Smart Transportation Alliance

OPTICITIES – A technical view on the harmonisation of urban ITS mobility data

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1. The OPTICITIES project

Mobility stakes are increasingly important in today's fast-growing urban centres all over the world, but particularly in the European Union, where 75% of inhabitants live in urban areas. The 21st century is indeed the century of cities, where we can also find the bulk of economic development and of innovation potential.

After forty years of massive investments, infrastructure networks inter-connections have become a priority to secure urban population growth and economic development. This was introduced in transport public policies through the concepts of inter-modality, multimodality and co-modality. Moreover, in the 1990s, information and communication technologies applied to transport modes led to the deployment of network management systems and user information services.

However, at the same time, environmental and financial constraints have greatly limited the capacity of building new transport infrastructure. Thus, a new approach based on service and on the optimisation of existing infrastructure has emerged to meet the increasing mobility demand.

The **OPTICITIES (Optimise Citizen Mobility and Freight Management in Urban Environments**, http://www.opticities.com) project is one of the responses to the need for a harmonised urban mobility dataset. OPTICITIES is a EU-funded FP7 project that provides a vision of an optimised urban mobility from the user needs and the public policy standpoints, together with business models from service providers. This vision is shown in Figure 1. The main objectives of the project are:

- Set up high-level services for travellers and urban logistics, addressing user needs and urban mobility public policy.
- Support mobility policy and an open market for business development around urban ITS, through a contractual framework between public and private actors.
- Define standards and architecture to foster interoperability among cities and among travel modes.
- Set up a comprehensive data mobility store in European cities controlled by public stakeholders.
- Develop innovative services managed by the private sector or public stakeholders using the urban mobility data store, and being supported by an adapted contractual framework.

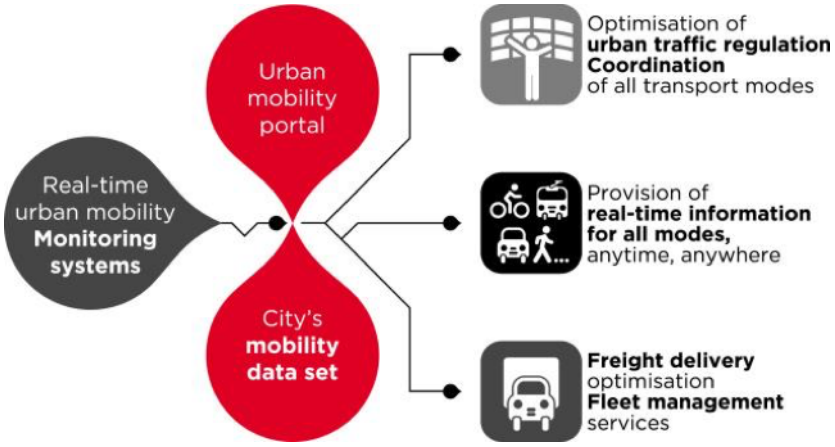

Figure 1: OPTICITIES overall vision

To achieve these objectives, the major breakthroughs expected in terms of innovation are the following:

- Consolidation of multiple sources of urban mobility data from all modes. Based on existing standards, the practical connections between them will be specified.
- European interoperability of urban mobility data and mobility solutions. Interoperability of traveller information applications with various urban datasets: different apps working in different environments.
- Provision of real-time information for all modes, available anytime, anywhere: the multimodal urban navigator and the journey assistant.
- Continuity of services between traveller mobility applications and in-car GPS.
- New monitoring systems for urban freight, multimodal data in large cities, road works.

2. OPTICITIES Open ITS task methodology

To build and deploy smart city and smart mobility applications and infrastructures, a standardisation process is necessary. This process also contributes to reducing the dependence of data silos, in which each entity that operates in the city and the region is the data holder. The OPTICITIES Open ITS task aims at specifying a reference architecture and developing a conceptual interoperability framework for urban mobility support standards. Current relevant existing standards are mapped in this framework, therefore ensuring interoperability between OPTICITIES system and entities in many levels, so that data and information can always be exchanged at the appropriate level.

One of the main challenges of OPTICITIES is to provide a consistent way to integrate different kinds of data related to urban mobility. Urban traffic data, inter-urban traffic data, railway data and public transport data, just to mention a few, have been traditionally developed separately. Their supporting standards have also been drafted separately one to the other. As a consequence, mobility managers have had to deal with different datasets,

even when referring to the same element of the network. A bus stop is a component in a public transport line, with its associated bus lines, schedules and real-time passing times, for example. But that same bus stop is a point in a street or road link, with its associated number of lanes, nearby traffic lights, real-time traffic volume, etc. And yet it is also a geographical point in the city, with its walk-way, nearby points of interest, etc.

So far, there has been no successful specification on cross-referencing all these different datasets. Given the variety of: i) data from different sources and different purposes at each city, ii) supporting standards, and iii) specifications of related data management elements, it makes sense to start with the definition of a common element to use as a reference for all the data. This common data reference would facilitate joint operation with several different datasets – such as those used now by the cities, when applicable. The key aspect is to define the types of objects that can be used in this common reference. If we look at the data characteristics in the different urban data management systems, it seems that good candidates for referencing are objects that belong, or at least are very close, to a static class; for instance, elements of topographic nature, or of a very long cycle life, such as: road infrastructure, public transport stops, car parking areas, bike parking areas, points of interest, etc.

Of course, once these objects have been defined and identified, it is also important to consider that the key point of these reference data is that they can be linked to several 'local' datasets. In some cases, these objects may be directly referenced – point locations, for example –, but in others, definition of these objects may be different depending on the 'local' dataset used. It is necessary to find a way to make these links, so they can be connected and referenced in a consistent way for the applications using the dataset. One of the ongoing activities at the standardisation groups is focused on specifying the links between different datasets and their corresponding supporting standards.

3. Building the mobility dataset

One of the key points of OPTICITIES is to collect different types of mobility related datasets and provide services making a combined use of some of them. These datasets usually focus on one or a few specific data categories, the same as the standards. Therefore, it is important to have a sufficient, accurate knowledge of the main mobility-related data categories. Figure 2 provides an overview of these categories.

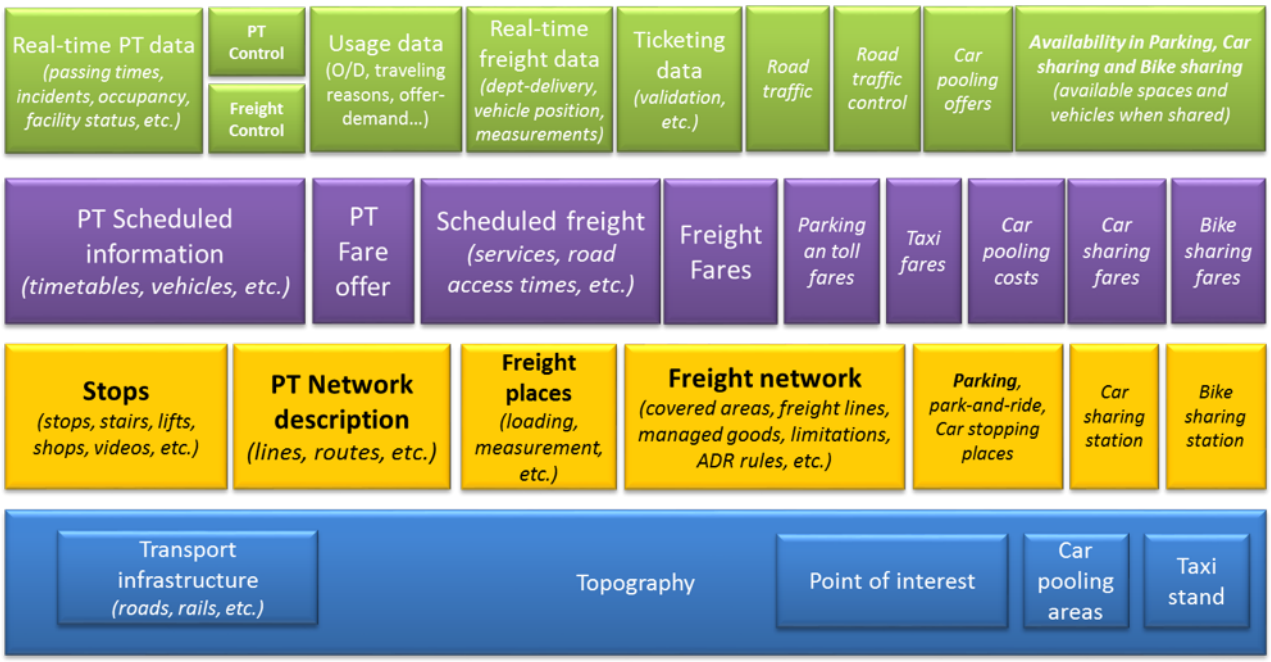

Figure 2: Overview of OPTICITIES data categories

Given the variety of data from different sources and different purposes at each city – even in the selected three cities (Lyon, Gothenburg, and Madrid) in which the most complete OPTICITIES interoperability tests are to be conducted–, along with the variety of supporting standards, it seems natural to start the process with be the definition of a common ground that can be used as a reference for all data. A first approach to the definition of this common dataset is to establish what could be considered as 'reference data', or data close to a static type –i.e. elements of topographic nature or very long life cycle.

Once the objects of the reference dataset are identified, it is important to consider how to link these reference objects to different 'local' datasets. In some cases, these objects may be directly referenced, but in others their definition may be different depending on the 'local' dataset used. It is necessary to find a way to make these links so they can be connected and referenced in a consistent way for the applications using the dataset.

This brings forth again the importance of the definition of applications and use cases in the identification of the reference layer of the dataset. Interoperability use cases determine which datasets have to be implemented in each city, and allows to establish comparisons of current conditions between cities, in terms of available data, requirements for supporting standards, etc. Figure 3 highlights the most relevant data categories identified after analysing the OPTICITIES interoperability use cases.

4. The multimodal dataset, standards and profiles

Standardisation already deals with many aspects of the OPTICITIES scope, including the multimodal dataset mentioned in the previous section. Some of these supporting standards are TRANSMODEL, SIRI and NeTEx for the public transport, DATEX and DATEXII for road traffic, and GDF for geographical information. Google-driven GTFS and GTFS-RT initiatives should be added too, since they are widely used, mainly for Open Data.

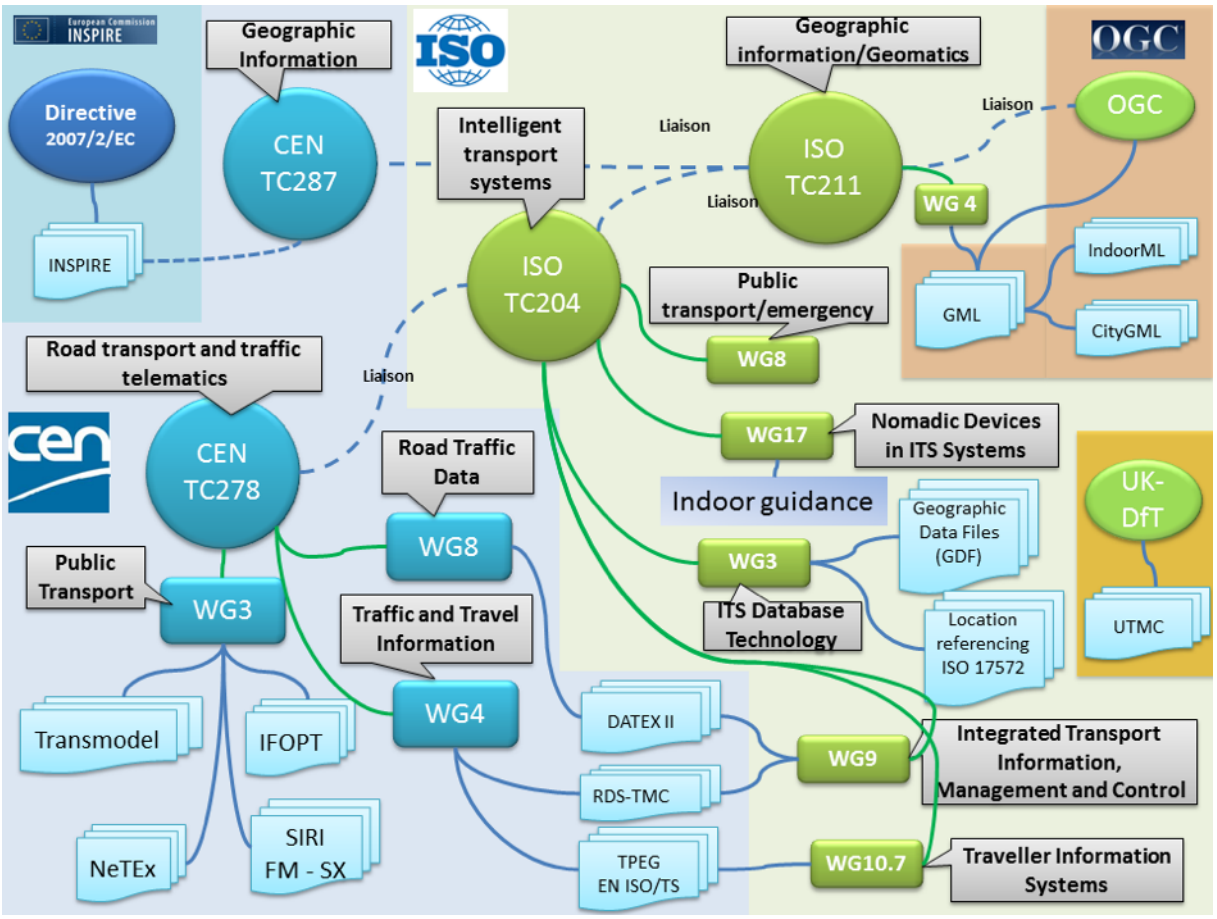

Figure 3: Overview of multimodal dataset related standards and working groups

The OPTICITIES Open ITS task aims at facilitating the deployment of the multimodal dataset in different environments, and therefore two additional aspects have been carefully analysed within the project: 1) the standards profiles, and 2) the connection between data models.

4.1. Data management profiles

Standards are, by their nature and definition, consensus documents. In the case of the CEN and ISO standards, and more particularly in the field of traffic applications, these are established at an international level, with a significant number of different stakeholders involved in their development and discussion. This means that CEN and ISO standards take into account requirements that are far beyond local implementations of such standards. The standard writing procedure itself makes document updates become long processes, so standards are actually conceived to have a life as long and stable as possible.

As a result, standard documents are quite large and detailed, and usually quite difficult to read. The main issue can be that, except for a small part, the connection between the document and a practical application that should be compliant with it is not perceived.
A way to solve this issue with standards is the use of profiles, that is, an additional document to the standard which specifies rules for implementation in a given context. Additionally, profiles can be accompanied by the definition of a specific testing procedure to assess the compliance of the implemented solution with the profile standard.

From a practical point of view, profiles can be seen as an implementation guideline for a given standard. Instead of having to face the challenge of analysing the whole standard, discovering the relevant parts for a given application, and then adjusting optional values and parameters for the intended application, profiles can be specified to address the needs of a particular application and then be used for any subsequent similar initiative.

4.2. Connection between data models

One of the main OPTICITIES goals is not only to manage and provide services from separate sets of data, but also to combine them in a consistent and valuable manner. Therefore, connections need to be done between the relevant standards.

Figure 4 provides a possible approach on how the connections between the main selected standards are expected to be.

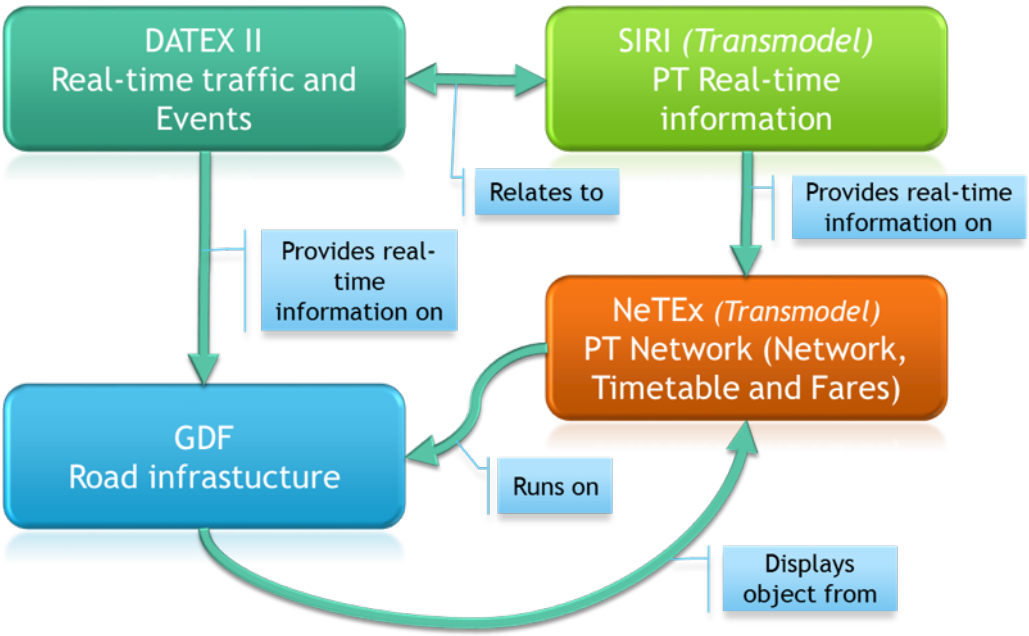

Figure 4: Overview of connection between data models/standards

The Road Infrastructure (GDF model) can be considered as the 'root data' that are going to be used as a pivot between datasets. Basically, this means that these 'root data' will not only refer to the other data but will be referred by the other ones. However, this sentence is not completely true, since the road infrastructure needs to get knowledge about public transport, and will therefore contain very simple public transport objects description referencing Transmodel (NeTEx), which deserves a comprehensive description.

5. The final step – Deployment of the multimodal dataset in different cities

During the work of the Open ITS task, it was important to identify the conditions that would support the definition of a deployment roadmap for the OPTICITIES multimodal dataset and its interfaces. Thus, the activities focused mainly on the assessment of the current status of the systems and services at each city and the assessment of the steps to be taken from the current situation to the agreed final deployment scenarios.

These final deployment scenarios are defined in such a way that they minimise the migration effort for the cities to provide the desired services, and, at the same time, ensure that this effort will be reasonably well protected in the future.

Different aspects that should be considered in the deployment are:

- Technical
    - Is it necessary to change the current implementations? To what extent?

    - What would be the technical difficulties in migrating to the intended approach?
        - Data collection
        - Data aggregation
        - Data processing
        - Data storage
        - Data exchanges
        - …
    - Are there any standardisation issues with the current implementation?
        - Data areas that are not covered by standards
        - Implemented services or tools using not supported or limitedly supported standards or completely proprietary solutions.
- Organisational
    - Do the existing operational processes need to be updated in order to undertake the necessary technical changes?
    - Is specific additional training necessary to manage and operate the new deployment elements?
- Urban mobility data management policy-related
    - What are the current policies in urban mobility services in the city? Are there any kinds of restrictions or difficulties in the intended deployments?
    - How could potential policy-related issues be handled and what would be the impact on the current implementations and on the deployment of intended scenarios?

Taking into account these aspects each of the cities analysed within OPTICITIES, a strategy to achieve the interoperability goals set for the urban mobility dataset was outlined. The key aspect was the definition of different scenarios for the implementation of this dataset:

- Do nothing and keep proprietary formats.
    - This is not recommended, as it goes against the progress the EC is aiming at.
- Decide to use the standards recommended by OPTICITIES – based on proposed profiles – in a near future, but not in the time-scale of the project.
    - In line with an intermediate migration scenario.
- Decide to use some of the standards recommended by OPTICITIES – based on proposed profiles – within the time-scale of the project, and others in the near future.
    - In line with an intermediate migration scenario.
- Decide to use all the standards recommended by OPTICITIES – based on proposed profiles – within the time-scale of the project.
    - Ideal situation with immediate migration, ensuring alignment with the EC standardisation efforts.

However, in most of the cases, it is interesting to note that, independently on the specific current status of the implementation of mobility management systems in the cities, the overall process consists in integrating the data from different sources, processing it, and providing either raw or elaborated data (as services), to different entities of the mobility environment. OPTICITIES has formulated a proposal on data which are necessary to support the core services in urban mobility, and in addition a number of recommendations on how to achieve the data management system for such a scenario.

A possible technical scenario that could be considered as a first approach to this system is shown in Figure 5.

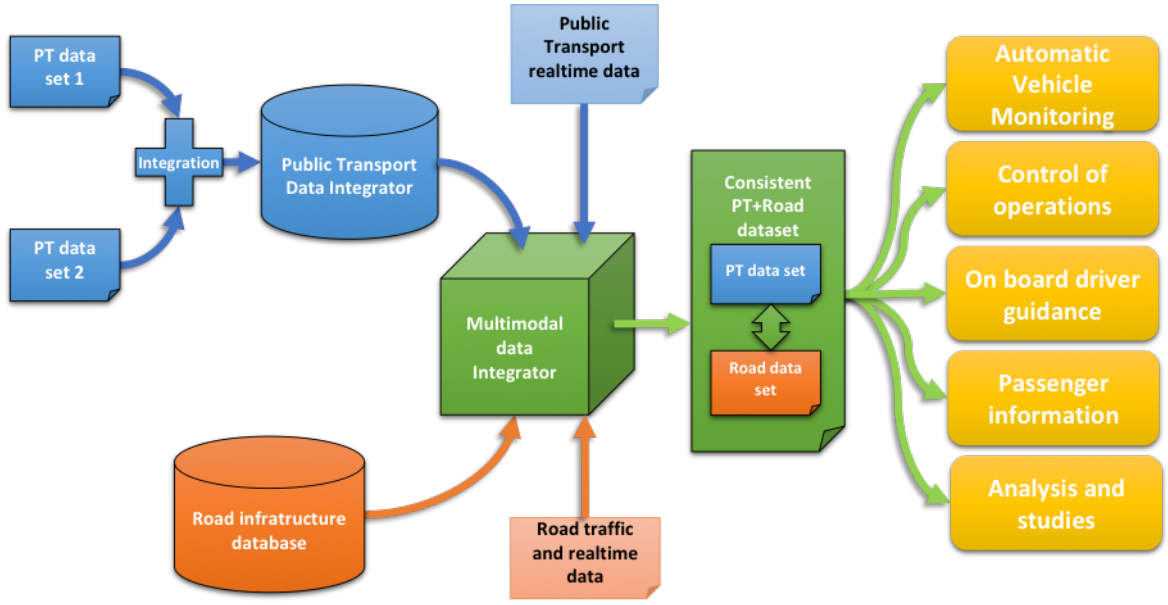

Figure 5: General overview of a multimodal data aggregation system

This is in fact very similar to the solution implemented at the CITRAM in Madrid; to some extent to some extent, this validates the general ideas of OPTICITIES regarding integration of data, and, especially, the technical feasibility of such an integration. Moreover, it is one of the intermediate deployment scenarios proposed by OPTICITIES, in which the system could temporarily use non-CEN or non-ISO solutions for some system functionalities. This leads to an interesting discussion on what actually should be standardised in an urban management system. OPTICITIES considers only two standardised points: the dataset and the access point. However, it is advisable to consider more standardisation points to facilitate migration paths for cities in different situations, or a definition of deployment roadmaps.

Other recommendations that were extracted for the deployment of the multimodal dataset are:

Technical / Data-related issues
The key to an appropriate management of the urban mobility is the quality of data feeding the system. All modes (including pedestrian, bicycle, etc.) have to comply with it, as well as all types of data taken into account: - *Static / Quasi-static* - *Scheduled / Planned* - *Real-time / Unplanned*
The development and deployment of added value services in the framework of mobility services require other loosely-related categories, such as: - *POI information* - *Weather information* - *…*
Even in apparently of small significance integration layers, data exchanges can, and should be, supported by as widely adopted standards as possible.
CCTV information is a very valuable asset and it increases the awareness of the environment. It provides also potential for automated analysis processes in a way that other sensors cannot. The differences in the data management systems in case of a large number of local, regional and even national operators, (from both private and public sectors) add a significant complexity to integration tasks.
As mobility broadens its scope outside cities/regions, the issues related to the integration of data at national level must be considered. This brings forth issues of scalability, data handling, etc.
Direct implementation of a tool supported by the urban mobility data integration layers is a very tangible result of what is, in pure essence, a conceptual vision.
GTFS / GTFS-RT is a functional data provision scheme. Its implementation as a preferred choice specification should not be dismissed.
In situations in which it may be difficult to homogenise data management systems, it may be reasonable to use GTFS and similar formats for their perceived easier implementation across multiple operators.
A single access point to the information in the city should be an objective by itself. OPTICITIES Urban Mobility Portal is a step in this direction.
Updating of information regarding different operators' data should be consistent.
Updating of information regarding different operators' view on a same event (e.g. public works and its impact on the public transport network and traffic, or schedule updates) should be consistent.
Real-time information for certain modes, including taxis, is not sufficiently specified.
Walking origin and destination sections of a trip are still not completely specified, and therefore, data collection for those is not considered yet.
Fare and ticketing information is another area not completely specified and therefore not

integrated in the solutions.
Mechanisms to integrate unstructured data (crowd-based data, basic raw data from sensor networks, etc.) need to be explored.

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