



MOBILITY DATA SPACES AND MAAS

BUILDING A COMMON, CONNECTED, AND INTEROPERABLE GROUND
FOR THE FUTURE OF MOBILITY



1 TABLE OF CONTENT

1	TABLE OF CONTENT	2
2	EXECUTIVE SUMMARY	4
3	INTRODUCTION	6
4	WHAT? WHY? FOR WHO	7
4.1	WHAT IS A DATA SPACE? WHY DOES IT MATTER FOR MAAS?	7
4.2	OUR OBJECTIVES	7
4.3	OUR AUDIENCE	8
5	MOBILITY DATA SPACE: OBJECTIVES, FEATURES, AND ECOSYSTEM	9
5.1	OBJECTIVES AND BUSINESS CASES	9
5.2	TOPOLOGY	10
5.3	FEATURES	11
5.4	RELATION TO NATIONAL ACCESS POINTS (NAP)	12
6	API IN THE MOBILITY DATA SPACE	14
6.1	THE ROLE OF API PLAYS IN THE MOBILITY DATA SPACE	14
6.2	WHAT TYPES OF APIS ARE REQUIRED	14
7	DATA MODELS OF MOBILITY DATA	17
8	OPEN DATA AND DATA LICENSES	19
9	IMPLEMENTATION OF MOBILITY DATA SPACES	20
9.1	HOW TO JOIN A MOBILITY DATA SPACE	20
9.2	HOW TO ESTABLISH A MOBILITY DATA SPACE	20
9.3	ROLES WITHIN A MOBILITY DATA SPACE	21
10	EXAMPLES OF DATA SPACES	23
10.1	MOBILITY DATA SPACE IN GERMANY	23
10.2	TRAVEL DATA SPACE EONA-X	25
10.3	CATENA-X FOR AUTOMOTIVE	26
11	THE WAY FORWARD	28
12	REFERENCES AND AUTHORS	29
12.1	INDIVIDUAL AUTHORS	29
12.2	SUPPORTING ORGANISATIONS AND GROUPS	29
12.2.1	<i>DATA4PT</i>	29
12.2.2	<i>ITxPT</i>	29
12.2.3	<i>MaaS Alliance</i>	30
12.2.4	<i>MobilityData</i>	30

12.3	REFERENCES	30
12.4	TABLE OF FIGURES	30

2 EXECUTIVE SUMMARY

In its MaaS market playbook, MaaS Alliance advocates for “**Advanced data sharing models and incentive schemes**”, which naturally leads to the Mobility Data Spaces. Mobility Data Spaces can be seen as the potential answer to support the development of fair and trusted data sharing models and incentives. In the long run, they should **enable the roll-out of sustainable MaaS services** and the development of the MaaS market **with potential solutions to** the challenges of setting MaaS services:

- **Interoperability** of systems (data, protocols, connectivity);
- Agreements of **implementation** (governance, legal);
- **Terms of business** (financial, subsidies).

The **core objectives** of Mobility Data Spaces are to **support the uptake and wider usage of shared mobility means** (intermodal or multimodal) **by establishing a trusted technical environment for data usage between multiple stakeholders.**

Their **minimal mandatory features** are:

- **Access** to the data
- **Share** the data between two parties,
- **Adding value** to the data,

The **data exchange and trust setting** are created **via a set of APIs** that **provide authentication and authorisation.** First, the API caller initiate a connection through a Connector API with the Data Space. Then, the connection with the actual API provider, also with Connector API.

Datasets within the same Mobility Data Space should be expressed in any data standard that is relevant to the parties sharing and working on these datasets. We recommend to make sure that data **standards are interoperable** and mapped toward more **aligned data models** for better consistency. The **best practice** is to set and **use reference semantics** such as Transmodel as the widest data model for mobility.

The data license choice for datasets should be based on their commercial value and sensitivity:

- **Open by default for data** that are enlisted in the European directive for mobility services and are **already shared via National Access Points**;
- **Data with a commercial benefit** should be shared using a **set of standardized data sharing agreements** (or templates);

- **Data** that are **sensitive** should be shared in **respect of the existing local regulations and laws for data privacy**, including the European Union General Data Protection Regulation (GDPR).

The roles of any member to a Mobility Data Space are:

- **Manage their data assets**, corresponding contracts and policies, as well as actively monitoring the execution of their contracts and policies and the management of the connector infrastructure;
- **Maintain the descriptions** of data up-to-date;
- **Inform** the coordinating entity **about changes**;
- **Report** to the coordinating entity **any violation** of policies and rules;
- **Monitor** the operation of **the connector** infrastructure;
- **Participate** in working groups to further **evolve** the Data Space.

3 INTRODUCTION

The **MaaS Alliance** is a **public-private partnership** working to **establish the foundations for building a common approach to Mobility-as-a-Service (MaaS)** and unlocking the economies of scale needed to support the successful implementation and uptake of MaaS globally.

MaaS Alliance defines Mobility-as-a-Service (MaaS) as “the integration of various forms of transport and transport-related services into a single, comprehensive, and on-demand mobility service”¹.

The MaaS Alliance’s **vision** is to **facilitate an open MaaS ecosystem** that benefits users, societies, and the environment. To reach this goal, the Alliance brings together stakeholders from all sectors to enable the successful deployment of MaaS around the world.

The core of MaaS is data. To offer the right options toward all individual users we need to be sure that the data in the ecosystem is accurate and reliable. To use, shared, and spread this data into a relevant proposition is critical to MaaS.

Within the MaaS Alliance, we are working hard to contribute and facilitate an open MaaS ecosystem. We combined the efforts of the experts, we listened to the industry and learned from the developments and initiatives. We discussed what the best approach is to Build a common, connected, and interoperable ground for the future of mobility. Having set this scope, we are exploring the **Mobility Data Space concept** in 2021-2022, now providing the results with this publication.

¹ <https://maas-alliance.eu/wp-content/uploads/2021/03/05-MaaS-Alliance-Playbook-FINAL.pdf>

4 WHAT? WHY? FOR WHO

4.1 What is a Data Space? Why does it matter for MaaS?

In its MaaS market playbook², MaaS Alliance advocates for 8 principles to build an Open MaaS Ecosystem. One of them is “**Advanced data sharing models and incentive schemes**”, which naturally leads to the Mobility Data Spaces.

Data Spaces were first mentioned and worked on by the International Data Spaces Association (IDSA), based in Germany. The coalition work aims to provide a secure, sovereign system of data sharing in which all participants can realize the full value of their data.

As per the EU-funded OPEN DEI project, a **Data Space** is defined as “a **decentralized infrastructure for trustworthy data sharing and exchange in data ecosystem based on commonly agreed principles**”³.

Mobility Data Spaces can be seen as the potential answer to support the development of fair and trusted data sharing models and incentives. In the long run, they should **enable the roll-out of sustainable MaaS services** and the development of the MaaS market **with potential solutions to** the challenges of setting MaaS services:

- **Interoperability** of systems (data, protocols, connectivity);
- Agreements of **implementation** (governance, legal);
- **Terms of business** (financial, subsidies).

This position has been further **reinforced by the European Commission in their Data strategy**. References to Data Spaces were made in the Data Governance Act⁴. Mobility is part of the sectors that are looked at for the creation of “Common European data spaces”⁵.

4.2 Our objectives

MaaS Alliance aims to ensure interoperability, connectivity, and trust to build an Open MaaS Ecosystem. So, the aim of this white paper is to bridge the gap between data space providers and MaaS stakeholders.

² <https://maas-alliance.eu/wp-content/uploads/2021/03/05-MaaS-Alliance-Playbook-FINAL.pdf>

³ <https://www.opendei.eu/case-studies/workshop-on-the-common-european-mobility-data-space-02-december-2021/>

⁴ <https://digital-strategy.ec.europa.eu/en/policies/data-governance-act>

⁵ <https://digital-strategy.ec.europa.eu/en/library/staff-working-document-data-spaces>

This white paper does not aim to re-invent the wheel nor to re-define what a Mobility Data Space is. On the contrary, leveraging the work done by the industry, this white paper aims to **offer a better comprehension of the concept to all MaaS stakeholders.**

After reading this white paper, we want the readers to have a clearer understanding on:

- What does a Mobility Data Space stand for;
- What does it bring to the MaaS ecosystem;
- The way forward recommended by MaaS Alliance.

4.3 Our audience

This white paper is **primarily aimed** for **people who are working in data operations** within organisations that are mobility providers, MaaS providers and/or public authorities. They can be producing, sharing and/or consuming the data. This audience is:

- Data architects who are building and improving the data;
- Software architects who define the schemes behind sharing the data;
- Data consumers who are using the data to build MaaS solutions.

The **second audience** of our white paper is for all **decision-makers** who are working within organisations that are mobility providers, MaaS providers and/or public authorities. They are in charge of deciding if their organisations should get involved with a Mobility Data Space or not. This audience is:

- C-level people working for private sector organisations in mobility;
- Decision-makers for public organisations in mobility;
- Policy-makers for the coordination of the mobility industry.

5 MOBILITY DATA SPACE: OBJECTIVES, FEATURES, AND ECOSYSTEM

5.1 Objectives and business cases

The **core objectives** of Mobility Data Spaces are to **support the uptake and wider usage of shared mobility means** (intermodal or multimodal) **by establishing a trusted technical environment for data usage between multiple stakeholders.**

As of today, data sharing and usage between MaaS stakeholders remains complex and can be heavy in resources (financial, human, etc.). To address this, the **promises** of Mobility Data Spaces are:

- A **harmonized technical infrastructure** for data exchange and integration;
- A wider **accessibility** of the data;
- A semantic **interoperability** of the data;
- **Trust** within the ecosystem with templates for data sharing business terms;
- **Replicability** and **reliability** of services.

Building a business case for Mobility Data Spaces should also reflect the **diversity of stakeholders** within the mobility industry and their different needs. Current stakeholders of the ecosystem are:

- **Travellers:**
 - They should be put first as the ultimate beneficiaries of the Open MaaS Ecosystem;
 - Aside from the protection of their personal data, they do not influence much the business case of Mobility Data Spaces;
- **Mobility providers:**
 - They offer services to travellers;
 - They are part of the data value chain as the primary producer of data;
 - Their influence on the business cases is related to the cost of data production, maintenance, and quality work;
- **Data aggregators:**
 - They offer services to either travellers (e.g., trip planning) or to other organisations of the ecosystems (e.g., data dashboards for cities, performance analysis for mobility providers, etc.);
 - They are part of the data value chain as the primary consumer of data;
 - Their influence on the business cases is related to the cost of data consumption, aggregation, and added-value work;
- **Facilitators:**

- They are responsible for the incorporation and maintenance of the Data Space;
- They are the primary beneficiaries of the business cases.

Business cases for Mobility Data Spaces are yet to be fully defined. As of today, governments are subsidising efforts to explore their set up via open calls or grants. Most of the subsidies cover the exploration work to set a local/national/regional Data Space in defined sectors such as mobility, tourism, health, etc.

In the longer run, business cases for Mobility Data Spaces could build upon the fact that competition between providers can lower costs for consumers, and the fact that the service should support geographic roaming, much like a cell phone contracts. In the particular case of Europe, this means that the pan-European standardisation and integrity of Mobility Data Spaces could lead to **support European MaaS services with a portability of travellers' preferences**, that could be applied in any location.

5.2 Topology

A general topology is shown in the figure below.

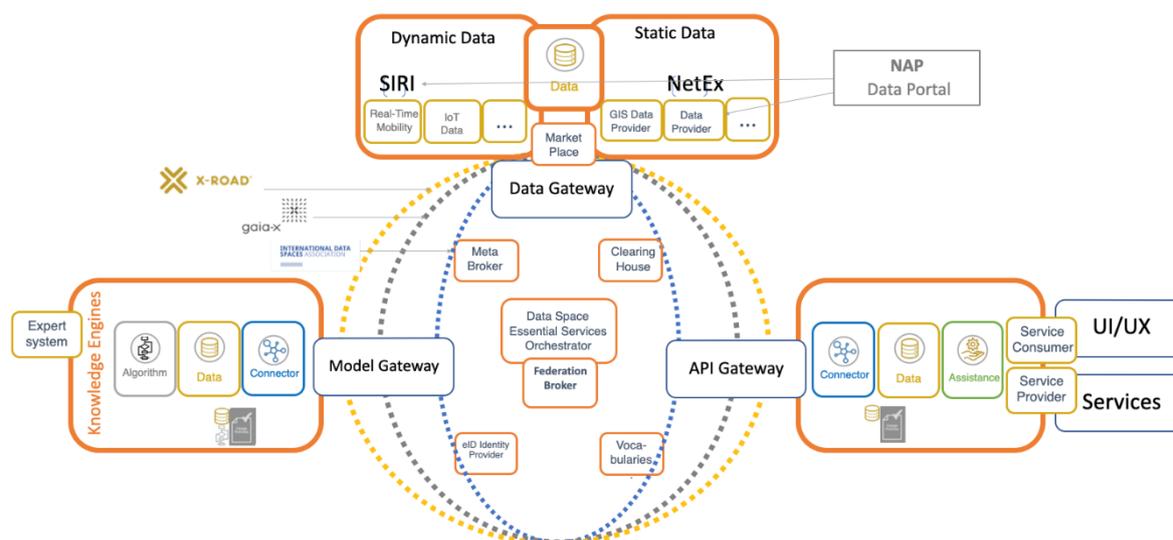


Figure 1: Topology overview of Mobility Data Spaces -
Source: Source: Olaf-Gerd Gemein, truzzt Alliance, 2022 Dublin

This topology incorporates the main design principle of a Data Space as trusted Federator or Aggregator of data and data services, and distinguish a data space fundamentally from data -platform, -portals, -warehouse, -hubs or -lakes. The Data Space is at its core a service orchestrator, with the following core functions:

- Meta broker
- Clearing House

- Identity provider
- Vocabulary provider

The Design Principles for Data Spaces⁶ define the following building blocks:

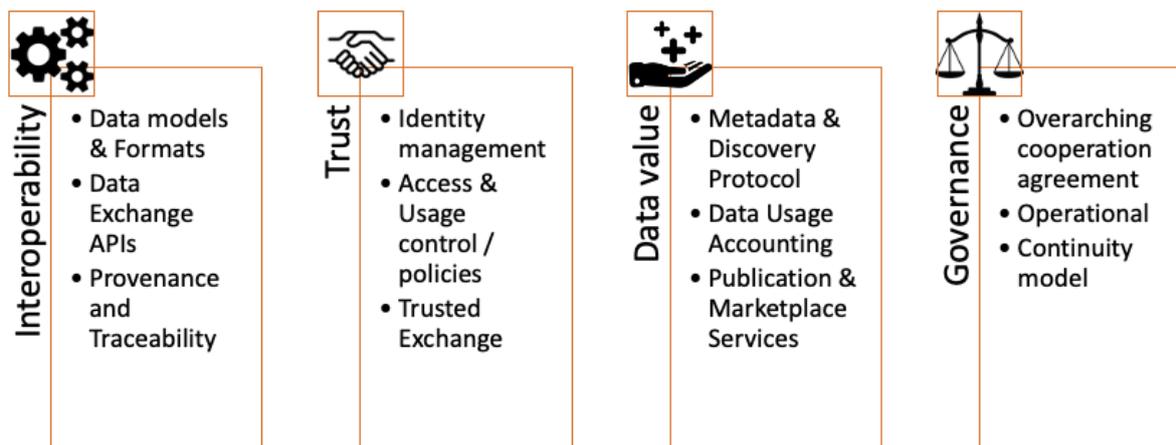


Figure 2: Building blocks for Data Spaces -
Source: Design Principles for Data Spaces

This white paper will explore further the interoperability part as the one belief that the authors shared: standards must be interoperable to support the development of MaaS for all. For the other parts, we recommend the work done by our colleagues from the Open DEI⁷ project and the International Mobility Data Space⁸.

5.3 Features

As described above, the main idea behind a mobility data space is a shared infrastructure for all stakeholders of the mobility industry to access and share data. The minimal mandatory features are:

- **Access** to the data
 - which should be done via an API to allow a seamless maintenance of the data;
 - which should always start with public open data;
 - which should be interoperable;
- **Share** the data between two parties,
 - once trust is established between them;

⁶ <https://design-principles-for-data-spaces.org/>

⁷ <https://www.opendei.eu/>

⁸ <https://internationaldataspaces.org/>

- once an agreement is reached on the conditions of the data sharing (i.e., license agreement);
- **Adding value** to the data,
 - which can range from public feedback on the data to improve its quality (e.g., revised station locations for shared mobility services) to data analysis (e.g., quality assessment);
 - which could be monetized before being reshared.

These features are universal in the sense that they are **not impacted by**:

- The **type of data** (e.g., mobility static data, data from other sectors, users' preferences, financial data, etc.);
- The **type of organisations** involved (e.g., mobility providers, data aggregators, etc.);
- The **relationship between** these **organisations**.

Additional **optional features** of the mobility data space can be for example:

- **Support** for data producers (e.g., automated validation of the data quality, conversion tools between data formats, assistance to define the best data license to use, etc.);
- Data **storage**;
- Data **maintenance** (e.g., automated notification to the data producer to check if the data needs any update).

5.4 Relation to National Access Points (NAP)

Each European Member State must establish a National Access Point (NAP)⁹ for mobility data, mandated by the ITS Directive 2010/40/EU¹⁰ and its Delegated Regulations. By now, there are more than 30 operational National Access Points, where mobility related data is published and made available for use¹¹.

Since the core objective of a **NAP** is to make available mobility data for all at a national level, it could be considered as a **building stone for a mobility data space**. In that case, there are 3 scenarios possible:

- A NAP becomes one of the data providers of a mobility data space;
- A NAP is growing toward becoming a national mobility data space;

⁹ https://transport.ec.europa.eu/transport-themes/intelligent-transport-systems/road/action-plan-and-directive/national-access-points_en

¹⁰ <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32010L0040>

¹¹ <https://napcore.eu/>

- A mix of the two scenarios above is also possible if a given mobility data space has a wider geographical coverage than a European Member State.

The **first scenario** seems the **easiest to implement** as the role of a data provider for a data space is well defined. For a NAP to take that direction, we envision the required steps as:

- The creation of an authorized ID for the NAP to publish data on the mobility data space;
- The NAP to consolidate agreements from data providers to re-publish their data;
- The definition of an API that will act as a data harvester of the datasets and metadata collected and published by the NAP.

The **second scenario** could be seen as a good way forward to **ensure national data sovereignty and a fair access to data**. This scenario must reflect the local and regional legal obligations for open data and privacy rights. The latter is further reinforced by the fact that NAPs are public-owned entities and do not pursue any commercial interest. They could act as the most neutral party possible to steward a national mobility data space. In that case, we suggest that they follow our recommendation for the implementation of a data space.

The **third scenario would be the one that we recommend for any region that has intense multimodal trips within its borders** (e.g. the European Union, a region with specific trade agreements such as ASEAN, etc.). It would allow MaaS offers to develop on a sustainable scale (e.g., volume of options provided, reduction of the environmental impact of data storage, etc.) while having coverage that is significant for end-users. In the case of the European Union, it could be a natural evolution of the NAPCORE¹² project with them working on the implementation of a mobility data space at the European level.

¹² <https://napcore.eu/>

6 API IN THE MOBILITY DATA SPACE

In the data space context, one talks about "data provider" and "data consumer". Pure data is not enough so there is a need for interfaces. The interfaces are realized through APIs.

API (Application Programming Interface) is an interface or contract between service provider and service consumer. In addition to the actual data, API provides based on data model operations such creating, updating, deleting and fetching data entities.

6.1 The role of API plays in the Mobility Data Space

The data consumer (also called API consumer) does not need to know how the service is implemented or where it operates. API consumer however needs to know the following prior integrating to the service:

- What is the **contract** (also called API specification) for the service;
- What are the **endpoints** in the API and where to find endpoints for development, test and actual production use;
- How the API callers are **authenticated and authorised**;
- Where to get access to the API **credentials**;
- Are there **limitations** in the use of API (such as rate limits) and the data (such as storing the data acquired by the API);
- What is the **versioning and deprecation policy** for the API (for example, if the API has backwards incompatible changes, will there be a new API version).

Data Spaces should provide guidance on all of the topics above so that data providers and data consumers can join the data space in an efficient way.

6.2 What types of APIs are required

APIs around Data Spaces can be classified as follows:

- Data Space Connector API around the Data Space itself
 - It orchestrates the sharing of data in a secure way and publishes it to the federated catalogue service that advertises data to other participants
 - For an example, see the IDSA Catalog Data Model¹³;
- Connector APIs for Data Space participants
 - It enacts the authentication of the participants, which supports trust building;

¹³ <https://international-data-spaces-association.github.io/DataspaceConnector/Documentation/v6/DataModel>

- For examples, see Eclipse¹⁴ or the IDS Trusted Connector¹⁵.

The position of the Connectors within the Data Space can be represented as follow:

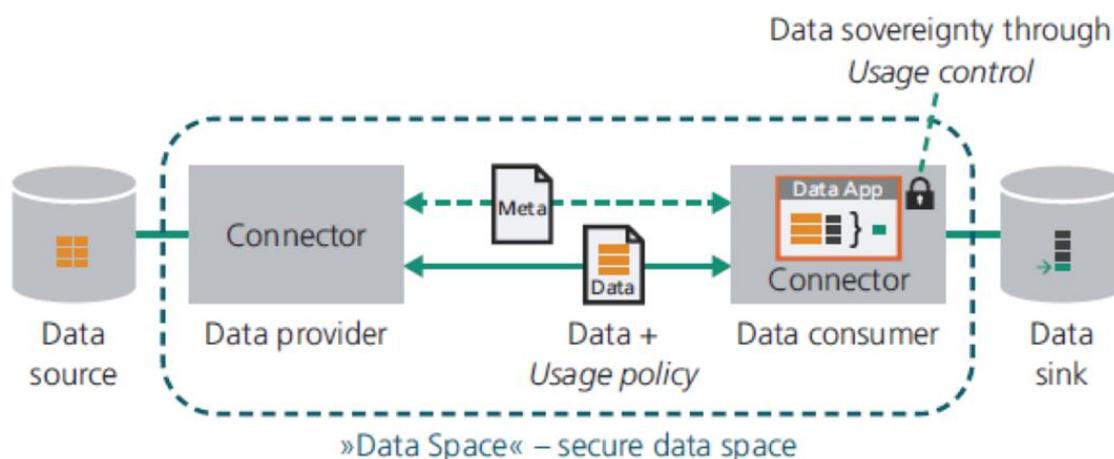


Figure 3: Functional principle of data sovereignty through mechanisms for data usage control -
Source: Holger Drees at 27th ITS World Congress, Hamburg, Germany, 11-15 October 2021

API interfaces provided by Data Space are used to negotiate and subscribe to the Data Space ecosystem. Data Space typically provides separate set of APIs for API provider and API consumer.

For the actual data exchange, the API caller (API consumer) would first initiate a connection through a Connector API with the Data Space and then the connection with the actual API provider, also with Connector API.

Data exchange between the API consumer and API provider may have different usage scenarios, starting from simple data retrieval up to more complex scenarios such as getting notifications on a changed data. The data flow relying on the above-mentioned APIs and Connectors can be summed up with the diagram below.

¹⁴ <https://github.com/eclipse-dataspacespaceconnector/DataSpaceConnector>

¹⁵ <https://industrial-data-space.github.io/trusted-connector-documentation/docs/overview/>

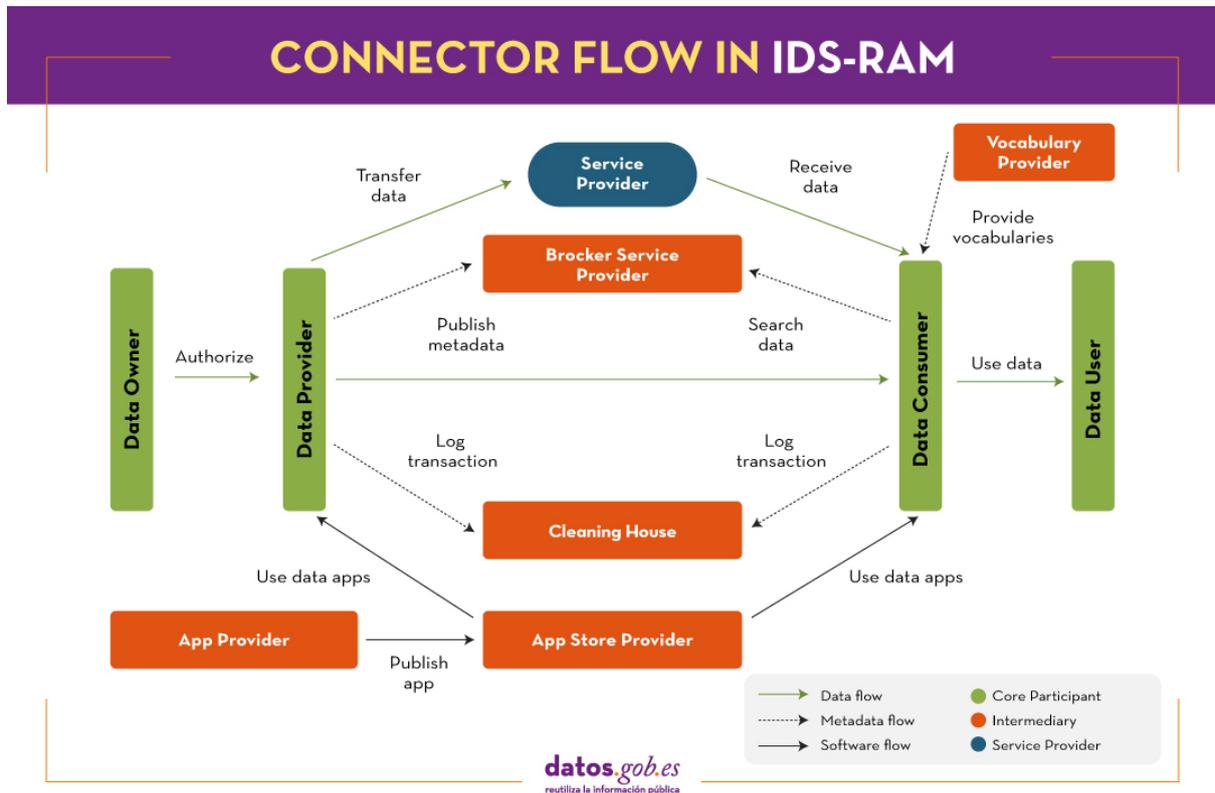


Figure 4: The connector flow in IDS-RAM - Source: Datos.gob.es¹⁶

¹⁶ <https://datos.gob.es/en/blog/ids-ram-reference-architecture-model-and-its-role-data-spaces>

7 DATA MODELS OF MOBILITY DATA

The **purpose of a data model** is in a first step to identify and to describe main data elements and their relationships using a **precise method allowing the implementation of data repositories and/or data exchange messages**. This makes it possible to provide coherent 'data spaces' where information is provided and/or exchanged in a well-defined way which facilitates the aggregation of multi-source data.

Mobility Data Spaces encompass data that are coming from different sources. By default, these sources make the data heterogeneous. This heterogeneity makes it difficult to combine data provided by multiple sources but, for instance, trip planning relies on combinations of information on possible partial itineraries (legs), timetables and fares providing the travellers with intermodal trip options.

To address this problem, **several standards** provide specifications of common data exchange formats. This is **not always sufficient**, as data are interlinked and the description of the links between data is necessary as well. **This is the reason why** not only data exchange formats but rather **data models (structures) have to be specified**.

One of such data models is called **Transmodel**¹⁷ (published under the title "Public transport reference data model" as EN12896). This data model aims to provide a generic description of the data objects and elements needed to support functions such as:

- the definition of stops for the conventional public transport operation;
- management of vehicle meeting points in the case of non-conventional transport (such as carpooling or vehicle sharing);
- timetable planning;
- definition of access rights to transport services;
- sales operations;
- charging of customers;
- trip plan provision.

It is a **conceptual model** (independent of any particular implementation) and is particularly rich (more than 1500 concepts), as it is multimodal and covers several functional/data domains.

In this context, the **National Access Points** which provide information related to a number of data categories **using Transmodel-based** (or Transmodel-compatible) **data exchange formats** can be considered as a 'mobility data space'.

¹⁷ <https://www.transmodel-cen.eu/>

Some other data models are monomodal (e.g., cover mainly rail operation or mainly for bike sharing) or are dedicated to a specific domain (e.g., infrastructure description or sales of fare products). These data models may also build 'data spaces' for mobility, but the limitation of their scope induces the limitation of the 'data space'. In this case, 'bridges' between such partial 'data spaces' may be built, which necessitates, however, the design of multiple converters and interfaces.

Though the authors of this white paper do not want to impose any data model, we strongly recommend that a mobility data space should be based on **reference semantics that would support a variety of data models and their interoperability**. Such semantics could be defined with the support of intermediaries such as vocabulary providers¹⁸.

Transmodel is, as of today, the widest data model for mobility that exists in Europe with some of its data exchange standards that are used in other countries (e.g., SIRI in the United States of America or Australia). Our **recommendation** is to use **Transmodel as the reference semantics** of a mobility data space.

However, this does not mean that the Mobility Data Space should only resurface data expressed in data exchange formats that directly derive from Transmodel. **Datasets should be expressed in any data standard that is relevant to the parties sharing and working on these datasets**. The recommendation is rather to make sure that data **standards are interoperable** and mapped toward more **aligned data models** for better consistency.

To learn more about interoperability, we recommend turning to the white paper the authors published in 2021: "*INTEROPERABILITY FOR MOBILITY, DATA MODELS, AND API*"¹⁹.

¹⁸ https://www.trusts-data.eu/wp-content/uploads/2022/06/04_TNO-april-2022-The-Vocabulary-Hub-to-configure-data-space-connectors.pdf

¹⁹ <https://maas-alliance.eu/wp-content/uploads/2021/11/20211120-Def-Version-Interoperability-for-Mobility.-Data-Models-and-API- -FINAL.pdf>

8 OPEN DATA AND DATA LICENSES

MaaS Alliance endorses the approach of “**Open by default**” for data sharing²⁰. As we recognize that producing data has a cost, we suggest that it is **applied to data** that fall under the European Delegated Regulation (EU) 2017/1926²¹ on EU-wide multimodal travel information services. This data could be shared using the Open License²², the Open Database License²³, or Sitra’s Rulebook for Fair Data Economy²⁴. In all these cases, with the data **already being open and published on National Access Points (NAPs)**, we do not foresee any difficulty to share them via Mobility Data Spaces. For example, Fintraffic (Finnish NAP) has already applied Sitra’s Rulebook to create a rulebook for their Mobility Data Ecosystem²⁵.

For any types of **data that could represent a commercial benefit** in being shared (e.g., operational data), we recommend the **establishment of a set of standardized data sharing agreements** that are fair to all stakeholders and should be **used as templates**. Though the definition of such standardized agreements can be the responsibility of the Mobility Data Space owner, we recommend building on the European Union (DG MOVE) work as part of their actions taken towards the development of Multimodal digital mobility services²⁶. If these actions lead to the definition of recommended standardized license agreements, they should be leveraged by Mobility Data Spaces as a way to support the scaling-up of MaaS market without spending resources on re-inventing the wheel.

For any types of **data that are sensitive** to share (e.g., personal data or private vehicles’ position), we recommend building data sharing schemes and licenses that are **compliant with**:

- The European Union **General Data Protection Regulation**²⁷ (GDPR);
- **Regional or national requirements and laws** for data privacy.

²⁰ <https://maas-alliance.eu/wp-content/uploads/2021/03/05-MaaS-Alliance-Playbook-FINAL.pdf>

²¹ https://eur-lex.europa.eu/eli/reg_del/2017/1926/oj

²² <https://www.etalab.gouv.fr/wp-content/uploads/2018/11/open-licence.pdf>

²³ <https://spdx.org/licenses/ODbL-1.0.html#licenseText>

²⁴ <https://www.sitra.fi/en/publications/rulebook-for-a-fair-data-economy/>

²⁵ <https://www.fintraffic.fi/fi/saantokirja> (documents in English included in the website)

²⁶ https://transport.ec.europa.eu/news/1st-public-workshop-impact-assessment-initiative-multimodal-digital-mobility-services-2022-03-17_en

²⁷ <https://gdpr.eu/>

9 IMPLEMENTATION OF MOBILITY DATA SPACES

The below will look into 2 scenarios:

- Establishing a Mobility Data Space;
- Joining a Mobility Data Space.

Bearing in mind that the MaaS Alliance does not believe in re-inventing the wheel, we would like to stress out that prior to establishing a new Mobility Data Space, one looks into the existing initiatives and evaluate them based on:

- Their scope;
- Their geographical coverage;
- Their features;
- Their membership conditions.

If any of these criteria do not match their needs or business cases, then establishing a Mobility Data Space makes sense.

9.1 How to join a Mobility Data Space

If there is an existing Mobility Data Space that one would like to join, the steps are quite simple:

- Apply for membership;
- Choose and deploy the technical infrastructure required to participate;
- Implement and adapt the Data Space connector and its APIs to the existing internal IT architecture.

9.2 How to establish a Mobility Data Space

To establish a Mobility Data Space, the stakeholders form an **entity** that acts **with the following goals**:

- Define and establish the **rules for participation**;
- Define a **common set of policies**;
- Define a **trust model** and act as a root of trust.

This entity is responsible for the registration process and onboarding of new members to the created Mobility Data Space.

Then, the **next steps** are:

- Establish a **list of data sources**;
- Suggest to the owners of these sources to join as **members**;
- Set up a **member registry**, that includes identification and attributes;

- Create a **federated catalogue of services** for the data users;
- Establish the **infrastructure and standardized data license agreements**;
- Define a description and **semantic integration of datasets**, a common ontology, and a reference semantics to be adopted by all members;
- Define the appropriate Data Space **connector**;
- Define the **implementation model** for the different Dataspace services.

Examples of functional architecture of Mobility Data Spaces can be found in publications by the IDSA²⁸ or Gaia-X²⁹.

As for design principles and building blocks for Mobility Data Spaces, we recommend referring to the ones drafted by the EU-funded OPEN DEI project³⁰.

As for the standardized data license agreements, we recommend referring to the Open License³¹ used by the French National Access Point³² or the rulebook³³ used by the Finnish National Access Point³⁴.

9.3 Roles within a Mobility Data Space

The roles of any stakeholder to a Mobility Data Space are:

- Participate in workshops to **define the scope** of the use cases and the required data sets;
- Participate in **contacting data source providers**, and participate in the progress of onboarding;
- Participate in **developing the data processing** and making data available for the mobility processes and tools;
- Participate in **project management**, monitoring and validation of integration with existing IT legacy of the stakeholders.

²⁸ <https://internationaldataspaces.org/use/reference-architecture/>

²⁹ <https://1drv.ms/b/s!AgxxevMq0vX8qt1C2qi9Os9InNobSA?e=ILHq3E>

³⁰ <https://zenodo.org/record/5105744/files/Position-paper-design-principles-for-data-spaces.pdf?download=1>

³¹ <https://www.etalab.gouv.fr/wp-content/uploads/2018/11/open-licence.pdf>

³² <https://transport.data.gouv.fr/>

³³ https://1drv.ms/b/s!AgxxevMq0vX8gqInf_p4bXOMJMj6gQ?e=Pc3VGv

³⁴ <https://www.fintraffic.fi/en/trafficecosystem>

The roles of any member to a Mobility Data Space are:

- **Manage their data assets**, corresponding contracts and policies, as well as actively monitoring the execution of their contracts and policies and the management of the connector infrastructure;
- **Maintain the descriptions** of data up-to-date;
- **Inform** the coordinating entity **about changes**;
- **Report** to the coordinating entity **any violation** of policies and rules;
- **Monitor** the operation of **the connector** infrastructure;
- **Participate** in working groups to further **evolve** the Data Space.

10 EXAMPLES OF DATA SPACES

The below list 3 examples of data spaces that relates to the mobility industry. Enlisting them below does not mean that MaaS Alliance is endorsing them. Other examples could have been chosen

10.1 Mobility Data Space in Germany

The main objective of the instantiation of a Mobility Data Space in Germany is leveraging trust & security in the Mobility Ecosystem: trusted data transmission via the Mobility Data Space³⁵, as a basis for innovative products, services and business models. At the centre of the architecture, it provides a catalogue of data and data services as per the figure below.

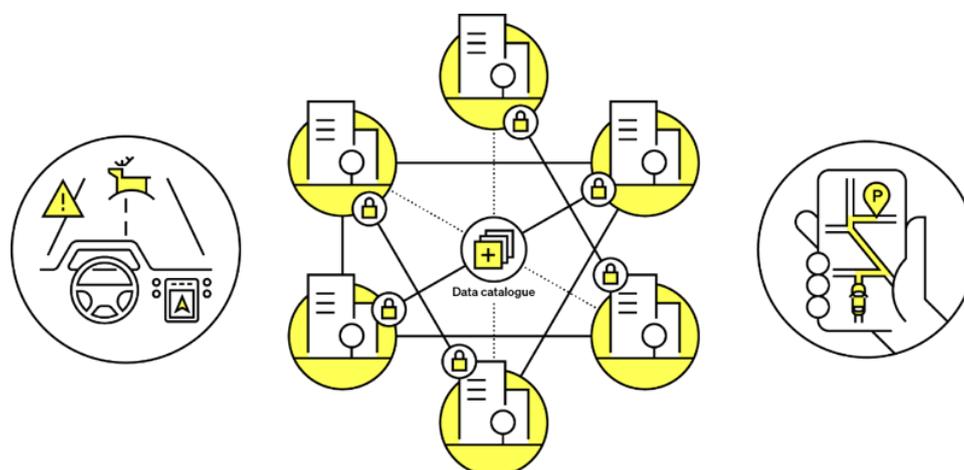


Figure 5: Data catalogue at the centre of the German Mobility Data Space -
Source: Michael Schäfer, MDS, Dublin 2022

The Mobility Data Space started with a resolution named “Concerted Action Mobility” from November 2019. **Over 200 stakeholders** of the German mobility landscape from science, industry and public administration worked on its conception. The German National Academy of Science and Engineering (acatech³⁶) coordinates and steers the process until today. The **supporting organisation** of the Mobility Data Space is the "DRM Datenraum Mobilität GmbH", which was founded in 2021 as a **neutral non-profit organisation**. Its task is to further develop the Mobility Data Space and to orchestrate it both technically and commercially. Its founding shareholder is acatech. Other shareholders include BMW INTEC Beteiligungs GmbH, Caruso GmbH, Deutsche Bahn, Deutsche Post AG, HERE Europe, HUK-COBURG

³⁵ <https://mobility-dataspace.eu>

³⁶ <https://en.acatech.de/>

Insurance, Mercedes-Benz AG and Volkswagen Group Info Services AG, as well as the states of North Rhine-Westphalia and Baden-Württemberg.

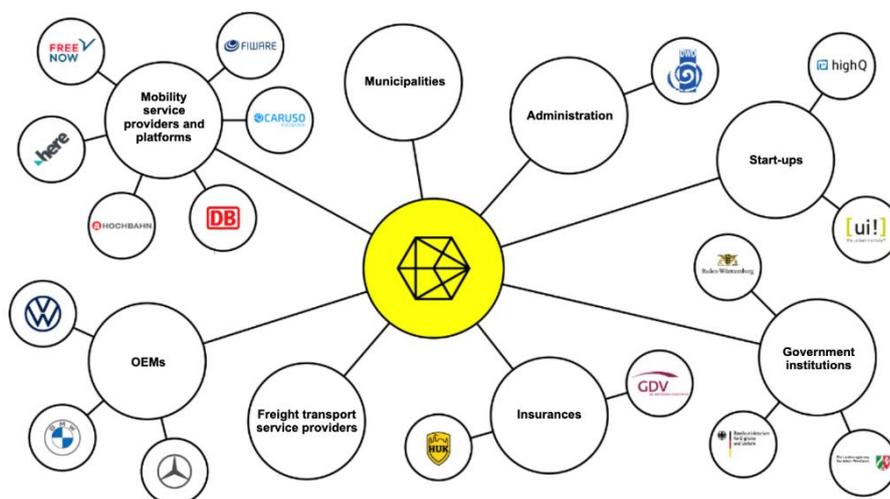


Figure 6: The ecosystem & network of the German Mobility Data Space -
Source: Michael Schäfer, MDS, Dublin 2022

The focus for the last 2 years was the definition and incorporation of several business cases such as:

- Local Hazard Information (BMW and Volkswagen);
- Sustainable use of electric drives (Caruso);
- Smart parking (FIWARE);
- Travel mode recommendation in accordance with weather conditions (Free Now);
- AI-based optimisation of current mobility offers (highQ);
- Slippery Road (Mercedes Benz);
- Information on capacity utilisation (ui!).

Across the different use cases, the types of data available are:

- Traffic information;
- Roadworks and road conditions;
- Traffic flow;
- Parking;
- Realtime fuel price incl. electric charging;
- Traffic signs and speed information;
- Weather information;
- Public transport information (mirroring the German National Access Point);
- Car and bike sharing;
- Infrastructure.

The German Mobility Data Space is an industrial grade instantiation with SLA, hosted and maintained by the truzzt Alliance (IONOS, ATOS and orbiter). Until the end of 2024, the services are offered currently totally free of charge for end-users, based on a national initial funding. The technologies used for the incorporation are all based on the IDSA essential services and Open Source, published on GitHub³⁷.

As of today, the offer includes “**vocabularies**” such as ontologies, reference data models, and metadata elements. They can be used to annotate and describe datasets in the catalogue, this way supporting the semantic interoperability.

The **next steps** will include **premium services with high level trust and cyber security features**. It will allow to support sensitive data operations related to autonomous driving or privacy data control for business operations. The aim is to protect the data in use against malicious insiders, hackers or unauthorized third parties.

10.2 Travel Data Space EONA-X

The travel data space is driven by Amadeus and includes Air France KLM and Aéroport de Paris. The group wishes to extend to other French companies like SNCF and other European travel companies.

The objective is to offer to travellers in Europe a **multi-modal ecosystem** encompassing all **aspects of travel**. Two use cases have been identified: seamless travel allowing the sharing of digital identity, passenger name record, travel record, and social media interactions, and health pass to provide safe corridors and avoid repeated health checks. The compliance with GDPR and Health Authorities regulation is a prerequisite for these two cases.

“EONA-X³⁸”, the worldwide Mobility, Transport and Tourism dataspace aims to facilitate the data exchange to clearly enhance the safety, planning, sustainability, comfort, resilience, accessibility, and fun of all activities involved. This will ultimately generate opportunities for economic development and better quality of services both at a national and international levels. Specifically on tourism, it is important to highlight that the sector brings together a large pool of actors, mainly SMEs, with a relatively low digital investment capacity. In parallel, they have **many links with other sectors** (e.g., culture, energy, mobility, etc.). Both such elements necessitate the creation of a tourism data space that follows a simple, cost-efficient and with a high degree of standardisation process.

The European Tourism sector is highly beneficial, yet highly fragmented. In this instance, Gaia-X is aiming at making European tourism data available to improve the capacity to attract

³⁷ <https://github.com/International-Data-Spaces-Association/idsa>

³⁸ <https://eona-x.eu>

tourists by receiving improved and tailored experience offers through centring the sector on the customer and their needs. Better data availability would aid in the development and establishment of new businesses. Personal data must be kept private so that citizens have complete control. The **Gaia-X framework**³⁹ allows for the creation of sovereign and federated tourism data spaces that can be deployed with confidence and at scale. These **data spaces federate existing data initiatives** and invite new initiatives to join the federation in order to better manage tourism for both tourists and local inhabitants by predicting tourists' and marketers' demands in real time and responding almost immediately⁴⁰.

10.3 Catena-X for Automotive

In December 2020, German automotive manufacturers have created and announced the German Auto Data Alliance with BMW, SAP, Siemens, Robert Bosch, and ZF Friedrichshafen with the support of Deutsche Telekom. The association is complemented by a development area, where the actual development work is done. In addition to the development work at the core of Catena-X⁴¹, members work together in cooperation, consortia or projects outside the association and take on various development tasks with the goal of developing one or more standard candidates.

The **Catena-X consortium**, which is funded by the German Federal Ministry for Economic Affairs and Energy's "Future Investments in the Vehicle Industry" funding program⁴², will perform the core development work during the funding period until mid-2024. In contrast to classic funded projects, Catena-X is a transfer and implementation initiative that also envisages concepts of operation. This is being done quickly and agilely, as we expect the first operating companies to emerge in 2023.

The question of how Catena-X works and what holds the network basically together directs attention to the central components ("core assets") and core building blocks of the data ecosystem, which have a key function. They create the connections for **data exchange and ensure access to the data ecosystem**.

The **Eclipse Data Space Connector**⁴³ (EDC) is the essential key component to enable sovereign data exchange in the first place.

³⁹ <https://gitlab.com/gaia-x/data-infrastructure-federation-services>

⁴⁰ https://gaia-x.eu/wp-content/uploads/2022/07/Gaia-X-Tourism-Data-Space-Event-report_V3.pdf

⁴¹ <https://catena-x.net/de/>

⁴² www.kopa35c.de

⁴³ <https://github.com/eclipse-dataspaceconnector/DataSpaceConnector>

An important building block in the Catena-X network is the web portal, which enables access for all participants. Catena-X essentially creates a **central, uniform, and consistent solution** for the daily challenges of the automotive industry. In this context, the provision or exchange of data is an essential requirement for the success of the ecosystem. For this purpose, Catena-X provides various methods, tools, and standards to ensure **semantic interoperability**. **Digital Twins** have established themselves here as a central element for structuring and accessing data. With the help of defined **semantics**, both data provision and app development are simplified and encouraged.

Further insights into the development environment of Catena-X are provided by selected offers and solutions that are being created there, such as Business Partner Data Management (GPDM) and Item Relationship Service, which is being developed in the context of the "Sustainability" use case.

11 THE WAY FORWARD

This section details the way forward that MaaS Alliance will explore to leverage Mobility Data Spaces for their members. The below is not set in stone as MaaS Alliance will keep its right to adapt its work to the evolution of the MaaS market.

- Further exploration of existing initiatives of Mobility Data Spaces in Europe;
- Enlist projects that could benefit MaaS Alliance members;
- Engage with the most relevant projects via the signature of Memorandum of Understanding.

In the meantime, MaaS Alliance will continue its coordination work with the European Commission via:

- Its active participation to the Multimodal Passenger Mobility Forum that is looking into
 - The definition of European standardized license agreements to be used as templates by all mobility stakeholders;
 - The definition of data sharing principles to advance the roll-out of Multimodal Digital Mobility Services;
- Its engagement with the NAPCORE initiative.

Last, but not least, MaaS Alliance will work on an ontology and standards interoperability to benefit all members of the MaaS Alliance for the roll-out of their services. Such an ontology could be seen as the stepping stone for a reference semantics to be used in a Mobility Data Space led by members of the MaaS Alliance.

12 REFERENCES AND AUTHORS

12.1 Individual authors

The authors listed below appear in alphabetical order of their first name.

- Kasia Bourée, Data4PT, CEN TC278 WG3 SG4 (Transmodel) leader
- Merja Kajava, Aavista, CEO
- Olaf-Gerd Gemein, Mobility Data Space, truzzt Alliance, Business Architect
- Paul Theyskens, IMEC, Business Architect
- Roelof Hellemans, MaaS Alliance, Secretary General
- Tu-Tho Thai, MobilityData, Director of Partnerships & Events

12.2 Supporting organisations and groups

The organisations listed below appear in alphabetical order.

12.2.1 *DATA4PT*

The DATA4PT project aims to advance data-sharing practices in the public transport sector by supporting the development of data exchange standards and models in order to fulfil the needs of multimodal travel information service providers: “By supporting EU Member States in deploying a set of harmonised European public data standards (Transmodel, NeTEx and SIRI), DATA4PT wants to enable union-wide multimodal travel information services and contribute to a seamless door-to-door travel ecosystem across Europe that covers all mobility services.

The main objectives of DATA4PT consist of technical and organisational activities to facilitate the development and deployment of the European public transport data standards Transmodel, NeTEx and SIRI.

All these actions aim to enable the interoperable exchange of travel and traffic data and enhance partnerships amongst public authorities and travel information service providers.

12.2.2 *ITxPT*

ITxPT is a non-profit association which develops and delivers specifications of a standardized IT architecture with open interfaces enabling interoperability for on-board and back-office IT-systems in public transport.

ITxPT was formed in 2013 as follow-up of European Projects and is now joined by more than 150 members representing all Public Transport stakeholders: PTA, PTO and industry partners to support the adoption and development of IT standards.

ITxPT leads technical work in DATA4PT and NAPCORE (multimodal data working group).

12.2.3 *MaaS Alliance*

The Mobility as a Service (MaaS) Alliance is a public-private partnership creating the foundations for a common approach to MaaS, unlocking the economies of scale needed for successful implementation and take-up of MaaS in Europe and beyond. The main goal is to facilitate a single, open market and full deployment of MaaS services.

The MaaS Alliance is governed by a Board of Directors and driven forward by its Members and Partners.

12.2.4 *MobilityData*

MobilityData began in 2015 as a Rocky Mountain Institute project with the mission to improve travellers' information. It extended its mission and reach by becoming a Canadian non-profit in 2019 and a French one in 2021. With over 20 employees worldwide, MobilityData brings together and supports international mobility stakeholders such as transport agencies, software vendors, mobility apps, and cities to standardize and expand data formats such as GTFS and GBFS for public transport and shared mobility. MobilityData acts as an industry facilitator, creating opportunities for strengthened interoperability while assisting the industry's rapid transformation through training and tools. Learn more on mobilitydata.org.

12.3 References

The references below served as research materials and global assets for this white paper.

- [Designing Data Spaces](#) by Prof. Boris Otto et.al. at Springer
- [Gaia-X Architecture 22.04 Release](#)
- [IDS RAM 3.0 and ids ram 4](#)
- [iSHARE Scheme](#)
- [MyData Operators white paper 2022](#)
- [Open DEI - Design Principles for Data Spaces](#)

12.4 Table of figures

FIGURE 1: TOPOLOGY OVERVIEW OF MOBILITY DATA SPACES - SOURCE: SOURCE: OLAF-GERD GEMEIN, TRUZZT ALLIANCE, 2022 DUBLIN	10
FIGURE 2: BUILDING BLOCKS FOR DATA SPACES - SOURCE: DESIGN PRINCIPLES FOR DATA SPACES	11
FIGURE 3: FUNCTIONAL PRINCIPLE OF DATA SOVEREIGNTY THROUGH MECHANISMS FOR DATA USAGE CONTROL - SOURCE: HOLGER DREES AT 27TH ITS WORLD CONGRESS, HAMBURG, GERMANY, 11-15 OCTOBER 2021	15
FIGURE 4: THE CONNECTER FLOW IN IDS-RAM - SOURCE: DATOS.GOB.ES	16

FIGURE 5: DATA CATALOGUE AT THE CENTRE OF THE GERMAN MOBILITY DATA SPACE - SOURCE: MICHAEL SCHÄFER, MDS, DUBLIN 2022	23
FIGURE 6: THE ECOSYSTEM & NETWORK OF THE GERMAN MOBILITY DATA SPACE - SOURCE: MICHAEL SCHÄFER, MDS, DUBLIN 2022	24