

ICS 13.020.20; 35.240.60

Urban mobility data collection for real-time applications; Text in English

Urbane Mobilitätsdatensammlung für Echtzeitapplikationen;
Text in Englisch

Base de données sur la mobilité urbaine pour les applications en temps réel;
Texte en anglais

Zur Erstellung einer DIN SPEC können verschiedene Verfahrensweisen herangezogen werden:
Das vorliegende Dokument wurde nach den Verfahrensregeln einer PAS erstellt.

Gesamtumfang 60 Seiten

Dieses Dokument wurde durch die im Vorwort genannten Verfasser erarbeitet und verabschiedet.

Contents

	Page
Foreword	4
Introduction.....	6
1 Scope	8
2 Normative references	8
3 Terms and definitions.....	8
4 Context, Requirements and Foundation	10
4.1 Digitalization as Driving Force of Urban Mobility	10
4.2 Holistic Traffic and Mobility Insight	11
4.3 Eco-System of Urban Mobility Data for Real-Time Applications.....	14
4.4 The SUMP as Underlying Concept.....	16
4.5 Defining the Stakeholder Group.....	17
4.6 Impact of connected autonomous vehicles	18
4.7 Open data.....	19
4.8 KPI Circularity	19
5 Use Cases.....	20
5.1 General Information	20
5.2 Public Transport.....	21
5.2.1 Mobility solutions for public transport	21
5.2.2 On-demand shuttle buses for regional and long distance	22
5.2.3 Managing transport disruptions across the network with MaaS.....	23
5.3 Walking and cycling.....	24
5.4 Intermodal transport.....	24
5.4.1 Platform-based seamless transportation	24
5.4.2 Influence of major events on traffic.....	25
5.5 Urban road safety	26
5.5.1 Data-driven approaches for safe and clean urban roads.....	26
5.5.2 Connected autonomous driving	27
5.6 Road transport (flowing and stationary).....	29
5.6.1 Optimizing traffic through real-time data	29
5.6.2 Smart Parking	31
5.6.3 Alternate Routing	31
5.7 Urban logistics	33
5.7.1 Logistic Hubs	33
5.7.2 Urban Air Mobility.....	34
5.8 Mobility management	36
5.8.1 Mobility Hubs.....	36
5.8.2 Charging at my office	37
5.8.3 Multi-modal transportation led by employer	37
5.9 Intelligent Transport Systems	38
5.9.1 City-wide Environmental Sensing.....	38
5.9.2 Trend Analysis as input for ITS	38
5.10 Supra-regional mobility	39
5.11 Social Media	40
6 Roles and Responsibilities	41

7	Organisation and Operator model	42
7.1	Business models & licences models.....	42
7.2	Data sovereignty & governance	45
7.3	Urban infrastructures.....	47
8	Technical Architecture/ Infrastructure	48
8.1	General Observation and Relationships with Existing Work.....	48
8.2	Reference Architecture	48
8.3	Sample Solution: Real-Time Traffic Light Assistant	52
8.4	Sample Solution: Intermodal Journey.....	53
8.5	Sample Solution: Urban Air Mobility.....	54
8.6	Sample Solution: Platform for Walking and Cycling.....	55
8.7	Sample Solution: Smart Parking	57
8.8	Sample Solution: 3D model of the city, real-time communication with special size vehicles.....	58
	Bibliography.....	59

Figures

Figure 1 — The overall Eco-System of Urban Mobility Data for Real-Time Applications.....	15
Figure 2 — Schematic process of SUMP.....	16
Figure 3 — Overview of stakeholders that produce, use and are in need of real time urban mobility data	18
Figure 4 — Evolution autonomous driving.....	19
Figure 5 — Example platform business case smart parking & public transport	43
Figure 6 — Pricing models and data-driven business models.....	44
Figure 7 — Schematic picture of an Open Urban Platform, modified from DIN SPEC 91357	50
Figure 8 — EIP SCC (European Innovation Partnership on Smart Cities and Communities) Urban Platform Capability Map, from DIN SPEC 91357	52

Tables

Table 1 — Roles and Responsibilities.....	41
Table 2 — Real-Time Traffic Light Assistant.....	53
Table 3 — Intermodal Journey	54
Table 4 — Urban Air Mobility	55
Table 5 — Walking and Cycling.....	56
Table 6 — Onstreet-parking scenario and data flow	57

Foreword

This DIN SPEC has been developed according to the PAS procedure. The development of a DIN SPEC according to the PAS procedure is carried out in DIN SPEC (PAS)-consortiums and does not require the participation of all stakeholders.

This document has been developed and adopted by the initiator(s) and authors named below:

- Urban Software Institute GmbH
Prof. Dr. Dr. e.h. Lutz Heuser, Markus Bachleitner
- Wissenschaftsstadt Darmstadt
Joachim Fröhlich
- B2M Software GmbH
Bernhard Kempen
- BMW Group
Florian Mayer
- Continental Automotive GmbH
Dr. Frank Försterling
- Deutsche Telekom AG
Joachim Schonowski
- e.GO Mobile AG
Maximilian Heyder, Casimir Ortlieb, Dr. Michael Riesener
- Elektrobit Automotive GmbH
Claus Stellwag
- Ernst & Young GmbH
Siegfried Adam, Nadja Gläser
- Fraunhofer – Institut für Offene Kommunikationssysteme (FOKUS)
Prof. Dr. Schieferdecker, Nikolay Tcholtchev
- Mapbox Inc.
Christina Franken
- Microsoft Deutschland GmbH
Michael Sahnau
- SAP SE
Dr. Martin Klein
- Stadt Hamburg, Behörde für Wirtschaft, Verkehr und Innovation
Ludger Kühnhenrich
- Volkswagen AG
Jan Kempa

At present, there are no standards covering this topic in the body of German Standards.

DIN SPEC (PAS)s are not part of the body of German Standards.

A draft of this DIN SPEC (PAS) has not been published.

Despite great efforts to ensure the accuracy, reliability and precision of technical and non-technical information, the DIN SPEC (PAS)-consortium cannot give any explicit or implicit assurance or warranty in respect of the accuracy of the document. Users of this document are hereby made aware that the consortium cannot be held liable for any damage or loss. The application of this DIN SPEC (PAS) does not release users from the responsibility for their own actions and is applied at their own risk.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. DIN shall not be held responsible for identifying any or all such patent rights.

Provision of this document free of charge as a PDF via the Beuth WebShop has been financed in advance.

Introduction

The introduction of ICT-based mobility (ICT, information and telecommunication technologies) information has led to a significant extension of mobility services within urban areas. Today, citizens can choose between diverse public and private transportation services including sharing of cars, bikes or pedelecs. While this diverse variety of mobility services help to provide the best fit for individual mobility needs, it creates a significantly more complex structure on the urban mobility plan of any given city. In addition, the recent debate on air quality related to ICE (internal combustion engine) vehicles, in particular nitrogen oxide due to Diesel-based cars, has forced cities to adapt their current mobility concepts addressing the need of reducing air pollution and introduce new sustainable mobility concepts.

Since 2013, the European Commission has called out for sustainable urban mobility plans (SUMP) [1]. The goal of a SUMP has been defined as: *“A Sustainable Urban Mobility Plan has as its central goal improving accessibility of urban areas and providing high-quality and sustainable mobility and transport to, through and within the urban area. It regards the needs of the 'functioning city' and its hinterland rather than a municipal administrative region.”* According to the OECD, cities cannot stand alone, but are embedded in a wider region; therefore city sizes as classified in urban areas [2]:

- large metropolitan areas if they have a population of 1,5 million or more,
- metropolitan areas if their population is between 1,5 million and 500 000,
- medium-size urban areas if their population is between 500 000 and 200 000,
- and, small urban areas if their population is between 200 000 and 50 000.

According to the SUMP initiative, cities and urban areas shall implement concepts of sustainable urban mobility. This implies, on the one hand, an increased flexibility of multi-modal mobility as well as transparency for citizens, regarding which offers are actually available at a given time. On the other hand, digitization already provides a multitude of new information that is now largely collected in separate and partially isolated systems. In 2018 during the opening of the 5th European Conference on Sustainable Urban Plans in Nicosia, Cyprus, EU Commissioner Violetta Bulc called for *“Multimodality requires planning mobility as a system: break out of the silo approach and develop nodes where people can conveniently switch between different modes; plan for the convergence of networks, transport, energy, payments”* [3]. Convergence will require *“integrated infrastructure and processes”* as defined within the European Innovation Partnership on “Smart Cities and Communities” to allow for *“Sustainable Urban Mobility”*. In 2018, five lead initiatives for sustainable urban mobility are established including “new mobility services”, “electric vehicles for smart cities and communities” and “urban air mobility”. All of which require exchange of urban mobility data across different organizations, mostly in real-time.

The challenge for real-time applications is the technical and commercial access to urban mobility data, especially from public authorities. Data must be exchanged between mobility providers, city councils, city administration and mobility participants in order to fuse third party data with own data for related real-time applications. The requirements for this are standardized data formats, data access, data interfaces while retaining the new EU Global Data Protection Regulation (GDPR [4]), which has been implemented in May 2018. In addition, a common data model could be the next natural step, once this level of standardization has been achieved.

In Germany, the mobility data market (MDM [5]) has been active since 2014. Providers and consumers of traffic data both public and private can publish data on this platform. The MDM is operated by the German Federal Highway Research Institute (BaST [6]). Thus, it covers a broad range of different data sets of which many are not focussed on urban mobility aspects. In October 2018, about 130 data sets across Germany are available for public access. This rather limited number of data sets indicates that there is a need for a significant broader approach building upon the expertise gained within the MDM. These data sets of the MDM Portal can be complemented by so called Open Data Portals of cities and communities, which have been introduced. Some cities such as Cologne have taken a comprehensive approach to provide traffic data while others haven't made the data of traffic management systems or public transport systems available, at all. Similar observations exist for regional transport and mobility providers. Acknowledging that sustainable urban mobility for cities include their surrounding metropolitan areas, one has to conclude that as of 2018, there are only very limited real-time information available.

Changing traffic patterns, the growing need to act on climate and sustainability goals or changing demographics are just some examples showing the need for action. In many cases, these circumstances result in an increasing traffic in cities and decreasing mobility options e.g. public transport in rural areas. In addition further developments of online logistics are moving into the air. This requires already today the integration of urban air mobility into upcoming urban mobility planning. Due to opportunities based on new technologies, municipalities and cities are requested to implement concepts of sustainable urban mobility. Urban / rural mobility touches a wide span of different modes of transport, like logistics, public or individual transport. With regards to individual mobility, this implies an increased flexibility of multi-modal mobility as well as transparency for citizens. They need to receive the most appropriate service offering in a simple way, e.g. based on availability at a given time. Digitization already provides a multitude of new information that is now largely collected in separate and partially isolated systems. Concepts of "Smart Mobility" integrated in "Smart City" concepts need to enable cross-domain interaction and thus leverage an enhanced usage of the available data. Since mobility couples (overcoming) distance (in a certain) time, it always transports the desire of humans to make the timespan travelling distances as quick and as comfortable as possible. Existing and upcoming information and telecommunication technologies are important enablers towards mobility in real-time.

To conclude, sustainable urban mobility plans depend heavily on information and communication technology and require a significant change in urban planning. During the last hundred years, cars have dominated the urban mobility planning. Nowadays, urban mobility data (software and algorithms) will dominate sustainable urban mobility plans. Changes in ICT are so constant and short term that standard urban planning cycles need to be adapted up to the point of leveraging real-time mobility information to adjust the urban system to changing demand on urban mobility. Urban and transportation planners are not in a position to overlook the vast variety and volume of real-time mobility data available through new mobility services, IoT-enabled Traffic and Transport Management Systems. Therefore, an overarching concept based on a generic technical architecture, related possible business models, and a list of sample use cases is required to shed light into the information base to enable the next generation of sustainable urban mobility planning. While around 1 000 cities in the EU have adopted SUMPs, there is still not an adequate guideline on (type of) real-time information that is required, on how to access and consume the information, and the required potential information that has to be made available to cities and urban mobility planners.

Thus, a consortium of different stakeholders has come together to develop the below DIN SPEC 91367 as a reference specification of urban mobility data collection for real-time applications. The intent is to provide the required insight to city and regional administrations on what additional information needs to be incorporated when developing sustainable urban mobility plans. Furthermore, the DIN SPEC should provide a soundbase to increase an open exchange of mobility data across the different stakeholders. The implementation could happen in different ways leveraging portals such as the MDM Portal, Open Data Portals or the recent published concept of "open urban platforms" (OUP) as specified in the DIN SPEC 91357. As a result, urban and transportation planners will be able to better address the rapidly changing mobility demands of their citizens and enterprises while improving and maintaining a healthy and livable environment.

1 Scope

This DIN SPEC provides a guideline about data models, data accesses, data interfaces in the fields of traffic management systems, public transport, logistics, infrastructure (for example the integrated multifunctional "Humble" Lamppost (imHLA)(see DIN SPEC 91347)), floating car data and other mobility management systems of this sort.

The center of gravity is the horizontal, i.e. sector-wide integration or interoperability to reuse existing (IoT) infrastructures such as "smart" city furniture, traffic (e.g. "connected car"), smart mobile devices, or smart buildings.

Furthermore, this DIN SPEC (PAS) provides a guideline about access formats and license formats whose commercial application intends to enable cities to facilitate participation in the economic development of the digitalisation of mobility.

This DIN SPEC (PAS) is aimed at mobility providers, mobility service providers, commercial transport companies, municipalities, public transport.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

DIN and DKE maintain terminological databases for use in standardization at the following addresses:

- DIN-TERMinologieportal: available at <https://www.din.de/go/din-term>
- DKE-IEV: available at <http://www.dke.de/DKE-IEV>

3.1 real-time

ability of a system to provide a required result in a bounded time

[SOURCE: DIN EN 61158-5-14:2015-09, 3.5.25]

3.2 right time

getting information (or have them available) at the time when it is needed

3.3 open data

data sets provided by public authorities and public enterprises to the general public

Note 1 to entry: Often, this term is also used to define the usage of the data sets as "free of charge" using an appropriate open data license agreement. Open data is open if the provided data can be processed and used by anyone and for any purpose. In general, Open data shall adhere to criteria such as "timeliness", "as close as possible to the data source", "publication under an open license" such as CC BY 2.0 which was published by the Creative Commons NPO and allows sharing, replication and modification of the data even for commercial purpose.

[SOURCE: DIN SPEC 91357:2017-12, 2.1]

3.4**circularity**

logic of or relating to reasoning in which the conclusion is ostensibly proved, but in actuality it or its equivalent has been assumed as a premise

[SOURCE: Dictionary [7]]

3.5**Mobility Data Marketplace****MDM**

marketplace where parties can offer metadata about data which can be provided or is required by them

3.6**urban mobility**

all types of transportations in a city environment

Note 1 to entry: examples for types of transportations are public transport, private cars or walking

3.7**supra-regional mobility**

covers the transport of goods and / or / humans between regions where the distance is typically in the range of 50 km to 200 km

3.8**Mobility-as-a-Service****MaaS**

service offering for people to bring them to a chosen destination with variable routing and means of transportation

3.9**intermodality**

intermodal transport

<transport> combination of multiple modes of transport

Note 1 to entry: "Intermodal transport" is a subsection of multimodal transport that describes a multi-leg transport chain in which one and the same transport or loading unit (or person or group of persons) is carried using at least two different modes of transport

Note 2 to entry: Intermodality is often also commonly referred to as a „mixed mobility

[SOURCE: DIN SPEC 91340:2016-10, 3.76]

3.10**multimodality**

multimodal transport

<transport> use of multiple means of transport to cover a distance

[SOURCE: DIN SPEC 91340:2016-10, 3.107]

3.11**digitization**

representation of analogue objects in a digital way

3.12**digitalization**

new usage of digital processes/methods/goods

3.13

Unmanned Aerial Vehicles

UAVs

all types of drones

3.14

prosumer

person/organization which provides data to and consumes data from a system

3.15

floating car data

FCD

method where car data is collected from many cars to determine the current traffic situation

Note 1 to entry: Examples for car data are position, current time or speed

4 Context, Requirements and Foundation

4.1 Digitalization as Driving Force of Urban Mobility

The current digital evolution coupled with ICT technologies enables the digitization of almost everything (the internet of (every)thing(s)). As such cities are dealing in current Smart City concepts with wide ranging domains, like energy and mobility, forming a digital ecosystem. Different settlements, like cities, rural districts, rural areas, communities or villages each form a local ecosystem based on geo-location, natural surrounding, demographics, industries and the current political systems.

Mobility concepts for different types of cities and regions require a sustainable planning on a local, but also regional level. This holds true especially for the required infrastructure, consisting of roads, signs, streetlights, buildings and much more. While cities and their surrounding area form metropolitan areas, they need to address needs of different kind of neighborhoods such as industrial parks, housing areas, central business districts and the like. With a bunch of new services and technologies available and upcoming, the combination of the needs in a holistic, future looking and sustainable way is required. A mobility concept like SUMP (see 4.4) needs to look beyond city limits and include the adjacent surrounding as stated in the respective guidelines. This includes services like street traffic, rail transport, aerial traffic, public transport, private transport, bikes, pedestrians, parking but also related subjects like energy management (for electric vehicles), building and facility management or new business models like sharing, point systems for sustainable transport usage and operational models. Most upcoming new services are based on (connected) data, like intermodal mobility services, which simply connects different transport modes for individual mobility based on personal preferences or ad-hoc needs and current services.

These new services require adaptation of existing roles and responsibilities or “guiding” frameworks, some require new ones. One example is the current search of many municipalities for a “Chief Digital Officer” (CDO) helping to steer, guide and frame municipal administration, local or global industry / business and local politics towards a local smart city (mobility) strategy.

A dominant aspect is the availability of different urban mobility data sets both from and to the transport authorities. As many of the data sets reside inside different information and management systems, the need of a cross-departmental and cross-sectoral coordination underpins the relevance of such a horizontal function as a CDO. Thus integration of specific domain data, towards a cross-domain mobility ecosystem, and the final integration and usage on an open urban platform is an essential backbone for cities and regions.

Assuming the overarching digitalization of cities and regions towards so called “smart cities and regions”, the role of sustainable urban mobility services will be top ranked. Moreover, new mobility services providers have entered the market, already. Their growing impact shows that cities and regions have to factor in the private sector mobility services when addressing the SUMP. At the same time, authorities need to reflect which influence and impact they have on the further development of new mobility services as they are provided more and more independent of the actual urban mobility plan of any given city or region.

4.2 Holistic Traffic and Mobility Insight

In growing metropolitan conurbations, planning a common mobility strategy can be complicated. For example, various administration authorities, each with their own field of responsibility, bring a huge organizational overhead when connecting different parts of the city for a strategy development.

In the recent past and moreover in the upcoming future, sensor-based devices will capture more and more details about the real traffic conditions both by vehicles and mobile devices as well as street furniture such as traffic lights and street lights. A common and thus more consistent holistic view of the overall situation should be possible.

Today, different stakeholders only have partial situational awareness and thus predictions and decisions are based on limited insights. The transport departments collect data through their traffic management and monitoring systems. The public transport authorities collect the traffic conditions through their fleets in relation to their planned schedules. Private fleets manage and monitor their fleets by separate management systems. The automotive industry collects information from their vehicles as floating car data. The telecommunication industry as well as Internet Service Providers collect data from mobile devices and relate them. Infrastructure operators roll out devices on lampposts or other traffic infrastructure to observe the related areas. Parking operators collect information about their available capacity and turnover. New mobility service providers such as car-sharing companies, ride-sharing service providers, (e-)Bike sharing companies collect traffic information. And many more sources could be listed. But currently, due to missing cross data usage, current technology creates rather deeper single service insight and significant stress to the traffic, sometimes leading to higher and less predictable congestion and a rather poorly managed overall traffic flow. For rural or less populated areas, it could mean that mobility services are provided for just a few people or objects resulting in non-profitable services. The question remains, how a holistic view on urban traffic could be more sustainable, e.g. in terms of required resources, improved air quality and be cost effective.

Despite the huge expected benefit, the investment for developing a common system to bundle all relevant input sources is too high to develop a standalone solution, especially for small cities.

Based on these partial views on the traffic situation, stakeholders make decisions with limited insight and almost no reliable predictions. Assuming all these data sources were holistically available to any stakeholder, fleets could operate in a more efficient and predictable way, transport systems could adjust to the traffic situations and improve traffic flow, especially reducing the number of hot spots.

Cities can be enabled to collect any relevant data for traffic flow to determine a holistic view in real-time. That can be provided to city authorities and 3rd party stakeholders. Furthermore, external (including commercial) data sources can be embedded to improve the system.

In growing metropolitan conurbations, planning a common mobility strategy requires a complex coordination among different authorities.

Moreover, a holistic traffic insight allows new mobility services such as multi-modal transport services to be more efficient and successful. This could end up in very individual multi-modality solutions or combined business models, e.g. focusing on best price (for public transport), most sustainable transport or mixtures of these. By providing insights to participants, educated decisions on taking alternate routes or means of transport will allow for a better journey experience while leveraging the existing transport infrastructure in a significant better way.

Thus, the objectives of an integrated real-time traffic model and information are given below in a categorized form:

Strategic planning and innovation:

- Better decision making for strategic planning of transport departments, public transport authorities, and (large) fleet operators.
- Stimulate more new mobility services to improve the overall offering.
- Securing the overall performance of the transports systems and thus leveraging existing infrastructure significantly better.
- Offering new mobility service concepts in conjunction with city based monetisation, like point systems for sustainable transport choices.
- **Retrospective** analysis of extreme situations, like big events, natural disasters to prepare for next time a similar situation happens.

Increasing efficiency:

- Improving traffic safety and thus helping to reduce traffic incidents.
- Improving the conditions of roads and thus extending their lifetime.
- Enhance sustainable and resource efficient usage of sensors or any other IoT-device.

Reduction of negative effects:

- Cost reduction through combined planning and sensor provisioning (based on prediction services).
- Reduction of duration of journeys making mobility in the city more enjoyable.
- Reducing the overall air and noise pollution.

The city will integrate the provided data into a holistic traffic model for traffic planning and optimization. The data will be used for better operating (public) transport management systems. Furthermore, the city will provide holistic aggregated insights of the overall traffic flow.

Using suitable algorithms the traffic model of the city will be continuous updated with new data.

With information generated from this data, traffic can be influenced on multiple levels:

- Controlling traffic,
- optimizing traffic flow by spawning data to connected vehicles or directly to people (e.g. using different apps),
- improving local information and guidance systems (Billboards, Radio, Internet),
- generating "green waves of consecutive traffic lights,
- traffic influenced navigation, pre- and on-trip information, re-routing due traffic conditions,
- temporary blockage of roads for certain traffic, e.g. to improve air quality
 - traffic- or emission-based tolling to motivate using alternate transport options,
 - social routing towards improving air quality in highly impacted areas,

- optimizing fleet management to minimize impact on traffic conditions,
- recommendation for alternate multimodal transport options,
- data brokerage to commercial solution providers improving their service quality and adhering to the SUMP objectives of the given city or region.

In order to meet these objectives, on the one hand input from different stakeholders are required and cities have to address their needs by asking for access to data inputs in a way that it will not be in conflict with the valid commercial and political interest of the stakeholders. On the other hand, cities need to articulate clearly that a sustainable urban mobility plan and resulting implementation will only be possible, if stakeholders are willing to provide and share related information. A collective and non-discriminating approach is essential.

Possible data sources include:

- Any public infrastructure data:
 - traffic management system;
 - public transport system;
 - „intelligent“ infrastructure (lamp posts, traffic signs);
- incidents, events which may impact the traffic:
 - police / fire emergencies;
 - construction sites;
 - events (concerts, sport events, ...);
- road construction and other constructions impacting the capacity of the transport infrastructure;
- trip information (source-to-destination);
- floating Car data from different, mostly private sector companies;
- information about air pollution related to traffic;
- parking space availability;
- incoming traffic and passengers;
- utilization of mobility sharing services;
- mobile devices such as smart phones;
- CCTV cameras and other sensor devices collecting traffic related information, even in private areas.

Furthermore, there will be many more potential sources. Hereby, it is important that the requested data has high integrity and quality and should be clearly defined regarding the use cases and has to adhere to the regulatory framework of data protection and privacy as defined for example in the global data protective rights directive [4].

In addition, the business models have to be well-defined which provide transparency on how the data can and will be used, under which terms and conditions, and for what purpose.

4.3 Eco-System of Urban Mobility Data for Real-Time Applications

The current section describes the overall concept which is meant to provide the framework for dealing with urban mobility data for real-time applications. This overall concept aims at establishing a flexible eco-system that can be adapted according to the needs of a particular urban environment, in order to implement sophisticated mobility use cases. The concept has a couple of aspects framing the overall picture for urban mobility data collection and acting as an umbrella for use cases, technical decisions, data providers and various stakeholders. Figure 1 depicts the overarching eco-system starting with the stakeholder groups on the left, generating different relevant types of data, which combined with the prerequisites in the center of the figure lead to a variety of potential use cases in an urban environment.

Figure 1 positions the urban mobility data at the heart of the proposed concept. The acquisition, provisioning and utilization of such data is facilitated by a number of aspects, which are specified in the course of this DIN SPEC and provide the umbrella for establishing flows and utilizing mobility data for various use cases in an urban context. Thereby, the ultimate goal is to design a holistic concept for handling mobility data within a city. This holistic design involves relevant stakeholder groups such as public transport, (e-)mobility services, logistics, passenger air traffic, supporting services and individual transport. These groups serve as a cohort of all relevant players generating and eventually consuming data in the corresponding context. The generated data is illustrated on the right to the stakeholder groups and involves aspects such as "traffic data", "time travelled", routing information, number of passengers, data related to accidents and passenger flow information to name some typical examples. This data – combined with the prerequisites in the center of Figure 1 – has the potential to produce and enable crucial use cases, such as autonomous driving, alternate routing, traffic optimization through real-time data, urban air mobility and smart parking on holistic level. However, the prerequisites are paramount for realizing the above sample use cases. Therefore, in the following each of the prerequisites is elaborated in turn.

- *Openness* – The concept of openness is extremely important for real time urban mobility data. Thereby, the deployed systems and components should be provided as open in terms of providing open interfaces based on open standards to enable true interoperability and use across even different eco-systems. That is, it is expected that the interfaces to a system are well described, freely accessible (on technical level) by the community, and developed based on openly accessible standards, worked out in the scope of corresponding standardization bodies. Furthermore, the systems could consider the utilization of Open Data, which is either provided by public institutions or acquired within the community by using suitable methods (e.g. crowd sourcing). In addition, the utilization of Open Source components could potentially bring benefits when it comes to introducing and experimenting with new concepts and use cases.
- *Roles and Responsibilities* – The definition of clear roles and responsibilities with respect to urban data for real-time applications is of high value for the overall eco-system. The concrete roles with their descriptions and area of involvement are provided in the corresponding clause of this standard. Some of the key roles are given by the Primary Data Provider, Secondary Data Provider, Application Provider and the end User with regard to data and services/applications on top of this urban mobility data.
- *ICT Reference Architecture for Smart Cities based on EIP SCC (European Innovation Partnership 'Smart Cities and Communities') and OUP* – The overall set of components realizing the technical side of the eco-system is clearly expected to be based on state-of-the-art standards and international initiatives in the areas of Smart Cities and Communities. Creating and leveraging standards and related activities are promoted by the European Innovation Partnership on Smart Cities and Communities which resulted in DIN SPEC 91357. DIN SPEC 91357 specified a reference architecture for an Open Urban Platform based on open interfaces and a layered approach to structuring the ICT landscape of a city. Thereby, the key goal is to enable the dynamic composition and replication of Smart City solutions across cities thereby avoiding aspects such as vendor-lock-in.
- *Data Types, Data Providers and Stakeholders* – The next ingredient of paramount importance is the various types of data, data providers and stakeholders in the context of urban mobility data. As previously mentioned, these are initially illustrated/exemplified in Figure 1 and further elaborated in the corresponding use cases and discussions on roles & responsibilities as well as data platforms.

- *Classification of Data* – The classification of data can happen on multiple levels – e.g. real-time vs. static data, personal vs. non-personal, open vs. closed data, free of charge vs. commercial data and further. Depending on the use case various types of data are utilized which are also correspondingly discussed.
- *Use Case Analysis* – The current document provides a variety of use cases originating from the specific needs of the involved partners, especially including cities. Furthermore, the use case analysis involved the emerging trends in the area of urban mobility as viewed by large industrial players (e.g. automotive) and small midsize enterprises. These use cases are meant as typical representatives of emerging scenarios for urban mobility involving data for real-time applications.
- *Operator Model* – The operator model for urban mobility data for real-time applications is one of the key organizational aspects when establishing an urban platform for handling and providing mobility data. A special clause is dedicated on this topic dealing with various aspects relating to the emerging ICT landscape, to the models for data distribution (e.g. licenses) and to the topics of data governance and data sovereignty.

The above aspects and considerations are elucidated in detail following clauses, thereby specifying a viable path to developing an eco-system for urban mobility data.

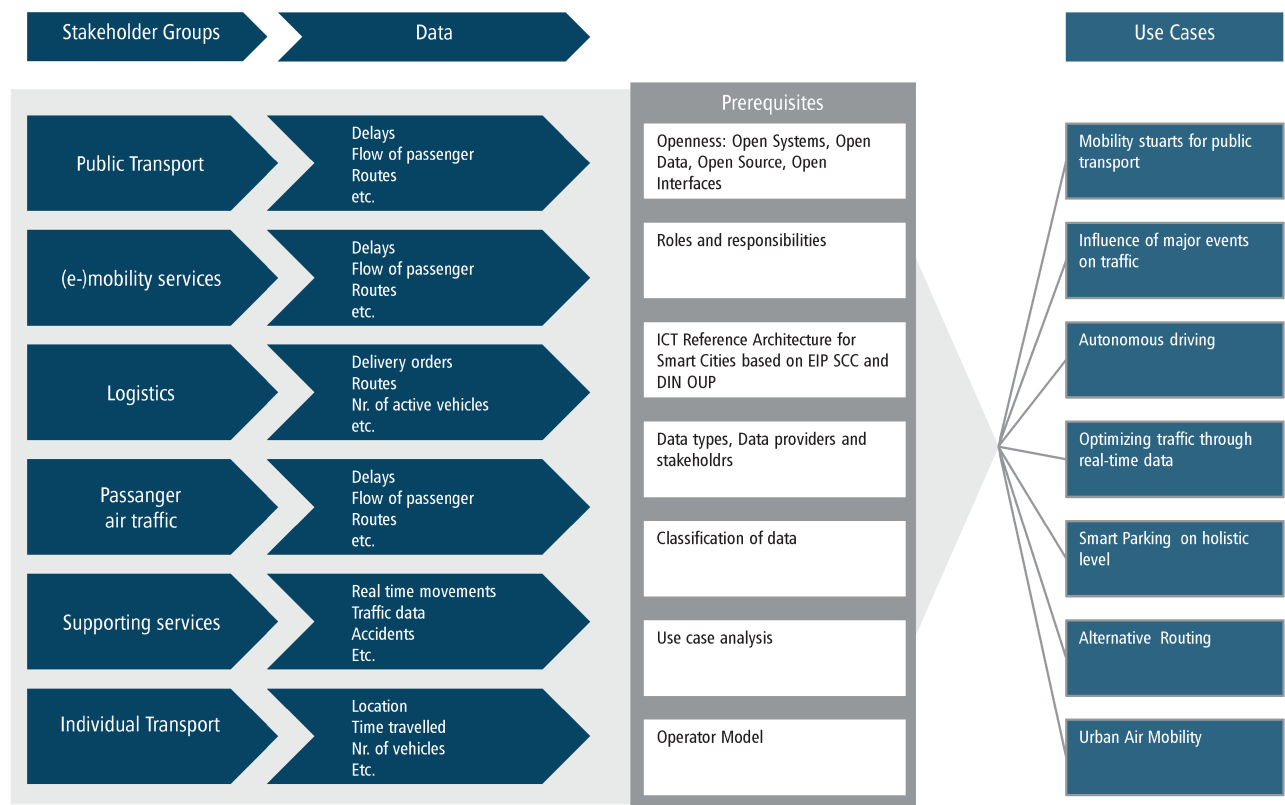


Figure 1 — The overall Eco-System of Urban Mobility Data for Real-Time Applications

A key important use case that spans over all the examples and utilizes a large amount of possible data involving the maximum number of stakeholders in an urban environment is given by the mobility-as-a-service-concept, which must be elucidated on top of the eco-system in Figure 1. Mobility-as-a-Service (MaaS), sometimes also described as Transportation-as-a-Service (TaaS) is a service offering to consumers which combines services of available public and private transportation providers in a specific region and bundles them in a user friendly interface, such as a smartphone app. This service follows a larger trend in urban service culture, with transport users in metropolitan regions increasingly choosing flexibility and convenience over owning a personal vehicle. Typically, a service user submits destination, travel needs (for example, a given time of arrival) and individual travel preferences to find the most suitable route from A to B, using any mode and means of transportation conveniently available. Payment for this service is also

handled by the MaaS provider through the interface. A user is charged per-trip or through a monthly subscription fee. Mobility-as-a-Service providers consume various data streams, such as public transport GTFS (General Transit Feed Specification), disruption and incident feeds to build ever optimized algorithms. The services can account for real-time changes and events altering regular travel schedules and incentivize specific modes of transport on the fly to distribute supply and demand across the whole network. This service concept relies on an open urban platform which aggregates the data from all service providers and relies on trustful and high quality data.

The term Mobility-as-a-Service covers therefore aspects such as “on-demand mobility”, “intermodal mobility”, and “payment and subscription services”. The goal is to offer highly custom multi-modal mobility solutions that are personalized to individual transport needs, offer a stable service quality independent from specific travel modes and providers, provide current travel conditions in real-time, and improve the experience and travel conditions across the whole network for all users.

4.4 The SUMP as Underlying Concept

The concept of a Sustainable Urban Mobility Plan (SUMP) has been set out by the EU Commission in December 2013 and adopted by more than one thousand cities across Europe. The SUMP should contribute to an urban transport and mobility system which addresses the needs and demands of the citizens and enterprises such as a balanced approach of the different means of mobility modality and thus a clear commitment to multimodal mobility. Through a SUMP, cities should make better use of urban space which leads to a change from the car-driven urban mobility planning. Traffic safety and security should be improved and as a result requires real-time information to be shared among the mobility stakeholders. Last but not least, reduction of air and noise pollution, greenhouse gas emissions, and energy consumption are major drivers. Any city and region should have a sustainable urban mobility plan (SUMP). The proposed concept of a SUMP provides a step by step process to be used for concept development towards implementation (see Figure 2).

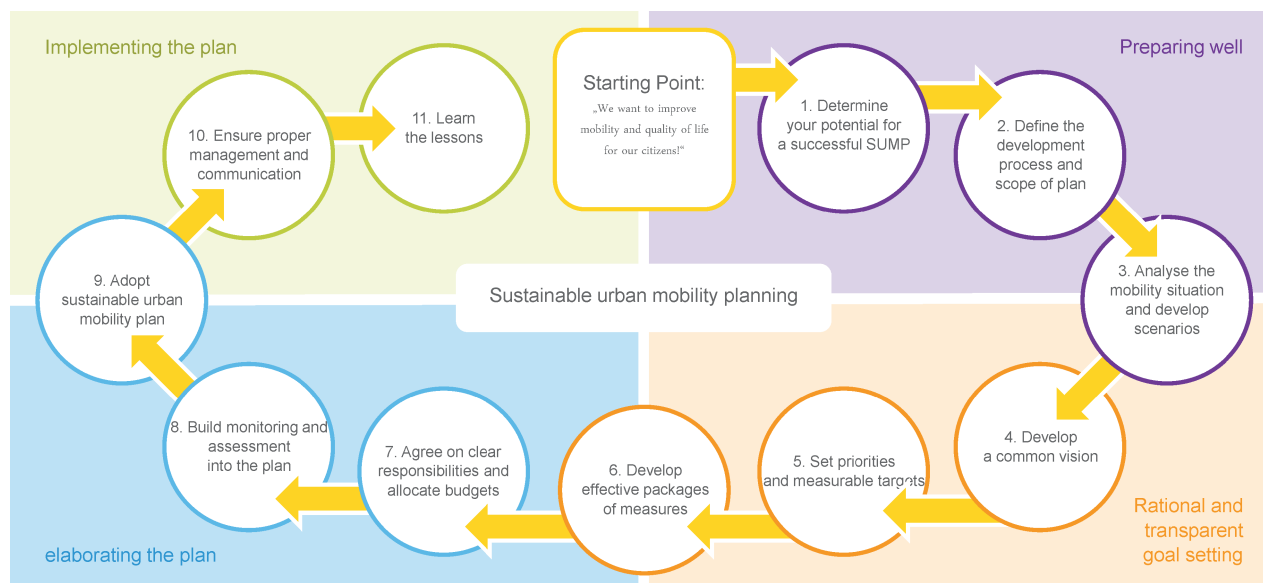


Figure 2 — Schematic process of SUMP

The SUMP should address the city as well as its surrounding region as a whole and not limited by administrative boundaries.

In accordance to the recommendations by the European Commission, a SUMP should be linked to an overall urban development plan and, in this context, refers to the future development of transport and mobility infrastructure and services. It equally includes a delivery plan for short-term implementation of the strategy, specifying the timing for implementation, clearly allocating responsibilities and identifying the required resources and finances.

Each SUMP should address all relevant transport modes, while encouraging a shift towards more sustainable modes. The plan puts forward an integrated set of technical, infrastructure, policy-based, and soft measures to improve performance and cost-effectiveness. It would typically address the following topics:

- Public transport;
- Walking and cycling;
- Intermodal transport;
- Urban road safety;
- Road transport (flowing and stationary);
- Urban logistics;
- Mobility management;
- Intelligent Transport Systems.

One can easily see that a SUMP addresses a horizontal integration of different stakeholders and will rely on the availability of appropriate urban mobility data. Therefore, a participatory approach, where local planning authorities involve different stakeholders is highly recommendable. This way, the city can engage all relevant stakeholders also during the implementation and thus increase the chance of acceptance and support.

The SUMP should also refer to an urban data management strategy of the city, often called a digitalization strategy. As more and more mobility services rely predominantly on available urban mobility data, the provisioning and consumption should follow general principles as for example addressed in DIN SPEC 91357 on “open urban platforms”.

4.5 Defining the Stakeholder Group

Who is involved in urban mobility and needs to be engaged within the eco-system of Urban Mobility Data for Real-Time Application? Different than in the past, due to the digitalization, a number of new stakeholders are involved, many of them are not regionally bound to the city or region but operating on a national or even global base. Therefore, the stakeholder group of urban mobility planning of the past will be significantly extended by new stakeholders who barely have implemented a proper relationship with the city, region, or relevant urban mobility planners.

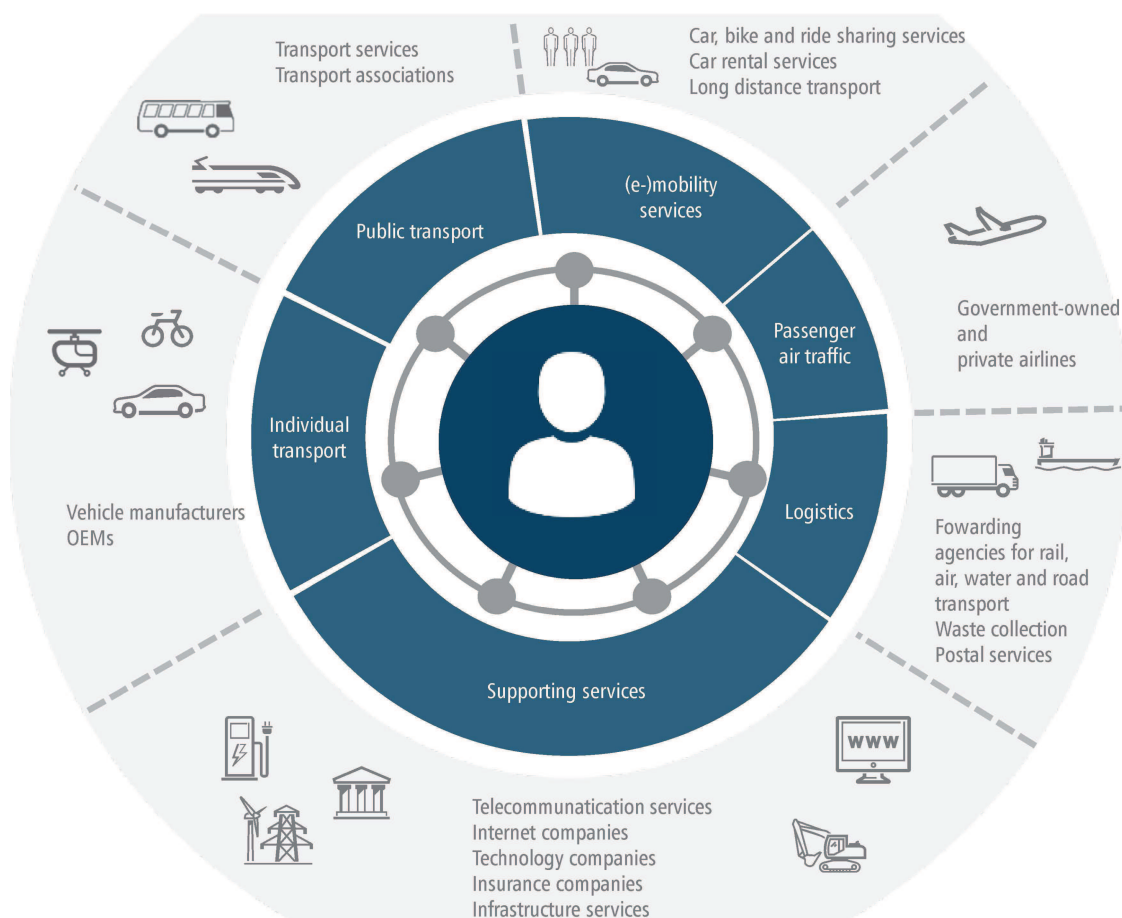


Figure 3 — Overview of stakeholders that produce, use and are in need of real time urban mobility data

Figure 3 shows the stakeholder ecosystem for open urban mobility data. Most use cases define the end user depending on the use case in the centre of the services. The idea of open urban mobility data is to create new services or more comfortable access to existing mobility services via mobile application. The end user directly benefits from new mobility services without directly organizing it. Mobility service providers will build new services around the user.

4.6 Impact of connected autonomous vehicles

Autonomous and automatic driving vehicles rely on a huge set of input data. Whereas most of the relevant data is generated by the sensor systems of the vehicle itself, automatic driving systems rely on external data to function properly. A main factor here is accurate and current map data. In urban areas, the necessary information about the usable area for autonomous driving changes permanently due to construction sites, altered traffic routing, damage to the traffic infrastructure or permanent weather conditions. Streets or single lanes might be non-usable for traffic, the right of way might change on intersections, speed limits might be altered or roads might be closed permanently because of snow or wind conditions. All this information and the underlying data have to be spawned to autonomous driving vehicles to enable a safe and reliable function.

The influencing conditions described above can be detected, analyzed, enhanced and distributed to vehicles by a smart city system, e.g. based on open urban platforms.

With a common smart city interface, traffic and infrastructure input data can be collected, analyzed and enhanced with municipal information. Then, generated or updated map data can be redistributed to autonomous vehicles on demand. Of course, the generated information is not limited to be used by automatic driving vehicles only. Also, the complex sensor systems of the vehicles generate input data for the system as well.