT-AP
Flanders	Fl.01	Fl.01.02	Fl.DPO.01.01	Permanent Bike counting Flanders	Agency Road and Traffic	External stakeholder(s)	No standard	OSLO/DCAT-AP

Flanders	Fl.01	Fl.01.03	Fl.DPO.01.01	Temporary traffic counting by Geomobility	City of Bruges	External stakeholder(s)	No standard	OSLO/DCAT-AP
Flanders	Fl.01	Fl.01.04	Fl.DPO.01.01	Temporary speed smileys by Krycer	City of Affligem	External stakeholder(s)	No standard	OSLO/DCAT-AP
Flanders	Fl.01	Fl.01.05	Fl.DPO.01.01	Permanent Bike countings by Signco	City of Antwerp	External stakeholder(s)	No standard	OSLO/DCAT-AP
Flanders	Fl.01	Fl.01.06	Fl.DPO.01.01	Citizen Science traffic measurements	Telraam	External stakeholder(s)	No standard	OSLO/DCAT-AP
Flanders	Fl.01	Fl.01.07	Fl.DPO.01.01	Smart Camera measurements	City of Genk	External stakeholder(s)	No standard	OSLO/DCAT-AP
Flanders	Fl.01	Fl.01.08	Fl.DPO.01.01	Traffic counting by Geosparc	City of Leuven	External stakeholder(s)	No standard	OSLO/DCAT-AP
Flanders	Fl.01	Fl.01.09	Fl.DPO.01.01	Traffic measurement by city of Kortrijk	City of Kortrijk	External stakeholder(s)	No standard	OSLO/DCAT-AP
Ile-de-France	Il.01	Il.01.01	Il.DPO.01.01	Public Transport IDF	IDFM (Ile-de-France Mobilities)	External stakeholder(s)	NeTEx	NeTEx
Ile-de-France	Il.01	Il.01.02	Il.DPO.01.02	Traffic data	Renault Group	External stakeholder(s)	No standard	Unknown
Ile-de-France	Il.01	Il.01.03	Il.DPO.01.03	EV charging stations	Renault Group, ADP, Apidae Tourisme, Accor, (Other Eona-X members...)	External stakeholder(s)	No standard	No standard
Ile-de-France	Il.02	Il.02.01	Il.DPO.02.01	Journey planners use data	Cities/Transport authorities	External stakeholder(s)	No standard	Unknown
Lisbon	Li.01	Li.01.01	Li.DPO.01.01	Traffic lights with sound	EMEL	Partner in the consortium	No standard	DATEX-II
Lisbon	Li.01	Li.01.02	Li.DPO.01.01	GIRA BSS	EMEL	Partner in the consortium	DATEX-II	DATEX-II
Lisbon	Li.01	Li.01.03	Li.DPO.01.01	Parking lot accessibility	EMEL	Partner in the consortium	DATEX-II	DATEX-II
Lisbon	Li.01	Li.01.04	Li.DPO.01.01	Onstreet EV charges	EMEL	Partner in the consortium	No standard	DATEX-II
Lisbon	Li.01	Li.01.05	Li.DPO.01.01	Micromobility parking	CML	External stakeholder(s)	No standard	DATEX-II
Lisbon	Li.01	Li.01.06	Li.DPO.01.01	MUPI (outdoor advertising)	JCDecaux/CML	External stakeholder(s)	No standard	DATEX-II
Lisbon	Li.01	Li.01.07	Li.DPO.01.01	Bus Stops	CML	External stakeholder(s)	No standard	DATEX-II
Lisbon	Li.01	Li.01.08	Li.DPO.01.01	Streetlight location	CML	External stakeholder(s)	No standard	DATEX-II
Lisbon	Li.02	Li.02.01	Li.DPO.02.01	BSS GIRA Pricing Plans	EMEL	Partner in the consortium	GTFS	GTFS
Lisbon	Li.02	Li.02.02	Li.DPO.02.01	BSS GIRA Availability	EMEL	Partner in the consortium	GTFS	GTFS
Lisbon	Li.02	Li.02.03 a	Li.DPO.02.01	Offstreet Location	EMEL	Partner in the consortium	DATEX-II	DATEX-II
Lisbon	Li.02	Li.02.04	Li.DPO.02.01	Offstreet Pricing Plans	EMEL	Partner in the consortium	DATEX-II	DATEX-II
Lisbon	Li.02	Li.02.05 a	Li.DPO.02.01	Onstreet Location	EMEL	Partner in the consortium	DATEX-II	DATEX-II
Lisbon	Li.02	Li.02.05 b	Li.DPO.02.01	Onstreet Pricing	EMEL	Partner in the consortium	DATEX-II	DATEX-II
Lisbon	Li.02	Li.02.06 a	Li.DPO.02.01	EV Charging Location	EMEL	Partner in the consortium	Unknown	Unknown
Lisbon	Li.02	Li.02.06 b	Li.DPO.02.01	EV Charging Pricing	EMEL	Partner in the consortium	Unknown	Unknown

Lisbon	Li.02	Li.02.07 a	Li.DPO.02.01	BiciPark Location	EMEL	Partner in the consortium	GBFS	GBFS
Lisbon	Li.02	Li.02.07 b	Li.DPO.02.01	BiciPark Pricing	EMEL	Partner in the consortium	GBFS	GBFS
Lisbon	Li.03	Li.02.03 b	Li.DPO.02.01	Offstreet availability	EMEL	Partner in the consortium	DATEX-II	DATEX-II
Lisbon	Li.03	Li.03.01	Li.DPO.03.02	Bus Routes	Carris Metropolitana & TML	Partner in the consortium and external stakeholder(s)	GTFS	GTFS
Lisbon	Li.03	Li.03.02	Li.DPO.03.02	Bus Stops	Carris Metropolitana & TML	Partner in the consortium and external stakeholder(s)	GTFS	GTFS
Lisbon	Li.03	Li.03.03	Li.DPO.03.02	Bus Schedules planned	Carris Metropolitana & TML	Partner in the consortium and external stakeholder(s)	GTFS	GTFS
Lisbon	Li.03	Li.03.04	Li.DPO.03.02	Bus Schedules programmed	Carris Metropolitana & TML	Partner in the consortium and external stakeholder(s)	GTFS	GTFS
Lisbon	Li.03	Li.03.05	Li.DPO.03.02	Bus occupancy	Carris Metropolitana & TML	Partner in the consortium and external stakeholder(s)	GTFS	GTFS
Lisbon	Li.03	Li.03.06	Li.DPO.03.03	Bus RT positioning	Carris Metropolitana & TML	Partner in the consortium and external stakeholder(s)	GTFS-RT	GTFS-RT
Lisbon	Li.03	Li.03.07	Li.DPO.03.03	ETA	Carris Metropolitana & TML	Partner in the consortium and external stakeholder(s)	GTFS-RT	GTFS-RT
Lisbon	Li.03	Li.03.08	Li.DPO.03.04	Infrastructure data	TML; Lisbon Metropolitan Area municipalities; infrastructure & traffic apps	Partner in the consortium and external stakeholder(s)	Unknown	Unknown
Lisbon	Li.03	Li.03.09	Li.DPO.03.01	Travel time disruption severity index	TML	Partner in the consortium	No standard	Unknown
Milan	Mi.01	Mi.01.01	Not in the Canvas	Systematic mobility matrix (home-to-work, home-to-school)	Area and enterprises/schools' mobility managers	External stakeholder(s)	None	Unknown
Milan	Mi.01	Mi.01.02	Mi.DPO.01.03	Mobility demand matrix (on-board/in-station surveys)	ATPL	Partner in the consortium	No standard	No standard
Milan	Mi.01	Mi.01.03	Not in the Canvas	Modal share estimate (surveys)	ATPL	Partner in the consortium	No standard	Unknown
Milan	Mi.01	Mi.01.04	Mi.DPO.01.01	LPT geographic network (routes, trips, stops)	ATPL	Partner in the consortium	GTFS	Netex
Milan	Mi.01	Mi.01.05	Mi.DPO.01.01	Scheduled LPT service	ATPL	Partner in the consortium	GTFS	Netex
Milan	Mi.01	Mi.01.06	Mi.DPO.01.02	Real-time vehicle locations	LPT operators/ATPL	Partner in the consortium and external stakeholder(s)	GTFS-RT	SIRI
Milan	Mi.01	Mi.01.07	Mi.DPO.01.02	Real-time trips updates and service alerts	LPT operators/ATPL	Partner in the consortium and external stakeholder(s)	GTFS-RT	SIRI
Milan	Mi.01	Mi.01.08	Mi.DPO.01.03	On-board passenger counts (entrance/exits at stops and trips matrix)	LPT operators/ATPL	Partner in the consortium and external stakeholder(s)	No standard	No standard
Milan	Mi.01	Mi.01.09	Not in the Canvas	Flexible LPT services trips data	LPT operators/ATPL	Partner in the consortium and external stakeholder(s)	None	Unknown
Milan	Mi.01	Mi.01.11	Mi.DPO.01.04	Metro lines status	ATM (Azienda Trasporti Milanesi)	External stakeholder(s)	No standard	Unknown

Milan	Mi.02	Mi.02.01	Mi.DPO.02.01	Agregated Static and dynamic Bike sharing data	AMAT	Partner in the consortium	No standard	Unknown
Milan	Mi.02	Mi.02.02	Mi.DPO.02.01	Agregated Static and dynamic Scooter sharing data	AMAT	Partner in the consortium	No standard	Unknown
Milan	Mi.02	Mi.02.03	Mi.DPO.02.01	Agregated Static and dynamic Motorbike sharing data	AMAT	Partner in the consortium	No standard	Unknown
Milan	Mi.02	Mi.02.04	Mi.DPO.02.01	Agregated Static and dynamic Car sharing data	AMAT	Partner in the consortium	No standard	Unknown
Milan	Mi.02	Mi.02.06	Mi.DPO.02.02	OD demand matrix	AMAT	Partner in the consortium	No standard	No standard
Sofia	So.01	So.01.01	So.DPO.01.04	GPS location of e-scooters	Sharing service provider (Lime)	External stakeholder(s)	No standard	Unknown
Sofia	So.01	So.01.02	So.DPO.01.04	GPS location of e-bikes	Sharing service provider (Cyrcl)	External stakeholder(s)	No standard	Unknown
Sofia	So.01	So.01.03	So.DPO.01.04	GPS location of e-cars	Sharing service provider (Spark)	External stakeholder(s)	No standard	Unknown
Sofia	So.01	So.01.04	So.DPO.01.06	Street network	Geographic Information System - Sofia Ltd. (GIS-Sofia)	External stakeholder(s)	No standard	Unknown
Sofia	So.01	So.01.05	So.DPO.01.06	Pedestrian network	Sofia Municipality	Partner in the consortium	No standard	Unknown
Sofia	So.01	So.01.06	So.DPO.01.06	Sidewalks	GIS-Sofia	External stakeholder(s)	No standard	Unknown
Sofia	So.01	So.01.07	Not in the Canvas	Cycling networks	Sofia Municipality	Partner in the consortium	Unknown	
Sofia	So.01	So.01.08	So.DPO.01.01	GPS location of public transport vehicles (buses, trams, trolleybuses)	SUMC	Partner in the consortium	GTFS-RT	GTFS-RT
Sofia	So.01	So.01.09	So.DPO.01.01	Public transport stops	SUMC	Partner in the consortium	GTFS	GTFS
Sofia	So.01	So.01.10	So.DPO.01.02	P+R available spaces	SUMC	Partner in the consortium	No standard	Unknown
Sofia	So.01	So.01.11	So.DPO.01.02	Available charging points in P+R	SUMC	Partner in the consortium	No standard	Unknown
Sofia	So.01	So.01.12	So.DPO.01.03	Paid parking zones	SUMC	Partner in the consortium	No standard	Unknown
Sofia	So.01	So.01.13	So.DPO.01.05	Air quality data	Sofia Municipality	Partner in the consortium	No standard	Fiware Smart Data Models
Sofia	So.01	So.01.14	So.DPO.01.05	Ari quality data	Bulgarian Executive Environment Agency (ExEA)	External stakeholder(s)	No standard	Fiware Smart Data Models
Stockholm	St.01	St.01.01	St.DPO.01.01	Static road data	City of Stockholm, Trafikverket	Partner in the consortium and external stakeholder(s)	WFS / WMS	WFS / WMS
Stockholm	St.01	St.01.02	St.DPO.01.01	Traffic regulation data	City of Stockholm, Trafikverket	Partner in the consortium and external stakeholder(s)	WFS / WMS	WFS / WMS
Stockholm	St.01	St.01.03	St.DPO.01.04	Public transport data	Samtrafiken	External stakeholder(s)	NeTEx	NetEx
Stockholm	St.01	St.01.04	St.DPO.01.02	Goods data	City of Stockholm	External stakeholder(s)	Unknown	Unknown
Stockholm	St.01	St.01.05	St.DPO.01.03	Micromobility data	City of Stockholm	External stakeholder(s)	Unknown	Unknown
Stockholm	St.01	St.01.06	St.DPO.01.02	Traffic count data	City of Stockholm	External stakeholder(s)	Unknown	Unknown
Stockholm	St.01	St.01.07	St.DPO.01.03	Car sharing data	City of Stockholm	External stakeholder(s)	Unknown	Unknown
Stockholm	St.01	St.01.08	St.DPO.01.02	Air Quality & Weather data	City of Stockholm	External stakeholder(s)	Unknown	Unknown

Stockholm	St.01	St.01.09	St.DPO.01.02	Noise data	City of Stockholm	External stakeholder(s)	Unknown	Unknown
Stockholm	St.01	St.01.10	St.DPO.01.03	Charging infrastructure data	City of Stockholm	External stakeholder(s)	Unknown	Unknown
Stockholm	St.01	St.01.11	St.DPO.01.03	Statistics	SCB	External stakeholder(s)	Unknown	Unknown
Tampere	Ta.01	Ta.01.01	Ta.DPO.01.01	Public transport static data (stops, routes, stop times, transfers, trips)	Tampere public transport authority	Partner in the consortium	GTFS	Netex
Tampere	Ta.01	Ta.01.02 a	Ta.DPO.01.02	Public transport dynamic data (vehicle position)	Tampere public transport authority	Partner in the consortium	GTFS-RT	SIRI
Tampere	Ta.01	Ta.01.02 b	Ta.DPO.01.03	Public transport dynamic data (vehicle position)	Tampere public transport authority	Partner in the consortium	GTFS-RT	OPRA
Tampere	Ta.01	Ta.01.03	Not in the canvas	Public transport accessibility data (vehicles and stops)	Tampere public transport authority	Partner in the consortium	GTFS	NeTEx
Tampere	Ta.01	Ta.01.04	Not in the Canvas	Occupancy data	Tampere public transport authority	Partner in the consortium	Unknown	SIRI/GTFS-RT
Tampere	Ta.01	Ta.01.05	Ta.DPO.01.04	Park & Ride data	City of Tampere	Partner in the consortium	Liipi, GeoJSON	Netex
Tampere	Ta.01	Ta.01.06	Not in the Canvas	Vehicle charging infrastructure data	City & charging service providers	Partner in the consortium and external stakeholder(s)	OCPI	DATEX-II
Tampere	Ta.01	Ta.01.07	Ta.DPO.01.05	Maintenance vehicles (winter-) real time data	City of Tampere	Partner in the consortium	WMS/WFS	Unknown
Tampere	Ta.01	Ta.01.08	Ta.DPO.01.05	Event data (road/lane closures, large road works, big events)	City of Tampere	Partner in the consortium	DATEX II Light	DATEX-II
Tampere	Ta.01	Ta.01.09	Ta.DPO.01.02	Public transport - service alerts (AND trip update)	Tampere public transport authority	Partner in the consortium	GTFS-RT	SIRI
Tampere	Ta.01	Ta.01.10	Ta.DPO.01.04	City bike data	City of Tampere	Partner in the consortium	GBFS	GBFS/NeTEx
Tampere	Ta.01	Ta.01.11	Ta.DPO.01.04	bike parking data	City of Tampere	Partner in the consortium	GeoJSON,WMS/WFS	GBFS
Tampere	Ta.01	Ta.01.12	Ta.DPO.01.04	E-scooter data	Voi	External stakeholder(s)	NeTEx	NeTEx
Tampere	Ta.01	Ta.01.13	Ta.DPO.01.04	E-scooter data (other providers)	City of Tampere	Partner in the consortium	GBFS	GBFS

Annex 3 - DPO overview

Parameter under analysis	DPO Type	Region of DPO	DPO Nr.	Governance	Data space federation	Business model
Mobility related data product offering (static)	**Static public transport**	Milan	Mi.DPO.01.01	Open	Unknown	No revenue scheme applied (open, public)
		Ile-de-France	Il.DPO.01.01	Open	Required	No revenue scheme applied (open, public)
		Barcelona	Ba.DPO.01.01	Currently not, Future usage monitoring and access control planned	Not required	No revenue scheme applied (open, public)
		Sofia	So.DPO.01.01	Unknown	Required	Mixed revenue scheme (open & subscription)
		Tampere	Ta.DPO.01.01	Open	Required	No revenue scheme applied (open, public)
		Budapest	Bu.DPO.01.01	Access control (only for registered users)	Not required	Mixed revenue scheme (open & subscription)
		Lisbon	Li.DPO.03.02	Open	Not required	No revenue scheme applied (open, public)
		Tampere	Ta.DPO.01.03	Open	Required	No revenue scheme applied (open, public)
	Travel demand data	Milan	Mi.DPO.01.03	Open	Not required	No revenue scheme applied (open, public)
		Lisbon	Li.DPO.03.02	Open	Not required	No revenue scheme applied (open, public)

		Milan	Mi.DPO.02.02	Open	Not required	No revenue scheme applied (open, public)
	Road transport infrastructure	Stockholm	St.DPO.01.01	Access control & request limit required	Required (not strictly defined)	No revenue scheme applied (open, public)
		Lisbon	Li.DPO.03.04	Open	Not required	No revenue scheme applied (open, public)
		Lisbon	Li.DPO.01.01	Open and unknown for external data sources (potentially access control needed)	Not required	No revenue scheme applied (open, public)
		Ile-de-France	Il.DPO.01.03	Access control in place	Required	Mixed revenue scheme (open & subscription)
		Sofia	So.DPO.01.06	Access control in place	Required	Mixed revenue scheme (open & subscription)
		Barcelona	Ba.DPO.02.02	Open	Not required	No revenue scheme applied (open, public)

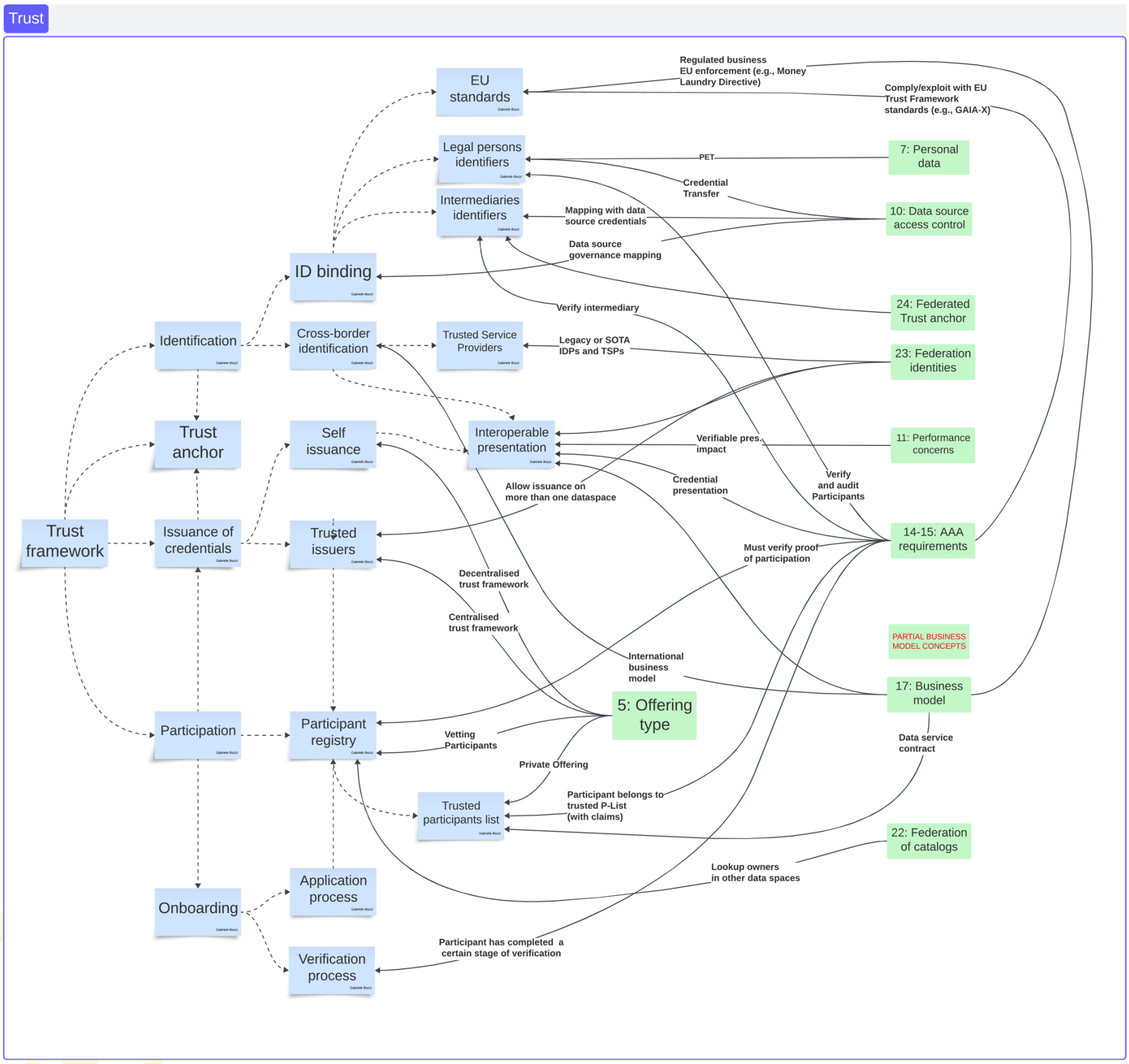
	MaaS service	Ile-de-France	Il.DPO.02.01	Open	Required	Unknown
	Shared mobility	Stockholm	St.DPO.01.03	Unknown	Not required	No revenue scheme applied (open, public)
		Lisbon	Li.DPO.02.01	Open and unknown for external data sources (potentially access control needed)	Not required	Unknown
		Budapest	Bu.DPO.01.02	Open	Not required	Unknown
		Milan	Ml.DPO.02.01	Open	Not required	No revenue scheme applied (open, public)
	Static parking management	Sofia	So.DPO.01.02	Open	Required	Mixed revenue scheme (open & subscription)
		Sofia	So.DPO.01.03	Open	Required	Mixed revenue scheme (open & subscription)
		Lisbon	Li.DPO.02.01	Open and unknown for external data sources (potentially access control needed)	Not required	Unknown

	Public transport accessibility	Budapest	Bu.DPO.02.01	Access control (only for registered users)	Not required	No revenue scheme applied (open, public)
Mobility related data product offering (dynamic)	**Traffic data**	Stockholm	St.DPO.01.02	Access control & request limit required	Required (not strictly defined)	No revenue scheme applied (open, public)
		Flanders	Fl.DPO.01.01	Currently not, Future access control planned	Required	Revenue scheme applied (payed services)
		Barcelona	Ba.DPO.02.01	Open	Not required	No revenue scheme applied (open, public)
	Real time public transport	Milan	Mi.DPO.01.02	Open	Unknown	No revenue scheme applied (open, public)
		Milan	Mi.DPO.01.04	Unknown	Not required	Unknown
		Tampere	Ta.DPO.01.02	Open	Required	No revenue scheme applied (open, public)
		Lisbon	Li.DPO.03.01	Open	Not required	No revenue scheme applied (open, public)
		Budapest	Bu.DPO.01.01	Access control (only for registered users)	Not required	Mixed revenue scheme (open & subscription)
		Lisbon	Li.DPO.03.03	Open	Not required	No revenue scheme applied (open, public)
		Stockholm	St.DPO.01.04	Open	Required (not strictly defined)	No revenue scheme applied (open, public)
		Barcelona	Ba.DPO.01.03	Unknown	Not required	Value exchange

		Barcelona	Ba.DPO.01.02	Unknown	Not required	Value exchange
		Sofia	So.DPO.01.01	Access control & request limit required	Required	Unknown
	Multimodality	Tampere	Ta.DPO.01.04	Open	Required	No revenue scheme applied (open, public)
		Sofia	So.DPO.01.04	Unknown	Required	Mixed revenue scheme (open & subscription)
		Lisbon	Li.DPO.02.01	Open and unknown for external data sources (potentially access control needed)	Not required	Unknown
	Parking management	Sofia	So.DPO.01.02	Open	Required	Mixed revenue scheme (open & subscription)
		Tampere	Ta.DPO.01.04	Open	Required	No revenue scheme applied (open, public)
		Lisbon	Li.DPO.02.01	Open and unknown for external data sources (potentially access control needed)	Not required	Unknown
	Roadworks & incidents	Tampere	Ta.DPO.01.05	Open	Required	No revenue scheme applied (open, public)
	Road transport infrastructure	Ile-de-France	Il.DPO.01.02	Access control in place	Required	Revenue scheme applied (payed services)
Environmental related data product offering	**Air quality**	Stockholm	St.DPO.01.02	Access control & request limit required	Required (not strictly defined)	No revenue scheme applied (open, public)

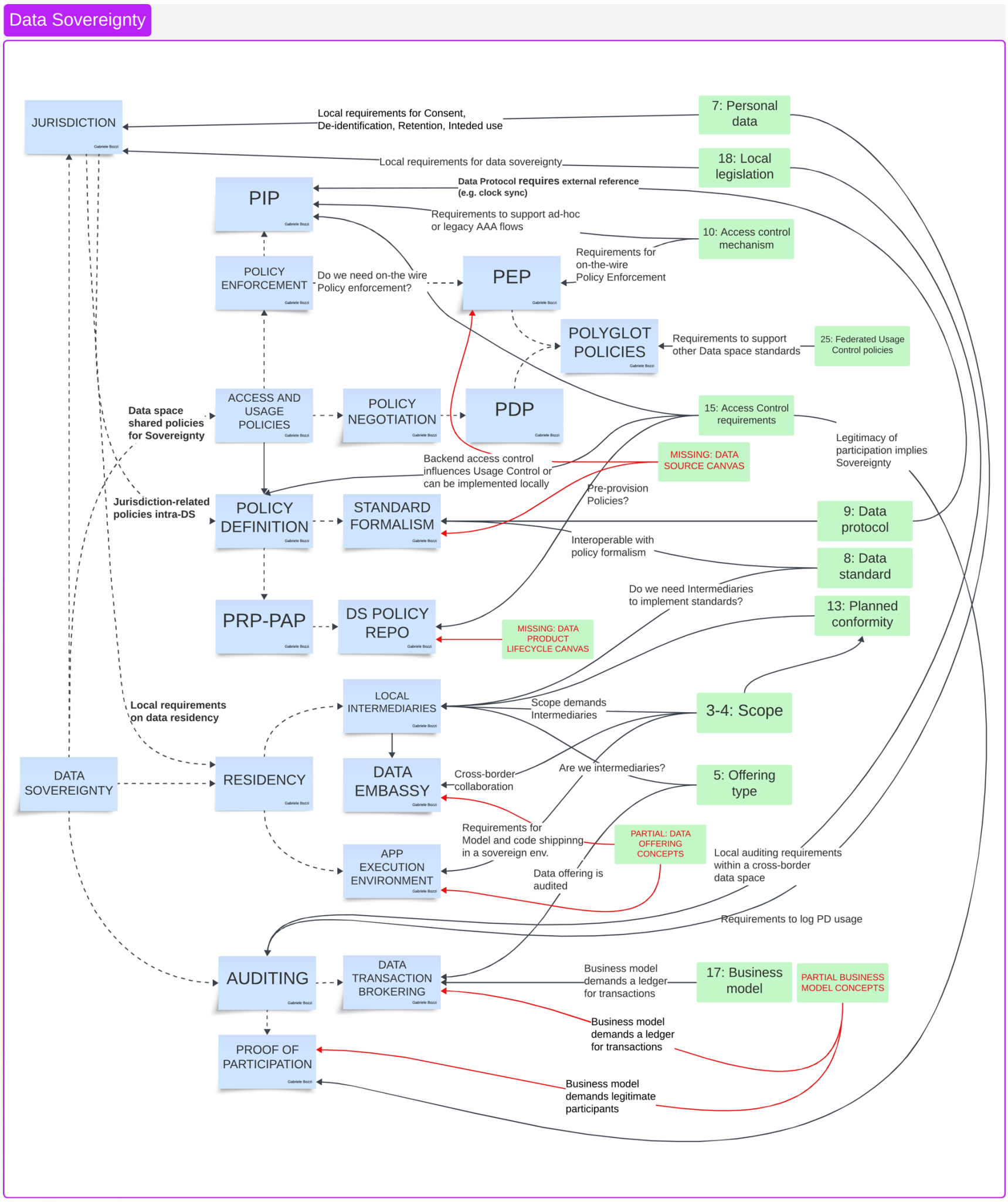
		Sofia	So.DPO.01.05	Open	Required	No revenue scheme applied (open, public)
		Barcelona	Ba.DPO.02.04	Open	Not required	No revenue scheme applied (open, public)
	Noise measurements	Stockholm	St.DPO.01.02	Access control & request limit required	Required (not strictly defined)	No revenue scheme applied (open, public)
	orological data	Barcelona	Ba.DPO.02.03	Open	Not required	No revenue scheme applied (open, public)
Mobile phone data product offering	**Mobile phone data**	Barcelona	Ba.DPO.01.04	Unknown	Not required	Revenue scheme applied (pay-as-you go and one-time payments)

Annex 4 - Mapping of canvas questions to trust capabilities



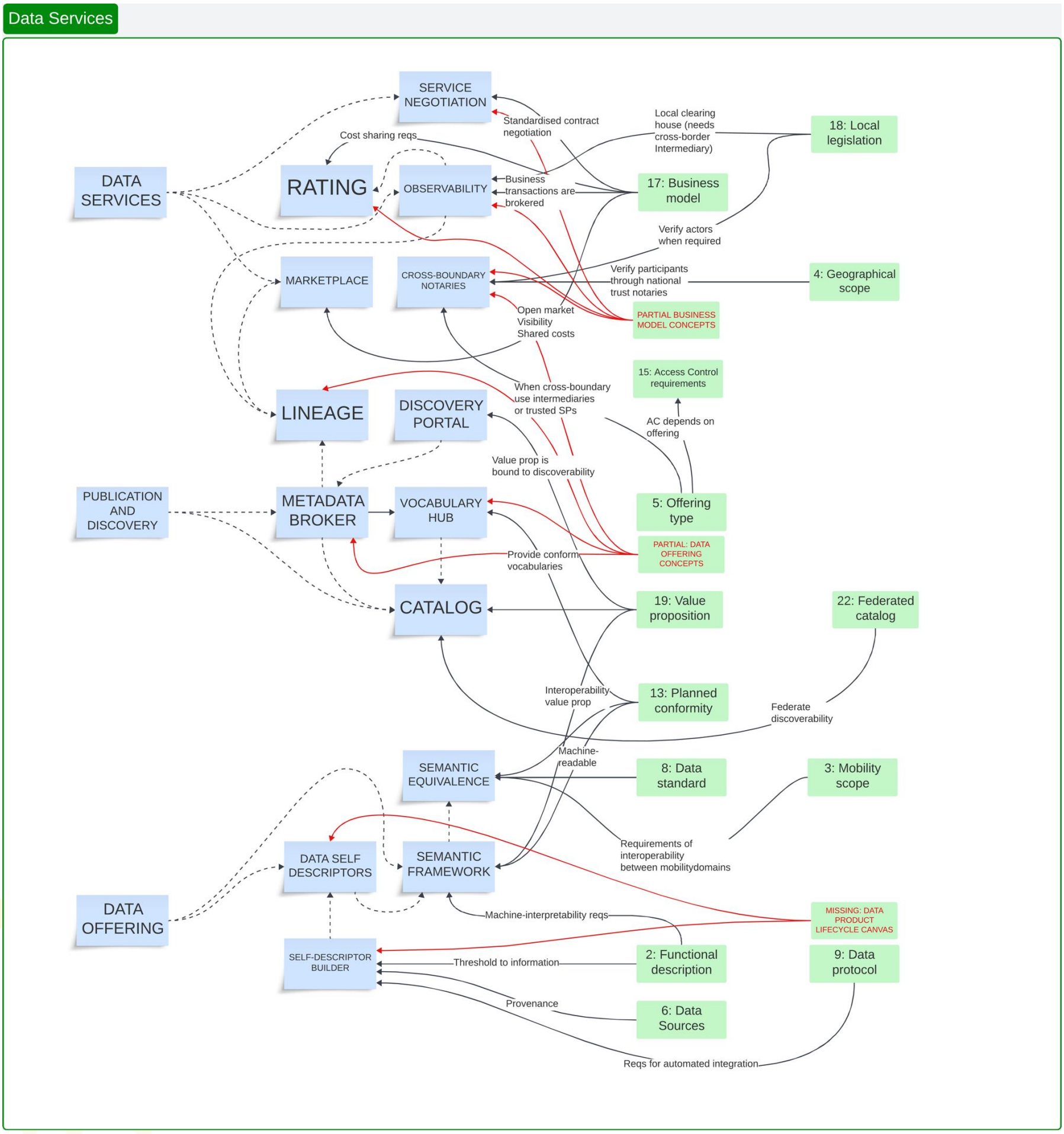
Restricted Use

Annex 5 - Mapping of canvas questions to data sovereignty capabilities



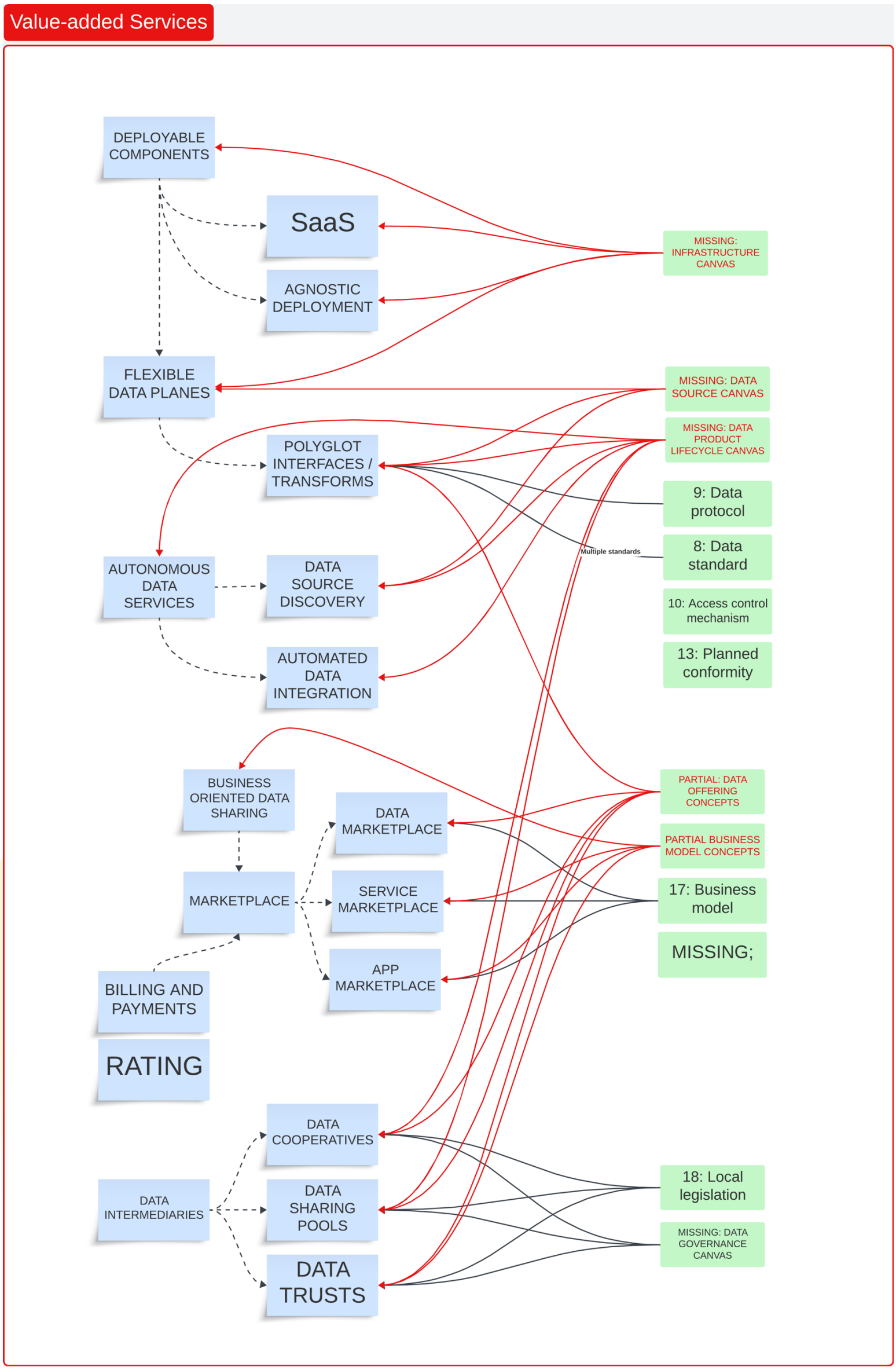
Restricted Use

Annex 6 - Mapping of canvas questions to data services capabilities



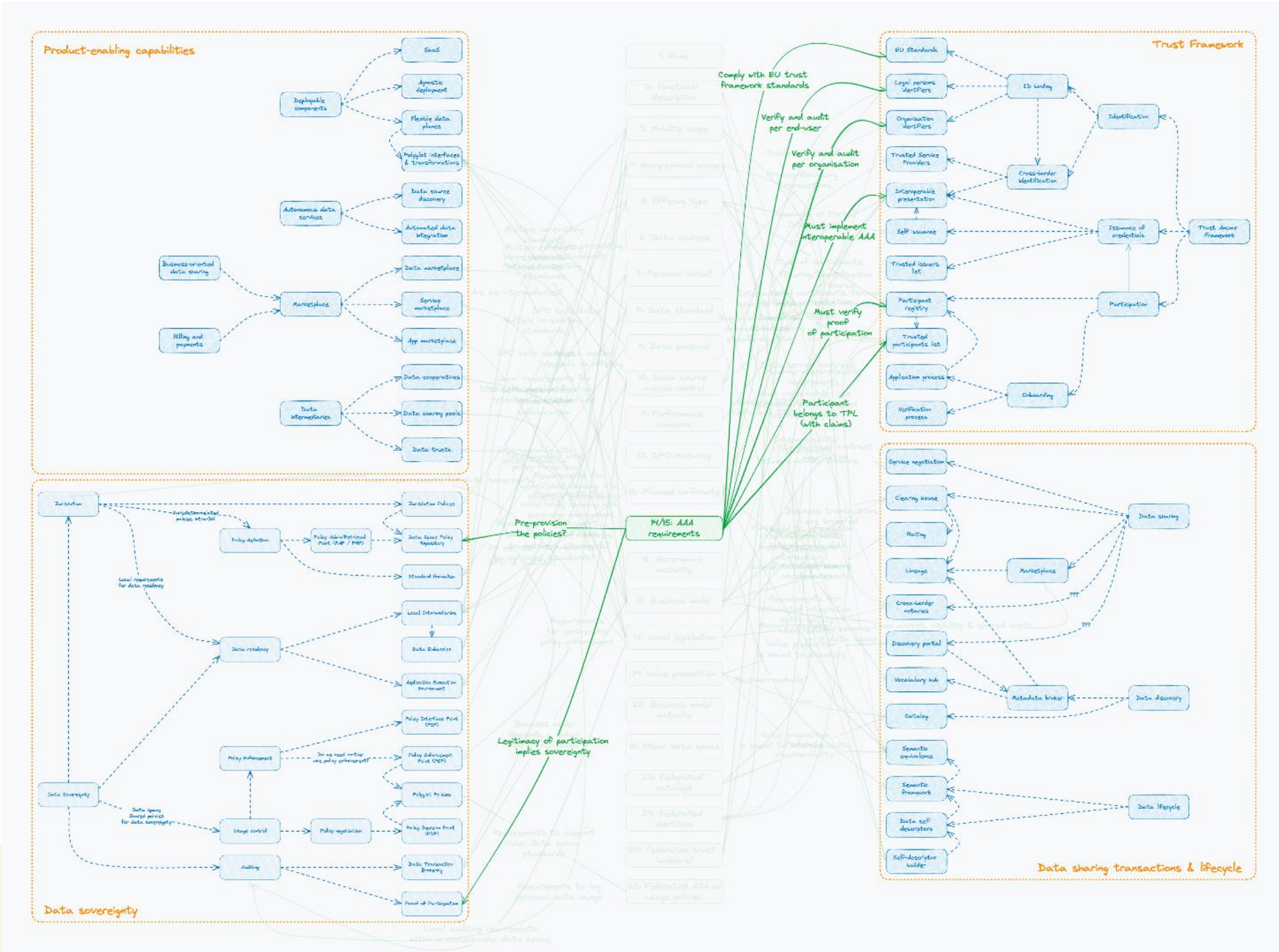
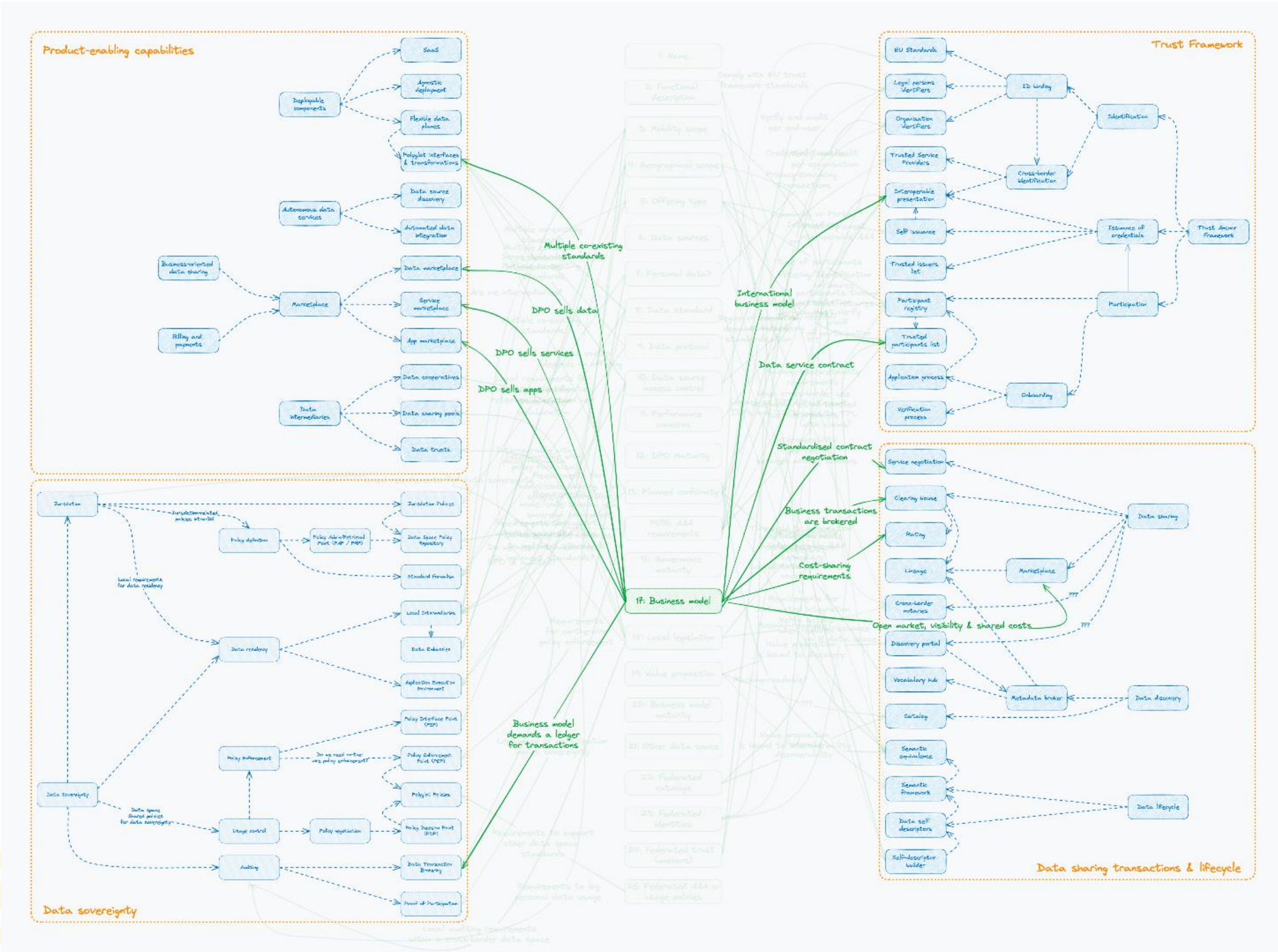
Restricted Use

Annex 7 - Mapping of canvas questions to value-added services capabilities



Restricted Use

Annex 8 - Mapping of question 17 (Business model) to capabilities.



Annex 9 - Mapping of questions 14 and 15 (AAA requirements) to capabilities.