IMPORTANCE OF DATA STANDARDS FOR EUROPEAN PASSENGER MOBILITY

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Abstract

In the paper, the Transmodel series of standards for public transport are proposed to address and solve data interoperability challenges for multimodal public transport domain with special focus to passenger mobility. Additionally, an implementation example of the standards is presented. The paper aims to increase the awareness for the need of ITS standards.

Keywords

Harmonized ITS standards, Reference Data Models, Mobility, Public Transport, Data Exchange

Introduction to passenger mobility

Transportation research does not give common definition for passenger mobility, therefore we will define it as a movement of a passenger using any kind and mode of motorized, non-motorized, collective or individual mean of transportation.

Analysis of the modal split for inland passenger transport for EU-28 in 2014 [5] (see Figure 1, blue bar represents percentage of inland passenger-km driven with cars, yellow bar corresponds to busses and green corresponds to trains) shows that passenger cars accounted for 83.4% of inland passenger transport, with motor coaches, buses and trolley buses (9.1%) and trains (7.6%) both accounting for less than a tenth of all traffic [6]. All data is based on movements on national territory, regardless of the nationality of the vehicle. This indicator is defined as the percentage share of each mode of transport in total inland transport, expressed in passenger-kilometers (pkm). It is based on transport by passenger cars, buses and coaches, and trains.

Between 2000 and 2014 the relative importance of the use of passenger cars was relatively stable, with its share always within the range of 82.4 % to 83.4 %. Over this period, the relative importance of passenger transport by train increased steadily (although there was a fall between 2008 and 2009) from 7.2% at the beginning of the period and falling to 6.7% in 2003, then increasing to 7.7% in 2012 and stabilizing at 7.6% by 2014. Combined with this development was a fall in the importance of passenger transport by motor coaches, buses and trolley buses, from 10.4% in 2000 down to 9.1% by 2014, with most of this fall occurring between 2008 and 2009 [6].

Domestic air and maritime transport is not included due to the lack of comparable data. Air and sea transport are already well developed and have predominantly international nature. Some 880 million passengers were carried by air in 2014 in the EU-28 [7]. Ports in the EU-28 handled 400 million maritime passengers in 2013 [7].

The relatively stable and slowly increasing use of passenger cars (+1% between 2000-2014) can generally be attributed to the economic growth in the new EU members. Economic growth rises per capita traffic volume [1], which replaces use of buses (collective transport) with cars (individual transport).

At the same time in (sub)urban areas with developed public transport, passengers replace buses and cars with higher-speed vehicles (aircraft, high-speed trains). That explains decline in use of passenger cars in EU in the period 1990-2014. The reasoning is supported with the small increase (+0,4%) of use of trains in the period 2000-2014 and the reciprocal relationship between the use of buses (decline) and trains (increase). This is a known direct relationship between limited travel time budget of passengers, who are unwilling to spend more than one hour per day commuting, and development of increasingly flexible and rapid modes of transport [1] [8]. If faster infrastructures and performant digital environment are not supplied, the fixed travel time budget will force per capita traffic volume to saturate. Increasing demand for passenger (urban, rural) mobility in digital society requires harmonized multimodal travel information services, which must be accurate and available across borders. For this to achieve, heterogeneity of all participating information systems, including those that support tasks for:

- passengers (journey planning, fare delivery, real-time feedback),
- public transport authorities (network topology & access nodes management, timetables registration, concession statistics, reports),
- public transport operators (tactical planning, fare collection, operational management, driver scheduling), and
- network operators (automated vehicle monitoring),

must be managed towards a (trans-) national digital interoperability.

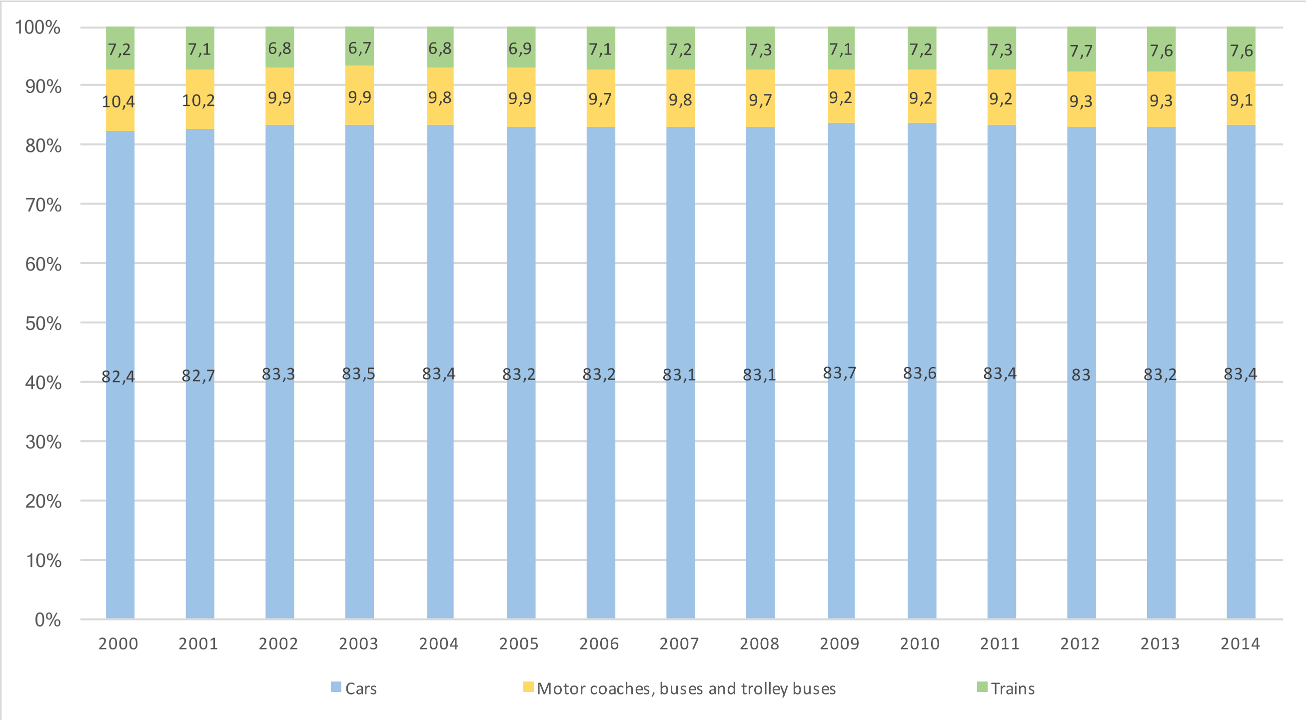

Figure 1. Modal split of inland passenger transport, 2000-2014 (% of total inland passenger-km)

The paper focuses on digital interoperability of all the above information systems needed for seamless passenger mobility.

Problems and solutions

To develop integrated Public Transport information systems, to provide passenger information across transport modes and across borders, a range of ITS data and data exchange standards are developed that might be re-used Europe-wide. Those who want to implement these standards face, however, a series of problems. One of them relies on the fact that over the past decades standards have been developed without the necessary coordination. Another problem resides in the fact that all along the development of a standard, very different needs are considered. Standards are therefore often voluminous and their understanding is time consuming if not discouraging for the users. Finally, often not the entire standard is needed for a situation but only a part of it. The specification of useful *parts of a standard* and of *the way* these parts are implemented is often not documented and thus makes interoperability of systems quite difficult.

Another disadvantage of current practice is that there is often little reuse of models or data; applications tend to be stand-alone "silos" and interfaces or data bases are developed without taking advantage of the outputs of other Public Transport business areas, i.e. without any consideration of other layers of information. For example, the data models used for network topology description are relevant for many applications but are often separately defined in each subsystem. This may generate inconsistencies when an integration of different systems is attempted.

For these reasons an approach consisting in the development of a series of *coherent standards* has been adopted for *data standards for Public Transport*.

Overview of standardization for passenger mobility

The Figure 2 provides a global overview of available international norms as collected by the 7th Framework Programme project OPTICITIES [9]. The figure is interesting for passenger mobility. For obvious readability reasons, this overview doesn't include national standards, neither de-facto standards.

One of the key points of OPTICITIES was, once collected all the different types of mobility related datasets, to provide services making a combined use of several of them. The datasets usually focus on a specific data category (or on a few categories) of data, and standards usually do so. Therefore, it is important to have a sufficiently precise knowledge of the main mobility related data categories: the following figure provides a synthetic overview of these categories.

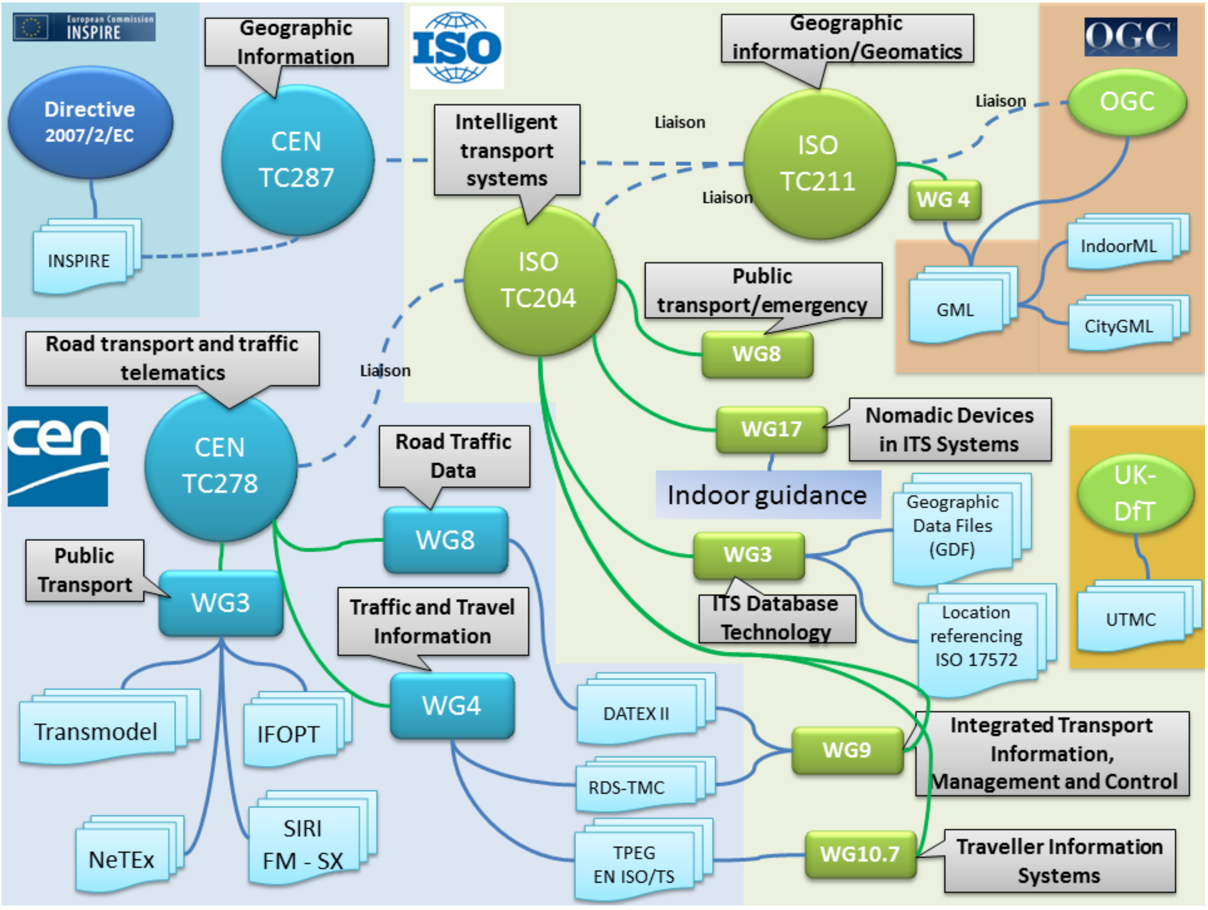

Figure 2. Overview of available standards

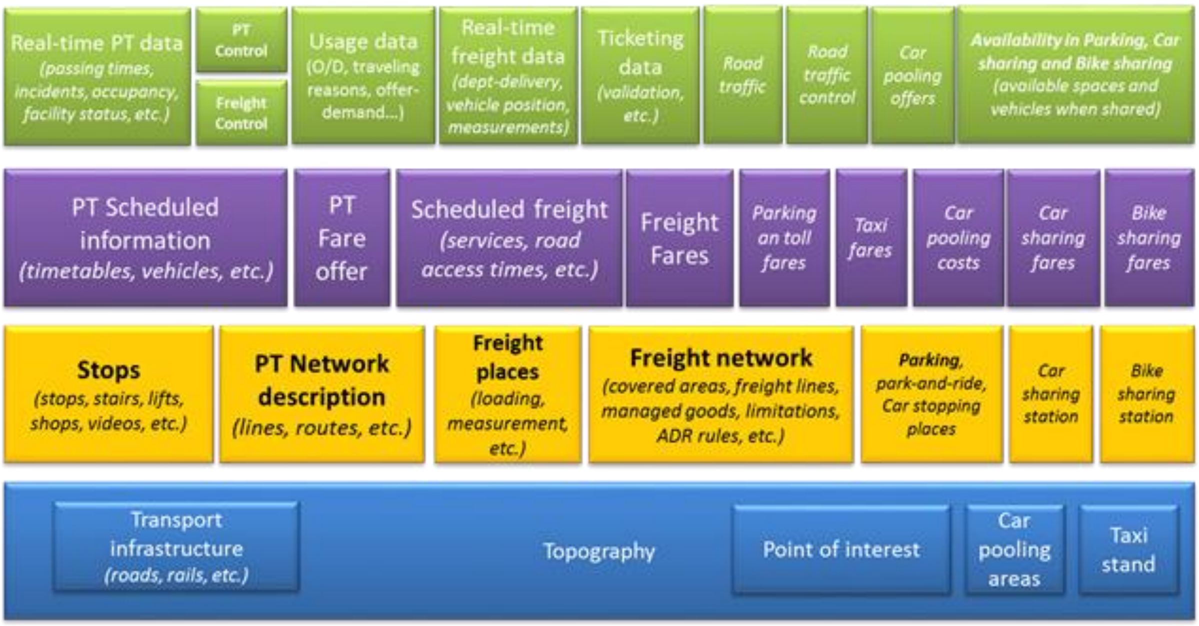

Figure 3. General overview of mobility related data categories

Transmodel family of standards

Transmodel [10] is a result of a range of European projects over several years which provided input for CEN TC278 WG3 (Public transport). A European-wide process is of course complex, but national developments are themselves characterised by several shortcomings: they do not take into account requirements other than for existing locally used features and furthermore are not designed for cross-border applications, for example often not allowing for unique identification of stops. As a consequence, a duplication of data often occurs, in particular for networks located near a border.

Transmodel-based implementations have taken place in the past and are under way in several European countries (for example France, UK, Sweden, Italy, Germany, etc.) but also in a range of countries outside Europe (implementation of SIRI in Israel, Australia and USA).

Transmodel aim and contents

The functional coverage of Transmodel is much broader than passenger information as shown in the figure below (Figure 4).

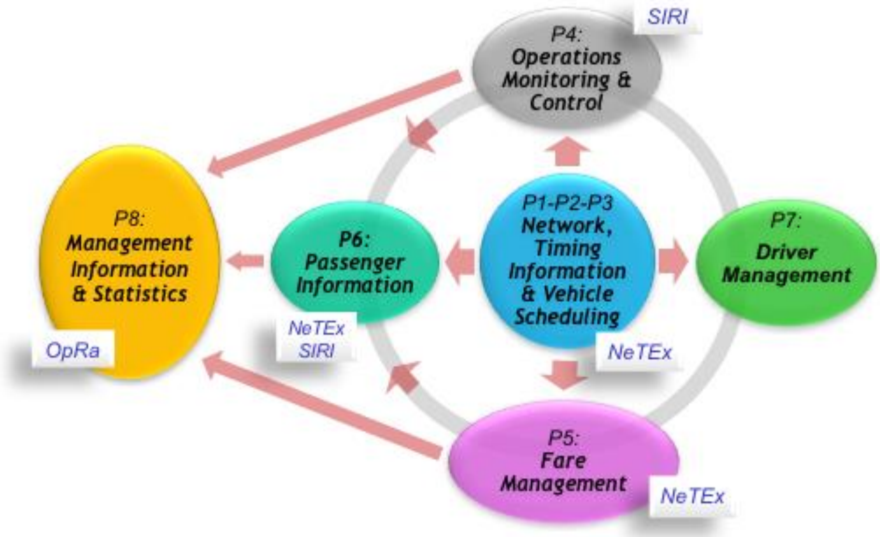

Figure 4. Transmodel business areas

It should be stressed that Transmodel does not standardise the functional architecture of a Public transport system: the simplification of "information architecture" was the primary aim of a range of European projects that elaborated Transmodel, a standard Reference Data Model for Public Transport.

An "information architecture" refers to the overall structure of information used by an information system. Transmodel expresses the semantics of main Public Transport functional domains in terms of *data structures*.

Data concepts, their main characteristics and relationships represent the static view of the different domains and are represented as a conceptual data model using the UML methodology.

Transmodel has been adopted as a European norm (EN12896) already in 2006.

Since that time technologies have evolved, new types of fare products are available, trip planning applications are enhanced and integrate not only urban transport, but also long distance trips. The new version of Transmodel (Version 6) considers such new requirements, modularizes Transmodel to facilitate its usage and understanding and preserves the coherence between the conceptual model and the XML implementations, such as NeTEx, part of the European Directive (Priority Action A).

A model-driven design and modularity

The approach chosen by the group of experts who have developed on one hand the Reference Data Model for Public Transport (Transmodel) and on the other hand its implementation as an XML schema (NeTEx) consists in 3 steps: starting from a conceptual model (Transmodel), a physical UML Unified Modelling Language) model is developed and then an implementation using XML (Extended Markup Language).

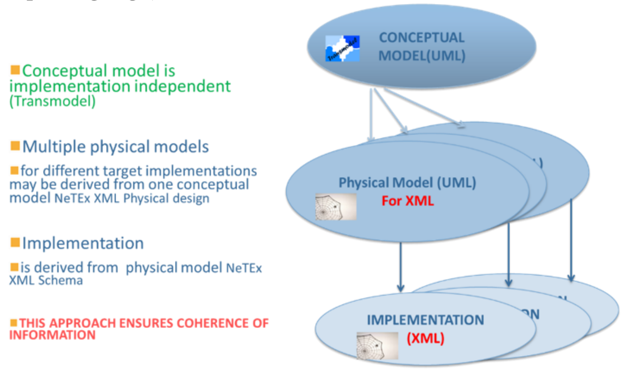

Figure 5. Model-driven design

This approach has the advantage of providing a modular approach as well: each data concept is uniquely defined and thus, the system may be enlarged progressively without the danger of data duplication. An additional application, if based on the same reference data model, will be integrated into an existing system without re-definition of data. The model driven approach is also useful for systems using concepts that differ from the reference: a mapping of concepts to the reference eases the development of data converters.

Implementations examples across Europe

Usage of PT standards in Italy: Regional Service Centre (CSR) for an integrated Electronic Ticketing System

The CSR has been designed as the unique Piedmont Region central mobility informative and governance system aimed at providing Infomobility services, interoperability and at monitoring and controlling regional mobility. CSR considered all the relations among several involved stakeholders like Local Public Administrations, PTOs and final users.

BIP (spell out BIP) project [1], developed by 5T, has represented an innovative integrated ticketing system for public transport, railways and virtually all other transport systems. BIP can even be integrated with cultural services. The project is involving over 100 transport operators, nearly 3,400 vehicles, more than 8,600 stopping points, nearly 400 train stations with a total investment of 50 million euro.

To be compliant with the project, the Public Transport (hence called PT) companies should design and implement an electronic contactless ticketing system based on Calypso technology, an Automatic Vehicle Monitoring system (AVM) enabling real-time and off-line monitoring of executed service and a video-surveillance system for passengers' safety.

Other (non-PT) services, on the other hand, only require being compliant with the exchange protocol and with the unified smart card, that can host all service contracts and can act as an electronic purse (with pre-paid credit) to access services without contract subscription.

Obviously, a system with this high level of complexity required a central system able to exchange data from and to these service operators (aggregated in consortia named CCA with a dedicated system to store and analyse all this data) and, perhaps, to act as an independent judge to solve every issue between different operators (clearing referee). Aiming at this, the Piedmont Region local authority created a Regional Service Centre (called "CSR-BIP"): 5T as an in-house public authority company was chosen for these duties and will act as CSR-BIP on behalf of Piedmont Region. It is composed of 3 main "pillars":

- Local Public Transport (TPL) that stores all planned transport service data;
- Electronic Ticketing System (SBE) devoted to a fare system and to solve possible clearing disagreements among various operators; it also manages data security;
- Business intelligence (BI) that is devoted to reporting and Public Administration analysis functions.

To communicate and exchange data with PT operators and Public Administration, CSR–BIP has developed an abstract data model aimed at heterogeneous data migration called BIPEx. It has been inspired to 3 main standard models:

- Transmodel (CEN TC278 ENV12896) [4]: common conceptual model for describing Public Transport data and systems;
- NeTEx (CEN TC278 TS 16614) [5] (currently in development): an efficient European wide standard for exchanging Public Transport schedules and related data;
- SIRI (CEN TC278 TS 15531 - Service Interface for Real-time Information) [6]: an XML protocol model created to allow real-time information exchange on Public Transport and based on Transmodel.

BIPEx protocol summarizes and completes the above standards tailoring them to project architecture and to Italian reality. It is XML based and is divided in 3 main parts:

- Planned service (TPL): to exchange planned service of PT agency (with dedicated structures for service network and timetables) derived from NeTEx protocol;
- Electronic Ticketing System (SBE): related to PT usage data; this part was developed by merging the selected parts of NeTEx and Transmodel;
- Real-time information: real-time positions of vehicles related to their current service state and are used both for info-mobility service and for vehicle monitoring; this part was derived from protocol model SIRI.

The protocol has a framed structure where each one of the above parts is contained in a specific frame interconnected to the others with referenced indexes.

The 5 main frames of BIPEx TPL and SBE parts are:

- ServiceCalendarFrame contains the validity period for the entities as groups of specific valid days;
- ResourceFrame contains the static information of all the project for what concerns organizations and CCA, vehicle types and service contracts;
- ServiceFrame is devoted to service network descriptions (stopping points, service links, journey patterns and service lines);
- TimetableFrame contains timetables for all public transport lines;
- FareFrame contains all fare products in Piedmont Region, each one with its own prices and usage parameters; it also contains validation data.

The same framed structure is used for Real-Time information part of the BIPEx protocol:

- VehicleMonitoringDelivery: GPS tracing and stopping point arrival times of every PT vehicle (used for travel planning and informative services);
- StopMonitoringDelivery: stopping point arrival times of PT vehicles (used only for informative services);
- ControlActionDelivery: documentary evidence of every unexpected change to the planned service due to incidents, traffic jam, vehicle breakdown and so on; this information is used for Business Intelligence.

BIPEx can be used in different ways depending on different actors that exchange data:

- data are required for service monitoring, final accounting, clearing and informative services;
- contracts and fare frames are required for transport interoperability and final accounting services.

Conclusions

The existence of a coherent series of standards based on Transmodel contributes not only to system interoperability but, through a standardised terminology, provides the Public Transport actors with a common language and thus contributes to build pan-European ITS community.

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