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## **Mobility Data Space – An Open and Decentral Ecosystem for Mobility Data**

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### **Abstract**

An increasing number of mobility scenarios are using intelligent planning, coordination and control in order to shorten travel and transport times, make better use of shared resources, reduce costs or protect the environment. Intelligent systems with the aim to support travellers and provide precise information on a wide range of mobility types require a variety of data from different sources. The Mobility Data Space (MobiDS) is being designed to meet those requirements. It uses the cross-domain architecture of the Industrial Data Space and combines it with the concepts and functionality of the existing Mobility Data Marketplace (MDM). It is characterised by an open, decentral architecture and represents at the same time an inherently robust and trustworthy system for safe and secure data exchange and processing. This decentral ecosystem fosters new ways of data exploitation – not only between traditional mobility actors, but also new and upcoming data providers and data users – and creates new business models through domain-specific services (“data apps”) that act as new virtual data sources itself, which can be obtained through the ecosystem’s own data app store.

**Keywords:** Mobility Data, National Access Point, Multimodal Traffic Information

## 1. Introduction

Today's and tomorrow's mobility landscape is offering more and more mobility services which are based on digital information. They are using intelligent planning, coordination and control in order to shorten travel and transport times, make better use of shared resources, reduce costs or protect the environment. Intelligent systems with the aim to support travellers and provide precise information on a wide range of mobility types require a variety of data from different sources. For this purpose, the Mobility Data Marketplace (MDM) [1] has been designed as a neutral platform and as Germany's national access point for traffic data, which can be used by both public authorities and the private sector as data exchange platform to provide and consume traffic data. Since the start of the MDM, it has turned out that road traffic cannot be treated as a closed ecosystem. The shift to multimodal travels also places new demands on the MDM. In addition, the Delegated Act on multimodal travel information (priority action A) [2] obliges EU Member States to provide a National Access Point (NAP) which links data of all – scheduled, demand-responsive and personal – transport modes. In order to enable data exchange and to foster new mobility services, a new comprehensive environment for multimodal traffic information is being developed with the Mobility Data Space (MobiDS) on the foundations of MDM, which has the potential to also fulfil the requirements of a NAP for multimodal traffic information.

Fraunhofer, together with more than 80 companies, has specified and implemented prototypically a domain-independent reference architecture for the creation of data value chains in form of the Industrial Data Space (IDS) [3] in two nationally funded projects (InDaSpace and InDaSpacePlus) and on its own resources. The components of the IDS reference architecture [4] form the basis for the MobiDS. Furthermore, the requirements of the ITS Directive [5] are assessed to satisfy them in the final implementation.

In addition to the range of technical functions for secure and sovereign data exchange and processing of the IDS, the MobiDS aims to become a broad ecosystem of comprehensive mobility data and uniformly accessible data services and applications for data refinement and use. Providers of data keep sovereignty over the usage of their data and security along the processing and value chain in a way similar to digital rights management ("usage control"). Provision and distribution of sensitive data is supported and traceability of data usage for possible billing is ensured. Data users gain easy access to a wide variety of data sources and data services, enabling them to implement new business models by securely using and linking new sources of mobility data. New business models will be made possible for developers of data apps for mobility services and applications that can be distributed via the MobiDS data app store.. End users benefit from the development of novel mobility applications and services through the broad availability of mobility data sources supported by the MobiDS.

## 2. Key concepts

The MobiDS is intended to build upon the key concepts of the IDS. The decentral architecture is an essential concept that enables ad-hoc data exchange and processing. Moreover, the IDS reference architecture model encompasses a comprehensive security concept, which ensures a high level of protection and confidence for the data exchange. This includes not only the protection of the data communication but also an identification process of participants and full control of the usage of data, even after being transmitted to another participant.

Participation in the secure data space is carried out via the IDS Connector that a data provider and consumer typically operates on their premises. The secure data space is created across linked connectors; it is therefore not a centralised platform, but an extensible network of decentralised actors that is also the secure execution environment for data apps. The IDS Connector serves as the foundation of the MobiDS Connector, which executes mobility data apps and transforms existing external mobility data streams into the internal semantic data model. This data model is based on the Resource Description Framework (RDF). A MobiDS Connector will be used primarily on the side of data providers with sensitive mobility data and on data platforms such as the MDM. The addition of a MobiDS Connector enables the MDM to obtain data from IDS data sources and to make it available to existing MDM data recipients, while at the same time passing on data coming from MDM data sources to IDS data recipients. The MobiDS Connector will be made available as a basic implementation in order to integrate new data offerings into the MobiDS. Another challenge will be the efficient forwarding of data sources to a large number of subscribers based on the model of the MDM. Finally, the envisioned MobiDS supports the existence of multiple identity providers and/or app store operators.

## 3. Business and system architecture

The MobiDS consists of decentral and central components. Figure 1 gives an overview of the most important components and their interaction through exchange of data, metadata and apps. Precondition for the decentral data exchange is the operation of a MobiDS Connector as a uniform and secure interface. Additionally, some central entities are required, especially in dynamic environments with changing data sources and consumers, including the MobiDS Directory for semantic metadata, the MobiDS Identity Provider and the MobiDS App Store.

The MobiDS Directory plays a central role in the MobiDS. Data sources and data apps can be published and their usage is described semantically. Additionally, it is synchronised with the MDM and open data portals, such as the mCLOUD [6], so that the MobiDS Directory always has an up-to-date and comprehensive overview of mobility data sources. Consumers (applications, services, data apps) search the MobiDS Directory for new data sources needed for their business processes. If necessary, this search process can be carried out automatically based on semantically described data sources and API concepts. The foundations of these semantic procedures are ontologies and vocabularies in which domain knowledge about mobility data formats and API concepts are modelled. The use of uniform ontologies

and vocabularies enables automated data exchange and interoperable services. A central Identity Provider manages and certifies the participants and provides information about their identity on request. Connector operators can use one or more central app stores to obtain data apps and operate them in their connector environment.

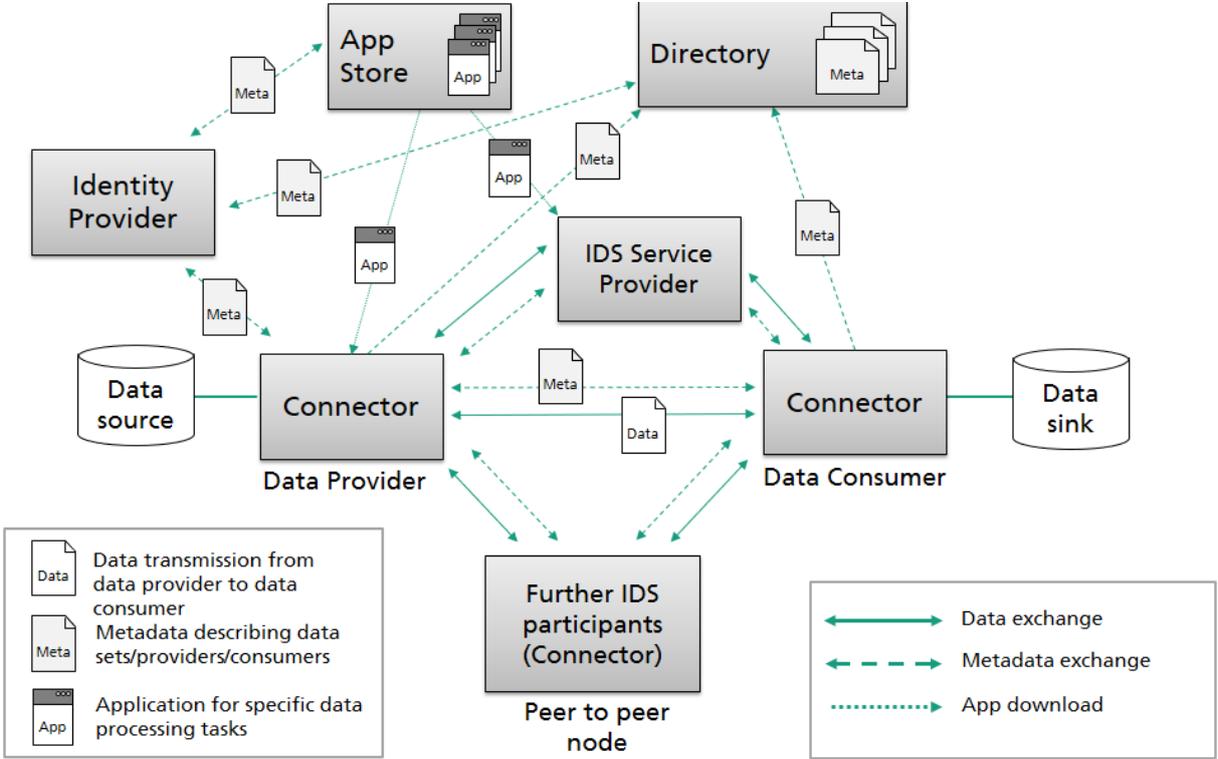


Figure 1 - Components and basis architecture of the IDS and of the MobiDS

4. Example scenario

The example scenario in Figure 2 illustrates the core parts of the MobiDS including the flow of data. A mobility service provider is offering short-distance journeys on dynamic routes. To support routing and to achieve optimal travel times, real-time traffic data is needed. In order to achieve the highest possible capacity utilization of its vehicles, the service provider needs traffic situation data for travel time forecasts routing and optimal travel times as well as mobility, movement and demand data. Traffic situation data is collected by road operators or road and environmental authorities through traffic detectors, which are already available in the MDM. Fleet operators (taxi, logistics, public transport) and navigation service providers collect Floating Car Data (FCD), representing individual travel speeds. This data is considered sensitive as it contains personal mobility profiles. Hence, it was not possible to share FCD with third parties as raw data by now. In the exemplary scenario, the FCD provider and the MDM use a MobiDS Connector. In this data space, the data provider can confidently determine how his sensitive floating car data is processed after being passed to the MDM and in which form the resulting data may leave the data space in the direction of the data recipient. In this way, the data provider can make its sensitive data available to external business processes, which obey the data usage restrictions. Such data transfer does not necessarily have to happen via a central platform. The MobiDS concept also

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supports the direct data exchange between two parties, such as in the example of sensitive mobile network movement data from telecommunications companies and transit schedules of transport companies, which are then used in the data consumer’s MobiDS Connector in terms of its business processes and in conformity with the data provider's processing rules.

Processing of the data is carried out by a data app and the MobiDS Connector provides the necessary runtime environment. Its conformity with the data provider's requirements has been verified by a certification body. It is executed in the MobiDS container of the MDM. Such data apps can be developed by an independent software developer, either on behalf of the data provider/data consumer, or in their own initiative to implement their business model. Data apps are offered in the MobiDS App Store. The data refined by an app can in turn be a new data source that is available to the users of the MDM. In this way, data apps can become the basis for a new mobility data ecosystem. The decentralised architecture of the IDS allows the integration of additional IT resources. The data space in the example above is extended to include an external cloud environment in which a more complex data app for calculating travel times and forecasts is executed.

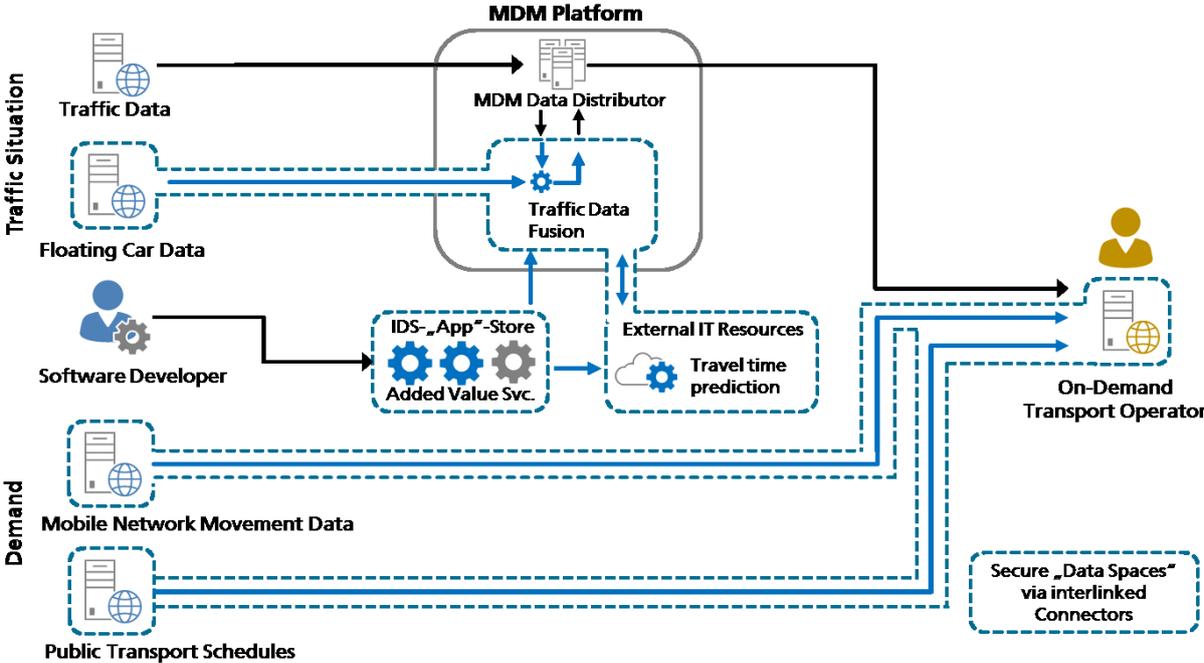


Figure 2 - Exemple scenario of a MobiDS use case

## 5. Conclusion and outlook

The Mobility Data Space presented here offers the foundation for an open and decentral ecosystem for mobility data as a verticalisation of the Industrial Data Space. It provides a whole new way to securely exploit existing and sensitive mobility data and to combine them with further data sources in order to create new virtual data sources. The concept of distributable data apps provides a new way to offer specific domain knowledge, such as algorithms and models, to a wide range of potential users. It is a new and comprehensive approach, which relies to a large extent on existing concepts and components. Their maintenance and further evolution is facilitated due to possible synergies of other IDS verticalisations.

The concepts of the existing Mobility Data Marketplace are being evaluated and integrated where applicable. The impact of the Mobility Data Space on the existing structure will be threefold: It will extend the MDM functionalities and make it open for new data types; it will involve new data providers and foster data exchange between traditional mobility stakeholders of different domains as well as the data exchange with new stakeholders; it will build an umbrella over existing platform approaches – like the MDM or the mCLOUD – and potentially all decentral approaches for mobility data exchange.

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