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A Data Space for Accessible Multimodal Transport: Enabling Inclusive Mobility

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1 ABSTRACT

It is a long-term strategic goal of the European Union to promote multimodal mobility and thereby create a more sustainable, efficient and liveable environment. Offering travellers a wider range of choices and promoting the integration of different transport modes can help to transform the way we get around. Despite existing infrastructure, a lack of accessible and integrated information creates significant barriers for travellers. Multimodal travel is even more difficult for people with disabilities because they have more specific needs in terms of infrastructure and their itinerary. More than 8% of the population in Austria have a registered disability.

This research proposes a solution from a data perspective. We aim for a non-discriminatory low-threshold access to mobility information, especially for the group of people with disabilities or impairments and for individuals with restricted mobility. The requirements have been worked out in a participatory process with co-creation workshops and expert interviews. A use case of a person with mobility impairments has been described together with a data requirements schema. This schema of data categories covers all passenger needs from travel itinerary, change between modes of transport, and getting support. It helps to identify data specifically for similar use cases.The requirements were the starting point to design and set up the prototypical data space for mobility data. Various data sources for mobility data in Austria have been identified and analysed for their content and quality. This subsequently allowed the definition of data products with their attributes and quality measures. Data products need to satisfy consumer's needs. In the context of this work, data products are for example: disabled parking spaces in Austria, or accessible routes in and around railway stations. The actual data also includes metadata that makes it easier to find the right data product and obtain information about its origin and license terms. A specific schema was defined to fulfil the requirements for mobility data.

To successfully operate a mobility data space, suitable operator models were analysed, and the legal requirements were defined. Digital services for mobility have significant market potential. We therefore suggest establishing a dedicated task force that brings together key public and private stakeholders to create a comprehensive implementation strategy. The primary goal should be to generate practical value through improved mobility services while maintaining a sustainable operational model that promotes broad participation from current market players and fosters ongoing innovation in the accessibility sector. Well-integrated and high-quality data are a prerequisite for more usable multimodal transport. People with disabilities or individuals with restricted mobility have additional requirements in data that must be taken into account. The general public also benefits from this development as more accessible options with better information strategies is valuable for everyone.

Keywords: Mobility Data, Data Space, Multimodal Transport, Inclusion, Co-creation

2 INTRODUCTION

Most of us who work are commuters, and many of us use various forms of public transport every day. We regularly use the same and well-known route, move from one bus to another in a familiar environment. But

remember the first time you were on your own in an unfamiliar, huge, sprawling railway station, just trying to find your way out. Now imagine a blind person or someone who relies on a wheelchair to find their way to the connecting train. Things turn out to be more complicated and take much longer. The further you get away from the big cities, the less information and travel options you have – another hurdle. 8.3% (around 760,000 people) of the population in Austria have a registered disability (BMSGPK 2024). Many more struggle with mobility restrictions or other challenges such as handling a pushchair, a dog and luggage at the same time.

Mobility is of great importance for social inclusion. Research shows that people with mobility impairments face numerous additional challenges and obstacles to mobility in everyday life (Prescott et al., 2020). This can be a bad condition of pavements or the difficulty to cross a road. It is known that there are still gaps in the integration of accessibility in the field of mobility (Disabled Coalition et al., 2023). Integrated mobility services must also take extensive account of accessibility and inclusion.It is a long-term strategic goal of the European Union to promote multimodal mobility and thereby create a more sustainable, efficient and liveable environment (EC, 2021). Offering travellers a wider range of choices and promoting the integration of different transport modes can help to transform the way we get around. Despite existing infrastructure, a lack of accessible and integrated information creates significant barriers for travellers. Multimodal travel is even more difficult for people with disabilities because they have more specific needs in terms of infrastructure and their itinerary.

To enable such services, integrated and linked data is required. Data spaces are being increasingly used for decentralised, secure, and trusted data sharing within a structured governance framework. Participants in a data space establish mutual trust, agree on common standards, and maintain sovereignty over their data by defining individual policies. Unlike centralised data platforms, data sharing within data spaces occurs peer-to-peer via connectors, ensuring that data remains under the control of its original owner while enabling efficient and secure exchanges. The main advantages of data spaces include interoperability, scalability, traceability, and findability of data, making them a viable alternative to centralised data platforms. The European strategy for data aims to create a single market for data, strengthening Europe's global competitiveness and data sovereignty. A key element of this strategy is the establishment of common European data spaces, ensuring that more data is made available for economic and societal use while allowing companies and individuals to retain control over their data (EC, 2020).

In this paper, we seek for data driven solutions to solve the problems mentioned above. The question is what is needed to establish a national mobility data space and examine this issue from different perspectives by involving the community. A participatory process was applied with the help of co-creation workshops and expert interviews. The contributions in this paper range from data requirements to a prototypical implementation, to the experiences we have made with the application in practice. In detail this comprises the following: a use case of a person with mobility impairments, and a data requirements schema which helps to identify data specifically for similar use cases. From a business perspective, we propose the formation of a dedicated task force combining key public and private stakeholders to develop a detailed implementation strategy. The focus should be on creating practical value through enhanced mobility services while maintaining a sustainable operational model that encourages broad participation from existing market players and enables continuous innovation in the accessibility sector. The legal perspective addresses the use of open data and lists more complex legal issues in the implementation of data spaces. From a technical viewpoint we further propose a concrete meta data schema for the use in a mobility data space. An important benefit for data space customers is the use of data products. We implemented a set of data products for the data space to fulfil the use case and will discuss two of them in more detail in this paper.

3 RELATED WORK

To advance theinitiative of data spaces, the Data Spaces Support Centre (DSSC)[1] facilitates these data-sharing environments, enabling data reuse across sectors while respecting EU values.Furthermore, the InternationalData Spaces Association (IDSA)[2] plays a leading role in developing the technical foundation for data spaces, ensuring secure and standardised data exchange. IDSA members have been working on key technologies, leading to major achievements such as the IDS Reference Architecture Model (latest version:

[1] https://dssc.eu/
[2] https://internationaldataspaces.org/

IDS-RAM 4.0), the IDSA Rulebook, and the Dataspace Protocol, all of which define clear rules for trusted data sharing. These efforts contribute to establishing the Dataspace Protocol as an international standard, reinforcing the foundation of a fair data economy.

Several initiatives have been undertaken to advance the development of mobility data spaces, including efforts addressing the needs of persons with limited mobility, which laid the groundwork and provided impetus for the CARINA project. In Austria, the DIANA 4 CCAM project (Aichholzer et al., 2022)has contributed to this advancement. DIANA 4 CCAM has pioneered a data cycle concept that supports the integration of AI functions in the mobility sector. Internationally, the most relevant precursors for CARINA include the European Mobility Data Space (MDS)[3], a virtual marketplace for the exchange of mobility data with over 150 participants, PrepDSpace4Mobility (Bakri et al., 2024), which provided the groundwork for the MDS, the French EONA-X Data Space[4], which integrates mobility and tourism data to enhance intermodal travel experiences, and the Data Space for Multimodal Passenger Mobility (DSMPM)[5], a secure and standardized platform that enables the seamless integration and sharing of diverse mobility data for inclusive multimodal travel experiences.

Building on these foundations and among other Austrian data space initiatives, the CARINA project will contribute to the foundations for a national mobility data space in Austria. Some other current initiatives are the project Övvvi[6], which has the aim to contribute to this cause through the collection, integration, analysis and structured provision of mobility data, and the project MultiMoFusion[7] where the goal is to enable demand-driven and sustainable transportation planning through data fusion of smartphone assisted self-interviewdata, floating phone data and other data sources. The most notable current Austrian data space initiative is the KoDRM-AT[8] project. KoDRM-AT shall develop legal, organisational and technical concepts and concrete implementation steps for a national mobility data space in line with the European Data Strategy (EC, 2020) to deliver a contribution to the Austrian mobility masterplan 2030 (BMK, 2021).

There are already several platforms in Austria that collect and provide extensive mobility data (BMK, 2024). The Graph Integration Platform (GIP)[9] for example, provides a basic structure of mobility data in Austria. It is implemented as a multimodal transport graph, enables a nationwide supply of high-quality transport services in a standardized way, based on a common data standard and it is the basis for various route planners and other applications. basemap.at[10] and EVIS.AT[11] also play an important role in the mobility data landscape in Austria. They utilise data from the GIP and the Verkehrsauskunft Österreich(VAO) . basemap.at is a cartographic product that includes a simplified representation of terrain, buildings, rivers and transport routes throughout Austria. EVIS.AT provides the current traffic situation, journey times and incident reports for the Austrian road network and is available for numerous traffic information services.

Static mobility data is available, but fragmented and difficult to access (Gatzert et al., 2023). The situation is different with dynamic mobility data. There is currently no regulation on how this data must be made available. Unforeseeable temporary changes, such as defective barrier-free facilities, construction sites or short-term organisational changes pose a particular challenge for people with mobility impairments. As a result, they are unable to participate in many activities (Prescott et al., 2020) (Disabled Coalition et al., 2023).

There are many applications and services that help end users in their everyday lives when it comes to mobility. For example, VAO[12] offers a mobility information platform including an intermodal dynamic real-time route planner. This route planner is used in various mobility apps in Austria with a usage of around 590 million routing requests in 2024 (BMK, 2024). It allows users to partially customise their query, such as selecting their preferred means of transport, the maximum distance they can cover on foot or the option of

[3] https://mobility-dataspace.eu/de/
[4] https://eona-x.eu/
[5] https://i4trust.org/wp-content/uploads/DSMPM-%E2%80%93-i4Trust-Impact-Story.pdf
[6] https://projekte.ffg.at/projekt/4777251
[7] https://projekte.ffg.at/projekt/4878696
[8] https://projekte.ffg.at/projekt/4788149
[9] https://www.gip.gv.at/
[10] https://basemap.at/
[11] https://evis.at/
[12] https://www.verkehrsauskunft.at/

using escalators, stairs and lifts. There are also some customisation options for cycling and driving. Nevertheless, there is no specific consideration of accessibility. There is further potential for improvement in better linking the various modes of transport within a route. Driving, cycling and public transport are currently considered separately. In addition, information such as public transport disruptions is not fully integrated.

The mobyome mobility app[13] aims to collect mobility data and raise awareness of users' own mobility behaviour. Users can record their everyday journeys. They then get feedback on the costs and emissions of their travel behaviour and possible alternatives. Although the app does not explicitly focus on accessibility, users have the option of choosing which alternatives are suitable for them afterwards.

Wheelmap[14] is a map on whichone can find wheelchair-accessible places and rate them according to their accessibility for wheelchair users. It is based on a crowd-sourcing principle, i.e., anyone can add places to Wheelmap and rate their accessibility based on various criteria. This approach helps to easily generate data about accessibility information on a broad basis, but it is not possible to guarantee certain data quality requirements. Continuous maintenance of the database cannot be guaranteed, as the provision of data is not regulated. Nevertheless, this is an important source for many people with disabilities.

4 METHODOLOGY

It all started with the idea of using data for more sustainable multimodal mobility and responding to individual mobility needs. A key driver was also to promote the inclusion of people with mobility impairments. As an initial activity the main stakeholders of the mobility scene in Austria were identified and invited to co-creation workshops. The workshops provided a good insight into the challenges and expectations of the stakeholders. Through the participation of different representatives, important aspects from the perspective of data providers and data operators as well as inputs from representatives of people with reduced mobility could be collected. The involvement of different stakeholders is important to ensure that the largest possible group of people benefit from the results.

The co-creation activities continued with expert interviews in the area of people with disabilities. The collected information was the basis to create personas and detailed use cases. In total three use cases were developed (Russegger, 2024) one of which we will focus on in this paper. With the help of the use cases, a data schema was developed which allows to determine the data requirements for travels especially for people with disabilities. This guided the concrete implementation. First the data sources were identified, and the required data sets were collected. Automatic data transformation processes were setup which clean and prepare the datasets. The results are data products which can be re-used in various use cases. The data products are shared in a data space as new data offerings. Implementing a prototype mobility data space with real data helped us in evaluating further business- and legal foundations. A contract was setup for exchange of raw data for a data intermediary who processes data and re-sells it on the mobility data space. Finally, the business foundations for operating a mobility data space were determined.

5 REQUIREMENTS ANALYSIS

This chapter describes the co-creation activities that were carried out. It first started with co-creation workshops and then continued with expert interviews. The collected information was the basis for the use case which then led to the development of the data requirements schema.

5.1 Co-Creation Workshops

Two co-creation workshops were held as video conference sessions lasting 90 minutes. In the first co-creation workshop 9 different stakeholder organisations participated and in the second 18 different organisations. The stakeholder organisations came from following areas: organisation for people with disabilities, operator of transport data infrastructure, tourism organisation association, legal or technical counsellor, public administration, public transport provider, research institution, interest group for public transport, business development consulting, and automobile association. To make the idea of a mobility data space clearer, an exemplary use case was prepared.The workshops were transcribed and then summarised

[13] https://app.mobyome.at/gemeinde
[14] https://wheelmap.org/

and structured. This was the basis for collecting the needs and availability of data, as well as collecting the challenges and expectations of people with disabilities.

The biggest challenges include a lack of easy access and intuitive user interfaces, but also the lack of links between different transport modes, as well as barriers for people with mobility impairments despite being labelled as barrier-free. Much information is still missing, e.g., information on the options for transferring between different modes of transport, or information on alternative routes in the event of breakdowns of barrier-free infrastructure. In some cases, the data does not even exist or has to be entered manually (e.g., failure of an escalator). In addition, the lack of regulated responsibilities and competences is a major problem, as it is not always clear who has to ensure that the data is up to date. Expectations of a data space were also mentioned: barrier-free access to information, a technically intuitive solution and a coherent data space to find as much of the required information as possible in one place, and up-to-date data on the accessibility of means of transport, stops, railway stations and underground stations.

5.2 Expert Interviews

Expert interviews were conducted to further refine the use cases and the specific scenarios. Therefore, a semi-structured interview format was chosen. The invited interview partners are themselves affected by mobility impairments as well as representatives of the interests of people with reduced mobility. The expert interviews included four participants. Two of them are dependent on a wheelchair, one is from an association for the blind, and one is an employee of an organisation for people with disabilities. The aim was to ensure that the developed use cases describe realistic scenarios and provide comprehensive insight of the challenges in mobility. The lack of information and therefore the results of it were discussed, as well as possible technical assistance, the requirements of people with different impairments (e.g., physical disability, cognitive impairment), and the everyday life of a person with disabilities.

5.3 Use Case

The following exemplary use case was developed to illustrate the data needs and to show how a typical itinerary of a person with disabilities looks like. (Russegger, 2024) describes in total three personas and mobility use cases for people with mobility impairments. In this paper we address as a representative the following one:

Markus is 36 years old and is dependent on a wheelchair. He lives in the outskirts of Graz and plans to visit his aunt Erna in Klagenfurt. He then travels on to an event in Tyrol. Markus is not reliant on public transport as he has his own car. Nevertheless, he would like to use public transport for the majority of his journey and plans to use his car only as far as a suitable public transport hub, such as a specific stop or train station.

A possible itinerary would look like this: By car via Keplerstraße – car park at the main station – express bus to St. Michael – ÖBB Railjet to Westbahnhof Klagenfurt – SURAAA shuttle to intermediate destination – <PAUSE> – SURAAA shuttle Westbahnhof Klagenfurt – to Innsbruck with ÖBB – Regiobus 160x to Reutte – Regioflink to final destination.

5.4 Data Requirements Schema

A data schema was developed to identifythe requirements on data in a structured way for this use case and also for similar other use cases for people with restricted mobility. This schema is a generalisation developed from the stakeholder interviews and co-creation workshops. Its aim is to identify the required data, to categorise it, and to check for completeness.

5.4.1 Travel Planning

Description: A service for creating an itinerary that is easy to use by considering the accessibility guidelines and is configurable or automatically adaptable for specific travel needs for people with restricted mobility.

Use case: For the described use case above this would be a smartphone app with a route planner to find the optimal route from his home to Klagenfurt.

Data needs: Public transport route network and timetables, road network including current traffic situation, information on accessibility of infrastructure, etc.

5.4.2 General Information about Travel Routes

Description: Giving the opportunity to choose between different options for a travel to get the personal best option. All necessary additional information about the equipment of the stations and means of transport.

Use case: Markus should only receive suggestions for travel routes that meet his needs. This means that both the modes of transport and the routes between the modes must be suitable for wheelchair users. This can be supplemented by photos, for example. If a reservation is required for one of the means of transport, Markus needs information about whom to contact and when. He must also be told exactly where he can park his car for routes that suggest using his car.

Data needs:Travel routes at different times; equipment of the modes of transport (ramps, braille lettering, suitable seats...) including current condition and capacity utilization; current condition and availability of ramps or stairs of the routes; location and condition of sanitary facilities.

5.4.3 Transfer Navigation

Description:Information on finding connecting transportation.

Use case: Markus needs additional information for transfer navigation information, for example how to get to lifts or wheelchair lifts or wheelchair ramps.

Data needs: Location and current condition on elevators, escalators; status and location on navigation aids at stations (boards, displays); precise indoor navigation including routes to elevators or escalators.

5.4.4 Transfer Times

Description: Information on transfer times depending on the user's mobility.

Use case: Depending on the circumstances, Markus may need longer to change than a person without a mobility impairment if, for example, access via the lift takes longer than via the escalator.

Data needs: Average time a person needs to change trains; reference values for transfer times for people travelling at different speeds and different mobility; transfer times if lifts have to be used.

5.4.5 Park/Bike and Ride

Description: Information about places where it is possible to change modes of transport and where cars or bicycles can be parked and at what cost.

Use case: If parts of the proposed route are to be travelled in Markus' own car, he needs to know where he can park it. It must also be known whether there are suitable car parks with more space for Markus to get out of the car.

Data needs:Locations of park/bike and ride facilities; current utilisation; locations of disabled parking spaces, including current capacity utilisation.

5.4.6 Last Mile

Description: Information on on-demand transportation providers, taxis or similar when travelling the last leg of a journey including where to find them, how to book it and how to use these services.

Use case: In addition to the information on what options are available for the last leg of the journey to his aunt and how he can use them, Markus also needs to know whether they are wheelchair accessible.

Data needs: Options for last mile transportations; on-demand transportation providers; location, opening hours, equipment of the means of transport offered.

5.4.7 Ticket Information

Description: Information should be provided on where to buy tickets for the modes of transport. If park and ride offers are included in the itinerary, information should also be provided on how to purchase tickets.

Use case: Markus has no special requirements regarding the way in which he buys his ticket. However, if extra tickets or seats need to be booked to use public transport with a wheelchair, this should also be clearly indicated.

Data needs: Location and opening hours of ticket counters; ticket purchase at ticket machines: notes on ease of use; different modalities of ticket purchase; need for extra tickets for wheelchair spaces, including capacity utilisation.

5.4.8 Deviations and Disruptions

Description: Travelers should be informed about deviations from the planned journey and offered suitable alternatives.

Use case:In the event of short-term deviations, Markus needs alternatives that continue to meet his needs. In the event of a different platform, Markus needs information on how to get to the new platform via a wheelchair-accessible route. In the event of train cancellations or delays, new routes must be calculated that also take the aforementioned aspects into account.

Data needs: Real-time information on cancellations, platform changes, delays or non-functioning infrastructure.

5.4.9 Personal Assistance

Description: Information on where and how to get further support should also be provided.

Use case: If Markus needs additional help, such as when changing trains or with his luggage, he should be able to call up information on where and how he can get help.

Data needs: Places or telephone numbers where one can get support; location and opening hours of information centres; connecting volunteers and people seeking help.

6 IMPLEMENTATION

This chapter describes the prototypical implementation of the data space and its results. It starts with the business relevance of such a project and the various legal considerations from free and open data to complex contractual relationships. The tasks of data governance are listed to build trust and interoperability. A concrete meta data schema for the use in a mobility data space was also implemented. The end of this chapter is dedicated to the data products – the digital asset in a data space for its customers.

6.1 Business and Legal Foundations for a Sustainable Mobility Data Space

The business perspective:A sustainable mobility data space must build upon and enhance existing infrastructure and applications rather than creating parallel structures. Current mobility applications and platforms already serve millions of users daily, including essential accessibility information needs. The business value lies in augmenting these established services with standardized accessibility data and enabling new integrated solutions. With around 760,000 people (8.3% of the population) having registered disabilities in Austria in 2022 (BMSGPK, 2024) there is significant potential for both improving existing services and developing specialized mobility solutions.

Given this market potential, we propose the formation of a dedicated task force combining key public and private stakeholders to develop a detailed implementation strategy. This task force should address critical questions of governance, data monetization models, and infrastructure funding, while ensuring both economic sustainability and public benefit. The focus should be on creating practical value through enhanced mobility services while maintaining a sustainable operational model that encourages broad participation from existing market players and enables continuous innovation in the accessibility sector.

The legal perspective:Numerous valuable mobility-related datasets are provided by public sector entities. These datasets are often available as open data (e.g., GIP data in Austria or the Mobilithek in Germany) or accessible via open standard interfaces (e.g., ÖBB or Wheelmap data upon registration). These data sources, whether directly or indirectly accessible, offer a rich repository of information on mobility activities and infrastructures. Leveraging these datasets enables the development of various applications that cover a substantial portion of mobility-related processes.

From a legal perspective, the use of public datasets is generally straightforward, as broad open licensing agreements govern their reuse. Open-data licenses, such as Creative Commons or the German Data License, typically allow extensive utilization. However, restrictions exist regarding liability and warranty. When utilizing such license-free datasets, data providers generally do not assume liability for their accuracy. This

issue becomes particularly relevant when dealing with real-time or near-real-time data, which are critical for accurately reflecting current mobility dynamics. In such cases, the open-data approach reaches its limitations.

Highly relevant real-time data are often not freely licensed or are technically challenging to obtain (e.g., sensor data along roadways or IoT-generated data from municipalities). In these cases, more complex legal issues must be resolved before the data can be utilized. Another challenge arises when data are collected by a municipality but subsequently transmitted, stored, and potentially shared by third-party intermediaries acting as data service providers. This results in a legal triangular relationship or data trusteeship. Such a structure is legally more intricate because the original data provider must first transfer the data both technically and legally to the intermediary, who then becomes a secondary data provider for further distribution. While legally feasible, this setup often presents challenges for stakeholders, as it necessitates establishing multiple contractual relationships.

This sometimes complex contractual landscape among mobility stakeholders can be streamlined if a data space assumes the role of a facilitator and curator, negotiating contractual agreements in advance and, in some cases, serving as a data trustee. Clearly defining the legal framework for data access rights, monetization models, and liability provisions is essential to ensure seamless data exchange. Furthermore, mechanisms for dispute resolution and arbitration play a critical role in efficiently managing conflicts and fostering long-term trust among stakeholders.

Compliance with data protection regulations must be ensured, particularly when mobility data could indirectly enable the identification of individuals. Adherence to the General Data Protection Regulation (GDPR) is therefore imperative.

6.2 Data Space Governance and Metadata Management

Data governance refers to the comprehensive set of rules, processes, and responsibilities for managing and utilizing data within an organization. The primary objectives are to ensure data quality, data protection, interoperability, and compliance, thereby enabling efficient, secure, and legally sound data usage.

Data spaces are decentralized data ecosystems, and this project contributes to the Austrian mobility data space. While data governance in data spaces follows the same fundamental principles as in organizations, aspects such as trust, data sovereignty, and legal certainty among participants are even more critical. Within a single organization, a higher level of inherent trust exists between data providers and consumers. However, in a heterogeneous and decentralized data ecosystem like a data space, trust and interoperability must be established first. Therefore, contract-based governance mechanisms – including access policies, interoperability standards, quality assurance frameworks, and compliance regulations – are essential for enabling controlled, transparent, and efficient data sharing (Guggenberger et al., 2025).

A core principle of data governance in data spaces is data sovereignty. Each participant must retain control over their data and be able to define the conditions under which data may be shared or utilized by others. This is implemented through contractual agreements and technical mechanisms, such as access control, identity management, and policy enforcement (ref. Margoni et al., 2023). Frameworks such as the IDS-RAM (International Data Spaces Reference Architecture Model) and Mobility DCAT-AP provide well-defined structures and guidelines for these requirements.

For the planned future implementation of a national mobility data space, it is recommended to establish a strong governance structure. To make this work, a steering committee of interested organisations should bring together key stakeholders of public administration, mobility providers, research institutions, and technology experts. Everyone needs clearly defined roles: Who will be the coordinator or operator, who provides data, under which conditions and contracts, who creates and operates data services, who administrates, curates and operates the data apps and data services, who will be the final beneficiary (end-user), who ensures everything runs smoothly (business continuity)? This setup should align with existing regulations, such as the EU Data Strategy, the Data Governance Act, and Austria's Mobility Masterplan 2030. Without solid governance structures, there is no trust. And without trust, data-sharing won't work. Contracts are just as important as technology. A secure and controlled data-sharing environment requires clear rules on who can access what, under which conditions, and for what purpose. In our project we developed standardized agreements which define data usage rights, licensing terms, and compliance

measures. These templates could be used as a blueprint for future initiatives to make sure data is shared efficiently, legally, and fairly.

For the operating of data space and/or data services it is necessary to have all components for the data journey and application journey are up and running smoothly. That includes high-quality data, accurate data science components and necessary connectors and other systems. A Mobility Data Space is only useful if the information it provides is accurate and up to date. Therefore, we propose to include a Data Quality Assurance Framework from the beginning to automatically check for missing or incorrect data.

Metadata management is another crucial component of data governance in data spaces. Standardized and uniform metadata are essential for ensuring that data is discoverable, interpretable, and reusable. In this context, vocabularies such as DCAT (Data Catalog Vocabulary) play a key role, particularly in domain-specific applications like mobility. Extensions such as MobilityDCAT-AP address the unique requirements of mobility data, including infrastructure information and transportation modalities (cf. DSSC, 2024).

An established standard in this field is DCAT – the Data Catalog Vocabulary. It is an RDF-based vocabulary designed to support interoperability between data catalogs and is currently in its third version (Albertoni et al., 2024). Various application profiles have been derived from the W3C recommendation to adapt the vocabulary to domain-specific use cases. For instance, dedicated profiles exist for mobility data (Molinas Comet et al., 2025) and statistical data (Sofou and Dragan, 2016). Depending on the specific application scenario and the type of data being exchanged, it is advisable to use DCAT for a mobility data space while extending it with mobility-specific metadata. As illustrated inFigure 1, classes and properties were adopted from MobilityDCAT-AP (Molinas Comet et al., 2025) for this purpose.

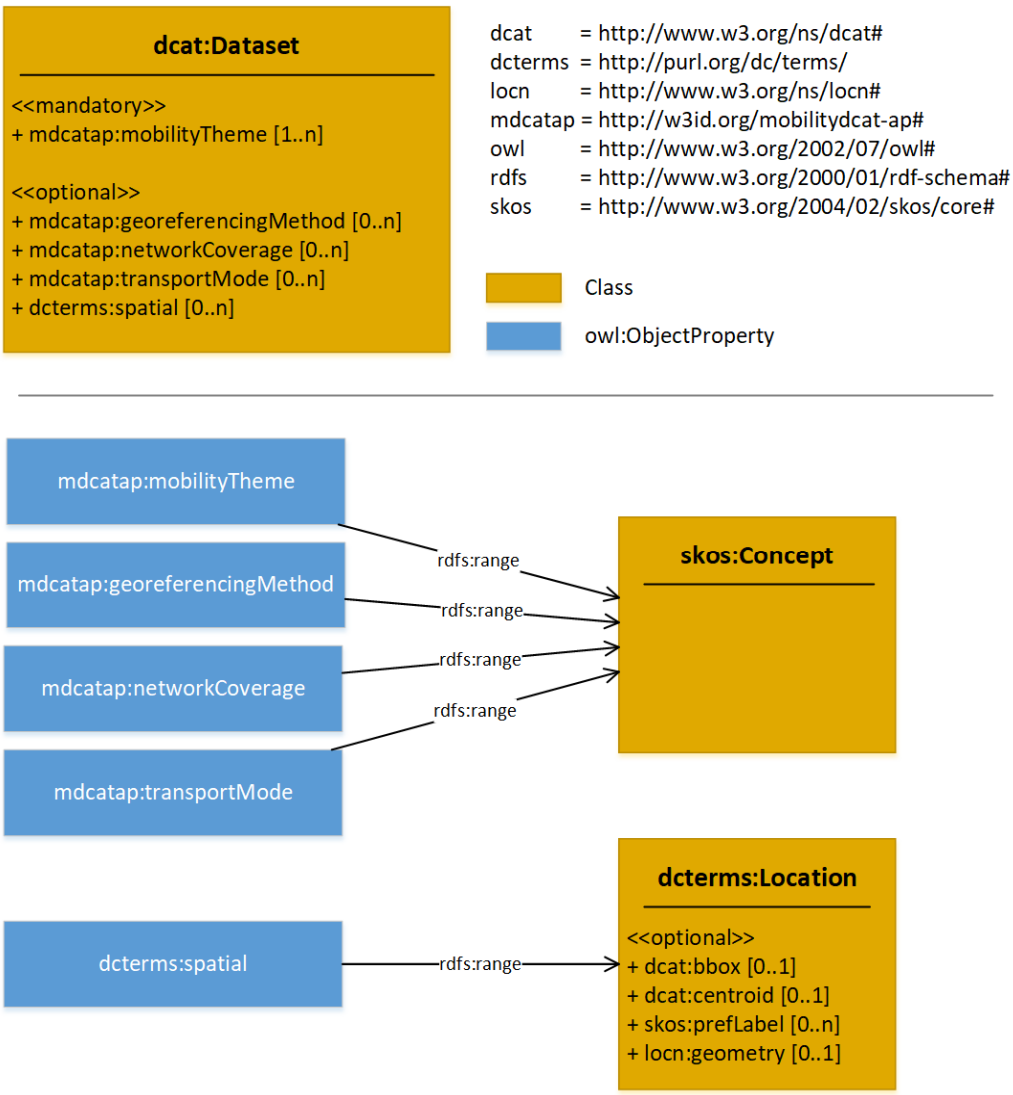

Figure 1: The proposed metadata schema builds upon the Data Catalog Vocabulary and the mobility extension for DCAT.

6.3 Data Products

Data spaces enable controlled and trusted data exchange between participants. The value creation typically begins with raw data provided by data providers. This data is processed, harmonized, and refined through specialized data processing services. The combination of relevant data and associated processing services ultimately forms a data product, which is made available to other participants in a standardized and quality-assured manner (DSSC, 2023).

Particularly valuable is that not only the final data product but also all intermediate results of the processing chain can be offered as new data assets within the data space. For example, normalized datasets, analysis results, or aggregated statistics can be made available as independent resources. This modular structure allows other participants to build upon different levels of the processing chain and develop new services or data products. This creates a dynamic ecosystem where data and services can be continuously evolved and used in new contexts.

This approach significantly reduces barriers to entry for new participants in the data space. Instead of building complete processing chains from scratch, organizations can leverage existing data products or intermediate results as building blocks for their services. This not only accelerates development but also promotes data quality through reuse of well-maintained datasets. Furthermore, the standardized description of properties and usage conditions in data productofferings creates transparency and facilitates the discovery of relevant data resources.

In the context of accessible multimodal transport, data products play a crucial role in combining various data sources into meaningful services. For instance, raw data about infrastructure accessibility, real-time vehicle locations, and service disruptions can be processed and combined into comprehensive mobility information services. Each step in this process potentially creates valuable intermediate data products that can be used for different purposes, from route planning to accessibility analysis. This flexibility is particularly important in addressing the diverse needs of people with limited mobility, as different applications may require different views or combinations of the same base data. Below we describe two exemplary data products that were implemented for the prototype.

6.3.1 Disabled Parking Spaces in Austria

This data set contains the geolocation, a corresponding address, and a description of disabled parking spaces in Austria. It combines data from Graz, Tyrol, Salzburg and Vienna, and it is updated once a day.

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Data Attributes

- provenance: origin of this record
- name: name of the parking place
- address: address name of the parking place
- municipality: municipality where this parking place belongs to
- comment: additional information for this record or parking place
- lat: latitude coordinate of this parking place
- lng: longitude coordinate of this parking place

6.3.2 Traffic Monitoring

Infrastructure based traffic monitoring data can be used in different ways to support multi-modal transport of passengers and goods. Real-time as well as long term data – or some kind of processed or post-processed set of datacreated from the original data –from specific parts of road infrastructure which are hot spots that cause delays or uncertainties for a timely arrival at the end destination of a transport mode, can be used to feed into any kind of end user application for travel planning. One kind of processed data that can be utilizedinend user travel planning applications, is long term traffic occurrence dataat said hot spots in different granularity, i.e., every minute, hour, day or month, depending on the applicationstraffic statusforecastaccuracy requirements. The main attributes forsuch data is the current time stamp (i.e., time, day or month), which

kind of road infrastructure the object is detected is on (e.g., road or sidewalk) andhow many objects are detected at a specific time stamp.

7 CONCLUSION

In more and more areas of mobility, data is being digitally recorded or even generated automatically. This ranges from train timetables and traffic monitoring systems to your own car that collects sensor data. Due to the different sources and responsibilities, this results in many heterogeneous and decentralised databases that are little or not at all linked with each other. We are in the middle of a digital transformation process that involves making these data sets available and usable. This was also taken up at the political level. Here are some examples: The European Union has released the data governance act and the data act to promote the exchange and use of data. In Austria the activities around intelligent transport systems (ITS) and the "Action Plan Digital Transformation in Mobility" (BMK, 2022) aiming to bring digital mobility services closer to users of the mobility system.

Developments in the field of data spaces in recent years are aiming at enabling homogeneous as well as trustworthy data exchange and governance within these frameworks. This is also the basis for a healthy and well-functioning data economy. Data exchange and data economy are still an unknown area for many people. As part of this implementation, we learned in interviews that people are often hesitant to take advantage of this opportunity. On the other hand, people have exaggerated expectations. They assume to generate high revenues within a short period of time. Both must be balanced, and the situation must be assessed realistically. There is some effort necessary to create substantial amount of high-quality data. Data must have integrity and a trustful framework for data exchange must be given. This includes technical and legal aspects at the same time.

Digital services for mobility have significant market potential. We therefore suggest establishing a dedicated task force that brings together key public and private stakeholders to create a comprehensive implementation strategy. The primary goal should be to generate practical value through improved mobility services while maintaining a sustainable operational model that promotes broad participation from current market players and fosters ongoing innovation in the accessibility sector.

Mobility is of great importance for all people and therefore also for social participation. Travelling multimodal faces various challenges but it is a strategic goal and has the potential to create a more sustainable, efficient and liveable environment. People with mobility impairments face numerous additional challenges and obstacles to mobility in everyday life. It is our goal to give this group the opportunity to participate in public transport on an equal basis. As a positive side effect, also other groups will benefit from a better adaptability to user needs. As a result, there is an urge for mobility services that are better tailored to individual needs. Interlinked and high-quality data provides the basis for such services.

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