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## Interoperability Framework and Governance enabling Mobility as a Service

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### Abstract

The Interoperability Framework (IF) designed and developed in the IT2RAIL project and promoted in the GoF4R project (both funded under the EU Shift2Rail programme) reduces and potentially eliminates the need for centrally directed and coordinated adoption of centralized platforms or single standards. The Interoperability Framework creates an explicit, formal, shareable, machine-readable and computable description of Data and Services in order to allow a higher degree of automation of distributed processes across multiple data formats and unspecified actors. The novelty of the Interoperability Framework is that it links data/services *across* the web, providing applications with a ‘web of transport data’ abstraction of distributed resources: no *centralized* architecture and platforms are requested. This makes the IF a real enabler for the European-wide adoption of the Mobility as a Service (MaaS) paradigm.

### Keywords:

Interoperability, MaaS, Web of Transportation Data

### Introduction

The value (demand) of mobility products increases with their ability to complement other compatible products the Customer can combine to solve ‘life experience’ problems [1]. Customer-centric means the ability of the transport/travel system (including walking) to supply mobility as a network product, i.e. a product participating in a network of other complementary, compatible services that can be integrated to solve a problem. Customer-centric products, scope of Mobility as a Service, can only be provided if the interoperability issue is solved.

In this view, the IT2Rail (<http://www.it2rail.eu/>) and GoF4R (<http://www.gof4r.eu/>) projects recognize interoperability not only as a demanding engineering ICT challenge but also as a fundamental requirement for the realization of an extension of the Citizens environment (for work, school, business, shopping, leisure etc.), supplied by a Network Industry of specialized mobility services providers.

Interoperability refers to the ability of devices or systems to participate in the coordinated performance of tasks and functions in the execution of some business process, in which *exchanging data is a simple means*, but not the purpose of interoperability itself. In fact, interoperability is predicated on the partners involved in the exchange of the data agreeing on the computational model that is

applicable to such data and in processing them accordingly, i.e. according to some shared logical interpretation of what the data mean and what can be meaningfully be done with them.

### *The semantic heterogeneity problem*

In current database systems most of the data semantics reside in the applications rather than in the DBMS. Moreover, data semantics are often not represented directly in the application code, but rather in the assumptions which the application--or, more correctly, the programmer—makes about the data. This situation is tolerated in local database environments largely because the local applications work with a shared set of assumptions. However, serious problems are likely to occur during a database integration - or federation - effort because sets of local assumptions clash and local applications do not have access to the semantics represented in the "foreign" applications. This is the semantic heterogeneity problem. When semantic information that is hidden in applications is made explicit and accessible through the data base then the semantic problem becomes a much more tractable syntactic problem [1].

However, sharing and *understanding* assumptions is *costly*: you need to have and exercise power of control over the “programmers” with three consequences:

- Scope of control is reduced resulting in a limited adoption
- Extending the scope of control increases non-technical *costs* more rapidly than sharing and understanding resulting in limited and longer time to adoption
- Vendors do not know or understand your assumptions, they don't have an incentive to develop the tools, which you need to build yourself, resulting again in limited adoption.

### **Interoperability Framework**

The challenge is to establish a framework which will enable the business applications belonging to a critical mass of European travel and transport industry players to ‘interoperate’ so as to provide the customer with: comprehensive information on available transport options and the corresponding processes for their booking, payment, ticketing, consumption, modification, and, more exclusively for the business partners (e.g. transport/travel service providers, distributors, retailers), their financial settlement.

The IT2Rail project [2] has adopted the *‘meta standard approach’* from the beginning, based upon a logical cost-benefit analysis: a meta-standard approach allowed current and ongoing investments in existing and emerging standards to be protected, and promised a near-zero cost dialogue capability with any other member of an eco-system using the same ‘meta-standard’. Indeed, the membership of such an eco-system could be derived from its Service Registry in which current members publish and *annotate* their services with terms belonging to the meta-standard **‘ontology’**, thus affording some automated translation between different standards tackling the same or similar business process.



These technologies, if widely adopted, will be able to:

- lower the cost of accessing data
- connect multi-modal providers and the services sectors;
- overcome the fragmentation of multiple data formats and communication protocols;
- maximise growth potential for the development of new products and services and reduce the cost and time-to-market for the ICT integration.

Good governance, through GoF4R project, will define the processes and environment to best promote the use of the IF components and secure the confidence for service providers to deploy them.

### **Ticketing: disruptive concept**

At the heart of multimodal transportation, ticketing systems are one of the major enablers. Such systems are often, if not always, tailored to yield the best possible transportation solution to the traveller. In order to do so, they integrate various specificities (geographical, business, political, technical, etc.) that create high value services for the end-user.

Some ticketing systems, in particular in urban transportation or even interurban transportation, are not based on the traveller identity being linked to a resource (a seat, a vehicle etc.). In such systems, access control and fare product consumption are much elaborated and often require a specific technical infrastructure with fare media (e.g. contactless smart card, magnetic ticket), security infrastructure, access systems.

Lots of efforts are currently being put to achieve interoperability between such systems at regional scale and national scale. However, the considered interoperability relies mainly on the said existing technical infrastructure. It aims at solving fare media fragmentation (i.e. having numerous contactless smart cards) by unifying the fare media into a single one. It also aims at creating interoperable fare products by defining products that every actor of the eco-system has to support and implement.

Such interoperability is very interesting for the traveller but presents some major drawbacks. First, the larger the eco-system, the harder it gets for all stakeholders to cooperate in a competitive environment (and create interoperable products). If the considered scale is Europe-wide, it is clearly an issue. Second, it is a rather costly approach as legacy systems have to be adapted to handle the common fare media and fare products. This can be a blocking point for small public transport operators.

IT2Rail has chosen to take **a complementary approach to ticketing interoperability**. This approach is inspired by the air industry and the rail mainlines, where ticketing interoperability is independent from such technical infrastructure constraints and thus implemented in a different way. ***This approach is contractual***: it aims at formalizing the relationship between the transportation eco-system and the traveler by defining business processes with open specifications and interfaces and defining business artefacts shared between systems. In detail, the “ticket” is transformed into a set of three elements: The ***Entitlement*** – *the full customer travel contract* - , the ***Token*** – *the travel rights for a given travel (or several ones) expressed in a machine readable format* - and the ***Embodiment*** – *the physical support of*

*the token (from the paper ticket to the RFID or NFC smartphone) understandable by the relevant validation device.*

## **Governance**

The establishment of good governance will effectively secure the confidence of the industry to use the Interoperability Framework (IF) semantic technologies. The objective of the Governance of the IF for Rail and Intermodal Mobility (GoF4R) project is to define sustainable governance for the IF that will create the right conditions to introduce seamless mobility services and foster the development of multi-modal travel services, in line with EU strategies and policy<sup>1</sup>.

GoF4R will help overcome obstacles currently impeding development of market innovation by fostering a large acceptance of the “semantic web for transportation.”

The objectives will be achieved through a partnership of specialist participants including research institutions, a major European rail operator, and industry associations representing the passenger and multi-modal transport sectors and public transportation authorities. Participants, who are also involved in the consortium of designers for the IF, will focus on the establishment of sustainable governance that will promote community confidence. ***The governance structure will create the basis for long term stability and controlled future evolution of the IF***, promoting industry confidence so that it is attractive to invest in future products and services.

The project encompasses current and future stakeholders who will exploit the IF as described in the Shift2Rail Multi-Annual Action Plan<sup>2</sup>, contributing to the realization of a distributed semantic “web of transport” integrating the TAP-TSI<sup>3</sup> specifications (of the European interoperable rail system) as one of its elements.

The governance models proposed in GoF4R will assure the interests of European travellers by fostering market uptake by mobility service providers. It will facilitate new business opportunities for improved mobility and travel related services and improve the incorporation of new stakeholders in the European arena by removing technological, administrative and economic boundaries.

## **Enabling Mobility as a Service**

Following recent mega-trends in the mobile and sharing economy, and thanks to the latest ITS developments, Mobility as a Service (MaaS) schemes are seen as the way citizens will use to move themselves in the future. MaaS wave will allow breaking the borders between the different means of transport, offering customers combined mobility packages as a viable alternative to car ownership.

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<sup>1</sup> [https://ec.europa.eu/transport/themes/strategies/2011\\_white\\_paper\\_en](https://ec.europa.eu/transport/themes/strategies/2011_white_paper_en)

<sup>2</sup> <http://www.shift2rail.org/wp-content/uploads/2016/01/Presentation-of-the-Shift2Rail-Multi-Annual-Action-Plan.pdf>

<sup>3</sup> <http://tap-tsi.uic.org/>

Indeed, a MaaS is a mobility distribution model in which customer's major transportation needs are met thanks to one single integrated service provider combining transportation infrastructures, travel information, payment services and more.

While there are many local initiatives (e.g. Gothenburg, Hannover, Stuttgart) smelling like MaaS, a real enabler for MaaS systems interoperability and roaming is still missing. On this regard, new technologies can play a crucial role for a large scale and stable business operation of MaaS at global level.

Interoperability Framework (IF) and Travel Companion are technologies developed within Shift2Rail IP4 to meet the engineering challenges associated with leveraging current actions on establishing open-data policies (to reduce data access costs), and data exchange standardisation (to reduce data exchange costs). The IF aims at *automating* the description and sharing of the exchanged data models, thus allowing for:

- a) the *automated* data format conversion across heterogeneous standards and systems.
- b) a *meaningful* data interpretation and processing by diverse transport ICT systems, and

Following the latest MaaS experiences in Europe, these technologies can meet the needs of MaaS stakeholders: mobility and transport service providers, MaaS providers, end-users. Through the IF technology, the portion of the total costs of compatibility of mobility services, which can be attributed to the ICT interoperability, is reduced significantly, producing important effects in the structure and dynamics of the market for customer-centric mobility, particularly for MaaS:

1. **End-Users** benefit from the positive externalities, i.e. higher value, resulting from mobility services that are truly complementary and compatible not only between themselves, but with all other services individuals or businesses integrated in the digital environment in which they live, work and operate;
2. **Mobility and transport service providers** benefit both from the reduced costs of provision of the services, and from the expanded value of the demand that the additional supply of compatible and complementary services generates;
3. **MaaS providers** benefit from the decrease of the integration cost due to non-interoperable ICT systems, therefore facilitating the incorporation to the market of the new players and new products.

Conventional approaches to the interoperability of mobility services have concentrated on providing technical solutions for syntactical 'data/service format' aspects of the problem, and on compensating the limitations of these solutions with heavy centralised and costly organisational structures and actions. This has limited both the scope of the solutions and their adoption, creating economic barriers both to collaboration of established actors and to the entrance of new ones in the market of advanced mobility services. As an integral part of Shift2Rail IP4 the IF provides a significant technological innovation in the scope and range of interoperability problems that can be made amenable to computer

automation, and GoF4R will provide a governance and management structure specifically designed to match both the features of the technology and those of the market, fostering its uptake and sustainability. A widely-adopted IF will decrease the costs of ICT systems interoperability and therefore the costs of mobility services compatibility, thus promoting the appearance of new services and service delivery models that can enrich the customer experience on an individual basis, including on cultural and ethnical preferences.

To support the uptake of the Interoperability Framework technology and overcome the technical and non-technical barrier for the adoption of new integrated mobility platforms, the ultimate goal of GoF4R is to contribute to the path exposed in the White Paper (2011)<sup>7</sup> in line with the S2R Multi-Annual Action Plan. In particular, it will provide a governance and management structure for the IF explicitly designed to allow market forces to drive the future of European transportation by:

- Removing existing barriers to fully interoperable networks to achieve a *Single European Transport Area (SERA)*, easing the process of integration [2];
- Supporting innovation as a crucial ingredient of the SERA;
- Allowing access to key information for the customer – supporting a major shift to rail – and allowing a significant growth in demand.

The main benefits of the IF components that will encourage market uptake and enable an EU-wide MaaS adoption are:

- Enabling a complete transformation of the European transport system into a **global services and data market place**;
- Freeing stakeholders from **technological barriers**, so new actors and business models will be able to emerge and prosper for the benefit of European travellers;
- Promoting the development of a large, competitive market of independent and autonomous suppliers of **business services**, applications, devices and systems to the travel and transport industry by dramatically reducing the overhead, business and financial costs associated with making such services and applications interoperable;
- Promoting the development of a large, competitive market of independent and autonomous suppliers of **interoperability products and services** to developers of travel and transportation devices, applications and systems, thus submitting the cost of interoperability to downwards market pressure.

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